REVIEW REPORT of MSE Plus Wall System
March 2021; Revised October 2021
HIGHWAY INNOVATIONS, DEVELOPMENTS, ENHANCEMENTS AND ADVANCEMENTS (IDEA)

The MSE Plus Wall System has been evaluated in accordance with the IDEA protocol. Key information regarding this system re-evaluation is presented in this final review report. Comprehensive and important details of the system's components, design, construction and quality control measures are presented in the MSE Plus Wall Submittal.

Applicant Information

SSL, LLC
4740 Scotts Valley Drive
Suite E
Scotts Valley, CA 95066

Review Summary

This re-evaluation IDEA report of the MSE Plus system exclusively focuses on the updated structural connection between the facing panels and the inextensible steel reinforcement. The system was previously evaluated by the Highway Innovative Technology Evaluation Center (HITEC), and findings and conclusions are noted in the 1999 HITEC report which is included as part of the MSE Plus submittal. A review of the HITEC evaluation and a re-examination of the overall system are not part of this IDEA re-evaluation.

During the IDEA review process of the MSE Plus system the review team requested two resubmissions of the submittal, to provide more specific ties between the checklist responses and the independent connection test report (2003) and current AASHTO Bridge Design Specification requirements. The current version of the submittal reflects the revised content and all comments have been satisfactorily resolved. **The applicant has been thorough in its responses and there are no outstanding issues that should be brought to the attention of the transportation agencies. Rather, the agencies are encouraged to rely upon the final MSE Plus Wall System submittal for projects where this system is proposed.**

Submittal Checklist

The checklist used from the IDEA protocol for this re-evaluation is D3 – Technical Re-evaluation Checklist for Precast Concrete Panel with Inextensible Reinforcement. This is the first updated system with a precast (wet cast) concrete panel paired with inextensible metallic reinforcements evaluated by IDEA.

Confidential Information

The applicant has the option to omit information from the version of its submittal that is attached to this final report if it believes that such information is confidential. In such instances, the applicant will notify the IDEA review team. However, for MSE Plus wall system, no information has been designated by the applicant as confidential.

System Innovations
SSL does not claim any innovations for the MSE Plus Wall system as part of the IDEA evaluation.

System Description
The components for the MSE Plus Wall system consist of wet precast concrete facing units and inextensible steel mesh soil reinforcements. The facing unit connection which is the focus of this IDEA re-evaluation is a structural mechanical connection consisting of loop embeds cast in the facing and a tie bar detail (pin connection) which engages the mesh reinforcement layers which are field assembled. There are additional components used with the system including, compacted select backfill, coping and barriers, geotextile and drainage systems.

System History and Pertinent Connection Reference Information
The system was originally developed in 1997 using the Allowable Stress design platform. Other than the face panel connection the design methodology remains unchanged since that time. The introduction of the revised connection detail (subject of this re-evaluation) and transition to the current AASHTO LRFD design platform are the only substantive system changes.

The MSE Plus Wall system evaluation report was originally issued by HITEC in August 1999. The original connection evaluated by HITEC was internal to the panel. The current connection, subject to the IDEA evaluation has been tested by SSL in October 2003 and December 2012.

In 2003, the face panel to soil reinforcing connection was revised to a conventional structural connection using metallic steel cast into the facing panel by joining the soil reinforcement steel mesh to the panel via embedded loops in the facing and a pin connector. Refer to Section 1.2.5 of the submittal for details and Section 1.2.10 for a drawing of the connection.

In 2012, additional testing of the connection was performed to be in accordance with the AASHTO LRFD design platform. Connection testing was performed by SSL in December 2012 and was witnessed by an independent testing firm. The six connection pullout tests showed that the connection capacity met or exceeded the current AASHTO requirements.

The MSE Plus connection includes a pair of loops embedded in the concrete to resist the load for each wire as shown in the submittal drawing. The pullout capacity of the loop embeds is enhanced by the transverse W4.5 cross wires welded to six pairs of loops.

Section 1.1.6 of the submittal provides panel details for MSE Plus standard 5' x 6' x 6" panels, Type A, X and Y. The submittal notes that the panel reinforcement details will vary by local owner requirements. Face panel design calculations are provided in Appendix B and are considered satisfactory.

Section 1.2.7 and 1.2.8 provide the corrosion protection details and design for the connection components for a 75- and 100-year service life and are in accordance with AASHTO.

Section 1.2.11 provides a detailed and comprehensive report of the connection test program conducted in 2012. SSL's system currently uses W11, W20 and W24 welded wire mesh as soil reinforcement. The test results indicate the connection meets minimum strength requirements at tolerable serviceability deformations.

Section 1.3.1 addresses the MSE Plus HITEC report and is included as Appendix A of the submittal.

The system's quality control measures also changed in 2012 due to system refinements. The current MSE Plus Wall system QC manual, dated October 2013, is included as part of the submittal (Section 4.1). That report is comprehensive and meets the minimum standard of care.

Since 2003, in excess of 10 million square feet of the MSE Plus Wall system, using the current connection system, have been constructed. Section 5.1 provides a current list of projects which used the revised connection system. Section 5.1.4 provides a list of private- and public sector users who have approved the use of the system. Also provided is contact information for a person at the user agency who may be contacted regarding the wall system's performance. The following provides several notable details of MSE Plus retaining walls completed using the new connection.

- Three of the oldest structures are in California. They are the SR22 Project in Orange County, SR 101 Ralston in San Mateo County and Route 116 / 101 in San Ramon.
- Two of the tallest structures are also in California. The tallest structure was on SR 91 for a widening project in Corona California. Wall 115C was 52 feet tall and wall 115B had a similar height. The third tallest structure was a project for the Nevada Department of Transportation for the I- 580 Realignment Project constructed south of Reno, Nevada. One of the MSE walls on this project was 65.0 feet tall (Submittal section 5.1.3).

Retaining Wall Design

The revised connection system does not alter the design methods used since system inception and in particular, the center to center spacing of soil reinforcement mesh wires remain 8 inches. The design details shown beginning on page 171 of the HITEC report in Appendix A still apply. Input design parameters for the MSEW (3), distributed by ADAMA Engineering, computer program, are summarized in Attachment A of this report and provided in Section 1.2.13 of the Submittal.

System Innovations

This IDEA re-evaluation acknowledges and agrees with SSL, LLC that the MSE Plus Wall system does not provide any innovations.

References

American Association of State Highway and Transportation Officials, AASHTO LRFD Bridge Design Specifications, (9^{th} Edition, 2020).

FHWA-NHI-10-024 "Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes". (FHWA GEC-011), 2010

Attachment A – Summary of MSEW Input Parameters for MSE Plus System

Inextensible Soil Reinforcement:

Data\Type		3W11 x 0.5W11	4W11 x 1.0W11	5W11 x 1.5W11	6W11 x 2.0W11	4W20 x 2.5W11	5W20 x 3.0W11	6W20 x 3.0W11	6W24 x 3.0W11	7W24 x 3.0W11	8W24 x 3.0W11
$T_{long\text{-}term}$ (lb) (F_y*A_c) (75 years)		17,925	23,903	29,873	35,850	47,475	59,348	71,213	87,315	101,865	116,423
$T_{long\text{-}term}$ (lb) (F_y*A_c) (100 years)		15,368	20,490	25,605	30,728	42,608	53,265	63,915	79,215	92,415	105,615
Coverage Ratio (R_c)		0.27	0.40	0.53	0.67	0.40	0.53	0.67	0.67	0.80	0.93
Reinforcement width (b, in)		16	24	32	40	24	32	40	40	48	56
$T_{long\text{-}term\ per\ unit\ length\ of\ wall}$ (lb/ft) [(F_y*A_c)*R_c/b] (75 years)		3,585	4,781	5,975	7,170	9,495	11,870	14,243	17,463	20,373	23,285
$T_{long\text{-}termper\ unit\ length\ of\ wall}$ (lb/ft) [(F_y*A_c)*R_c/b] (100 years)		3,074	4,098	5,121	6,146	8,522	10,653	12,783	15,843	18,483	21,123
Pullout resistance factor, F*	Top of Wall	1.06	0.53	0.35	0.27	0.21	0.18	0.18	0.18	0.18	0.18
	Depth of 20 ft below top of wall	0.53	0.27	0.18	0.13	0.11	0.09	0.09	0.09	0.09	0.09
Friction Angle along reinforcement-soil interface ρ	Top of Wall	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Depth of 20 ft below top of wall	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scale-effect correction factor, α		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection Strengths:	σ[a] (lb/ft²)	$CRcr^b$ = F_{yc}/F_y									
		3W11 x 0.5W11	4W11 x 1.0W11	5W11 x 1.5W11	6W11 x 2.0W11	4W20 x 2.5W11	5W20 x 3.0W11	6W20 x 3.0W11	6W24 x 3.0W11	7W24 x 3.0W11	8W24 x 3.0W11
		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

F_y = Yield strength of reinforcement

F_{yc} = Yield strength of connection between reinforcement and precast panel

A_c = Area of reinforcement at the design service life (i.e., 75 or 100 years)

[a] Normal pressure (lb/ft²); [b] MSEW program term

Executive Summary

This re-evaluation was performed on the MSE Plus^{TM} Wall system, a mechanically stabilized earth (MSE) structure, based upon data submitted by the developer, designer, and supplier, SSL, LLC. The MSE Plus^{TM} system evaluation report was originally issued for this system by HITEC in August 1999.

In 2003 the panel to soil reinforcing connection, for this inextensible system, was revised from an internal connection to a more conventional connection using a metallic steel embed cast into the facing panel by joining the soil reinforcement to the panel embed using a pin connector. Connection testing for this revised system was first performed in 2003 by SSL and witnessed by Caltrans at their headquarters facility in Sacramento California.

In 2012 Caltrans required that MSE wall systems be re-evaluated for their LRFD approval. A key component and requirement to obtain a LRFD system approval was to perform a new connection test. For 2003, the testing criteria was different in that the connection capacity requirement was based on that the tensile force resisting capacity was to be at least 2.0 times, $T_{allowable}$ the design allowable tensile force, of the connected soil reinforcement. For 2012 that requirement changed to the connection must exceed the yield strength of the largest soil reinforcement type to be used for the connection. For SSL our maximum wires size is W24.

Connection testing was performed by SSL on December 6, 2012 and was witnessed by Caltrans and Twining Inc. The 6 pull tests show that connection capacity exceeded the Caltrans testing requirement by 103% to 114%.

For design, the methodology remains the same, other than now internal stability designs are based upon the AASTHO LRFD as opposed to the ASD methodology at the inception of the system in 1997.

Constructing the wall system remains unchanged as a result of the connection change. The system perhaps may be a little easier to construct using an external connection system as access to insert the pin into the embed is simpler.

SSL's quality control measures changed due to the improvements to the system and also due to the Caltrans LRFD requirement all companies' QC manuals require Caltrans approval. Enclosed is SSL's Caltrans QC manual.

With respect to the other components of the MSE Plus^{TM} Wall system there are no other changes other than the connection system in this evaluation. Since the revision of the connection system in 2003, in excess of 10,000,000 square feet of MSE structures have been completed.

Appendix D3
Technical Re-evaluation Checklist for Precast Concrete Panel with Inextensible Reinforcement

Guidelines for the Applicant to use this checklist:

1. Provide your submittal in Adobe portable document format (i.e. PDF).

2. Organize the submittal based on the numbered outline shown in the checklist below. Use the numbered outline as for a table of contents (TOC). Provide the response for each item in your report. Create *links* between the items in the TOC and the items in the report and appendices.

3. If reports, drawings, or calculations are requested for a section, provide them in the appendix tabbed for that section. For example, design calculations are required for Item 2.3.1. They should be included in Appendix 2.3.1.

4. Mark the checklist at each item to indicate "yes" you have included the relevant information. If you must check "no", please provide a brief explanation if appropriate.

Introduction			
Provide a succinct description of the system (i.e., facing, reinforcement, and connection type) that is being submitted for review. Should reference an appended Introduction TAB where the MSE Wall Specification is presented.			
Appendix Present full wall system specification			
Section 1: ERS Components			
Section 1: ERS Components			
1.1	Tab 1.1		Facing Unit
	Yes	No	Item
1.1.1	☐	☑	Does the system contain what you consider to be an innovation that is related to the facing unit? If yes, please describe the innovation briefly. As items below apply to the innovation, please describe the innovation in further detail.
1.1.2	☐	☑	Has the precast facing panel changed since the original evaluation?
1.1.3	☐	☑	If the answer is yes to 1.1.2, provide a description of the changes along with drawings showing the dimensions of the original facing unit and the revised facing unit, including concrete reinforcement and insert locations and dimensions.
1.1.4	☑	☐	Has the connection changed, if yes provide a description of the changes and drawing(s) showing the connection?
1.1.5	☐	☑	Describe any other changes to the facing unit (i.e., 28 day compressive strength, freeze thaw durability, etc.)
1.1.6	☑	☐	If the answer to 1.1.2 or 1.1.4 is yes, provide the structural design of the panel and the connection.
1.1.8	☐	☑	Provide the mix design for the concrete including aggregate size and gradation.
1.2	Tab 1.2		Inextensible Reinforcement

Appendix D3

Technical Re-evaluation Checklist for Precast Concrete Panel with Inextensible Reinforcement

	Yes	No	Item
1.2.1	☐	☑	Does the ERS contain what you consider to be an innovation that is related to the reinforcement? If yes, please describe the innovation briefly. As items below apply to the innovation, please describe the innovation in further detail.
1.2.2	☐	☑	Has the reinforcement changed or been modified since the original evaluation?
1.2.3	☐	☑	If the answer is yes to 1.2.2, provide a description of the changes along with drawings showing the dimensions of the reinforcement and the revised reinforcement.
1.2.4	☐	☑	If the answer is yes to 1.2.2, provide the 75 and 100 year design strength of the reinforcement.
1.2.5	☑	☐	Describe the facing unit-reinforcement connection and any changes with text and drawings.
1.2.6	☑	☐	If the answer to 1.1.2 or 1.1.4 is yes, for each connection device provide physical property specifications. Address ultimate and yield strengths as well as welds if they are applicable.
1.2.7	☑	☐	If the answer to 1.1.2 or 1.1.4 is yes, for each connection device describe corrosion protection measures and provide specifications. If coatings or galvanization are used, provide minimum thickness for 75-year and 100 year design life (based on the electrochemical requirements listed in AASHTO).
1.2.8	☑	☐	If the answer to 1.1.4 is yes, for each connection device provide sacrificial steel thickness for 75 and 100 year design life.
1.2.9	☐	☑	If the answer to 1.1.2 or 1.1.4 is yes, for each connection device provide the results of any corrosion tests that have been performed.
1.2.10	☑	☐	If the answer to 1.1.2 or 1.1.4 is yes, for each connection device provide detail drawings that show dimensional tolerances.
1.2.11	☑	☐	If the answer to 1.1.2 or 1.1.4 is yes, list facing unit reinforcement connection strength tests performed, provide test results and strength envelopes the Applicant recommends for design.
1.2.12	☐	☑	If the answer is yes to 1.2.2, list reinforcement pullout (ASTM D6706) tests performed on the current system components and provide results. Provide test soil properties, corresponding pullout friction factors (F*) and scale effect correction factors (α) Applicant recommends for design. Discuss how test results support these recommendations based on Appendix B at FHWA-NHI-10-025.
1.2.13	☑	☐	Summary table of input parameters used with (e.g., MSEW) computer design program.
1.3	Tab 1.3		Additional Information
	Yes	No	Item
1.3.1	☑	☐	Does the system have a HITEC Evaluation? If so, provide a copy, and summarize what has changed with the system since that evaluation.

1.3.2	☐ ☑ Does the system have an independent evaluation performed by a subject matter expert? If so, provide a copy, and summarize what has changed with the system since that evaluation.

Section 2 Design	
2.	Tab 2.0 Design Methodology
2.1	☑ ☐ If the answer is yes to 1.1.2, or 1.1.4, or 1.2.2, describe how and provide typical plan and section detail drawings of the facing and reinforcement to handle vertical and horizontal obstructions in the reinforced zone.
Section 3 Construction	
3	Tab 3.0 Construction
3.1	☐ ☑ Has construction changed?
3.1.1	☐ ☑ If the answer is yes to 3.1.1, provide construction manual for the wall system and at a minimum include the following items: describe procedures to install earth reinforcement at curved sections of the wall and at corners.
Section 4 Quality Control	
4.0	Tab 4.0 Quality Control
4.1	☑ ☐ If the answer is yes to 1.1.4, describe the quality control measures that are required for the manufacturing of connection devices. You may do this by providing a manufacturing QC manual.
Section 5 Performance	
5.0	Tab 5.0 Performance
5.1.	☑ ☐ If the answer is yes to 1.1.2, or 1.1.4, or 1.2.2, provide a description of the updated system's development and usage history. Then describe the following, for the updated system.
5.1.1	☑ ☐ Provide a description of the updated system's development and usage history. Then describe the following, for the updated system:
5.1.2	☑ ☐ The oldest three structures.
5.1.3	☑ ☐ The tallest three structures.
5.1.4	☑ ☐ Provide a list of private- and public sector users who have approved the use of the system. Also provide the contact information for a person at the user agency who may be contacted regarding the wall system's performance.
Section 6 Other Information	
6.0	Tab 6.0 Other Information
6.1	☐ ☑ In this section, please include anything you think will better help a reviewer understand your updated ERS that has not been adequately addressed in the previous questions.

Section 1 - ERS Components

Section 1.1.4

Item 1.1.4 - Has the connection changed, if yes provide a description of the changes and drawing(s) showing the connection?

Our original connection that was evaluated in the August 1999 by HITEC is a connection system that was internal to the panel. Our current connection that we wish IDEA to evaluate has been tested and witnessed by Caltrans on two different occasions. Once in October 2003 and again for our LRFD Caltrans review in December 2012.

The details of the connection systems are shown in Section 1.2.5 herein.

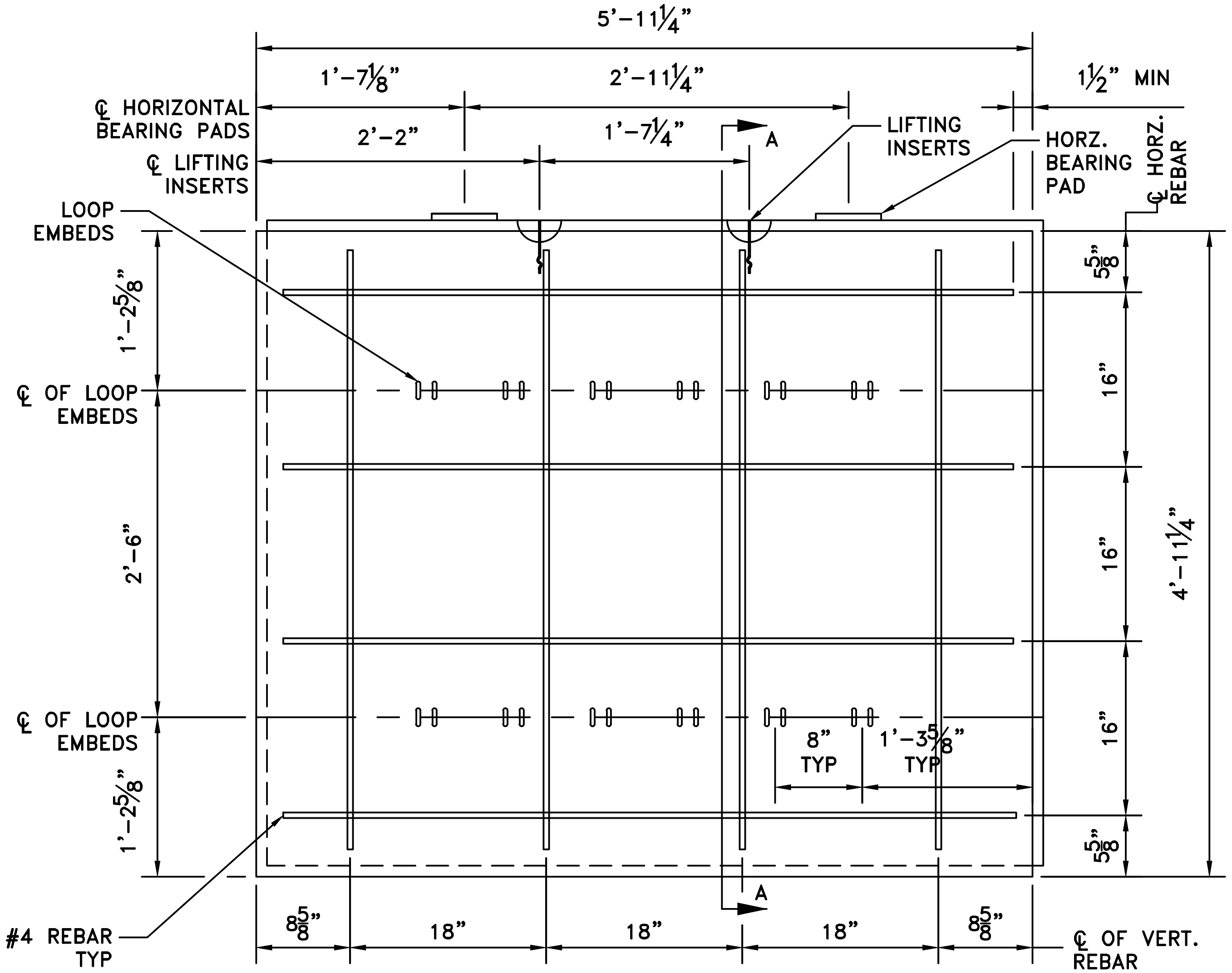
Section 1.1.6

Item 1.1.6 - If the answer to 1.1.2 or 1.1.4 is yes, provide the structural design of the panel and the connection.

The structural design of the panel has not changed with respect to bending and shear capacity since the line wires of the soil reinforcing mesh sheets remains at 8 inches on center. Our standard panel sizes 5' x 5' x 6" and 5' x 6' x 6" remains unchanged, with respect to dimensions.

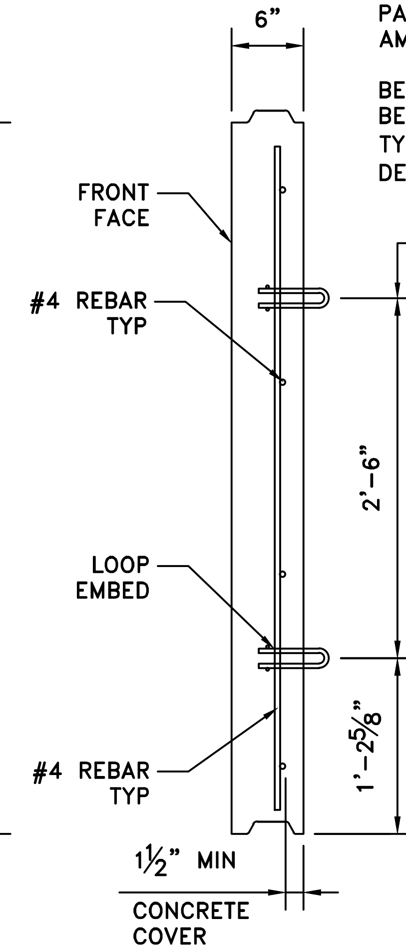
However, since at the time of original HITEC evaluation MSE structures were not evaluated based upon the current standard of AASHTO LRFD and specially with respect to the panel design and now must conform to AASHTO Section 11.10.2.3 Facing.

Attached are our basic panel details for our standard 5' x 6' x 6" panels, Type A, X and Y. Please note that the panel reinforcement details will vary by state as each local agency has their own specific design requirements. Our panels calculations are attached in Appendix B.



TYPICAL PANEL

SHOWN FROM BACK FACE



SECTION A–A

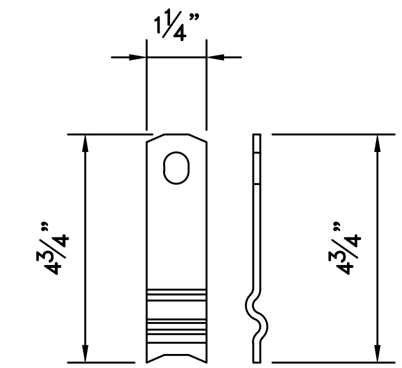
REBAR NOTE:
PANEL TYPES "A" & "Ai" REQUIRE THE SAME AMOUNT OF PANEL REINFORCEMENT.

BEARING PAD NOTE:
BEARING PAD PLACEMENT SHOWN IS FOR TYPICAL "A" PANEL ONLY, SEE STANDARD DETAILS: 5 OF 5 FOR "X" AND "Y" PANELS.

PANEL REINFORCEMENT TABLE

Panel Type	Vertical Bars Num / Size	Horz. Bars Num / Size
A	4 / #4	4 / #4
A2	4 / #4	2 / #4

18" MAX SPACING BETWEEN BARS



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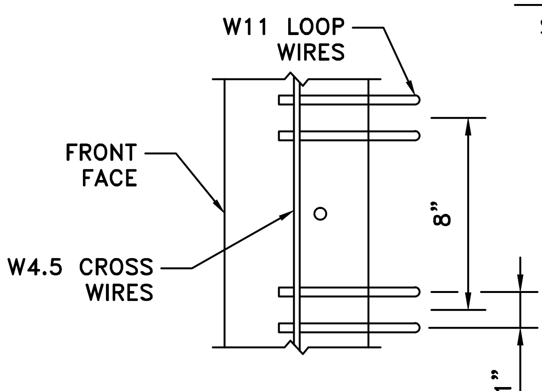
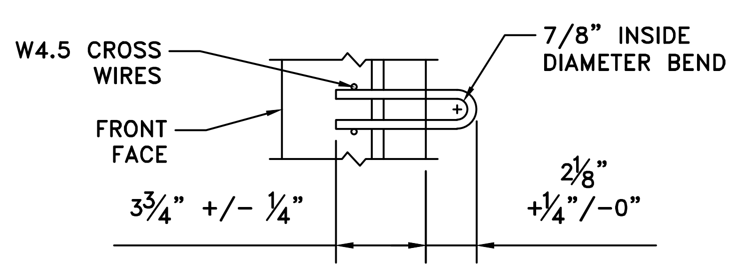
NOTE:
"WAVY–TAIL" STYLE OF INSERT SHOWN. OTHER INSERTS OF EQUAL OR GREATER CAPACITY MAY BE USED IF APPROVED BY SSL.



PLAN VIEW



ELEVATION VIEW

LOOP EMBED DETAILS

PANEL TOLERANCES:

OVERALL DIMENSIONS:

- STANDARD PANEL
  ± ½" VERTICAL
  ± ½" HORIZONTAL
- TOP AND SPECIAL PANELS
  ± 1" VERTICAL
  ± ½" HORIZONTAL

CONNECTION DEVICE LOCATIONS:

- EMBEDS
  ± 1" VERTICAL
  ± 1" HORIZONTAL

PANEL SQUARENESS:

- 90° PANEL CORNERS
  ± 3⁄16" USING 2' SQUARE
  (MEASURE 3 PANEL CORNERS)

PANEL DIAGONAL:

- PANELS WITH 90° CORNERS
  ½" MAX. DIFFERENCE BETWEEN DIAGONALS

SURFACE FINISH:

- FINISH AT FRONT FACE
  ± ⅛" IN 5'

STANDARD TYPE "A" PANEL DETAILS

CERTIFIED ONLY WITH RESPECT TO INTERNAL STABILITY OF REINFORCED EARTH STRUCTURES

SSL
INNOVATIVE CONSTRUCTION PRODUCTS
4740 SCOTTS VALLEY DRIVE, SUITE E
SCOTTS VALLEY, CA 95066
PHONE: (831) 430-9300 FAX: (831) 430-9340

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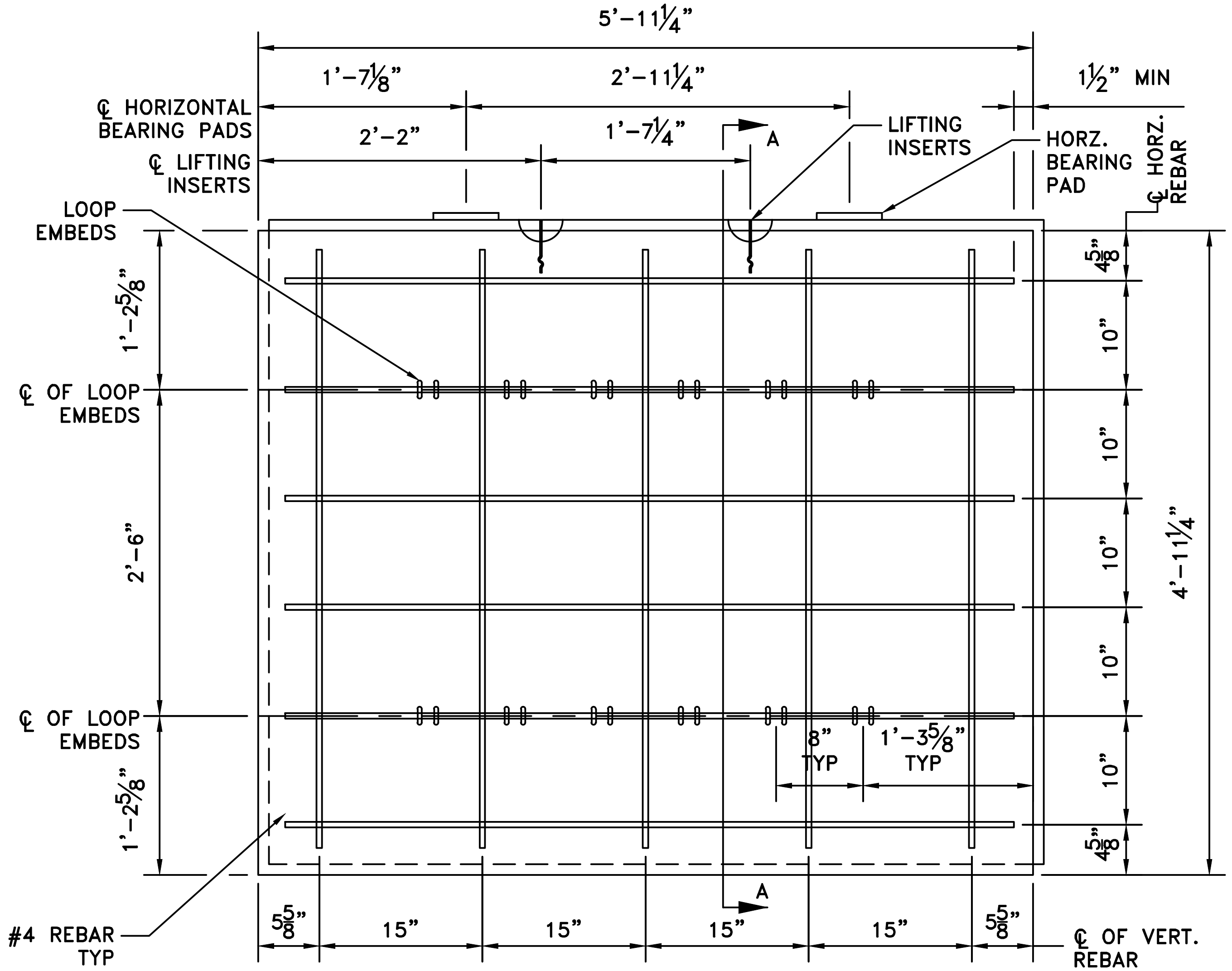
DRAWN BY: WM	03/09/21				
CHECK BY: WM	03/09/21				
DESIGN BY: FSH	03/09/21				
CHECK BY: FSH	03/09/21				
PROJ. ENGR: FSH		NO.	DATE	REVISION DESCRIPTION	BY

STANDARD DETAILS: 1 OF 5

STANDARD MSE WALL DETAILS

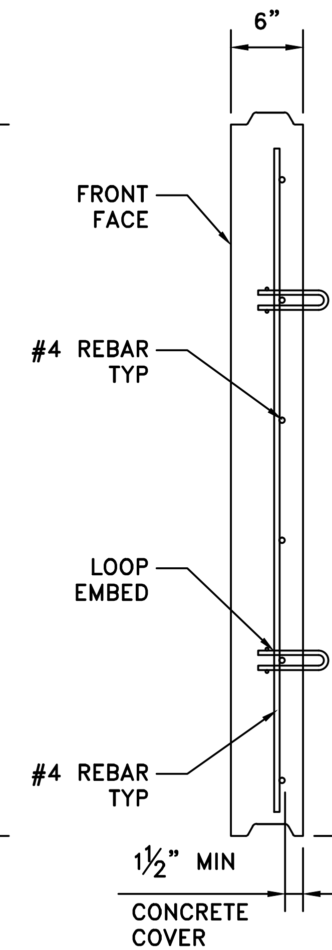
Scale: NTS
Job: --
Sheet: RW-01
Sheet 1 of 5

FRANSISCUS S. HARDIANTO
03/09/21



TYPICAL PANEL

SHOWN FROM BACK FACE



SECTION A–A

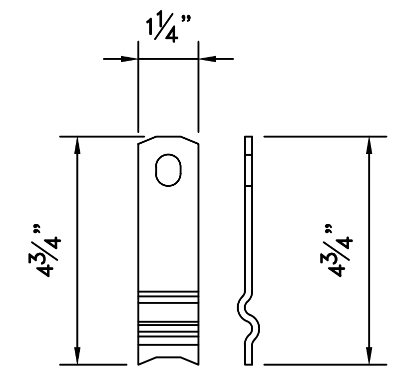
REBAR NOTE:
PANEL TYPES "X" & "XI" REQUIRE THE SAME AMOUNT OF PANEL REINFORCEMENT.

BEARING PAD NOTE:
BEARING PAD PLACEMENT SHOWN IS FOR TYPICAL "A" PANEL ONLY, SEE STANDARD DETAILS: 5 OF 5 FOR "X" AND "Y" PANELS.

PANEL REINFORCEMENT TABLE

Panel Type	Vertical Bars Num / Size	Horz. Bars Num / Size
X	5 / #4	6 / #4
X2	5 / #4	3 / #4

18" MAX SPACING BETWEEN BARS



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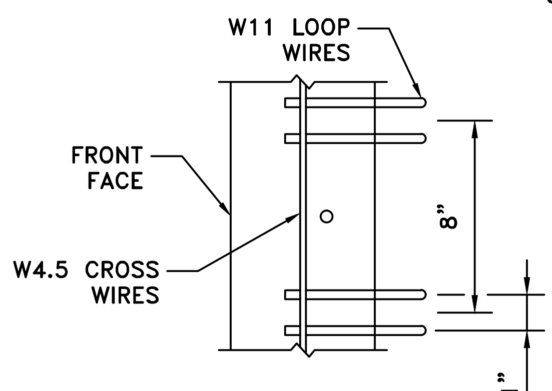
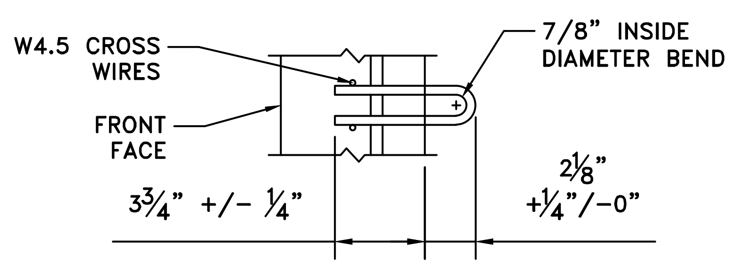


PLAN VIEW



ELEVATION VIEW

LOOP EMBED DETAILS

PANEL TOLERANCES:

OVERALL DIMENSIONS:

- STANDARD PANEL
  ± ½" VERTICAL
  ± ½" HORIZONTAL
- TOP AND SPECIAL PANELS
  ± 1" VERTICAL
  ± ½" HORIZONTAL

CONNECTION DEVICE LOCATIONS:

- EMBEDS
  ± 1" VERTICAL
  ± 1" HORIZONTAL

PANEL SQUARENESS:

- 90° PANEL CORNERS
  ± $\frac{3}{16}$" USING 2' SQUARE
  (MEASURE 3 PANEL CORNERS)

PANEL DIAGONAL:

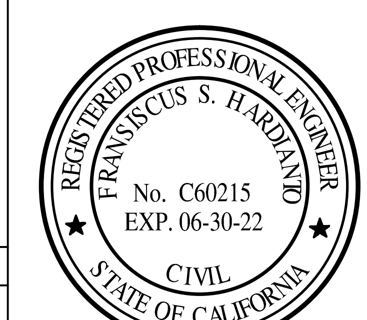
- PANELS WITH 90° CORNERS
  ½" MAX. DIFFERENCE BETWEEN DIAGONALS

SURFACE FINISH:

- FINISH AT FRONT FACE
  ± ⅛" IN 5'

STANDARD TYPE "X" PANEL DETAILS

CERTIFIED ONLY WITH RESPECT TO INTERNAL STABILITY OF REINFORCED EARTH STRUCTURES



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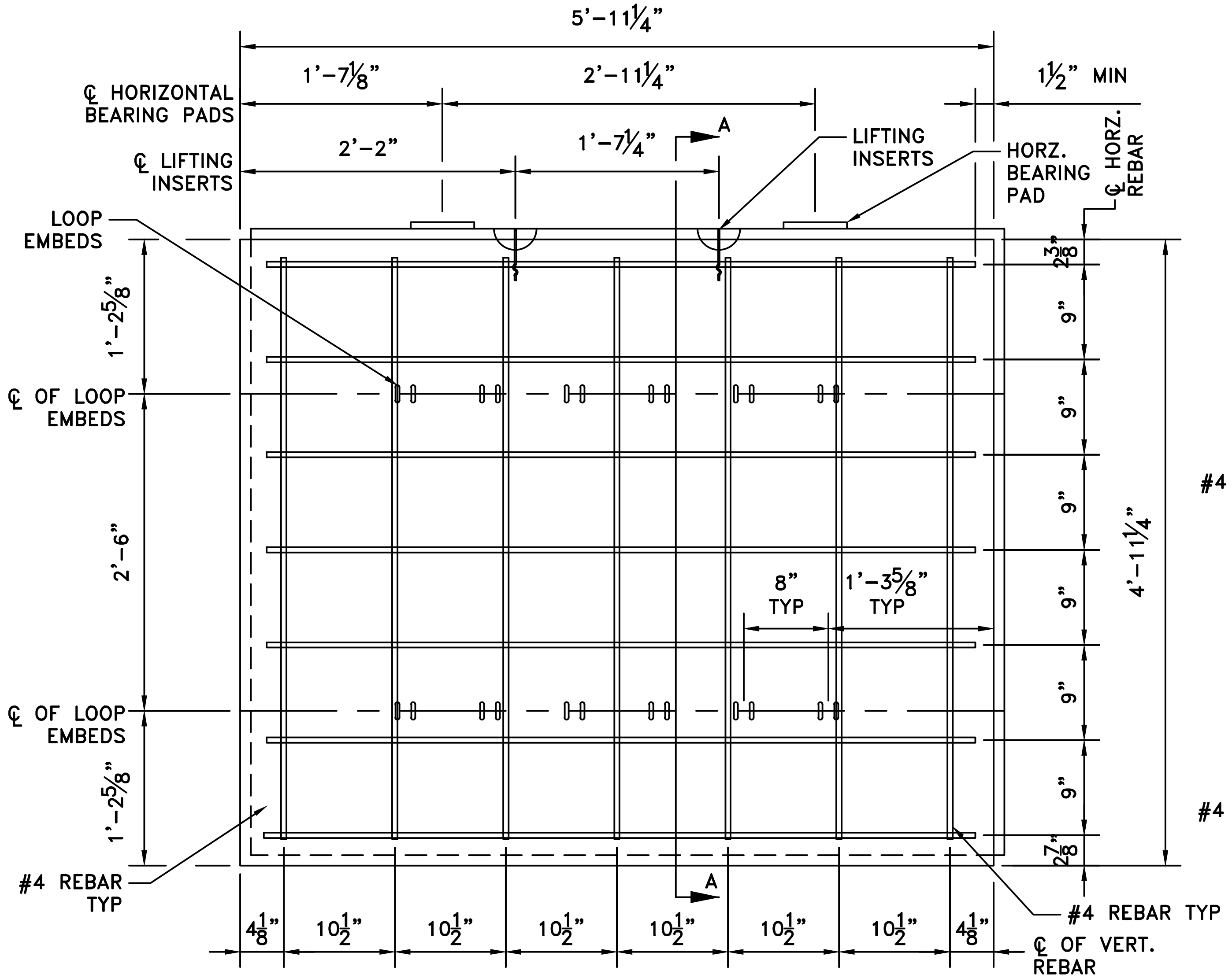
STANDARD DETAILS: 2 OF 5

STANDARD MSE WALL DETAILS

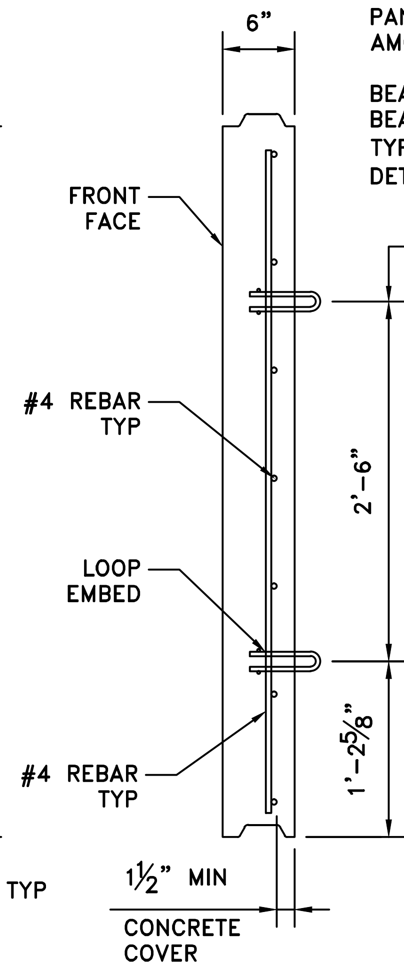
Scale: NTS
Job: --
Sheet: RW-02
Sheet 2 of 5

FRANSISCUS S. HARDIANTO
03/09/21



TYPICAL PANEL

SHOWN FROM BACK FACE



SECTION A–A

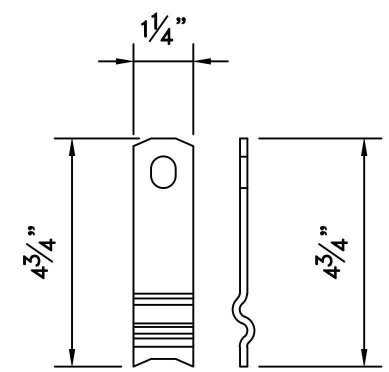
REBAR NOTE:
PANEL TYPES "Y" & "Yi" REQUIRE THE SAME AMOUNT OF PANEL REINFORCEMENT.

BEARING PAD NOTE:
BEARING PAD PLACEMENT SHOWN IS FOR TYPICAL "A" PANEL ONLY, SEE STANDARD DETAILS: 5 OF 5 FOR "X" AND "Y" PANELS.

PANEL REINFORCEMENT TABLE

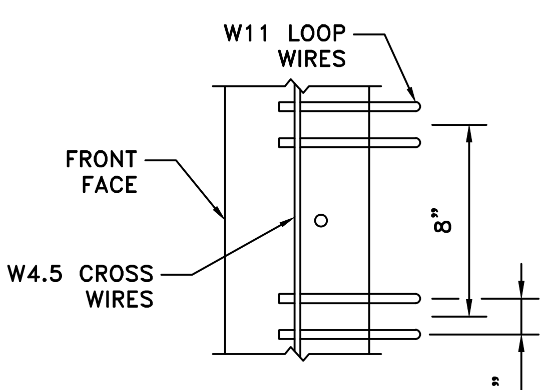
Panel Type	Vertical Bars Num / Size	Horz. Bars Num / Size
Y	7 / #4	7 / #4
Y2	7 / #4	4 / #4

18" MAX SPACING BETWEEN BARS

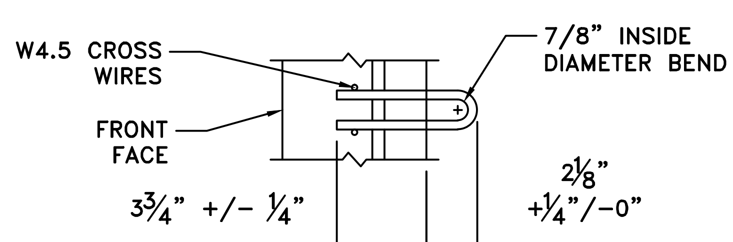


LIFTING INSERT DETAIL

NOTE:
"WAVY-TAIL" STYLE OF INSERT SHOWN. OTHER INSERTS OF EQUAL OR GREATER CAPACITY MAY BE USED IF APPROVED BY SSL.



PLAN VIEW



ELEVATION VIEW

LOOP EMBED DETAILS

PANEL TOLERANCES:

OVERALL DIMENSIONS:

- STANDARD PANEL
  ± ½" VERTICAL
  ± ½" HORIZONTAL
- TOP AND SPECIAL PANELS
  ± 1" VERTICAL
  ± ½" HORIZONTAL

CONNECTION DEVICE LOCATIONS:

- EMBEDS
  ± 1" VERTICAL
  ± 1" HORIZONTAL

PANEL SQUARENESS:

- 90° PANEL CORNERS
  ± $\frac{3}{16}$" USING 2' SQUARE
  (MEASURE 3 PANEL CORNERS)

PANEL DIAGONAL:

- PANELS WITH 90° CORNERS
  ½" MAX. DIFFERENCE BETWEEN DIAGONALS

SURFACE FINISH:

- FINISH AT FRONT FACE
  ± ⅛" IN 5'

STANDARD TYPE "Y" PANEL DETAILS

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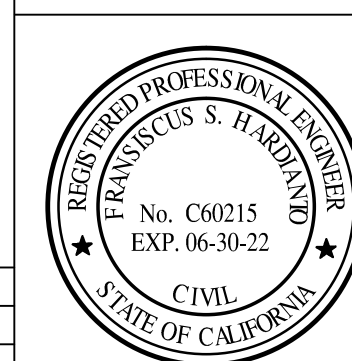

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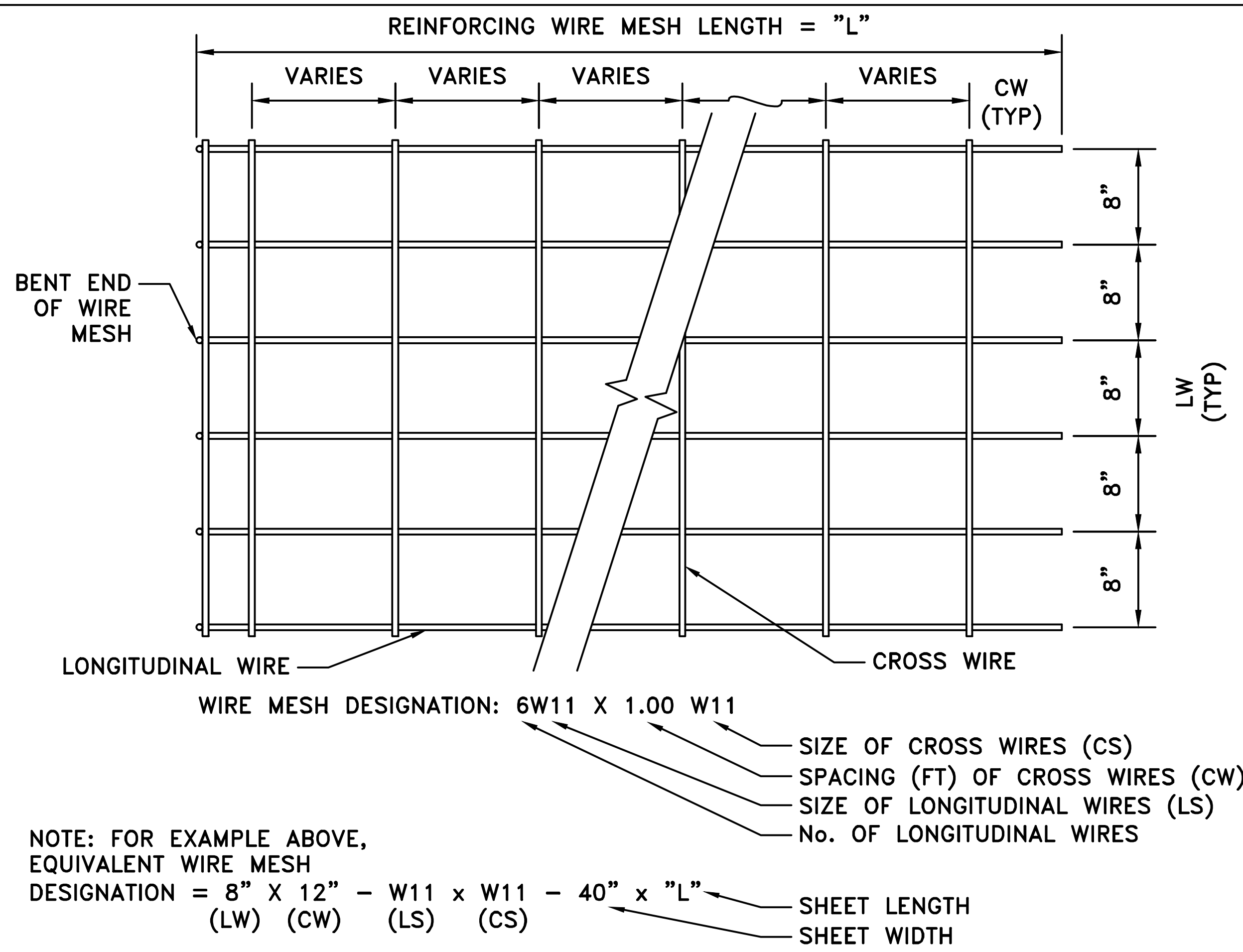
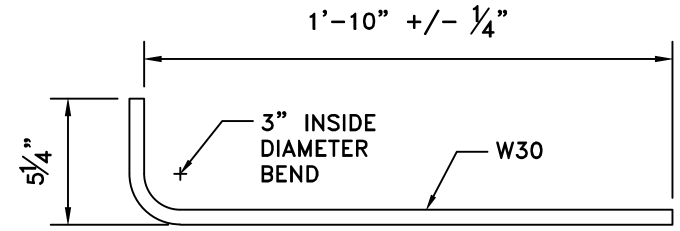
STANDARD DETAILS: 3 OF 5

STANDARD MSE WALL DETAILS

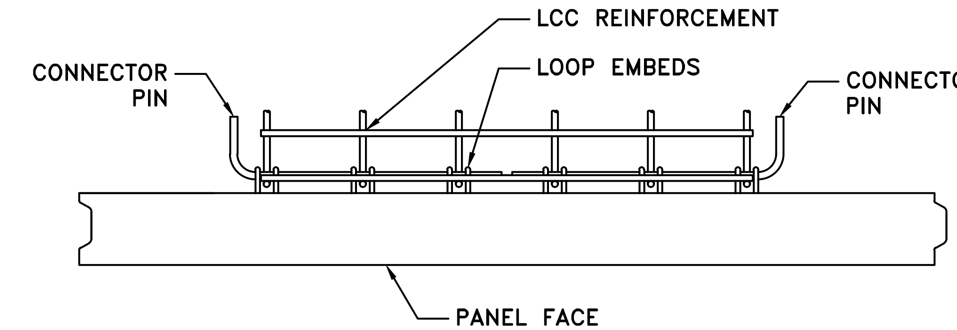
Scale: NTS
Job: --
Sheet: RW-03
Sheet 3 of 5



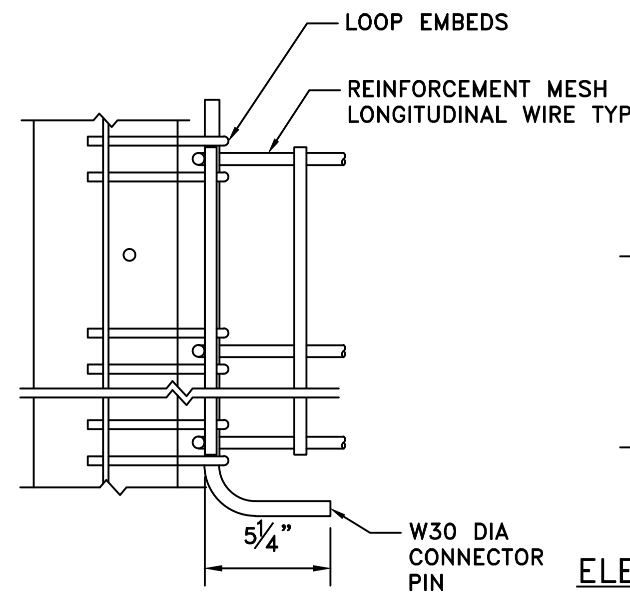
EXAMPLE REINFORCEMENT DETAIL



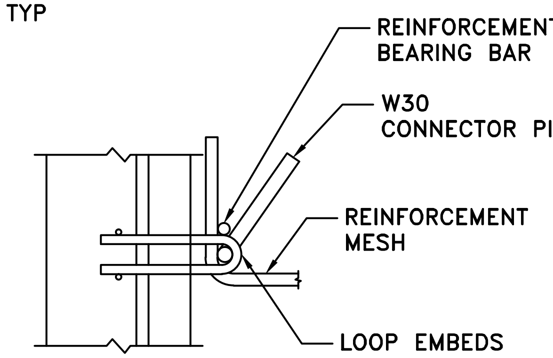
CONNECTOR PIN DETAIL



REINFORCEMENT CONNECTION DETAIL

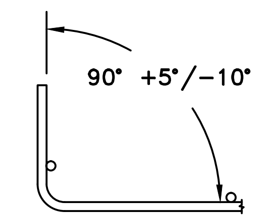


PLAN VIEW

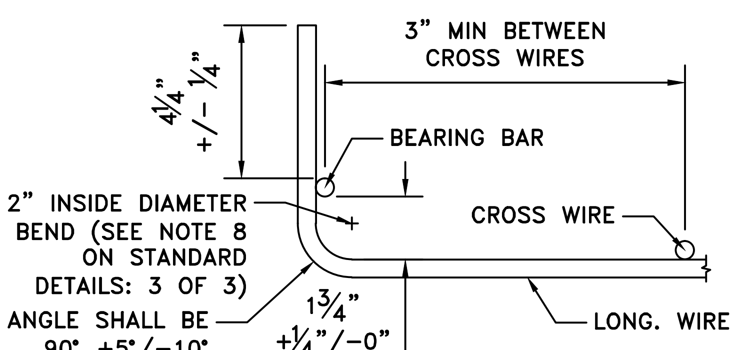


ELEVATION VIEW

REINFORCING MESH CONNECTOR BAR DETAIL

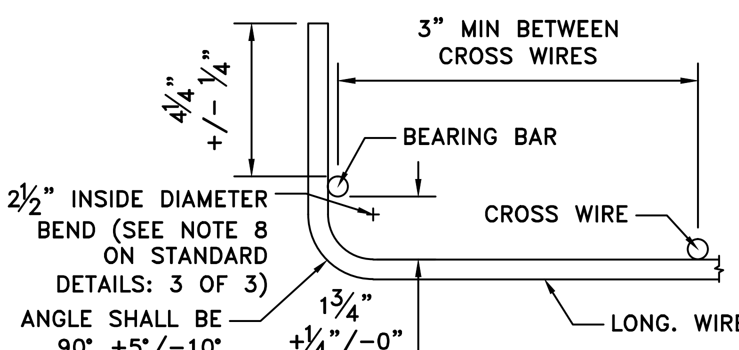


BEND TOLERANCE



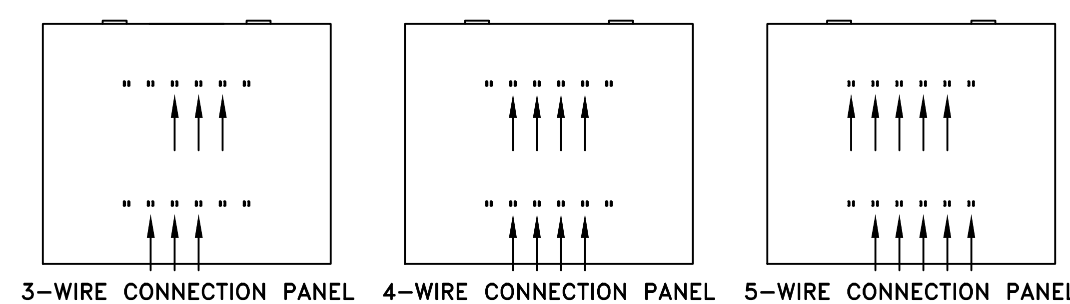
W11 & W20 WIRE MESH LOOP DETAIL

(CROSS WIRES & BEARING BAR SHALL MATCH CROSS SECTIONAL AREA OF LONGITUDINAL WIRES)



W24 WIRE MESH LOOP DETAIL

(CROSS WIRES & BEARING BAR SHALL MATCH CROSS SECTIONAL AREA OF LONGITUDINAL WIRES)



ATTACHMENT BY No. WIRES

(STANDARD PANELS ONLY)

NOTE: FOR SIX AND EIGHT WIRE CONNECTION PANELS, USE ALL CONNECTION POINTS PROVIDED.

SOIL REINFORCING DETAILS

CERTIFIED ONLY WITH RESPECT TO INTERNAL STABILITY OF REINFORCED EARTH STRUCTURES

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DESIGN BY: FSH	03/09/21				
CHECK BY: FSH	03/09/21				
PROJ. ENGR:	FSH				

STANDARD DETAILS: 4 OF 5

STANDARD MSE WALL DETAILS

Scale: NTS
Job: --
Sheet: RW–04
Sheet 4 of 5

FRANSISCUS S. HARDIANTO
03/09/21

MATERIAL PROPERTIES NOTES:

1. PANEL REINFORCEMENT BARS SHALL BE DEFORMED BILLET STEEL BARS FOR CONCRETE REINFORCEMENT CONFORMING TO THE SPECIFICATION OF ASTM DESIGNATION A 615, GRADE 60, INCLUDING SUPPLEMENTARY REQUIREMENT S1 OR LOW ALLOY STEEL DEFORMED BARS CONFORMING TO THE SPECIFICATIONS OF ASTM DESIGNATION A706. STRUCTURAL WELDED WIRE REINFORCEMENT THAT CONFORMS TO ASTM A1064 SPECIFICATIONS MAY BE SUBSTITUTED FOR ASTM DESIGNATION A615.

2. W11, W20 & W24 STEEL WIRE SHALL CONFORM TO THE ASTM DESIGNATION A1064. THE WELDED WIRE SOIL REINFORCEMENT AND LOOP EMBED SHALL BE WELDED IN ACCORDANCE WITH ASTM DESIGNATION A1064. ALL SOIL REINFORCEMENT MESH SHALL BE COMPOSED OF SMOOTH WIRE, DEFORMED WIRE SHALL NOT BE USED FOR SOIL REINFORCEMENT, LOOP EMBEDS AND CONNECTION PIN.

3. THE LOOP EMBEDS, SOIL REINFORCEMENT AND CONNECTION PINS SHALL BE GALVANIZED IN ACCORDANCE WITH ASTM DESIGNATION A123 AFTER BENDING.

4. CONCRETE PANELS TO HAVE A 28-DAY COMPRESSIVE STRENGTH OF 4000 PSI.

5. ALL PANEL REINFORCEMENT MUST HAVE A MINIMUM OF 1 1/2" COVERAGE WITH CONCRETE ON ALL SIDES.

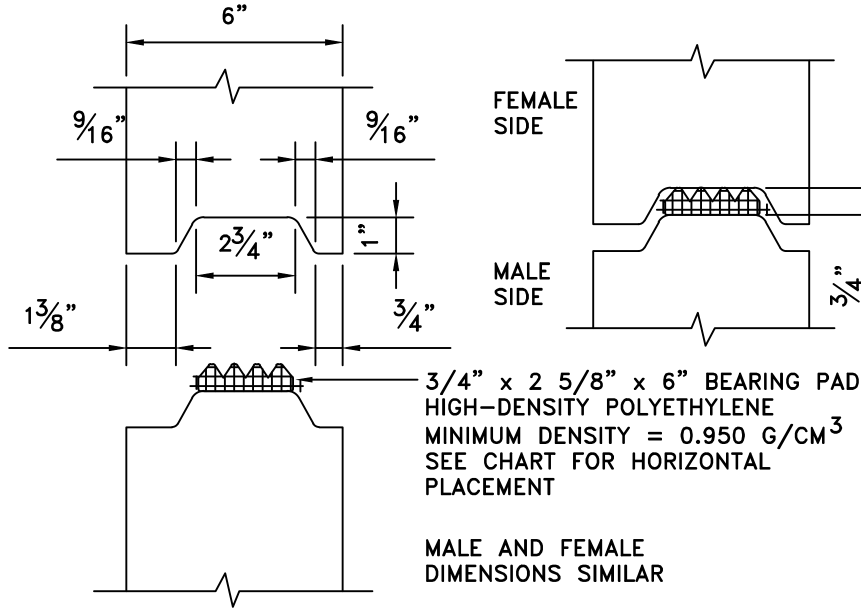
6. FOR PANELS WITH W11 & W20 MESH USE "A" PANEL REINFORCEMENT. PANELS WITH 6 W24 MESH USE "X" PANEL REINFORCEMENT. PANELS WITH 7 OR 8 W24 MESH USE "Y" PANEL REINFORCEMENT. PANELS WITH 2x6 W20 & 8 W24 USE "Z" PANEL REINFORCEMENT.

7. FILTER FABRIC IS A NON-WOVEN GEOTEXTILE COMPOSED OF POLYPROPYLENE FIBERS, WHICH ARE FORMED INTO A STABLE NETWORK SUCH THAT THE FIBERS RETAIN THEIR RELATIVE POSITION. FILTER FABRIC IS INERT TO BIOLOGICAL DEGRADATION AND RESISTS NATURALLY ENCOUNTERED CHEMICALS, ALKALIDS AND ACIDS.

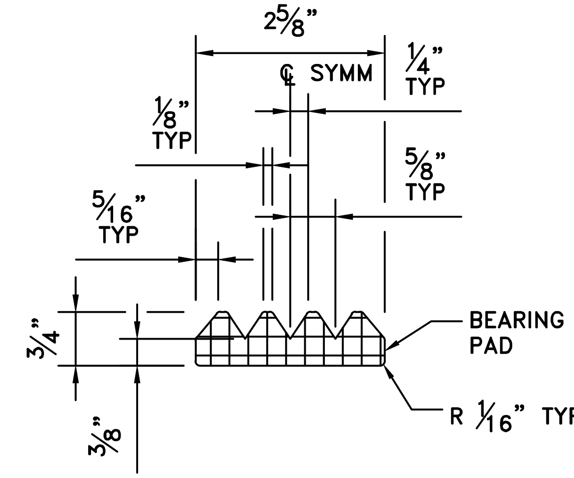
8. THE MINIMUM INSIDE BEND DIAMETER FOR THE SOIL REINFORCEMENT SHALL BE NO LESS THAN TWICE THE NOMINAL DIAMETER OF THE WIRE SIZE AND IN NO INSTANCE BE LESS THAN 1 INCH.

9. CROSS WIRES, BEARING BARS WIRE AND LONGITUDINAL WIRES ON SOIL REINFORCEMENT SHALL BE THE SAME SIZE.

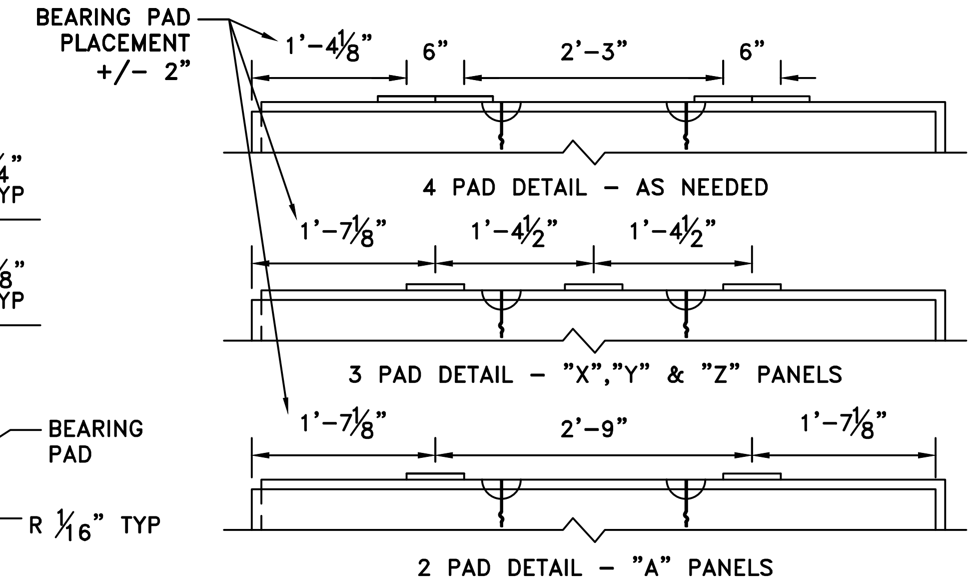
10. UNIVERSAL MESH SHALL BE SUPPLIED FOR THE USE OF REPLACING ANY STYLE OF MESH FOR THE PROJECT. THE UNIVERSAL MESH SHALL HAVE THE GREATEST NUMBER OF LONGITUDINAL WIRES, THE LARGEST CROSS SECTIONAL AREA OF LONGITUDINAL WIRES, THE SMALLEST CROSS BAR SPACING, THE GREATEST CROSS SECTIONAL AREA OF CROSS BARS, AND THE LONGEST LENGTH OF ANY STYLE OF SOIL REINFORCEMENT ON THE PROJECT. THE CONTRACTOR IS RESPONSIBLE FOR NOTING WHERE THE UNIVERSAL SOIL REINFORCING IS PLACED DURING CONSTRUCTION.



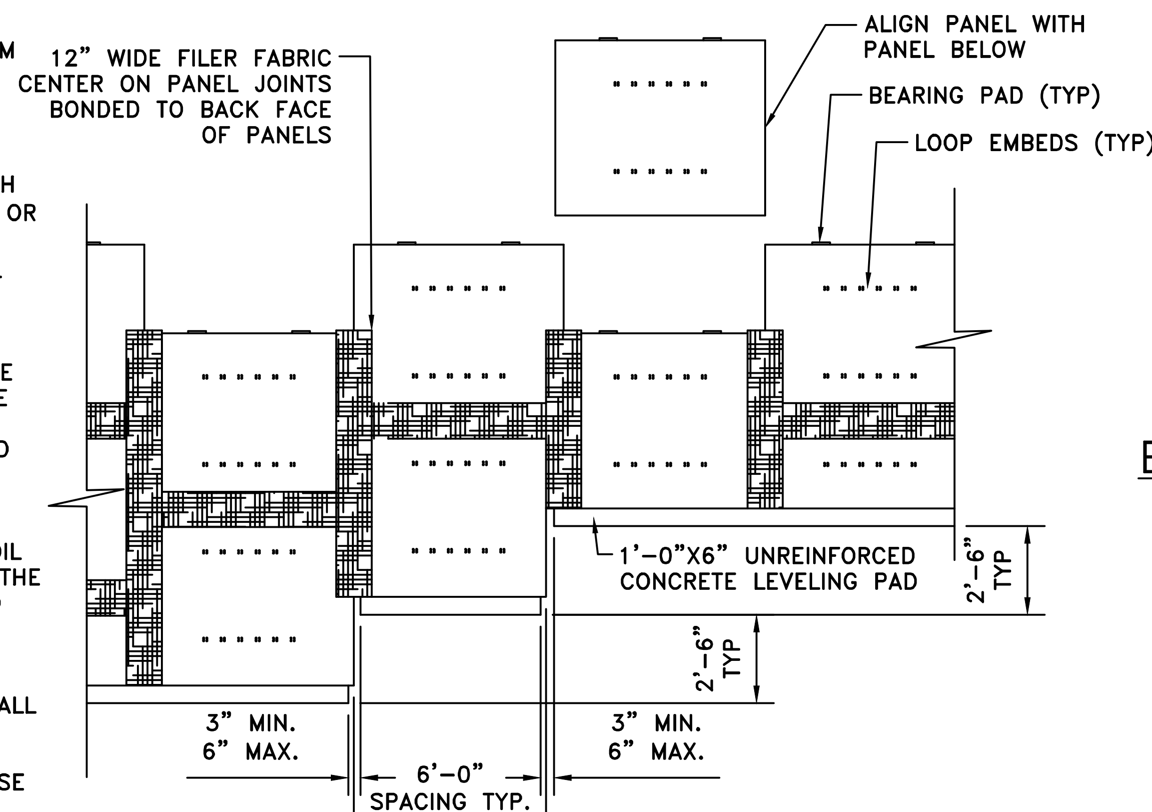
HORIZONTAL PANEL JOINT DETAIL



BEARING PAD DETAIL



BEARING PAD PLACEMENT

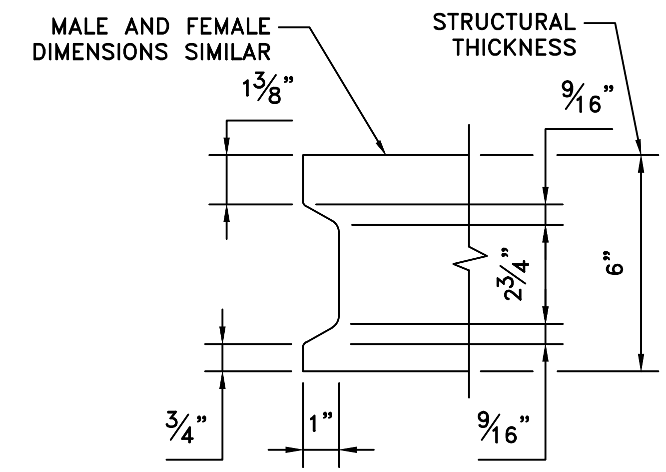


FILTER FABRIC DETAIL AND PANEL PLACEMENT

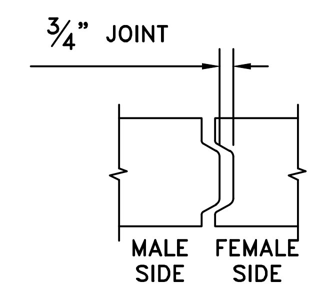
(BACK VIEW)

PANEL HT	Qty.
5 ft	2
10 ft	2
15 ft	2
20 ft	2
25 ft	2
30 ft	2
35 ft	3
40 ft	3
45 ft	3
50 ft	3

BEARING PAD CHART



VERTICAL PANEL JOINT DETAIL



MSE WALL INSTALLATION DETAILS

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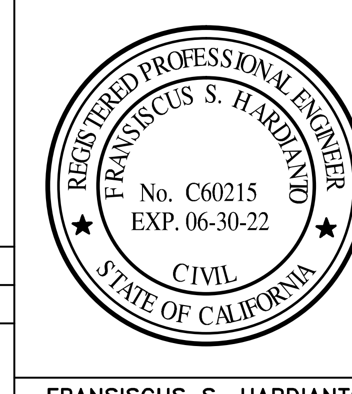

FRANSISCUS S. HARDIANTO
03/09/21

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DESIGN BY: FSH	03/09/21				
CHECK BY: FSH	03/09/21				
PROJ. ENGR:	FSH	NO.	DATE	REVISION DESCRIPTION	BY

STANDARD DETAILS: 5 OF 5

STANDARD MSE WALL DETAILS

Scale: NTS
Job: --
Sheet: RW-05
Sheet 5 of 5

Section 1.2.5

Item 1.2.5 - Describe the facing unit-reinforcement connection and any changes with text and drawings.

Our original connection evaluated by HITEC relies on the internal connection pin bearing on the concrete created by an internal void inside the panel.

Our latest connection is a pair of loops embedded in the concrete to resist the load for each wire as shown in the attached drawing. The pullout capacity of the loop embed relies on the transverse W4.5 crosswires resistance welded to 6 pair of loops.

See the attached panel detail in Section 1.1.6.

Section 1.2.6

Item 1.2.6 - If the answer to 1.1.2 or 1.1.4 is yes, for each connection device provide physical property specifications. Address ultimate and yield strengths as well as welds if they are applicable.

Loop embeds are manufactured in accordance with ASTM A1064 with using a minimum yield strength of the wire rod for the loop segments of 75,000 PSI. All materials are domestical sourced products.

Section 1.2.7

Item 1.2.7 - If the answer to 1.1.2 or 1.1.4 is yes, for each connection device describe corrosion protection measures and provide specifications. If coatings or galvanization is used, provide minimum thickness for 75-year and 100-year design life (based on the electrochemical requirements listed in AASHTO).

The loop embeds are galvanized in accordance with ASTM A123. The minimum coating thickness is 86 *um* both for 75 and 100-year design life. It is expected for the coating to last 16 years as required by AASHTO 11.10.6.4.2a and is shown as follows.

Galvanize coverage	= 20 oz per square foot
Rate of corrosion for zinc	= 15um / year first 2 years = 12um / year thereafter
Rate of corrosion for steel	= 12um / year 17 to 75 years
Galvanizing thickness	= (20 oz (1,728/16)) / (440 PCF x 144) = 0.341 inches = 86.59um

Section 1.2.8

Item 1.2.8 - If the answer to 1.1.4 is yes, for each connection device provide sacrificial steel thickness for 75 and 100-year design life.

75 Year Design Life Corrosion Reduction Analysis

Galvanizing coverage ASTM A123	= 20 ounces per square foot
Rate of corrosion for zinc	= 15um per year – first 2 years 4um per year – thereafter
For residual carbon steel	= 12um per year
Galvanizing thickness	= (20 oz x (1728 /16))/(440 x 144) = 0.0341 inches = 86.59um
First 2 years	= 2 x 15um = 30um per year
Number of years of galvanized coating	= 2 + ((86.59 – 30)um)/ 4um = 16.15 years
Steel loss	= (75 – 16.14) years x 12um / year = 706.32um = 0.0278 inches
W11 wire diameter	= 0.374 inches
Effective area for connection	= (0.374 – (2 x 0.0278) = ((0.318/2)^2 x 3.14) x 4 = 0.318 in^2
W24 wire diameter	= 0.553 inches
Effective area of W24 wire	= (0.553 – (2 x 0.02780) = (0.497/2)^2 x 3.14) = 0.194 in^2
Connection vs. Wire Area	= 0.318 in^2 / 0.194 in^2 = 1.64 - therefore okay.

100 Year Design Life Corrosion Reduction Analysis

Steel loss	= (100 – 16.14) years x 12um / year = 1,002.32um = 0.0396 inches
Effective area for connection	= 0.374 – (2 x 0.0396) = ((0.295/2)^2 x 3.14) x 4 = 0.275 in^2
Effective area of W24 wire	= (0.553 – (2 x 0.0396) = (0.474/2)^2 x 3.14) = 0.176 in^2
Connection vs. Wire Area	= 0.275 in^2 / 0.176 in^2 = 1.56 - therefore okay.

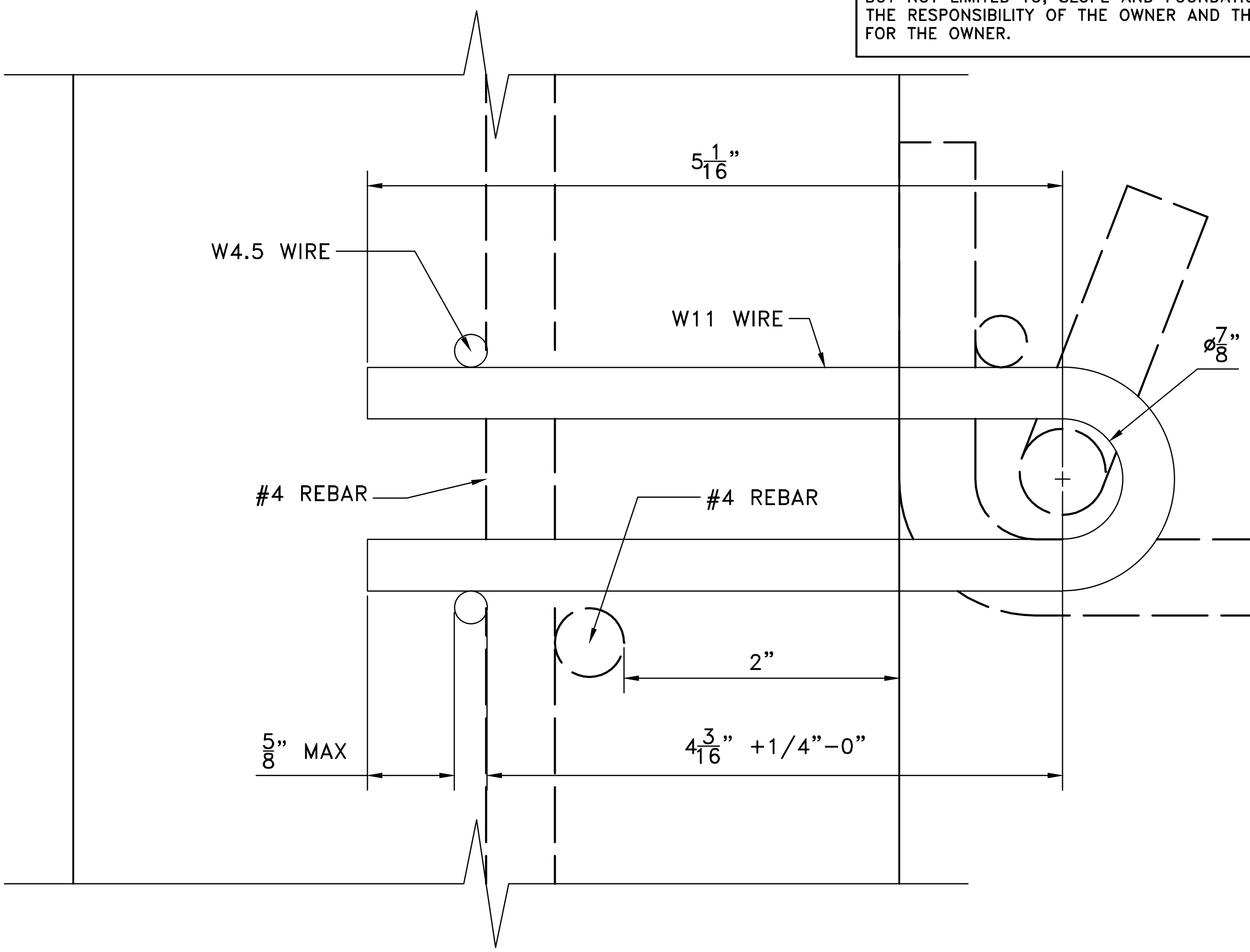
Section 1.2.10

Item 1.2.10 - If the answer to 1.1.2 or 1.1.4 is yes, for each connection device provide detail drawings that show dimensional tolerances.

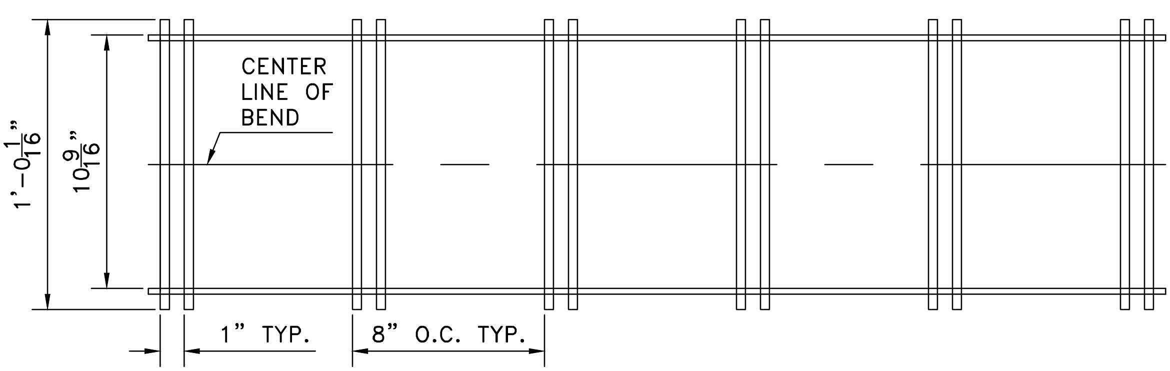
Please see that attached drawing.

THE DESIGN OF ALL MSE PLUSE™ WALLS IS BASED ON THE ASSUMPTION THAT ALL MATERIALS, INCLUDING THE BACKFILL AND METHODS OF CONSTRUCTION, CONFORM TO THE SPECIFICATIONS FOR MSE PLUSE™ RETAINING WALLS AND THE PROJECT BID DOCUMENTS

THESE DRAWINGS, AS WELL AS THE DESIGN, ARE CERTIFIED WITH RESPECT TO THE INTERNAL STABILITY OF THE MSE PLUS™ STRUCTURES ONLY. EXTERNAL STABILITY INCLUDING, BUT NOT LIMITED TO, SLOPE AND FOUNDATION STABILITY IS THE RESPONSIBILITY OF THE OWNER AND THE ENGINEER FOR THE OWNER.



EMBED: ELEVATION VIEW (IN PANEL)



EMBED RACK (BEFORE BEND)

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NO.	DATE	REVISION DESCRIPTION	BY

8" SPACING EMBED LOOP

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Scale: NTS
Job: XXXX
Sheet: RW-01
Sheet 01 of XX

Section 1.2.11

Item 1.2.11 - If the answer to 1.1.2 or 1.1.4 is yes, list facing unit-reinforcement connection strength tests performed, provide test results and strength envelopes the Applicant recommends for design.

Please the attached connection test report dated December 6, 2012, which was performed by SSL and witnessed by Caltrans. Testing was performed at Surecast West in Redlands, California.

In summary, the test results show for the Target Load (T_L), which is based upon the yield strength of the steel using the theoretical area of the W24 wire based upon no corrosion of the connection components. For a W24 wire the T_L is 0.24in^2 x 65,000 PSI = 15,600 lbs. To pass the Caltrans test requirements each sample must meet or exceed T_L without any type of component failure within the connection.

The SSL connection reached T_L in every test run, meaning that each sample passed testing. The W24 samples reached anywhere from 103% to 114% of T_L.

Five out of six test runs were concluded with the longitudinal wire fracturing at or directly above the bend where the wire deformed around the connector pin as shown in Photos 1 and 2. One test run was concluded when the transverse bar weld sheared. All samples exhibited similar or identical fracture characteristics.

AASHTO Section 11.10.6.4.4 states that connections shall be designed to resist stresses resulting form the active forces, T_O, which is the factored tensile load applied to the soil reinforcement connection at the wall face. In this instance, since the Caltrans testing is based upon a connection with no corrosion, T_O, would be determined as follows for AASHTO. T_O = 0.24 in^2 x 65,000 PSI x 0.65 = 10,140 lbs.

In summary, the Caltrans test requirement is much more stringent with a much higher standard than AASHTO's requirement, which is 65% of Caltrans. Thus, the SSL connection surpassed the AASTHO requirement significant margin.

SSL Connection Test: MSE*Plus*™ Panel Wall System

December 6, 2012

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TABLE OF CONTENTS

1. ABSTRACT

Mechanically Stabilized Earth (MSE) retaining walls are structures consisting of multiple layers of soil reinforcement placed in select backfill and connected to a facing element. SSL has developed a soil reinforcement connection for MSE retaining walls which uses welded wire mesh as soil reinforcement and precast concrete panels as a facing element.

This report details a test program developed by SSL to examine the capacity of the connection system along with the interaction of the soil reinforcement and the concrete panel facing element. Caltrans requires that all elements of the soil reinforcement connection system can reach the yield strength of the steel. This test will show that the steel reinforcing wire and all elements of SSL's connection system can reach the yield strength of the longitudinal wire element (65 ksi) before failure.

During the test, load is applied to soil reinforcement that is connected to a concrete panel. The soil reinforcement is gripped using a steel wire chuck that is fastened to the longitudinal wire and load is applied using a hollow-cylinder hydraulic ram that is supported by a steel frame placed on the concrete panel. A satisfactory or "passing" test run is one in which the yield strength of the steel or Target Load is reached without failure of the connection system. An unsatisfactory or "failing" test run is one in which any element of the connection system fails before Target Load is reached.

The test program included six steel soil reinforcement samples which consisted of single-wire W24 samples with W24 transverse bars. Each sample passed demonstrating that the SSL Panel Wall system can satisfy Caltrans requirements.

2. INTRODUCTION

The MSE Plus™ connection system has undergone the following changes to the welded wire mesh soil reinforcing elements:

- The bend radius of the longitudinal wires has been increased to 1.25" for W24 wire gauges.
- For Caltrans projects, the gauge of all transverse wires will equal to the gauge of the longitudinal wires.
- The use of *deformed* wire as soil reinforcement has been eliminated and only smooth wire will be used.

The Caltrans LRFD connection test requires the capacity of the MSE panel connection system to meet or exceed the yield strength of the reinforcing element.

The following report will detail the test program that was administered by SSL in order to ensure that the updated connection system, as a whole, can reach or exceed the yield strength of the longitudinal wire element.

2.1 BACKGROUND AND CALCULATIONS

SSL's system will utilize W11, W20 and W24 welded wire mesh as soil reinforcement for Caltrans projects. The samples for this test will be smooth-rolled wire in the W24 size, data for W11 and W20 wire sizes has been provided in the SSL Test Report dated March 20, 2012.

For this test, the Target Load (TL) is the yield strength of the longitudinal wire element of the soil reinforcing mesh (65,000 psi) multiplied by the cross sectional area of the wire. For W24 wire, the cross sectional area of the wire is 0.24 in^2. The TL requirement for W24 wire is shown below:

- W24: 65,000 psi x (0.24 in^2) = 15,600 Lbs.

The connection system will undergo elongation as load is applied. Different components of the connection system will contribute to elongation as the load increases. During a test run in which target load is met, the sequence of elongation is typically as follows:

- Phase 1: The 90˚ bend in the longitudinal wire opens until the free end comes in to contact with the back of the test panel (see Figure 1).

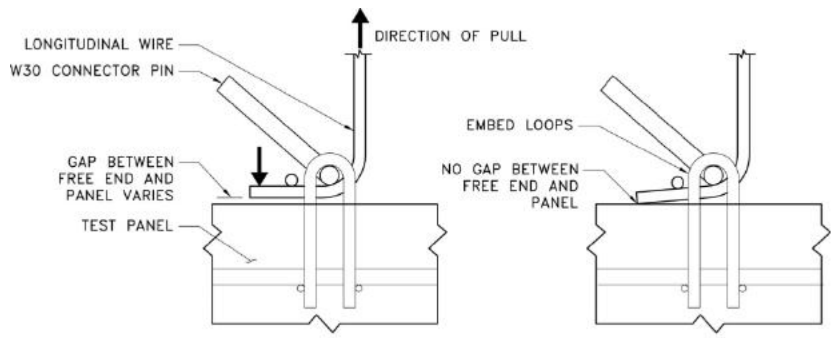


FIGURE 1

- Phase 1A: The transverse bearing bar is pulled tight against the concrete panel's embed loops (see Figure 2). *NOTE: Depending on the initial placement of the sample, Phase 1A of elongation may not occur*.

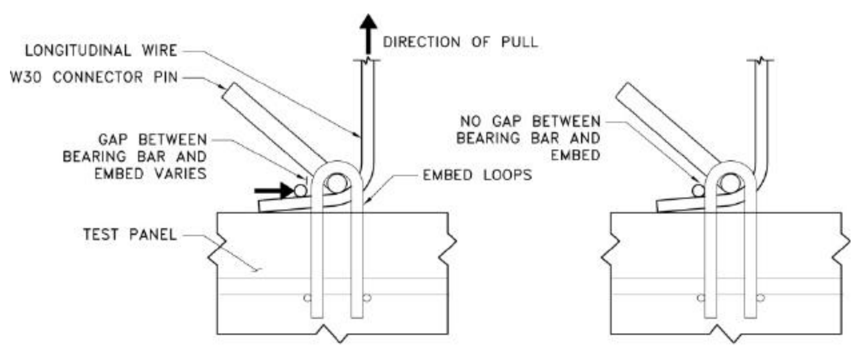


FIGURE 2

- Phase 2: The bend of the longitudinal wire will be pulled tightly against the W30 connector pin (see Figure 3).

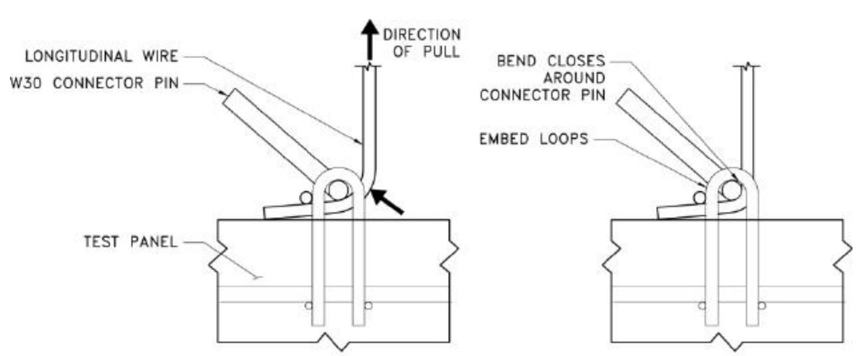


FIGURE 3

- Phase 3: The longitudinal wire element of the soil reinforcement will elongate in the length between the connector pin and the grip point of the steel wire chuck. *NOTE: 0.0574 in of elongation is expected to occur in a wire sample with a free length of 26.5 in. (see calculation in Section 9).*

- Phase 4: Loads in excess of the yield strength of the steel will cause plastic deformation or *necking down* of the longitudinal wire followed by fracture (see Photo's 1 and 2). *NOTE: Similar to W20, during test runs performed on W24 samples, the higher loads approaching and following yield strength will likely cause some deformation of the connector pin and embed loop elements of the system (the embed loops will deform by approximately 0.030 in as shown in Photo's 3, 4 and 5).*

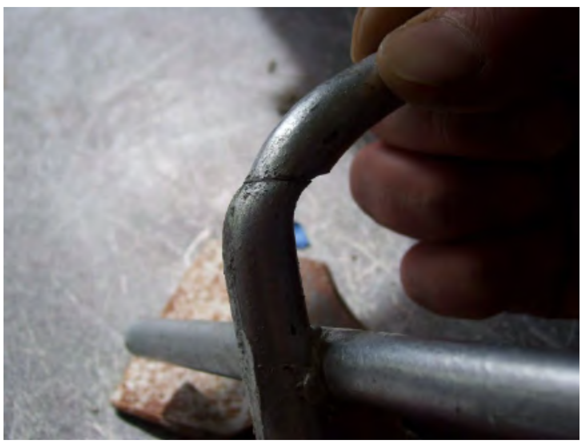


PHOTO 1**:** W20 NECKED DOWN AND FRACTURED

PHOTO 2: W11 NECKED DOWN AND FRACTURED

PHOTO 3: EMBED LOOP PRIOR TO TESTING (0.933 in)

PHOTO 4: EMBED LOOP AFTER W20 TEST (0.963 in)

PHOTO 5: DEFORMATION OF EMBED LOOP

The rate and length of elongation in all of the connection elements will vary due to any one of the following: wire size; bend angle; embed loop clearance and the initial placement of the wire sample (e.g, it is possible to connect the sample so that the transverse bearing bar is snug against the embed loops, eliminating Phase 1A of elongation).

Due to the arrangement of the steel test apparatus and the position of the hydraulic ram (See Figure 4) there is potential for deflection at the center of the beam that is supporting the ram. This deflection could interfere with the measurements being taken to record elongation. To minimize deflection, the subsequent supporting perpendicular beams are placed as close together as possible, typically around 10.5 in. apart. The expected maximum deflection caused by a point load of over 15,600 lbs on the center of a simply supported steel beam as exists in the test apparatus is .002 in. (See the calculations included in Section 9). Also, care should be taken to ensure that the base of the dial indicator is placed directly over the point at which the simply supported beam and the beam below intersect.

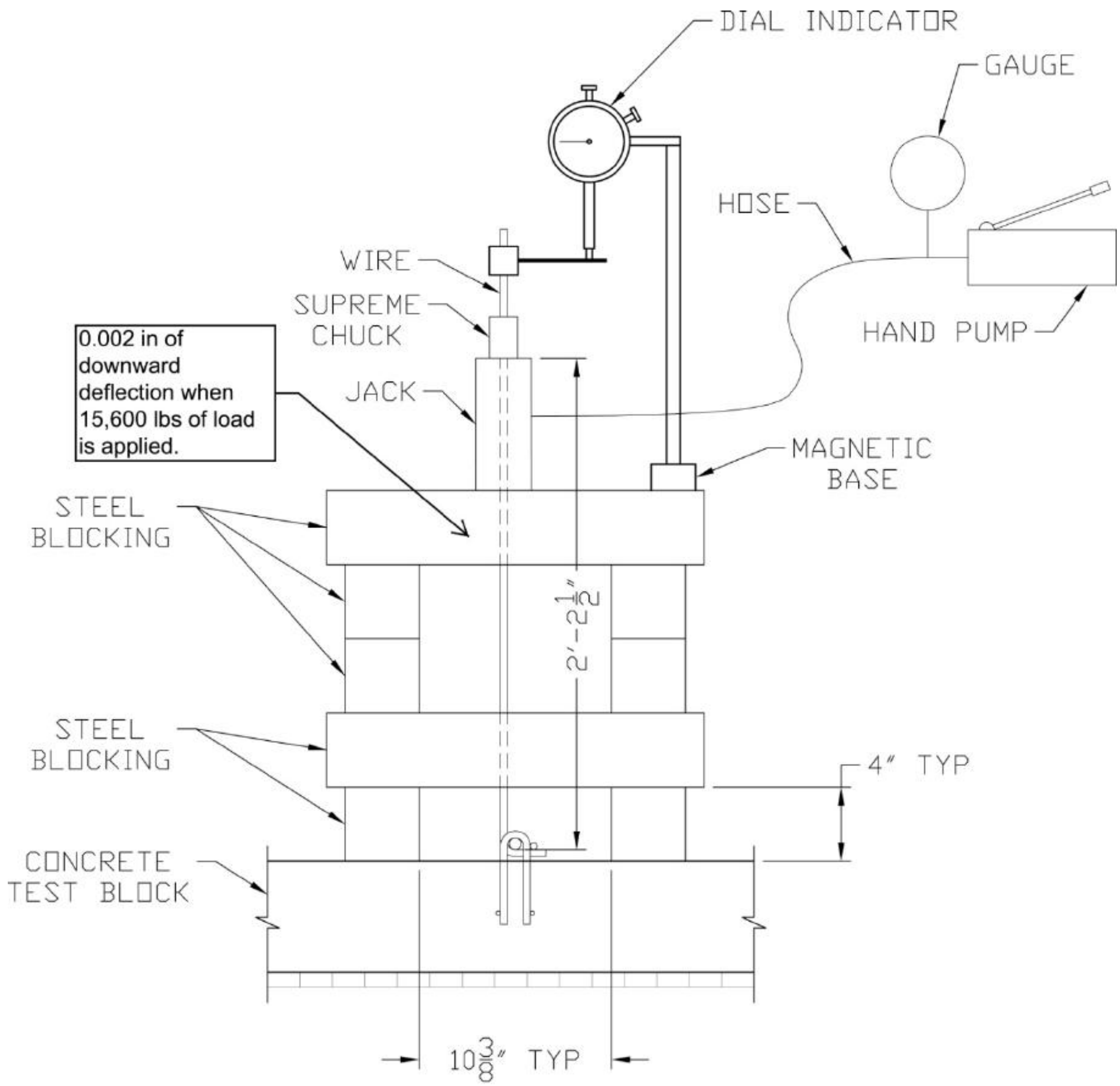


FIGURE 4: DEFLECTION IN TEST APPARATUS

2.2 MATERIALS AND EQUIPMENT

Wire samples were manufactured in accordance with ASTM A82 and the mesh sheets were fabricated in accordance with ASTM A185 and then galvanized in accordance with ASTM A123 (See compliance certifications included in Section 10).

Four, hollow-cylinder ram and gauge combinations were calibrated prior to testing by Technical Associated Services (TAS). The calibration reports provided by TAS are included in Section 7 of this report. The ram/gauge combinations are identified as follows with identical labels for both the ram and gauge:

- Ram/Gauge #1 (12k-12-1)
- Ram/Gauge #2 (12k-12-2)
- Ram/Gauge #3 (12k-12-3)
- Ram/Gauge #4 (12k-12-4)

Based on the calibration reports, the following gauge readings coincide with the target load (TL) for each wire size:

- W24:
  - 12k-12-1: 6,555 psi = 15,600 lbs force
  - 12k-12-2: 5,690 psi = 15,600 lbs force
  - 12k-12-3: 5,650 psi = 15,600 lbs force
  - 12k-12-4: 5,710 psi = 15,600 lbs force

The gauge reading at the initial 500 lb data point and the subsequent data points at 1,000 lb intervals are taken directly from the calibration reports. The gauge reading at target load (TL) is taken directly from the calibration report and will be highlighted yellow and marked TL on the data sheet.

The test frame as detailed in Figure 4 and Section 8, consists of short pieces (between 3 ft. and 5 ft. long) of 0.25 in thick, 4 in. square steel tubing. The lowest supporting beams are placed parallel to the embed loops to allow access for the connector pin, the next course of beams are placed perpendicular to the lowest beams at a distance apart that allows access to the desired number of wire samples. Beams are stacked perpendicular to one another until the desired height of the test apparatus is achieved. The top beam that supports the hydraulic ram must be placed perpendicular to the bottom beams and it will have a 0.75 in hole drilled in the center of the beam. The wire sample will be threaded through the hole in the top beam. It may be necessary to have beams stacked on each other in parallel in order to ensure that the beam supporting the hydraulic ram(s) is perpendicular to the bottom beams.

2.3 TEST REQUIREMENTS

This test will confirm:

- The tensile capacity of the reinforcing wire will meet or exceed the yield strength of the longitudinal wire.
- The load capacity of all elements of the panel to soil-reinforcement connection.
- The rotational ductility of the “L” portion of the bend under load.
- Measurement of the total elongation in the connection while under load, and comparison with expected elongation of the longitudinal wire at yield.

Each test-run will be concluded when one of the following events occurs:

- The weld between the transverse bearing bar and the longitudinal wire is broken.
- The transverse bearing bar is sheared by the panel embed loops.
- The longitudinal wire breaks at any location.

Below are the Pass/Fail criteria:

- Pass: If the connection breaks at any location after reaching the Target Load.
- Fail: If the connection breaks at any location before reaching the Target Load.

A representative from a qualified independent testing laboratory shall be present during all testing, a report prepared by the lab will be included in the final testing report.

3. TEST PROCEDURE

3.1 TEST PANEL FABRICATION

1. Install connector and reinforcing steel.
2. Pour test panel.
3. Form concrete cylinders for testing. Testing may be performed upon 4,000 PSI concrete cylinders breaks.

3.2 WIRE SAMPLE PREPARATION

1. When single wire sample is being tested, ensure that the transverse bearing bar does not overlap or come into contact with adjacent embed loops. A length less than 12'' for the transverse bearing bar is recommended.

2. When multiple wires of a sheet are being tested simultaneously, extreme care must be taken to ensure that there are no additional effects caused by the interaction between the transverse bearing bar and the adjacent embed loops. This can be done by:
   - Prior to testing, visually inspect embed loops to ensure that they are at a uniform height above the test panel
   - During testing, maintaining a consistent and even load to each wire that is being tested.
3. Prior to each test run, the wire sample must be thoroughly inspected with hand magnification device to look for cracks, condition of welds, condition of galvanizing, and any other structural or cosmetic defects. Record any observations.
4. Prior to each test run, the wire sample must be measured and recorded for length, angle of bend, distance between bend and transverse bearing bar, and the distance between the bend and the transverse cross bar (if present).
5. Prior to each test run, the wire diameter of all longitudinal and transverse wires must be confirmed and recorded. Measurements include thickness attributed to galvanizing.

3.3 PULL TEST

1. Attach wire mesh sheet with "L" connection to the test panel using W30 connector pin.
2. Install hollow cylinder ram onto the desired number of longitudinal wires and fasten with steel wire chuck. Care must be taken to ensure that all slack is out of the connection prior to installation of steel wire chuck.
3. For each wire being tested, attach measurement clip above steel chuck and align with magnetic base dial indicator. Care must be taken to place the base of the dial indicator above the point at which the top and subsequent steel tubes of the test apparatus cross this will minimize the effects of the maximum expected downward deflection of the test apparatus.
4. Apply load to connection(s), extreme care must be taken to ensure that equal load is being applied to each longitudinal wire. Unbalanced loads will be evident by differences in gauge readings. To balance the loads, make small increases in the trailing ram's pressure.
5. *Alignment Load 1, 500 lbs (AL1)*: Record elongation reading from dial indicator beginning at Alignment Load 1 and continue applying load and recording at 1,000 lb intervals until Alignment Load 2 is reached.
6. *Alignment Load 2 (AL2), varies by wire size:* When the free end of the longitudinal wire reinforcing element is pulled against the test panel (Phase 1) rotational ductility has been exhibited and Alignment Load 2 has been reached, record elongation and identify on data sheet as "AL2". Continue applying load and recording at 1,000 lb intervals until Target Load is reached.
7. *Alignment Load 3 (varies by wire size)*: When the transverse bearing bar is pulled tight against the embed loops (Phase 1A) Alignment Load 3 has been reached, record

elongation and identify on data sheet as "AL3". Continue applying load and recording at 1,000 lb intervals until Alignment Load 3 is reached. *Depending on the initial attachment of the wire sample, Alignment Load 2 and Alignment Load 3 may be reached simultaneously. If this is the case only AL2 will be notated on the data sheet.*

8. Due to a stroke limitations of 1", the Dial Indicator will likely need to be adjusted back to zero at some point during the test run, ideally this will be performed as close to TL or 1" of elongation as possible. The test administrator will make a notation on the data sheet indicating at which points the adjustment occurred. On the typed data sheet, the adjustment point will be indicated by a thick black line under the last elongation measurement taken before the adjustment.
9. Once Target Load is reached, record elongation and remove dial-indicator, continue applying load and recording elongation at 1,000 lb intervals using a tape measure until conclusion of test.
10. Record all aspects of the sample's performance including how/where breakage occurred, load at breakage or load at conclusion if no breakage occurred.
11. The wire sample must be thoroughly inspected after testing with hand magnification to look for cracks, weld condition and galvanizing condition. Record any observations.
12. The wire sample should be measured after testing and recorded for length, angle of bend, distance between bend and transverse bearing bar, and the distance between the bend and the transverse cross bar (if present). *If the test run is concluded by a longitudinal wire fracture, no relevant measurements of the sample can be made other than the examination of weld condition.*
13. Repeat test on remaining samples.

4. SUMMARY AND CONCLUSION

4.1 SUMMARY

For this test, Target Load (TL) was based upon the yield strength of the steel adjusted for the theoretical area of the samples. For W24 samples the TL is 15,600 lbs. In order to pass, each sample must reach TL before any type of failure in the connection.

Target load was reached in every test run, meaning that each sample passed testing. The W24 samples reached anywhere from 103% to 114% of TL.

Five out of six test runs were concluded by the longitudinal wire fracturing at or directly above the bend where the wire deformed around the connector pin as shown in Photos 1 and 2, one test run was concluded when the transverse bar weld sheared. All samples exhibited similar or identical fracture characteristics.

The results of the testing are presented in Tables 1:

TABLE 1: DATA SUMMARY (W24 X W24)								
TEST	SAMPLE	PASS/FAIL	TARGET LOAD (lbs)	LOAD REACHED (lbs)	% of TARGET LOAD (65 ksi)	ELONGATION (in)		RESULT
1	W24 X W24	PASS	15,600	16,667	107%	Phase 1	0.218	Weld Shear
						Phase 2	1.030	
						Phase 3	0.0574	
						Phase 4	0.143	
						Total	1.448	
2	W24 X W24	PASS	15,600	17,750	114%	Phase 1	0.125	Longitudinal Wire Fracture
						Phase 2	1.290	
						Phase 3	0.0574	
						Phase 4	0.278	
						Total	1.750	
3	W24 X W24	PASS	15,600	16,000	103%	Phase 1	0.256	Longitudinal Wire Fracture
						Phase 2	1.069	
						Phase 3	0.0574	
						Phase 4	-	
						Total	1.382	
4	W24 X W24	PASS	15,600	16,000	103%	Phase 1	0.206	Longitudinal Wire Fracture
						Phase 2	0.948	
						Phase 3	0.0574	
						Phase 4	-	
						Total	1.211	
5	W24 X W24	PASS	15,600	17,500	112%	Phase 1	0.228	Longitudinal Wire Fracture
						Phase 2	1.150	
						Phase 3	0.0574	
						Phase 4	0.315	
						Total	1.750	
6	W24 X W24	PASS	15,600	17,750	114%	Phase 1	0.210	Longitudinal Wire Fracture
						Phase 2	1.150	
						Phase 3	0.0574	
						Phase 4	0.333	
						Total	1.750	

For the six W24 samples, the total elongation ranged from 1.211 in to 1.750 in with an average of 1.549 in. Phase 1 of elongation ranged from 0.125 in to 0.256 in with an average of 0.207 in. Phase 2 of elongation ranged from 0.948 in to 1.290 in with an average of 1.106 in. Phase 3 measurements are based up the expected elongation calculation provided in Section 9. Phase 4 measurements were taken using a standard tape measure after the Target Load had been reached and the dial indicator had been removed. Five of six test-runs were concluded with a longitudinal wire fracture, meaning that an accurate measurement of the plastic deformation is largely impossible. The first test run was concluded with a shearing of the transverse bar weld, plastic deformation was 0.143 in. Phase 4 elongation ranged from 0 in to 0.333 in with an average of 0.178 in. (See Table 2 and Charts provided in Section 5).

The phases of elongation for both wire sizes are summarized in Table 2:

TABLE 2: ELONGATION BY PHASE	
PHASE 1	
90 degree bend in longitudinal wire opens until free-end comes in to contact with test panel.	
W24	
Average (in)	0.207
Range (in)	0.125 to 0.256
PHASE 2	
The bend radius of the longitudinal wire closes around the connector pin.	
W24	
Average (in)	1.106
Range (in)	0.948 to 1.290
PHASE 3	
The yield strength of the longitudinal wire is reached causing elastic deformation.	
W24	
Average (in)*	0.0574
Range (in)*	0.0574
PHASE 4	
The yield strength of the longitudinal wire is exceeded causing plastic deformation or necking down, followed by fracture.	
W24	
Average (in)	0.178
Range (in)	0 to .333
TOTAL	
The sum of all the phases of elongation.	
W24	
Average (in)	1.549
Range (in)	1.211 to 1.750

*Phase 3 measurement is based upon expected elongation.

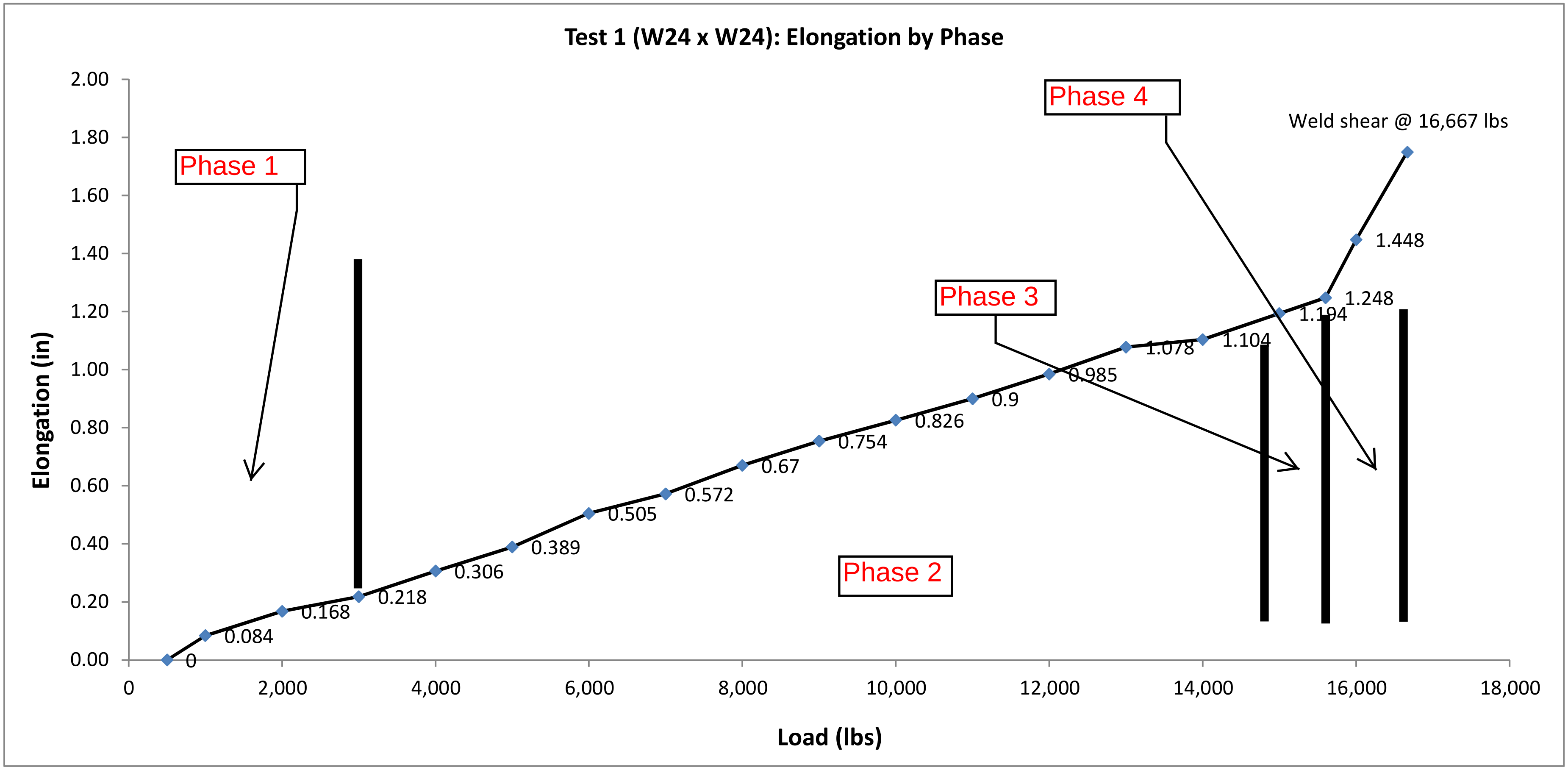
All samples tested were given a thorough visual inspection prior to testing, as noted on the Material Measurement sheets provided in Section 5, the condition of all samples was "OK".

4.2 CONCLUSION

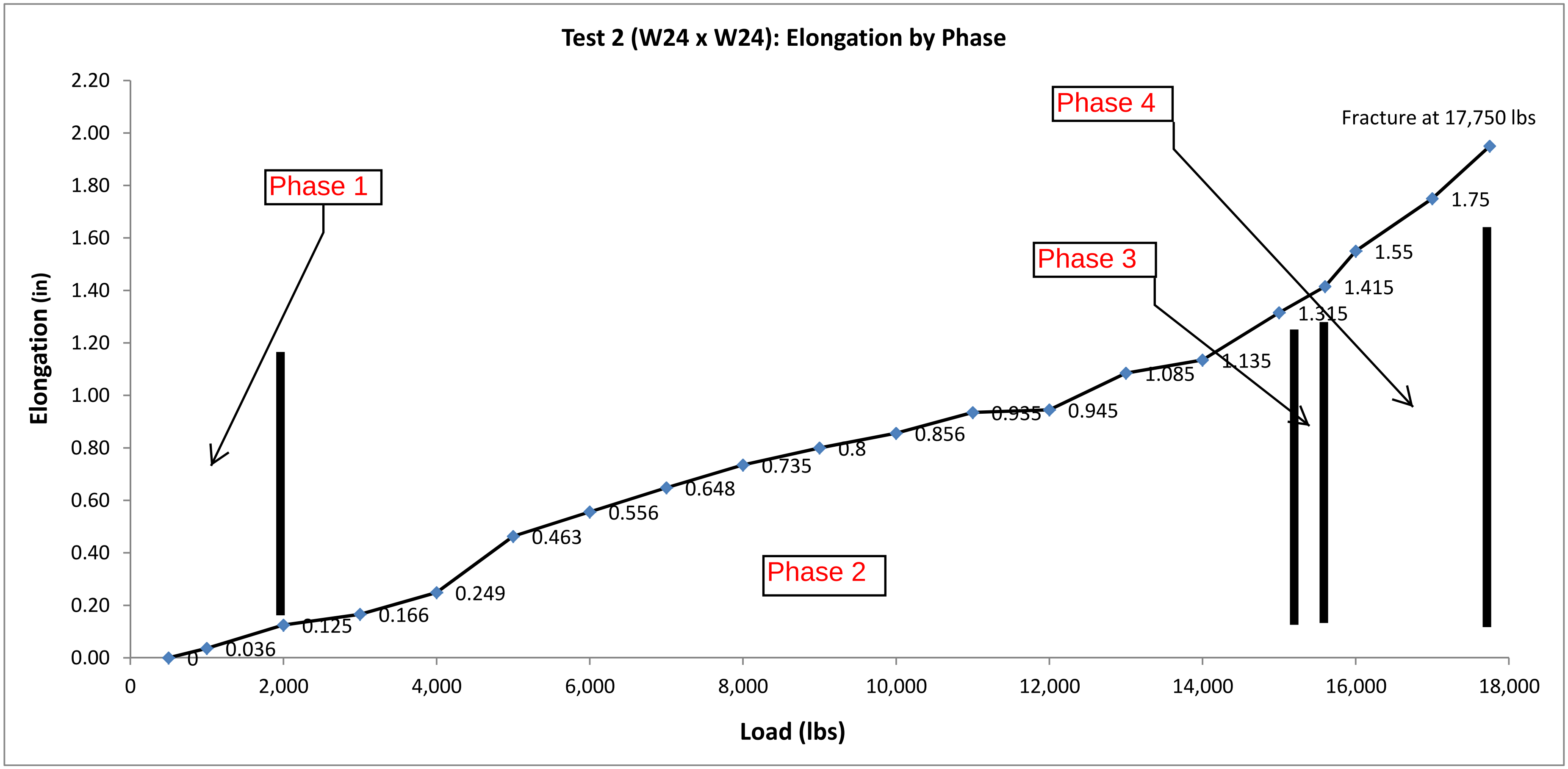
The test results provided herein conclude that all elements of the panel to soil-reinforcement connection of the MSE*Plus*™ system meet or exceed the tensile capacity of the reinforcing wire for W24 sizes which satisfies Caltrans requirements

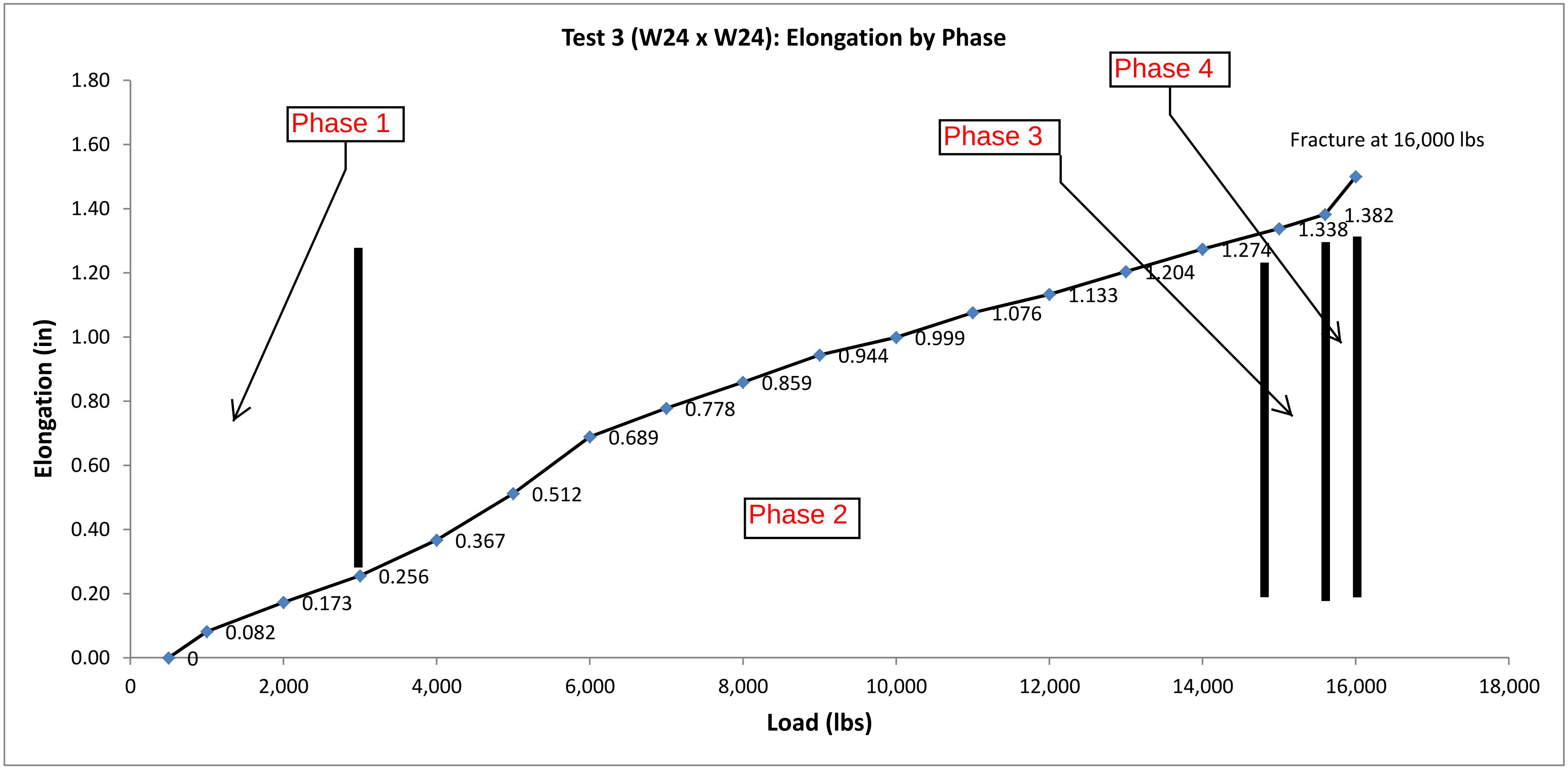
5. TEST DATA

5.1 CHARTS DETAILING ELONGATION BY PHASE

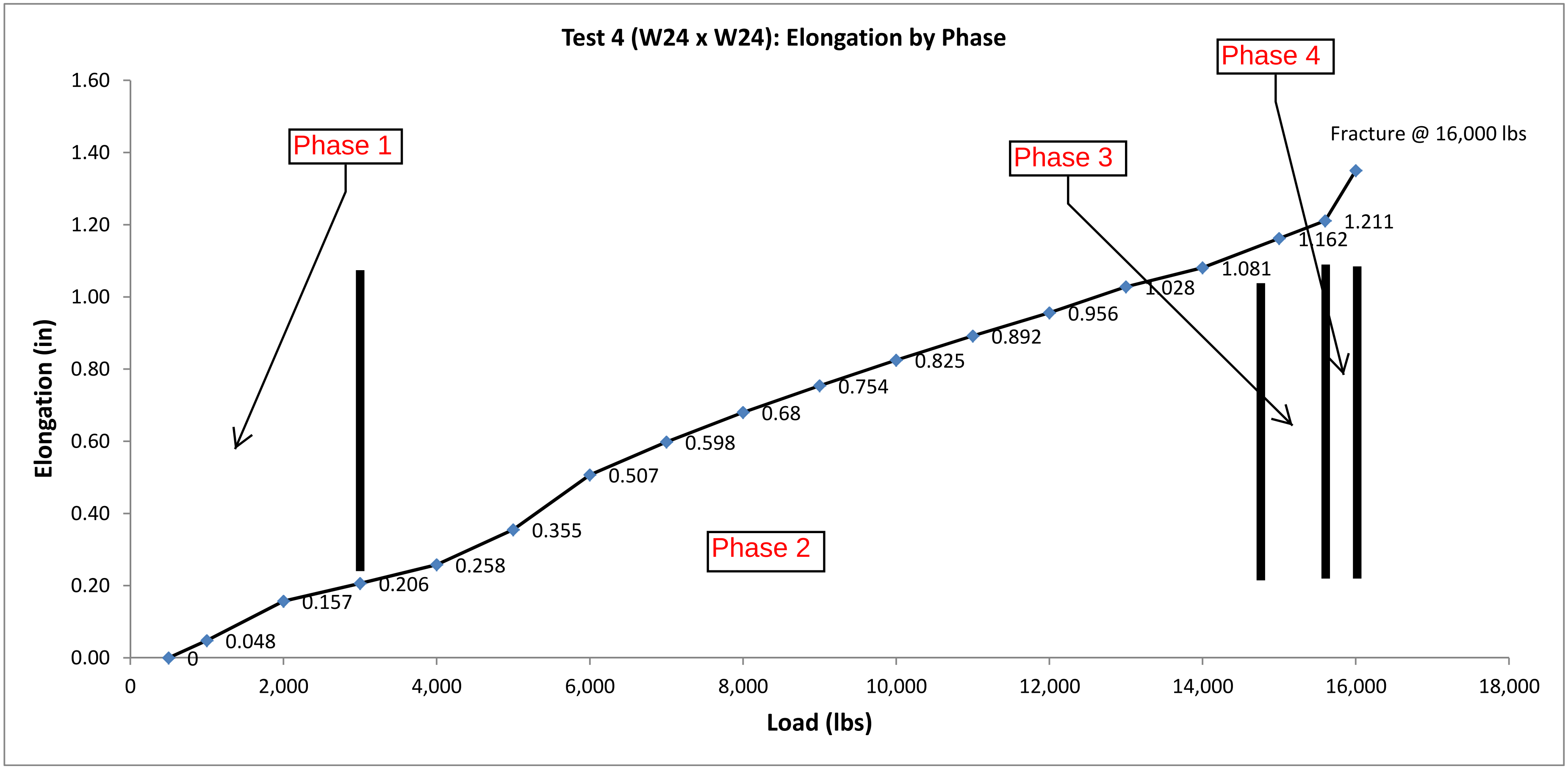


Test 1 (W24 x W24): Elongation by Phase
Elongation (in)
Load (lbs)
Phase 1
Phase 2
Phase 3
Phase 4
Weld shear @ 16,667 lbs
0
0.084
0.168
0.218
0.306
0.389
0.505
0.572
0.67
0.754
0.826
0.9
0.985
1.078
1.104
1.194
1.248
1.448
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000

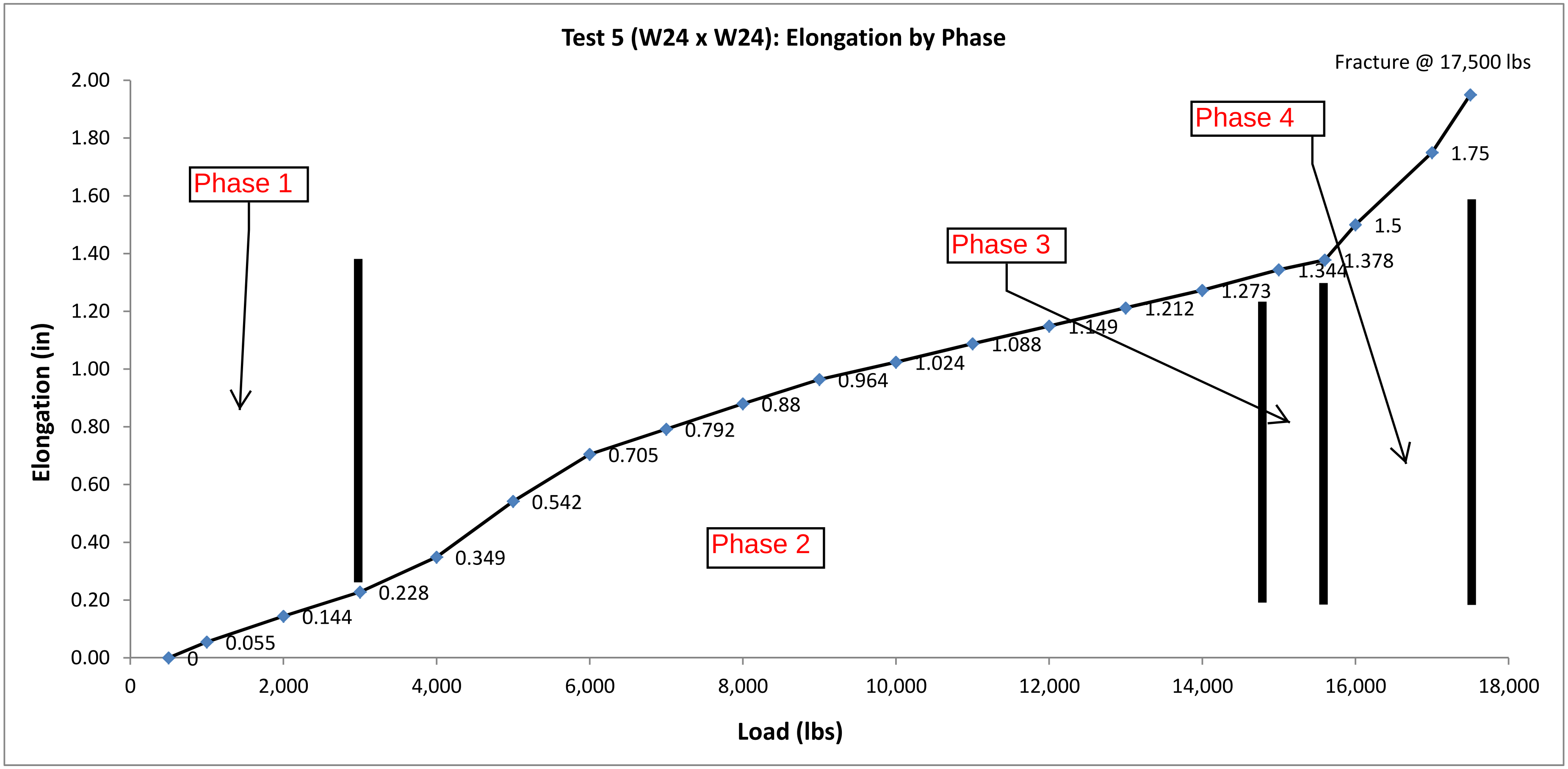

Test 2 (W24 x W24): Elongation by Phase
Elongation (in)
Load (lbs)
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
Phase 1
Phase 2
Phase 3
Phase 4
Fracture at 17,750 lbs
0
0.036
0.125
0.166
0.249
0.463
0.556
0.648
0.735
0.8
0.856
0.935
0.945
1.085
1.135
1.315
1.415
1.55
1.75



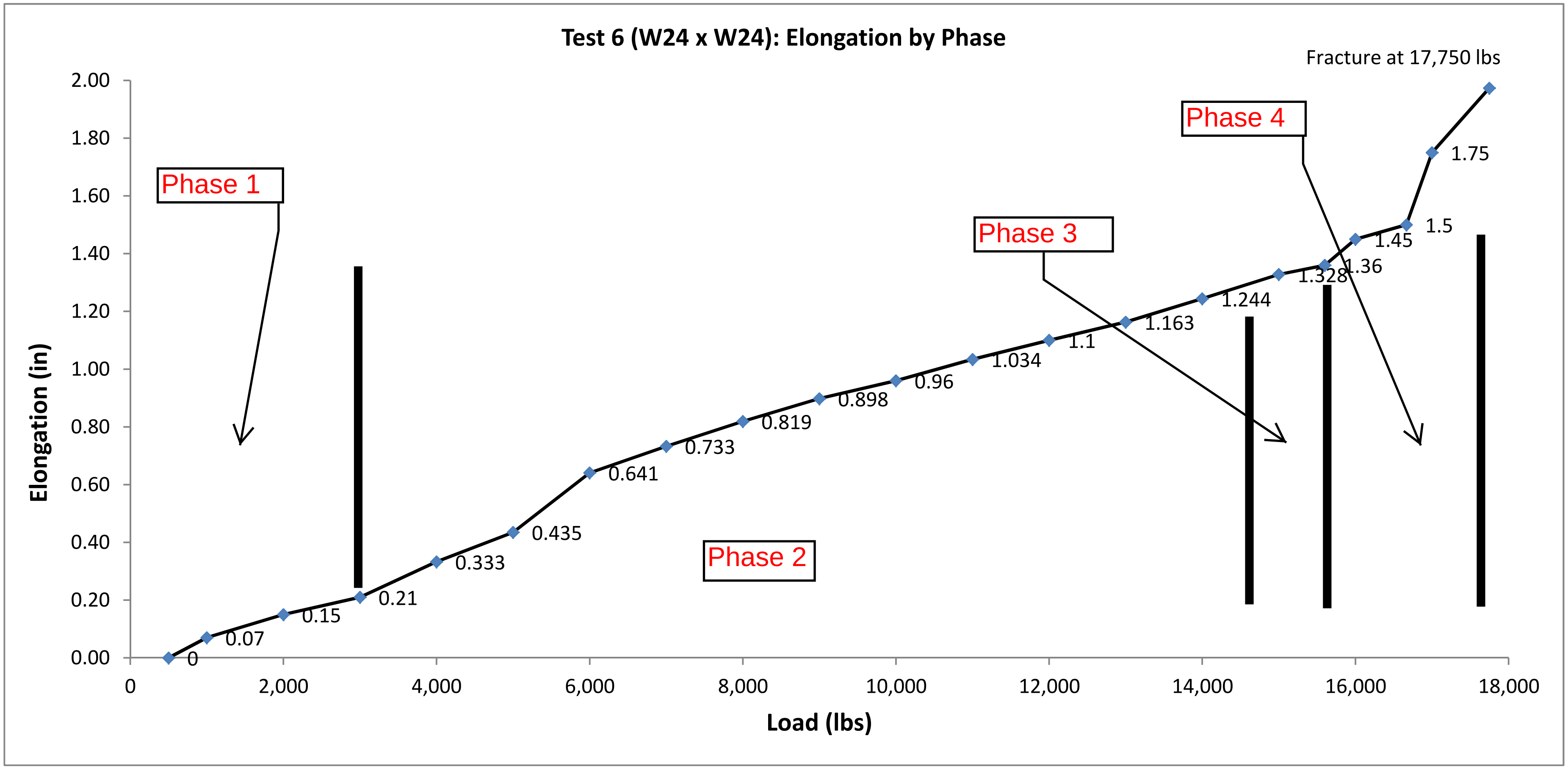
Test 3 (W24 x W24): Elongation by Phase
Phase 1
Phase 2
Phase 3
Phase 4
Fracture at 16,000 lbs
Elongation (in)
Load (lbs)
0
0.082
0.173
0.256
0.367
0.512
0.689
0.778
0.859
0.944
0.999
1.076
1.133
1.204
1.274
1.338
1.382
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000



Test 4 (W24 x W24): Elongation by Phase
Phase 1
Phase 2
Phase 3
Phase 4
Fracture @ 16,000 lbs
0
0.048
0.157
0.206
0.258
0.355
0.507
0.598
0.68
0.754
0.825
0.892
0.956
1.028
1.081
1.162
1.211
Elongation (in)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
Load (lbs)
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000



Test 5 (W24 x W24): Elongation by Phase
Fracture @ 17,500 lbs
Phase 1
Phase 2
Phase 3
Phase 4
Elongation (in)
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
Load (lbs)
0
0.055
0.144
0.228
0.349
0.542
0.705
0.792
0.88
0.964
1.024
1.088
1.149
1.212
1.273
1.344
1.378
1.5
1.75



Test 6 (W24 x W24): Elongation by Phase
Fracture at 17,750 lbs
Phase 1
Phase 2
Phase 3
Phase 4
Elongation (in)
Load (lbs)
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
0
0.07
0.15
0.21
0.333
0.435
0.641
0.733
0.819
0.898
0.96
1.034
1.1
1.163
1.244
1.328
1.36
1.45
1.5
1.75

INNOVATIVE CONSTRUCTION PRODUCTS

5.2 TEST DATA

SSL Connection Test

Test Date: 12/7/2012

Test #: 1

RESULTS: PASS, Weld shear at 16,667 lbs of forces

Sample Identification: W24 x W24 (#1)

Administered by: Nick Haven (SSL), Robert Ellefritz (SSL), witnessed by Jose Jimenez (Twining)

Ram/Gauge 12k-12-3

PSI	Elong	Load (lbs)
250/AL1	-	500
450	0.084	1,000
775	0.168	2,000
1125/AL2	0.218	3,000
1,500	0.306	4,000
1,825	0.389	5,000
2,225	0.505	6,000
2,550	0.572	7,000
2,925	0.670	8,000
3,300	0.754	9,000
3,650	0.826	10,000
4,000	0.900	11,000
4,350	0.985	12,000
4,725	1.078	13,000
5,050	1.104	14,000
5,425	1.194	15,000
5,650	**1.248**	**15,600**
5,800	1.448	16,000
6,000	Weld Shear	16,667
6,100		17,000
6,500		18,000
6,850		19,000
7,250		20,000

Elongation by Phase		
Phase 1	0.218	in
Phase 1A	-	in
Phase 2	1.030	in
Phase 3*	0.0574	in
Phase 4	0.143	in
Total	1.448	in

SSL Connection Test

Test Date: 12/7/2012

Test #: 2

RESULTS: PASS, Longitudinal wire fracture at 17,750 lbs.

Sample Identification: W24 x W24 (#2)

Administered by: Nick Haven (SSL), Robert Ellefritz (SSL), witnessed by Jose Jimenez (Twining)

Ram/Gauge 12k-12-3

PSI	Elong	Load (lbs)
250/AL1	-	500
450	0.036	1,000
775/AL2	0.125	2,000
1,125	0.166	3,000
1,500	0.249	4,000
1,825	0.463	5,000
2,225	0.556	6,000
2,550	0.648	7,000
2,925	0.735	8,000
3,300	0.800	9,000
3,650	0.856	10,000
4,000	0.935	11,000
4,350	0.945	12,000
4,725	1.085	13,000
5,050	1.135	14,000
5,425	1.315	15,000
5,650	**1.415**	**15,600**
5,800	1.550	16,000
6,100	1.750	17,000
6,400	Fracture @ Bend	17,750
6,500		18,000
6,850		19,000
7,250		20,000

Elongation by Phase		
Phase 1	0.125	in
Phase 1A	-	in
Phase 2	1.290	in
Phase 3*	0.0574	in
Phase 4	0.278	in
Total	1.750	in

SSL Connection Test

Test Date: 12/7/2012 | Test #: 3 | **RESULTS:** PASS, Longitudinal wire fracture at 16,000 lbs.

Sample Identification: W24 x W24 (#3)

Administered by: Nick Haven (SSL), Robert Ellefritz (SSL), witnessed by Jose Jimenez (Twining)

Ram/Gauge 12k-12-3

PSI	Elong	Load (lbs)
250/AL1	-	500
450	0.082	1,000
775	0.173	2,000
1125/AL2	0.256	3,000
1,500	0.367	4,000
1,825	0.512	5,000
2,225	0.689	6,000
2,550	0.778	7,000
2,925	0.859	8,000
3,300	0.944	9,000
3,650	0.999	10,000
4,000	1.076	11,000
4,350	1.133	12,000
4,725	1.204	13,000
5,050	1.274	14,000
5,425	1.338	15,000
5,650	**1.382**	**15,600**
5,800	Fracture @ Bend	16,000
6,000		16,667
6,100		17,000
6,500		18,000
6,850		19,000
7,250		20,000

Elongation by Phase		
Phase 1	0.256	in
Phase 1A	-	in
Phase 2	1.069	in
Phase 3*	0.0574	in
Phase 4	-	in
Total	1.382	in

SSL Connection Test

Test Date: 12/7/2012

Test #: 4

RESULTS: PASS, Longitudinal wire fracture at 16,000 lbs.

Sample Identification: W24 x W24 (#4)

Administered by: Nick Haven (SSL), Robert Ellefritz (SSL), witnessed by Jose Jimenez (Twining)

Ram/Gauge 12k-12-3

PSI	Elong	Load (lbs)
250/AL1	-	500
450	0.048	1,000
775	0.157	2,000
1125/AL2	0.206	3,000
1,500	0.258	4,000
1,825	0.355	5,000
2,225	0.507	6,000
2,550	0.598	7,000
2,925	0.680	8,000
3,300	0.754	9,000
3,650	0.825	10,000
4,000	0.892	11,000
4,350	0.956	12,000
4,725	1.028	13,000
5,050	1.081	14,000
5,425	1.162	15,000
5,650	**1.211**	**15,600**
5,800	Fracture @ Bend	16,000
6,000		16,667
6,100		17,000
6,500		18,000
6,850		19,000
7,250		20,000

Elongation by Phase		
Phase 1	0.206	in
Phase 1A	-	in
Phase 2	0.948	in
Phase 3*	0.0574	in
Phase 4	-	in
Total	1.211	in

SSL Connection Test

Test Date: 12/7/2012

Test #: 5

RESULTS: PASS, Longitudinal wire fracture at 17,500 lbs.

Sample Identification: W24 x W24 (#5)

Administered by: Nick Haven (SSL), Robert Ellefritz (SSL), witnessed by Jose Jimenez (Twining)

Ram/Gauge 12k-12-3

PSI	Elong	Load (lbs)
250/AL1	-	500
450	0.055	1,000
775	0.144	2,000
1125/AL2	0.228	3,000
1,500	0.349	4,000
1,825	0.542	5,000
2,225	0.705	6,000
2,550	0.792	7,000
2,925	0.880	8,000
3,300	0.964	9,000
3,650	1.024	10,000
4,000	1.088	11,000
4,350	1.149	12,000
4,725	1.212	13,000
5,050	1.273	14,000
5,425	1.344	15,000
5,650	**1.378**	**15,600**
5,800	1.500	16,000
6,100	1.750	17,000
6,300	Fracture @ Bend	17,500
6,500		18,000
6,850		19,000
7,250		20,000

Elongation by Phase		
Phase 1	0.228	in
Phase 1A	-	in
Phase 2	1.150	in
Phase 3*	0.0574	in
Phase 4	0.315	in
Total	1.750	in

SSL Connection Test

Test Date: 12/7/2012

Test #: 6

RESULTS: PASS, Longitudinal wire fracture at 17,750 lbs.

Sample Identification: W24 x W24 (#6)

Administered by: Nick Haven (SSL), Robert Ellefritz (SSL), witnessed by Jose Jimenez (Twining)

Ram/Gauge 12k-12-3

PSI	Elong	Load (lbs)
250/AL1	-	500
450	0.070	1,000
775	0.150	2,000
1125/AL2	0.210	3,000
1,500	0.333	4,000
1,825	0.435	5,000
2,225	0.641	6,000
2,550	0.733	7,000
2,925	0.819	8,000
3,300	0.898	9,000
3,650	0.960	10,000
4,000	1.034	11,000
4,350	1.100	12,000
4,725	1.163	13,000
5,050	1.244	14,000
5,425	1.328	15,000
5,650	**1.360**	**15,600**
5,800	1.450	16,000
6,000	1.500	16,667
6,100	1.750	17,000
6,400	Fracture @ Bend	17,750
6,500		18,000
6,850		19,000
7,250		20,000

Elongation by Phase		
Phase 1	0.210	in
Phase 1A	-	in
Phase 2	1.150	in
Phase 3*	0.0574	in
Phase 4	0.333	in
Total	1.750	in

5.3 ORIGINAL TEST DATA

SSL Connection Test

Test Date: 12/7/12 Test #: **RESULTS:**

Sample Identification: 24/24 #6 Administered by: [illegible]

Ram/Gauge 12k-12-1

PSI	Elong	Load (lbs)
250		500
475		1,000
850		2,000
1,275		3,000
1,700		4,000
2,150		5,000
2,525		6,000
2,925		7,000
3,025		**7,150**
3,350		8,000
3,800		9,000
4,200		10,000
4,625		11,000
5,050		12,000
5,475		**13,000**
5,900		14,000
6,300		15,000
6,725		16,000
7,150		17,000
7,600		18,000
8,000		19,000
8,425		20,000

Ram/Gauge 12k-12-2

PSI	Elong	Load (lbs)
250		500
450		1,000
800		2,000
1,150		3,000
1,525		4,000
1,900		5,000
2,250		6,000
2,625		7,000
2,690		**7,150**
2,950		8,000
3,325		9,000
3,675		10,000
4,050		11,000
4,400		12,000
4,750		**13,000**
5,125		14,000
5,450		15,000
5,850		16,000
6,200		17,000
6,525		18,000
6,900		19,000
7,275		20,000

Ram/Gauge 12k-12-3

PSI	Elong	Load (lbs)
250	0	500
450	0.070	1,000
775	0.150	2,000
1,125	0.210	3,000
1,500	0.333	4,000
1,825	0.435	5,000
2,225	0.641	6,000
2,550	0.733	7,000
2,625	0.755	**7,150**
2,925	0.519	8,000
3,300	0.898	9,000
3,650	0.960	10,000
4,000	+	0.079 11,000
4,350		0.140 12,000
4,725		0.203 **13,000**
5,050		0.284 14,000
5,425		0.368 15,000
5650 5,800	1.36"	0.400 16,000
6,100		17,000
6,500		18,000
6,850		19,000
7,250		20,000

Ram/Gauge 12k-12-4

PSI	Elong	Load (lbs)
200		500
400		1,000
775		2,000
1,150		3,000
1,525		4,000
1,875		5,000
2,250		6,000
2,625		7,000
2,650		**7,150**
2,975		8,000
3,350		9,000
3,700		10,000
4,050		11,000
4,450		12,000
4,800		**13,000**
5,150		14,000
5,500		15,000
5,850		16,000
6,250		17,000
6,600		18,000
6,950		19,000
7,325		20,000

Break @ Bend
6400 PSI
Tape Measured 1'-15/16" @ 5650 PSI

SSL Connection Test

Test Date: 12-7-12 Test #: **RESULTS:**

Sample Identification: 21/21 #1 Administered by: RJE

Ram/Gauge 12k-12-1

PSI	Elong	Load (lbs)
250		500
475		1,000
850		2,000
1,275		3,000
1,700		4,000
2,150		5,000
2,525		6,000
2,925		7,000
3,025		**7,150**
3,350		8,000
3,800		9,000
4,200		10,000
4,625		11,000
5,050		12,000
5,475		**13,000**
5,900		14,000
6,300		15,000
6,725		16,000
7,150		17,000
7,600		18,000
8,000		19,000
8,425		20,000

Ram/Gauge 12k-12-2

PSI	Elong	Load (lbs)
250		500
450		1,000
800		2,000
1,150		3,000
1,525		4,000
1,900		5,000
2,250		6,000
2,625		7,000
2,690		**7,150**
2,950		8,000
3,325		9,000
3,675		10,000
4,050		11,000
4,400		12,000
4,750		**13,000**
5,125		14,000
5,450		15,000
5,850		16,000
6,200		17,000
6,525		18,000
6,900		19,000
7,275		20,000

Ram/Gauge 12k-12-3

PSI	Elong	Load (lbs)
250	0	500
450	0.084	1,000
775	0.168	2,000
1,125	0.215	3,000
1,500	0.306	4,000
1,825	0.389	5,000
2,225	0.505	6,000
2,550	0.572	7,000
2,625	0.594	**7,150**
2,925	0.670	8,000
3,300	0.754	9,000
3,650	0.826	10,000
4,000	0.900	11,000
4,350	0.985	12,000
4,725	+	0.093 **13,000**
5,050		0.119 14,000
5,425		0.309 15,000
5650 5,800	1.248"	0.263 16,000
6,100		17,000
6,500		18,000
6,850		19,000
7,250		20,000

Ram/Gauge 12k-12-4

PSI	Elong	Load (lbs)
200		500
400		1,000
775		2,000
1,150		3,000
1,525		4,000
1,875		5,000
2,250		6,000
2,625		7,000
2,650		**7,150**
2,975		8,000
3,350		9,000
3,700		10,000
4,050		11,000
4,450		12,000
4,800		**13,000**
5,150		14,000
5,500		15,000
5,850		16,000
6,250		17,000
6,600		18,000
6,950		19,000
7,325		20,000

Break @ Transverse Bar Weld
6000 PSI
Tape Measured 1'-1 1/4" @ 5650 PSI

SSL Connection Test

Test Date: 12-7/12   Test #:   **RESULTS:**

Sample Identification: 24/24 #2   Administered by: RZ

Ram/Gauge 12k-12-1

PSI	Elong	Load (lbs)
250		500
475		1,000
850		2,000
1,275		3,000
1,700		4,000
2,150		5,000
2,525		6,000
2,925		7,000
3,025		**7,150**
3,350		8,000
3,800		9,000
4,200		10,000
4,625		11,000
5,050		12,000
5,475		**13,000**
5,900		14,000
6,300		15,000
6,725		16,000
7,150		17,000
7,600		18,000
8,000		19,000
8,425		20,000

Ram/Gauge 12k-12-2

PSI	Elong	Load (lbs)
250		500
450		1,000
800		2,000
1,150		3,000
1,525		4,000
1,900		5,000
2,250		6,000
2,625		7,000
2,690		**7,150**
2,950		8,000
3,325		9,000
3,675		10,000
4,050		11,000
4,400		12,000
4,750		**13,000**
5,125		14,000
5,450		15,000
5,850		16,000
6,200		17,000
6,525		18,000
6,900		19,000
7,275		20,000

Ram/Gauge 12k-12-3

PSI	Elong	Load (lbs)
250	0	500
450	0.036	1,000
775	0.125	2,000
1,125	0.166	3,000
1,500	0.329	4,000
1,825	0.463	5,000
2,225	0.556	6,000
2,550	0.648	7,000
2,625	0.677	**7,150**
2,925	0.735	8,000
3,300	0.800	9,000
3,650	0.856	10,000
4,000	0.935	11,000
4,350	+	0.010 12,000
4,725		0.150 **13,000**
5,050		0.200 14,000
5,425		0.350 15,000
5650 5,800	1.415"	0.450 16,000
6,100		17,000
6,500		18,000
6,850		19,000
7,250		20,000

Ram/Gauge 12k-12-4

PSI	Elong	Load (lbs)
200		500
400		1,000
775		2,000
1,150		3,000
1,525		4,000
1,875		5,000
2,250		6,000
2,625		7,000
2,650		**7,150**
2,975		8,000
3,350		9,000
3,700		10,000
4,050		11,000
4,450		12,000
4,800		**13,000**
5,150		14,000
5,500		15,000
5,850		16,000
6,250		17,000
6,600		18,000
6,950		19,000
7,325		20,000

Break @ Bend
6400 PSI
Tape Measured at 1'-1 3/8" @ 5650 PSI

SSL Connection Test

Test Date: 12/7/12 Test #: **RESULTS:**

Sample Identification: 24/24 #3 Administered by: DAE

Ram/Gauge 12k-12-1

PSI	Elong	Load (lbs)
250		500
475		1,000
850		2,000
1,275		3,000
1,700		4,000
2,150		5,000
2,525		6,000
2,925		7,000
3,025		**7,150**
3,350		8,000
3,800		9,000
4,200		10,000
4,625		11,000
5,050		12,000
5,475		**13,000**
5,900		14,000
6,300		15,000
6,725		16,000
7,150		17,000
7,600		18,000
8,000		19,000
8,425		20,000

Ram/Gauge 12k-12-2

PSI	Elong	Load (lbs)
250		500
450		1,000
800		2,000
1,150		3,000
1,525		4,000
1,900		5,000
2,250		6,000
2,625		7,000
2,690		**7,150**
2,950		8,000
3,325		9,000
3,675		10,000
4,050		11,000
4,400		12,000
4,750		**13,000**
5,125		14,000
5,450		15,000
5,850		16,000
6,200		17,000
6,525		18,000
6,900		19,000
7,275		20,000

Ram/Gauge 12k-12-3

PSI	Elong	Load (lbs)
250	0	500
450	0.082	1,000
775	0.173	2,000
1,125	0.256	3,000
1,500	0.367	4,000
1,825	0.512	5,000
2,225	0.659	6,000
2,550	0.778	7,000
2,625	0.811	**7,150**
2,925	0.859	8,000
3,300	0.944	9,000
3,650	+	0.055 10,000
4,000		0.132 11,000
4,350		0.159 12,000
4,725		0.271 **13,000**
5,050		0.330 14,000
5,425		0.394 15,000
5650 5,800	1.382"	0.438 16,000
6,100		17,000
6,500		18,000
6,850		19,000
7,250		20,000

Ram/Gauge 12k-12-4

PSI	Elong	Load (lbs)
200		500
400		1,000
775		2,000
1,150		3,000
1,525		4,000
1,875		5,000
2,250		6,000
2,625		7,000
2,650		**7,150**
2,975		8,000
3,350		9,000
3,700		10,000
4,050		11,000
4,450		12,000
4,800		**13,000**
5,150		14,000
5,500		15,000
5,850		16,000
6,250		17,000
6,600		18,000
6,950		19,000
7,325		20,000

Break @ Bend
5800 PSI
Tape Measured 1'-1¼" @ 5650 PSI

SSL Connection Test

Test Date: 12/7/10 Test #: **RESULTS:**

Sample Identification: 24/24 #21 Administered by: RJE

Ram/Gauge 12k-12-1

PSI	Elong	Load (lbs)
250		500
475		1,000
850		2,000
1,275		3,000
1,700		4,000
2,150		5,000
2,525		6,000
2,925		7,000
3,025		**7,150**
3,350		8,000
3,800		9,000
4,200		10,000
4,625		11,000
5,050		12,000
5,475		**13,000**
5,900		14,000
6,300		15,000
6,725		16,000
7,150		17,000
7,600		18,000
8,000		19,000
8,425		20,000

Ram/Gauge 12k-12-2

PSI	Elong	Load (lbs)
250		500
450		1,000
800		2,000
1,150		3,000
1,525		4,000
1,900		5,000
2,250		6,000
2,625		7,000
2,690		**7,150**
2,950		8,000
3,325		9,000
3,675		10,000
4,050		11,000
4,400		12,000
4,750		**13,000**
5,125		14,000
5,450		15,000
5,850		16,000
6,200		17,000
6,525		18,000
6,900		19,000
7,275		20,000

Ram/Gauge 12k-12-3

PSI	Elong	Load (lbs)
250	0	500
450	0.045	1,000
775	0.157	2,000
1,125	0.216	3,000
1,500	0.258	4,000
1,825	0.355	5,000
2,225	0.507	6,000
2,550	0.598	7,000
2,625	0.610	**7,150**
2,925	0.680	8,000
3,300	0.754	9,000
3,650	0.825	10,000
4,000	0.842	11,000
4,350	0.956	12,000
4,725	+	0.072 **13,000**
5,050		0.125 14,000
5,425		0.206 15,000
5650 ~~5,800~~	1.211"	0.251 ~~16,000~~
6,100		17,000
6,500		18,000
6,850		19,000
7,250		20,000

Ram/Gauge 12k-12-4

PSI	Elong	Load (lbs)
200		500
400		1,000
775		2,000
1,150		3,000
1,525		4,000
1,875		5,000
2,250		6,000
2,625		7,000
2,650		**7,150**
2,975		8,000
3,350		9,000
3,700		10,000
4,050		11,000
4,450		12,000
4,800		**13,000**
5,150		14,000
5,500		15,000
5,850		16,000
6,250		17,000
6,600		18,000
6,950		19,000
7,325		20,000

Transverse Bar Broke @ Weld
5800 PSI
Tape Measured 1'-1 3/8" @ 5650 PSI

SSL Connection Test

Test Date: 12/7/22 Test #: **RESULTS:**

Sample Identification: 24/24 # 5 Administered by: [illegible]

Ram/Gauge 12k-12-1

PSI	Elong	Load (lbs)
250		500
475		1,000
850		2,000
1,275		3,000
1,700		4,000
2,150		5,000
2,525		6,000
2,925		7,000
3,025		**7,150**
3,350		8,000
3,800		9,000
4,200		10,000
4,625		11,000
5,050		12,000
5,475		**13,000**
5,900		14,000
6,300		15,000
6,725		16,000
7,150		17,000
7,600		18,000
8,000		19,000
8,425		20,000

Ram/Gauge 12k-12-2

PSI	Elong	Load (lbs)
250		500
450		1,000
800		2,000
1,150		3,000
1,525		4,000
1,900		5,000
2,250		6,000
2,625		7,000
2,690		**7,150**
2,950		8,000
3,325		9,000
3,675		10,000
4,050		11,000
4,400		12,000
4,750		**13,000**
5,125		14,000
5,450		15,000
5,850		16,000
6,200		17,000
6,525		18,000
6,900		19,000
7,275		20,000

Ram/Gauge 12k-12-3

PSI	Elong	Load (lbs)
250	0	500
450	0.055	1,000
775	0.144	2,000
1,125	0.228	3,000
1,500	0.349	4,000
1,825	0.542	5,000
2,225	0.705	6,000
2,550	0.772	7,000
2,625	0.823	**7,150**
2,925	0.850	8,000
3,300	0.964	9,000
3,650	+	0.060 10,000
4,000		0.124 11,000
4,350		0.185 12,000
4,725		0.245 **13,000**
5,050		0.309 14,000
5,425		0.380 15,000
5650 5,800	1.378"	0.414 16,000
6,100		17,000
6,500		18,000
6,850		19,000
7,250		20,000

Ram/Gauge 12k-12-4

PSI	Elong	Load (lbs)
200		500
400		1,000
775		2,000
1,150		3,000
1,525		4,000
1,875		5,000
2,250		6,000
2,625		7,000
2,650		**7,150**
2,975		8,000
3,350		9,000
3,700		10,000
4,050		11,000
4,450		12,000
4,800		**13,000**
5,150		14,000
5,500		15,000
5,850		16,000
6,250		17,000
6,600		18,000
6,950		19,000
7,325		20,000

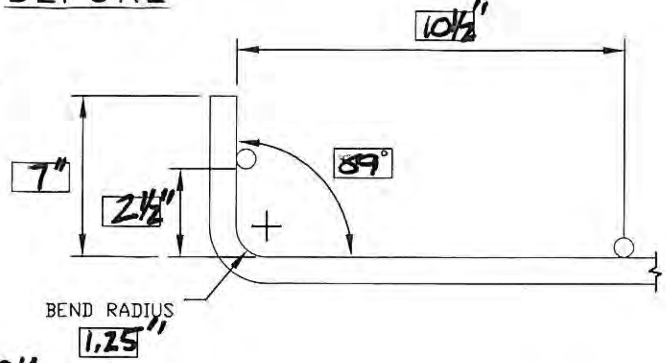
Break @ Bond
6300 PSI
Tape Measured 1'-1 3/8" @ 5650 PSI

INNOVATIVE CONSTRUCTION PRODUCTS

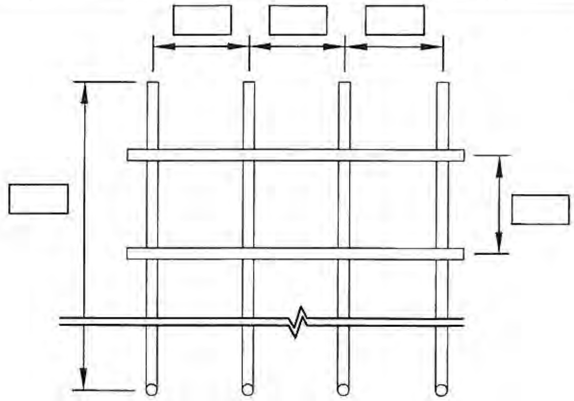
5.4 MATERIAL MEASUREMENTS

SPECIMEN NUMBER: #1

BEFORE



MESH BEND X-SECTION

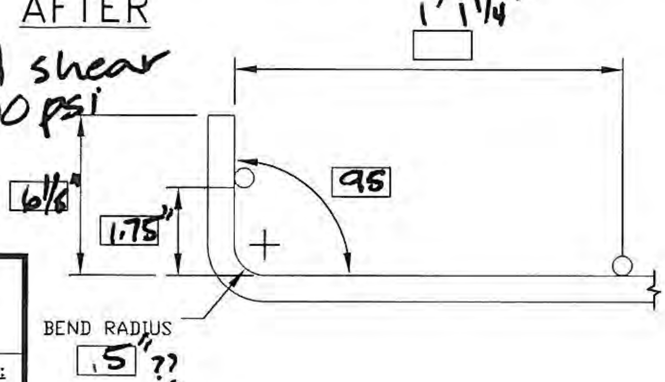


MESH PLAN VIEW

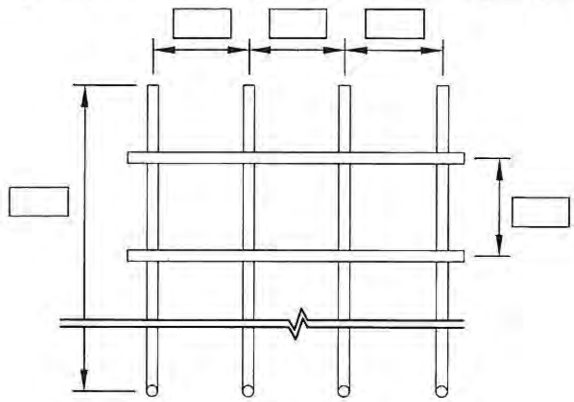
Weld OK

AFTER

★ Weld shear @ 6,000 psi



MESH BEND X-SECTION



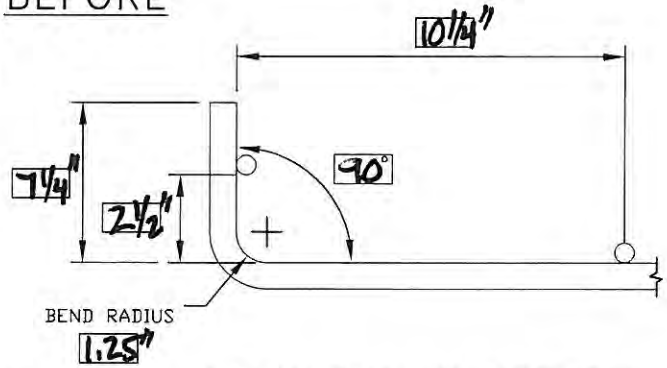
MESH PLAN VIEW

DATE TESTED: 12/7

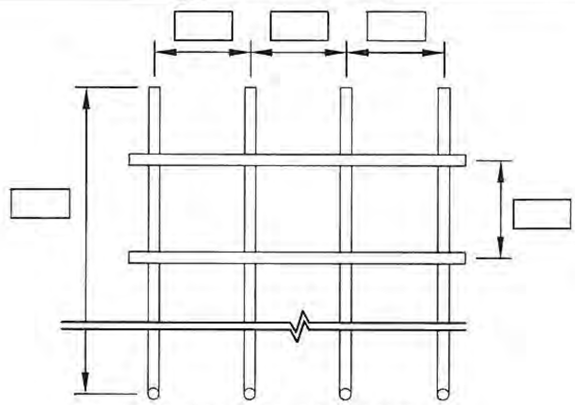
TESTER INITIALS: NH

SPECIMEN NUMBER: #2

BEFORE



MESH BEND X-SECTION

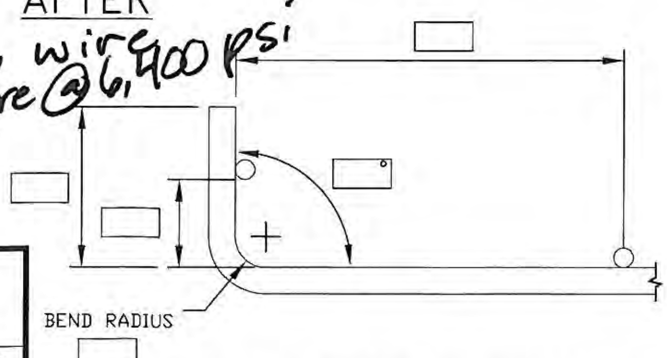


MESH PLAN VIEW

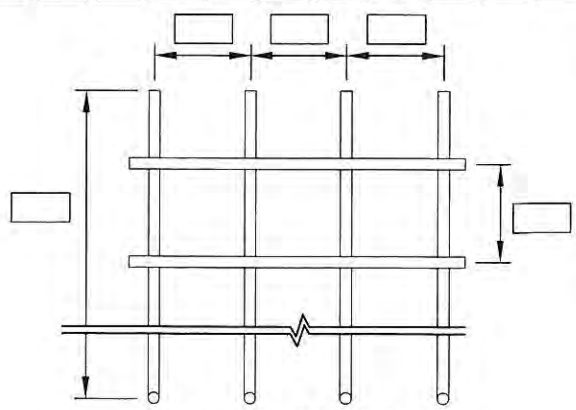
Weld OK

AFTER

★ Long wire fracture @ 6,900 psi



MESH BEND X-SECTION



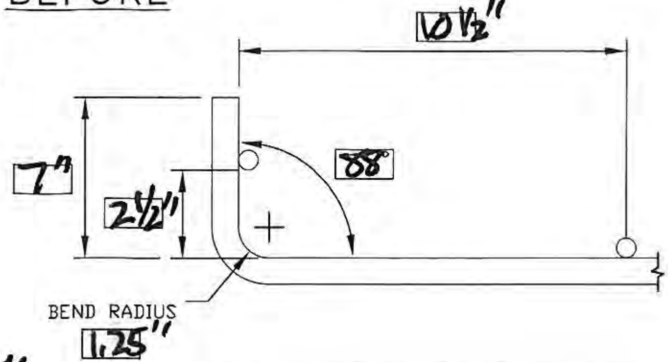
MESH PLAN VIEW

DATE TESTED: 12/7

TESTER INITIALS: NH

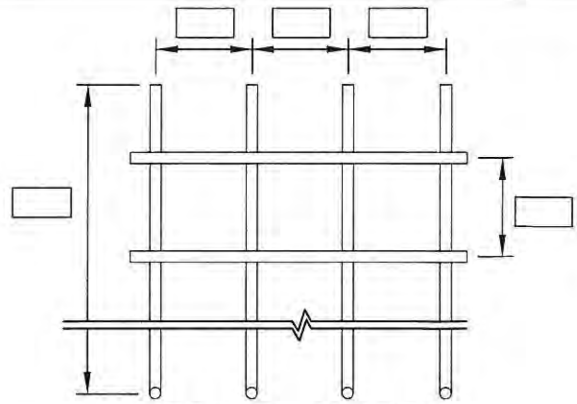
SPECIMEN NUMBER: #3

BEFORE



Weld OK

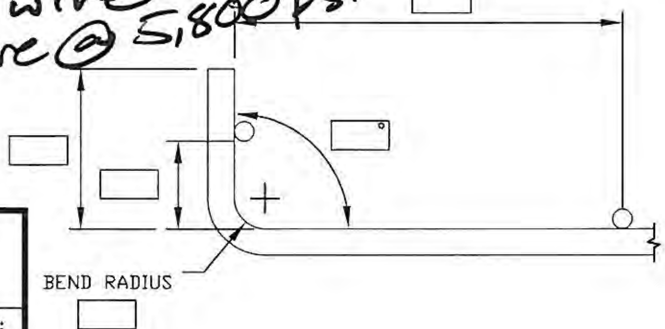
MESH BEND X-SECTION



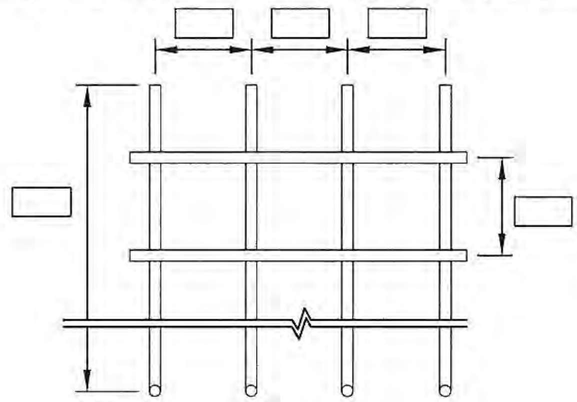
MESH PLAN VIEW

AFTER

*Long wire fracture @ 5,800 psi



MESH BEND X-SECTION



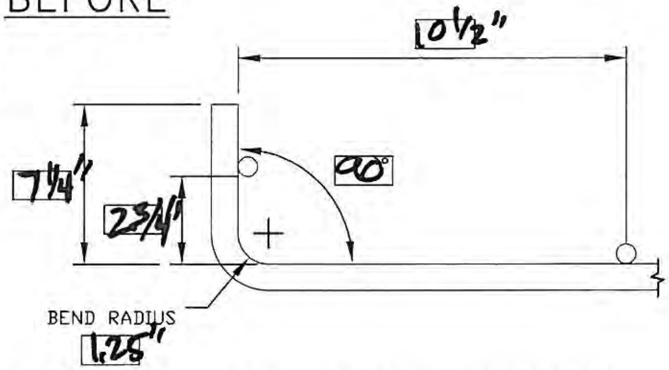
MESH PLAN VIEW

DATE TESTED: 12/7

TESTER INITIALS: NA

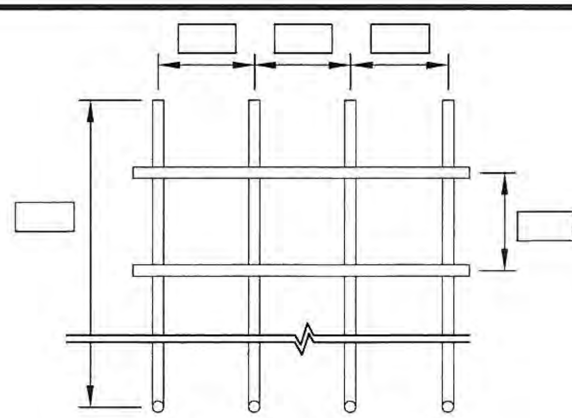
SPECIMEN NUMBER: #4

BEFORE



Weld OK

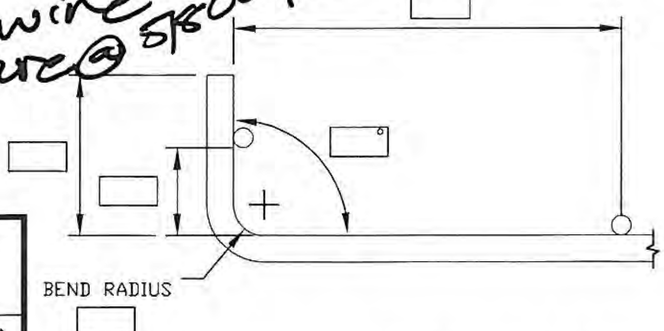
MESH BEND X-SECTION



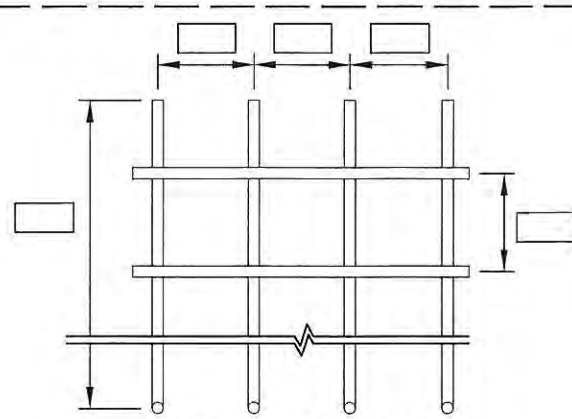
MESH PLAN VIEW

AFTER

*Long wire fracture @ 5,800 psi



MESH BEND X-SECTION



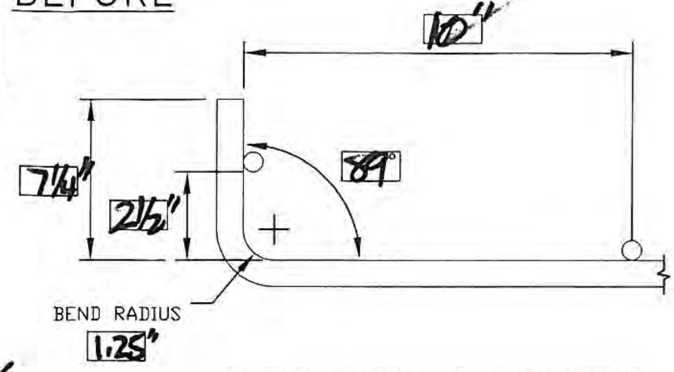
MESH PLAN VIEW

DATE TESTED: 12/7

TESTER INITIALS: NA

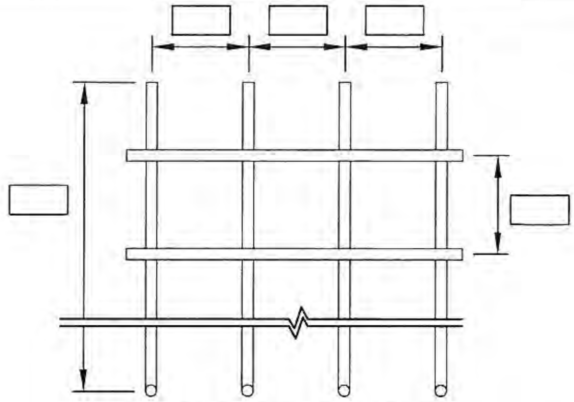
SPECIMEN NUMBER: #5

BEFORE



Weld OK

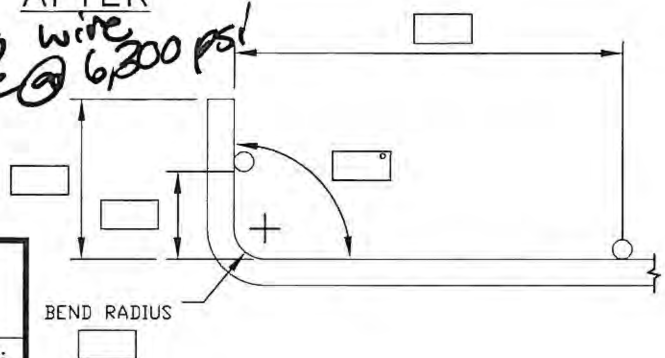
MESH BEND X-SECTION



MESH PLAN VIEW

AFTER

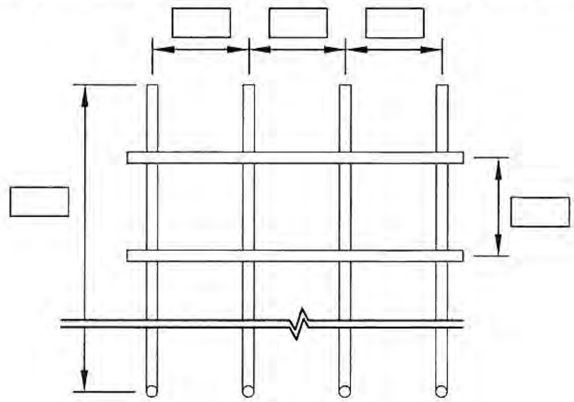
★ Long wire fracture @ 6,300 psi!



DATE TESTED: 12/7

TESTER INITIALS: NH

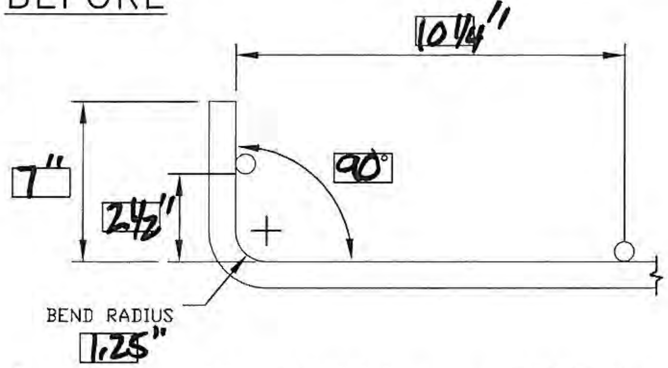
MESH BEND X-SECTION



MESH PLAN VIEW

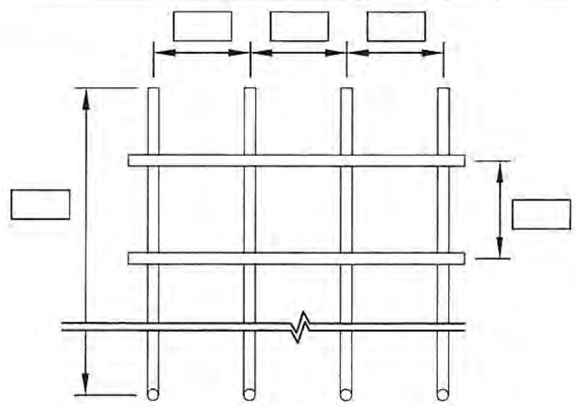
SPECIMEN NUMBER: #6

BEFORE



Weld ok

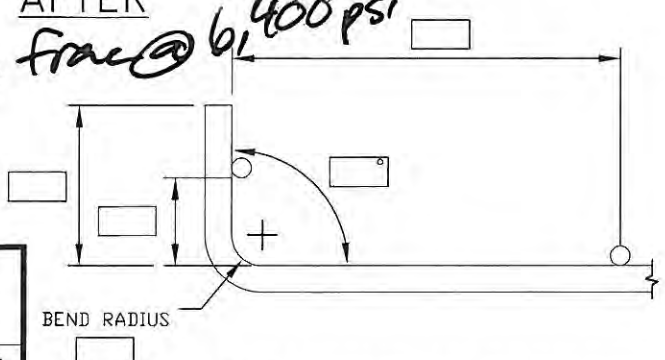
MESH BEND X-SECTION



MESH PLAN VIEW

AFTER

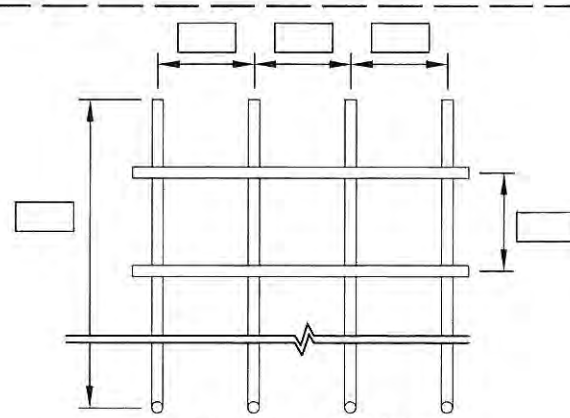
★ Long frac @ 6,400 psi



DATE TESTED:

TESTER INITIALS:

MESH BEND X-SECTION



MESH PLAN VIEW

6. INDEPENDENT VERIFICATION REPORTS

TWINING

Long Beach 562.426.3355 / Sacramento 916.649.9000 / San Bernardino 909.383.6660
San Diego 858.974.3750 / Ventura 805.644.5100 / www.twininginc.com

SERVICE TICKET

41100

CLIENT SURECAST WEST	DATE 12-7-12
ADDRESS	PO NO
CITY STATE ZIP CODE	TWINING JOB NO. 120018-3
PHONE FAX	PROJECT NO

JOB NAME SURECAST WEST	OSHPD NO. / DSA-APPL/PERMIT NO
ADDRESS 8203 ALABAMA ST	CONTRACTOR
CITY REDLANDS CA STATE ZIP CODE	CONTACT PERSON ANDREW SORIA
PHONE FAX	PHONE NO 909-335-6336

SERVICE(S) PERFORMED

- ☐ PACHOMETER
- ☒ PULL TEST
- ☐ TORQUE TEST
- ☐ MOISTURE TEST
- ☐ IN PLACE SHEAR TEST
- ☐ REBOUND HAMMER TEST
- ☐ CORE SAMPLING / REBAR SAMPLING
- ☐ MOBILE TESTING
- ☐ FIREPROOFING TEST
- ☐ OTHER(S) ____

DESCRIPTION OF WORK OBSERVED 6 PULL TESTS TO 15600 LBS ON W24x24 L CONNECTION WITH W30 CONNECTOR PIN, ELONG RESULTS TEST #1) 1.248" 2) 1.415" 3) 1.382" 4) 1.21" 5) 1.378" 6) 1.36" ALL PASSED PULL OUT TEST.
OBSERVED 2 PULL TESTS TO 13000 LBS ON W20x11 L CONNECTION WITH W30 CONNECTOR PIN. BOTH TESTS WERE INCONCLUSIVE. OBSERVED 5 PULL TESTS TO 7150 LBS ON W11x11 L CONNECTION WITH W30 CONNECTOR PIN. ELONG RESULTS. TEST #1) .970" 2) .960" 3) 1.22" 4) 1.25" 5) 1.20" ALL ~~TESTS~~ PASSED PULL OUT TEST.

START TRAVEL ☐ AM ☐ PM	TIME IN 8:00 ☒ AM ☐ PM	REGULAR 4	1.5 X (PREMIUM) Ø	2 X (PREMIUM) Ø
TIME OUT 12:00 ☐ AM ☒ PM	END TRAVEL ☐ AM ☐ PM	MEAL PERIOD (TIME) ☐ YES ☐ NO	MILEAGE 70 ☐ ROUND TRIP ☒ ONE WAY	EXPENSES

All field services performed are based on a portal to portal basis, unless agreed upon otherwise.

PERFORMED BY

(1) JOSE G. JIMENEZ	(2)	(3)
(4)	(5)	(6)

VERIFIED BY

COMPANY NAME SURECAST WEST	NAME (PRINT) Rob Elliott
DATE 12/7/12	NAME (SIGNATURE) [signature]

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SUBMIT TO TWINING

INNOVATIVE CONSTRUCTION PRODUCTS

7. EQUIPMENT CALIBRATION RECORDS

TECHNICAL ASSOCIATED SERVICES

7832 Franklin Drive Huntington Beach, CA 92648 T.(714) 841-0475 F. (714) 841-4180 http://www.tascalibration.com

Customer: *SURECAST West*
Contact: Rusty

Address: 8203 Alabama
City/St/Zip: Highland, CA 92346

CERTIFICATE OF CALIBRATION

Event Information

Calibration Date: 2-27-2012
Calibration Interval: 12 months
Due Date: 2-27-2013
Location of Equip. Calibrated: Lab

Test Number: HB-212111
Temp./Humidity: 17°C 61% Rh
Procedure: Mfg

Equipment Information

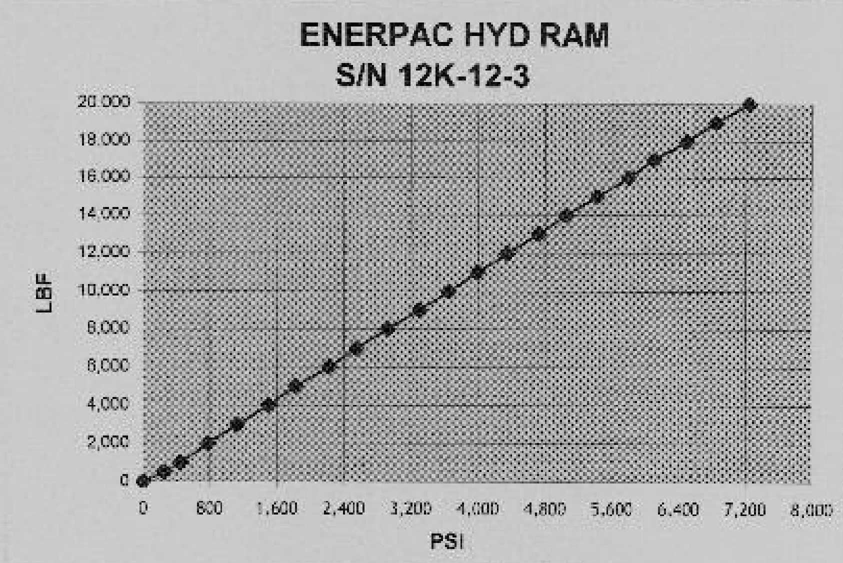
Description: Holl-O-Ram
Manufacturer: Enerpac

Model: RCH-123
Serial Number: 12K-12-3

Range: 12 ton
Gauge S/N: 12K-12-3

PSI	LBF	LBF/PSI
0	0	0
250	500	2.000
450	1,000	2.222
775	2,000	2.581
1,125	3,000	2.667
1,500	4,000	2.667
1,825	5,000	2.740
2,225	6,000	2.697
2,550	7,000	2.745
2,925	8,000	2.735
3,300	9,000	2.727
3,650	10,000	2.740
4,000	11,000	2.750
4,350	12,000	2.759
4,725	13,000	2.751
5,050	14,000	2.772
5,425	15,000	2.765
5,800	16,000	2.759
6,100	17,000	2.787
6,500	18,000	2.769
6,850	19,000	2.774
7,250	20,000	2.759

Calibration Results



7,150 lbf = 2,625 PSI
13,000 lbf =4,725 PSI

APPROVAL: Terry Summers

Calibration Standards

SN# or ID#	Due Date	Mfg.
9392	7/26/2012	Control
9205	4/7/2012	Strainsense

Remarks:

1.) Test conforms to ANSI/Z540 and ISO/IEC 17025.
2.) Calibration Standards used are traceable to NIST unless otherwise specified.
3.) Calibration data results relate only to the specified serial number stated in the equipment information section in this certificate.
4.) Equipment condition statements are the opinions of Technical Associated Services and are based on, but not limited to, data from measurements made, professional experience, and procedures utilized. It is the responsibility of the customer/user of this equipment to determine if the results identified meet the specific requirements of accuracy for its intended use.
5.) This report shall not be reproduced, except in full, without the written approval of Technical Associated Services.

TECHNICAL ASSOCIATED SERVICES

7832 Franklin Drive Huntington Beach, CA 92648 T.(714) 841-0475 F. (714) 841-4180 http://www.tascalibration.com

Customer: *SURECAST West*
Contact: Rusty

Address: 8203 Alabama
City/St/Zip: Highland, CA 92346

CERTIFICATE OF CALIBRATION

Event Information

Calibration Date: 2-27-2012
Calibration Interval: 12 months
Due Date: 2-27-2013
Location of Equip. Calibrated: Lab

Test Number: HB-212111
Temp./Humidity: 17°C 61% Rh
Procedure: Mfg

Equipment Information

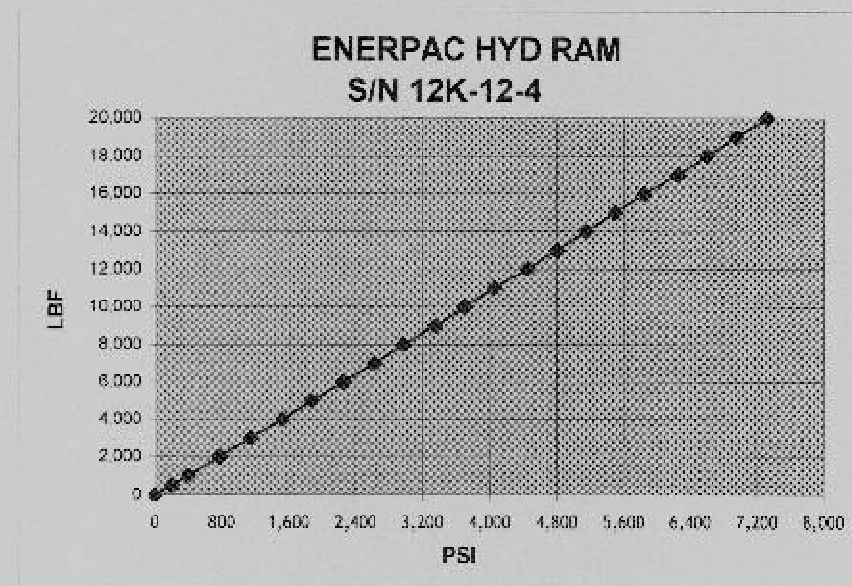
Description: Holl-O-Ram
Manufacturer: Enerpac

Model: RCH-123
Serial Number: 12K-12-4

Range: 12 ton
Gauge S/N: 12K-12-4

PSI	LBF	LBF/PSI
0	0	0
200	500	2.500
400	1,000	2.500
775	2,000	2.581
1,150	3,000	2.609
1,525	4,000	2.623
1,875	5,000	2.667
2,250	6,000	2.667
2,625	7,000	2.667
2,975	8,000	2.689
3,350	9,000	2.687
3,700	10,000	2.703
4,050	11,000	2.716
4,450	12,000	2.697
4,800	13,000	2.708
5,150	14,000	2.718
5,500	15,000	2.727
5,850	16,000	2.735
6,250	17,000	2.720
6,600	18,000	2.727
6,950	19,000	2.734
7,325	20,000	2.730

Calibration Results



7,150 Lbf = 2,650 PSI
13,000 Lbf =4,800 PSI

APPROVAL: Terry Summers

Calibration Standards

SN# or ID#	Due Date	Mfg.
9392	7/26/2012	Control
9205	4/7/2012	Strainsense

Remarks:

1.) Test conforms to ANSI/Z540 and ISO/IEC 17025.
2.) Calibration Standards used are traceable to NIST unless otherwise specified.
3.) Calibration data results relate only to the specified serial number stated in the equipment information section in this certificate.
4.) Equipment condition statements are the opinions of Technical Associated Services and are based on, but not limited to, data from measurements made, professional experience, and procedures utilized. It is ithe responsibility of the customer/user of this equipment to determine if the results identified meet the specific requirements of accuracy for its intended use.
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TECHNICAL ASSOCIATED SERVICES

7832 Franklin Drive Huntington Beach, CA 92648 T.(714) 841-0475 F. (714) 841-4180 http://www.tascalibration.com

Customer: *SURECAST West*

Contact: Rusty

Address: 8203 Alabama

City/St/Zip: Highland, CA 92346

CERTIFICATE OF CALIBRATION

Event Information

Calibration Date: 2-27-2012

Calibration Interval: 12 months

Due Date: 2-27-2013

Location of Equip. Calibrated: Lab

Test Number: HB-212111

Temp./Humidity: 17°C 61% Rh

Procedure: Mfg

Equipment Information

Description: Holl-O-Ram

Manufacturer: Enerpac

Model: RCH-123

Serial Number: 12K-12-1

Range: 12 ton

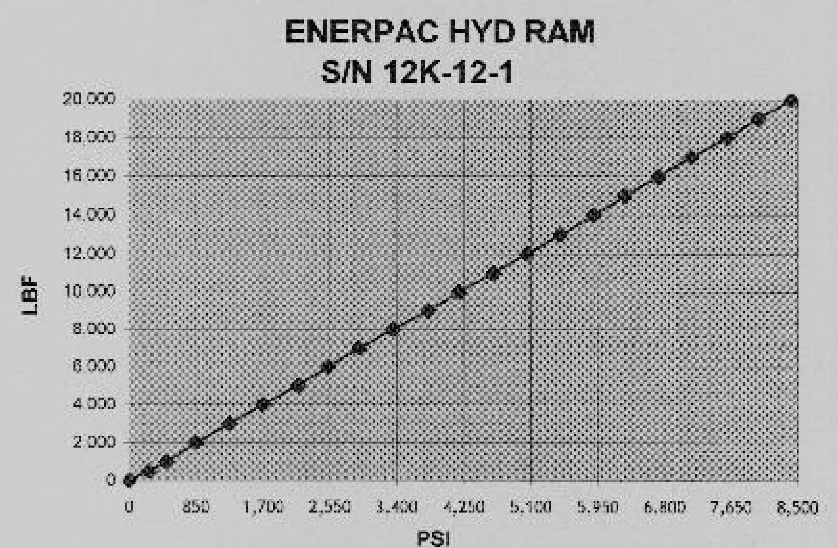
Gauge S/N: 12K-12-1

PSI	LBF	LBF/PSI
0	0	0
250	500	2.000
475	1,000	2.105
850	2,000	2.353
1,275	3,000	2.353
1,700	4,000	2.353
2,150	5,000	2.326
2,525	6,000	2.376
2,925	7,000	2.393
3,350	8,000	2.388
3,800	9,000	2.368
4,200	10,000	2.381
4,625	11,000	2.378
5,050	12,000	2.376
5,475	13,000	2.374
5,900	14,000	2.373
6,300	15,000	2.381
6,725	16,000	2.379
7,150	17,000	2.378
7,600	18,000	2.368
8,000	19,000	2.375
8,425	20,000	2.374

Calibration Standards

SN# or ID#	Due Date	Mfg.
9392	7/26/2012	Control
9205	4/7/2012	Strainsense

Calibration Results



7,150 lbf = 3,025 PSI
13,000 lbf =5,475 PSI

APPROVAL: Terry Summers

Remarks:

1.) Test conforms to ANSI/Z540 and ISO/IEC 17025.

2.) Calibration Standards used are traceable to NIST unless otherwise specified.

3.) Calibration data results relate only to the specified serial number stated in the equipment information section in this certificate.

4.) Equipment condition statements are the opinions of Technical Associated Services and are based on, but not limited to, data from measurements made, professional experience, and procedures utilized. It is ithe responsibility of the customer/user of this equipment to determine if the results identified meet the specific requirements of accuracy for its intended use.

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TECHNICAL ASSOCIATED SERVICES

7832 Franklin Drive Huntington Beach, CA 92648 T.(714) 841-0475 F. (714) 841-4180 http://www.tascalibration.com

Customer: *SURECAST West*

Contact: Rusty

Address: 8203 Alabama

City/St/Zip: Highland, CA 92346

CERTIFICATE OF CALIBRATION

Event Information

Calibration Date: 2-27-2012

Calibration Interval: 12 months

Due Date: 2-27-2013

Location of Equip. Calibrated: Lab

Test Number: HB-212111

Temp./Humidity: 17°C 61% Rh

Procedure: Mfg

Equipment Information

Description: Holl-O-Ram

Manufacturer: Enerpac

Model: RCH-123

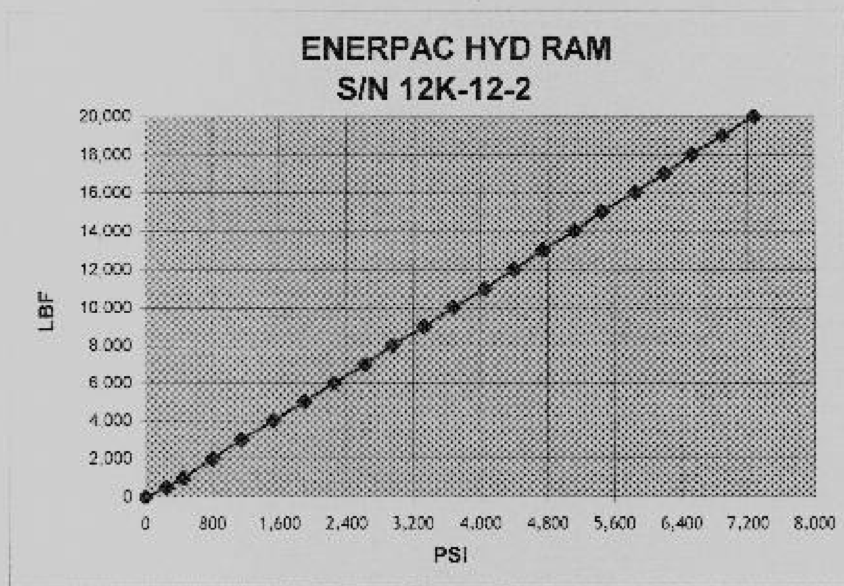
Serial Number: 12K-12-2

Range: 12 ton

Gauge S/N: 12K-12-2

PSI	LBF	LBF/PSI
0	0	0
250	500	2.000
450	1,000	2.222
800	2,000	2.500
1,150	3,000	2.609
1,525	4,000	2.623
1,900	5,000	2.632
2,250	6,000	2.667
2,625	7,000	2.667
2,950	8,000	2.712
3,325	9,000	2.707
3,675	10,000	2.721
4,050	11,000	2.716
4,400	12,000	2.727
4,750	13,000	2.737
5,125	14,000	2.732
5,450	15,000	2.752
5,850	16,000	2.735
6,200	17,000	2.742
6,525	18,000	2.759
6,900	19,000	2.754
7,275	20,000	2.749

Calibration Results



7,150 lbf = 2,690 PSI
13,000 lbf =4,750 PSI

APPROVAL: Terry Summers

Calibration Standards

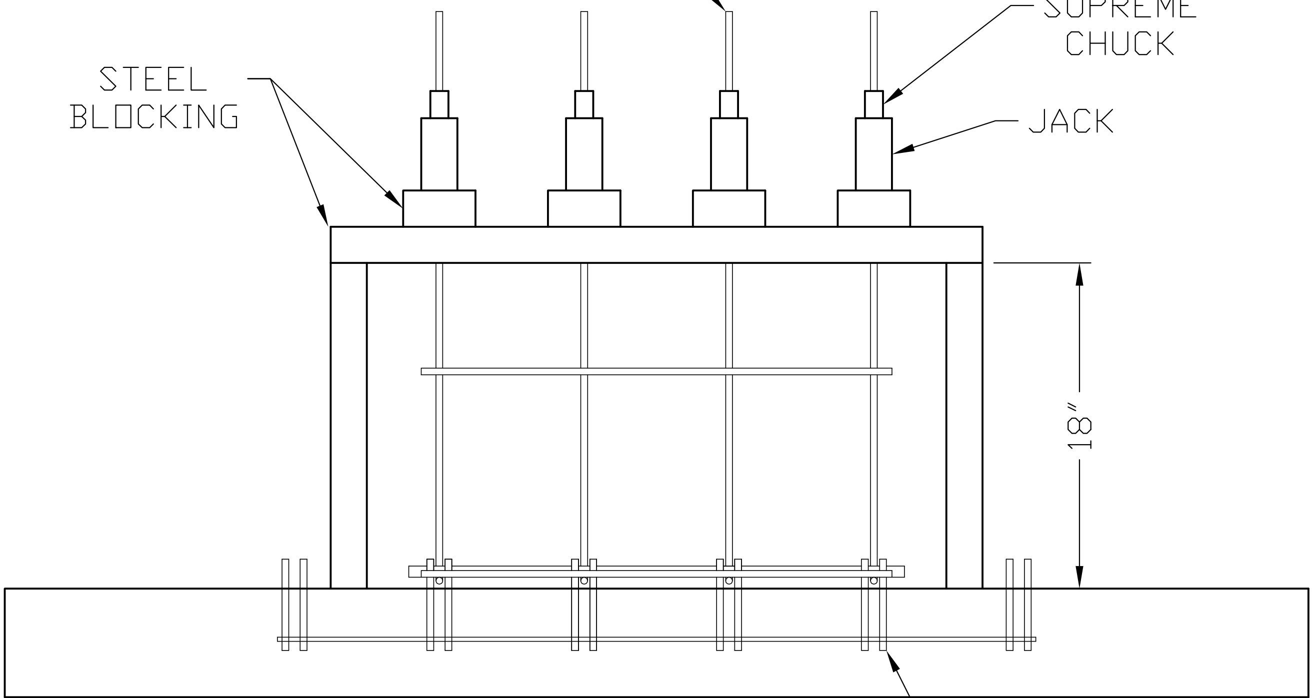
SN# or ID#	Due Date	Mfg.
9392	7/26/2012	Control
9205	4/7/2012	Strainsense

Remarks:

1.) Test conforms to ANSI/Z540 and ISO/IEC 17025.
2.) Calibration Standards used are traceable to NIST unless otherwise specified.
3.) Calibration data results relate only to the specified serial number stated in the equipment information section in this certificate.
4.) Equipment condition statements are the opinions of Technical Associated Services and are based on, but not limited to, data from measurements made, professional experience, and procedures utilized. It is the responsibility of the customer/user of this equipment to determine if the results identified meet the specific requirements of accuracy for its intended use.
5.) This report shall not be reproduced, except in full, without the written approval of Technical Associated Services.

INNOVATIVE CONSTRUCTION PRODUCTS

8. EQUIPMENT AND MATERIAL DETAILS



NOTE: 4 RAMS SHOWN FOR INFORMATIONAL PURPOSES ONLY. TEST MAY BE RUN WITH 1-4 JACKS AT A TIME.

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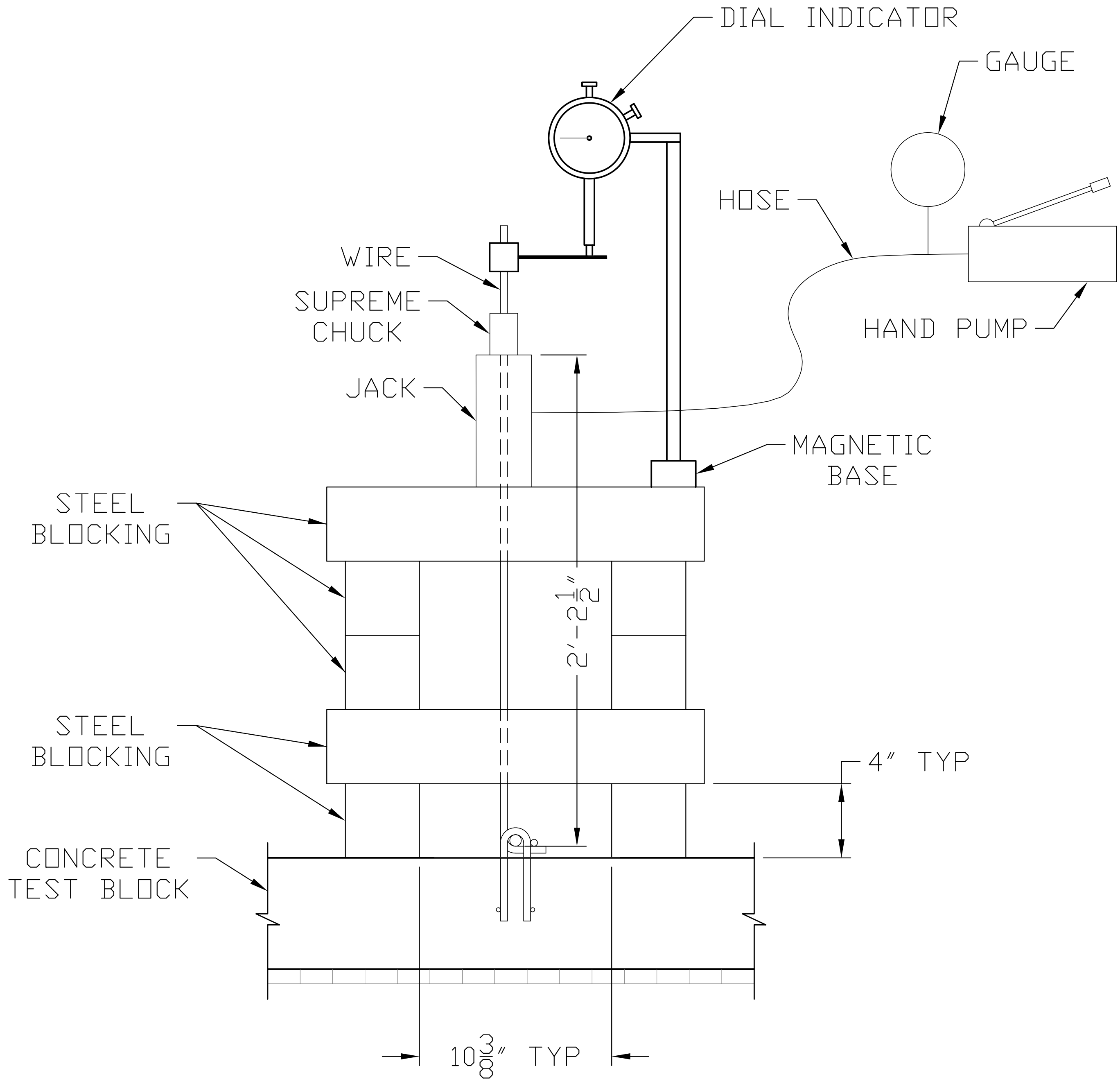
Date: 2/22/12	SSL LOOP HALF PANEL TEST BLOCK	SSL Specializing in Construction Products	Job. No. 0000
Designed by: DSM			
Checked by:	FIGURE 1A	4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 831 430 9300 Fax: 831 430 9340	Of



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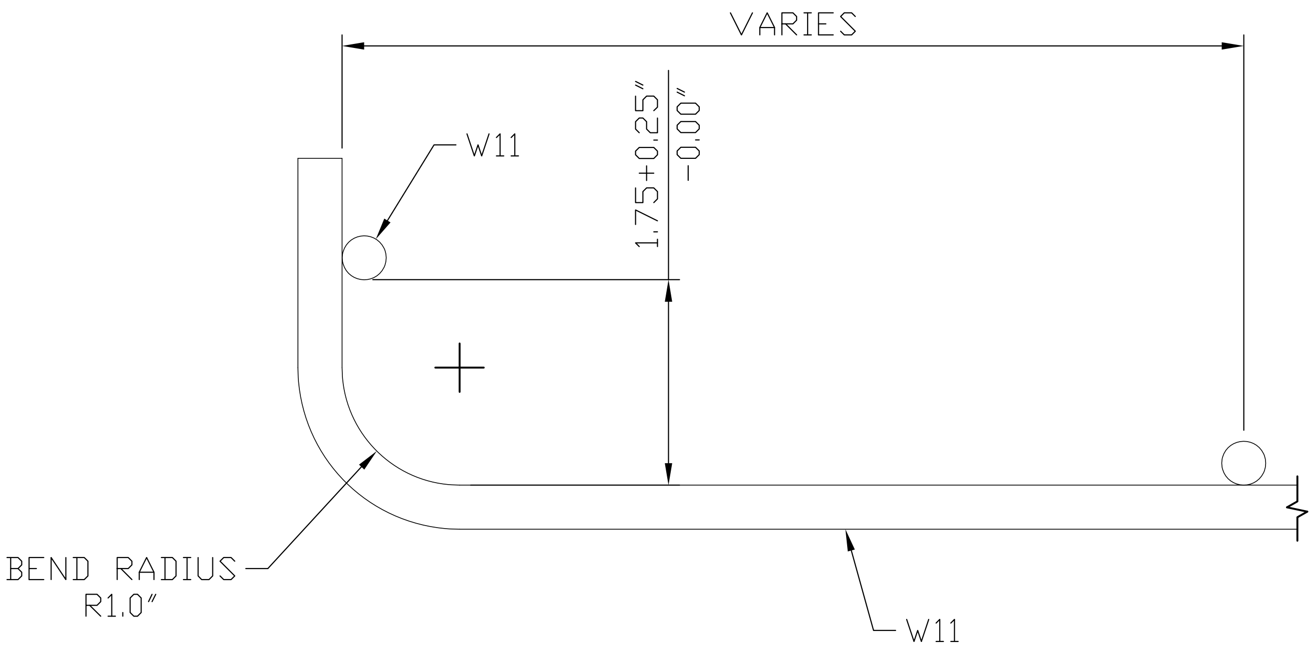
Date: 03/05/12	SSL LOOP TEST BLOCK SETUP	SSL Specializing in Construction Products	Job. No. 0000
Designed by: GTF			
Checked by:	FIGURE 2	4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 831 430 9300 Fax: 831 430 9340	Of



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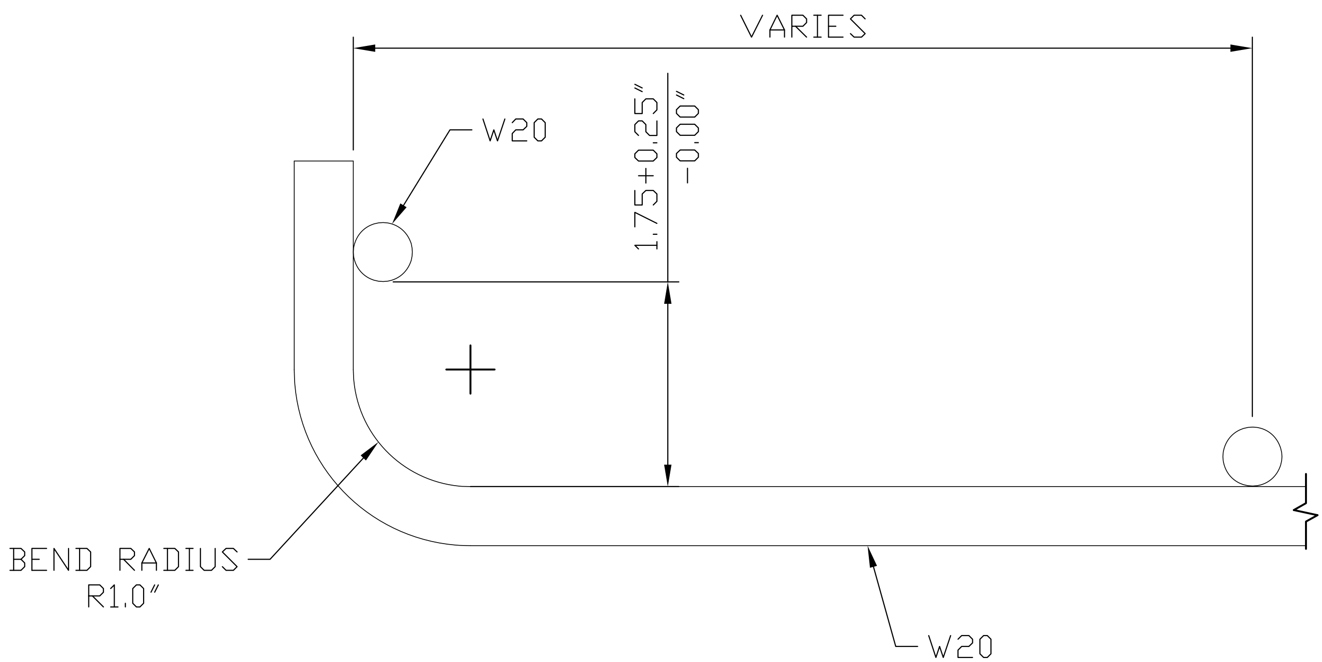
Date: 02/24/12	SSL W11 "L" LOOP MESH WIRE END DETAIL	SSL Specializing in Construction Products	Job. No. 0000
Designed by: DSM			
Checked by:	FIGURE 3	4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 831 430 9300 Fax: 831 430 9340	Of



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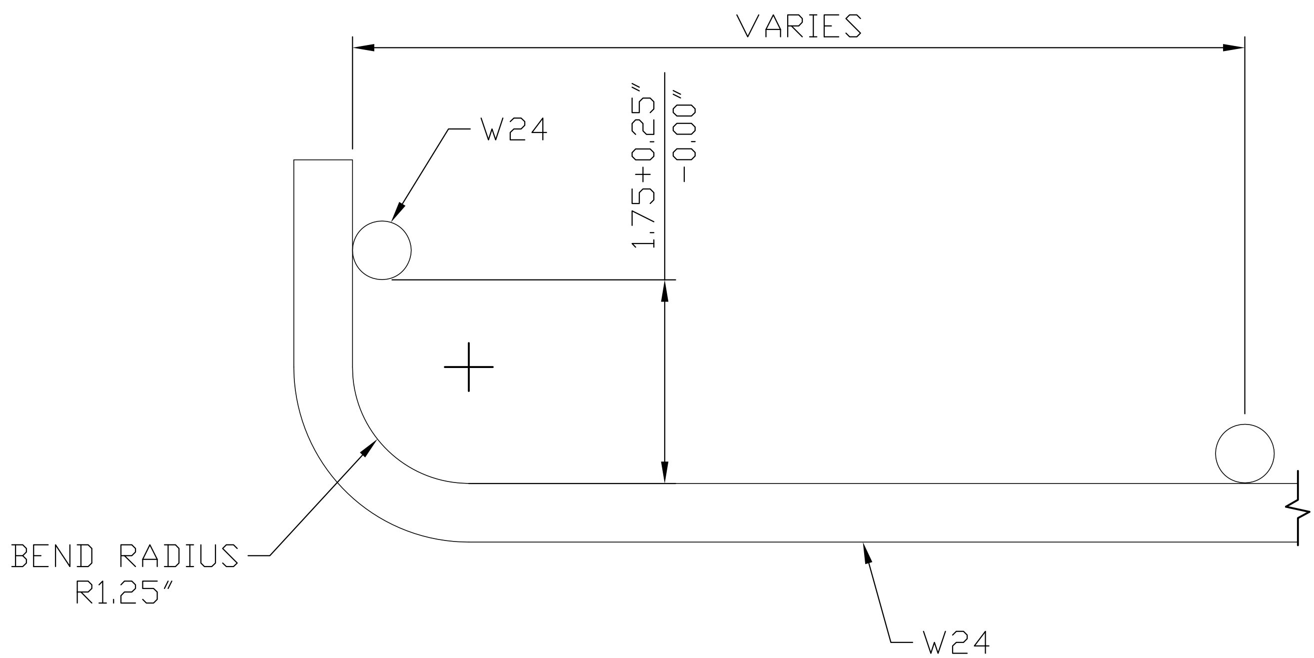
Date: 02/24/12	SSL W20 "L" LOOP MESH WIRE END DETAIL	SSL Specializing in Construction Products	Job. No. 0000
Designed by: DSM			
Checked by:	FIGURE 3A	4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 831 430 9300 Fax: 831 430 9340	Of



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Date: 01/18/13	SSL W24 "L" LOOP MESH WIRE END DETAIL	SSL Specializing in Construction Products	Job. No. 0000
Designed by: DSM			
Checked by:	FIGURE 3B	4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 831 430 9300 Fax: 831 430 9340	Of

9. CALCULATIONS

The expected elongation of the 26.5 in longitudinal wire sample is calculated using Young's Modulus:

$$E = \textit{Tensile Strength/Tensile Strain} = \sigma/\varepsilon = (F/A_0)/(\Delta/L_0) = FL_0/A_0\Delta L$$

Where:

E is Young's Modulus of Elasticity

F is the force exerted on an object under tension

A_0 is the original cross-sectional area through which force is applied

ΔL is the amount by which the object changes

L_0 is the original length of the object

Therefore:

$$\Delta L = 65{,}000 \text{ psi } (26.5 \text{ in}) / 30\,(10^6) = 0.0574 \text{ in}$$

Steel Beam

File: c:\Users\daniel\Documents\ENERCALC Data Files\colton panel calc.ec6
ENERCALC, INC. 1983-2011, Build:6.12.01.12, Ver:6.11.5.31

Lic. # : KW-06008867 **Licensee : SSL**

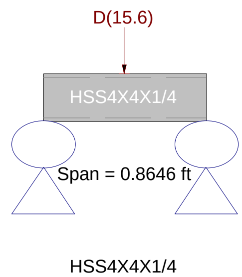
Description : HSS4"x4"x0.25" Steel Beam Deflection Calculation

Material Properties

Calculations per AISC 360-05, IBC 2009, CBC 2010, ASCE 7-05

Analysis Method : Load Resistance Factor Design
Beam Bracing : Completely Unbraced
Bending Axis : Major Axis Bending
Load Combination 2006 IBC & ASCE 7-05

Fy : Steel Yield : 50.0 ksi
E: Modulus : 29,000.0 ksi



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Load(s) for Span Number 1
Point Load : D = 15.60 k @ 0.4323 ft, (Jack)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	**0.268** : 1	Maximum Shear Stress Ratio =	**0.263** : 1
Section used for this span	**HSS4X4X1/4**	Section used for this span	**HSS4X4X1/4**
Mu : Applied	4.721 k-ft	Vu : Applied	10.920 k
Mn * Phi : Allowable	17.588 k-ft	Vn * Phi : Allowable	41.533 k
Load Combination	+1.40D	Load Combination	+1.40D
Location of maximum on span	0.432ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.002 in	Ratio =	6417
Max Upward Total Deflection	0.000 in	Ratio =	0 <180

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios		Summary of Moment Values							Summary of Shear Values		
Segment Length	Span #	M	V	max Mu +	max Mu -	Mu Max	Mnx	Phi*Mnx	Cb	Rm	VuMax	Vnx	Phi*Vnx
+1.40D													
Dsgn. L = 0.86 ft	1	0.268	0.263	4.72		4.72	19.54	17.59	1.32	1.00	10.92	46.15	41.53

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
	1	0.0000	0.000		0.0000	0.000

Vertical Reactions - Unfactored

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	7.800	7.800
D Only	7.800	7.800

10. MATERIAL COMPLIANCE CERTIFICATIONS

Concrete Reinforcements, Inc.

Quality Control Department

Test Data Sheet

DATE: 8/21/2012 **PROJECT NUMBER:** 23000T

CUSTOMER: SSL

TESTING DATE: 8/20/12

23000T-1	8XV W24XW24 TAG: TEST SHEETS - MK-1--5 SHEETS
23000T-2	8XV W24XW20 TAG: TEST SHEETS - MK-2--5 SHEETS
23000T-3	8XV W20XW11 TAG: TEST SHEETS - MK-4--5 SHEETS

The mechanical properties of the material ordered were tested for compliance with A.S.T.M. A-496 & A-497 the results are as follows:

WIRE SIZE	W24	W20	W11								
HEAT NUMBER	1290008743	1290010950	1290010433								
SAMPLE NUMBER	1	1	1								
LOAD (LBS)	22300	19700	11230								
TENSILE (PSI)	93.1K	98.5K	102K								
BEND TEST	PASS	PASS	PASS								
YIELD STRENGTH	82.1K	87.8K	84.9K								
WELD SHEAR	PASS	PASS	PASS								

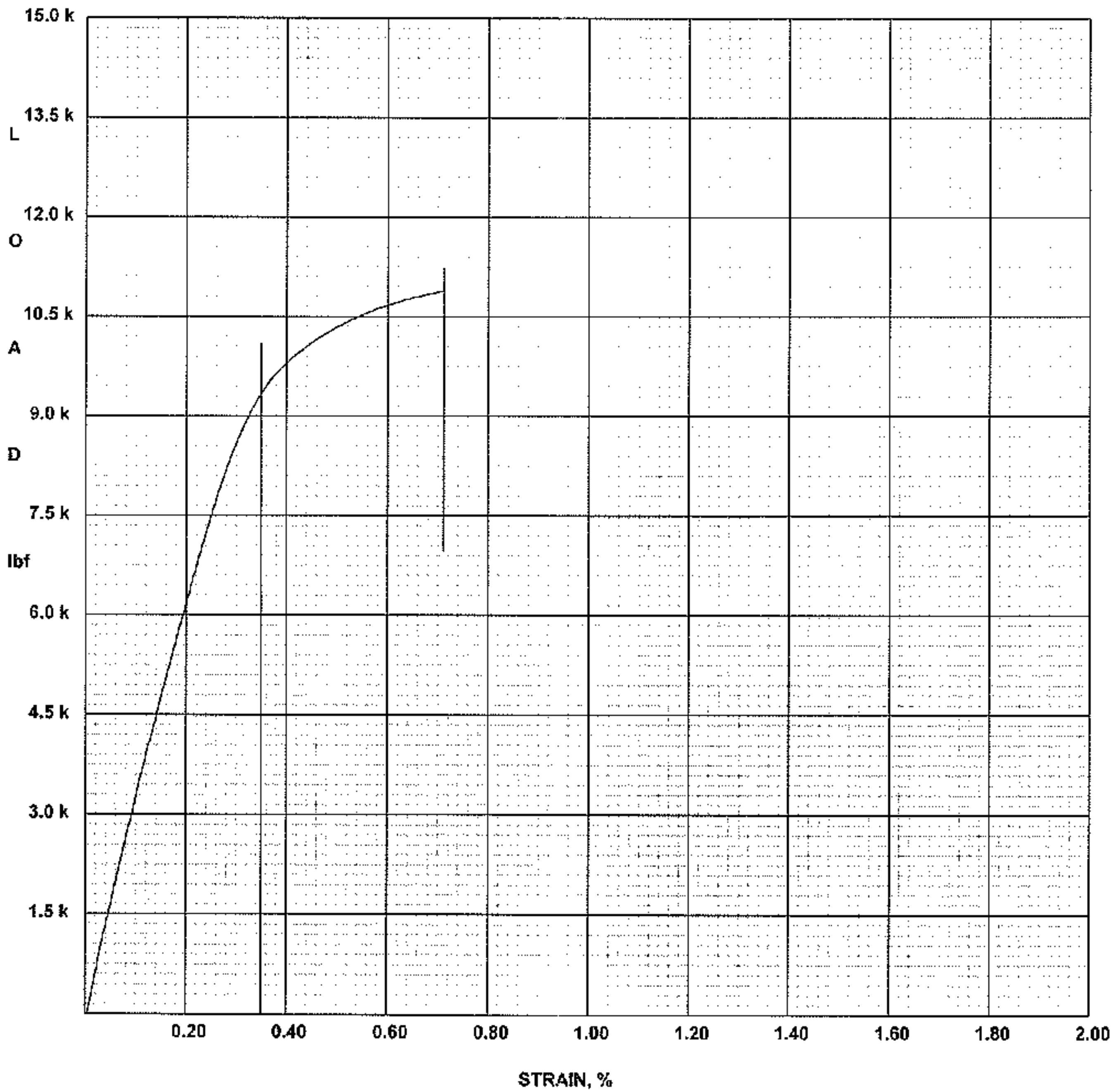
The undersigned certifies that the above is a true and accurate representation of the test results obtained on the described material as appearing on company records. This document certifies that the material mentioned above meets the required A.S.T.M. A-496/ A-497/ and A1064 designation. All of the material herein has been melted and manufactured in the U.S.A.

Very Truly Yours,
Concrete Reinforcements, Inc.

Shawn K. McElwee

Shawn K. McElwee
Quality Assurance

13450 W. Peoria Ave. Surprise, Arizona 85379 Phone 623-975-2970 Fax 623-975-2790



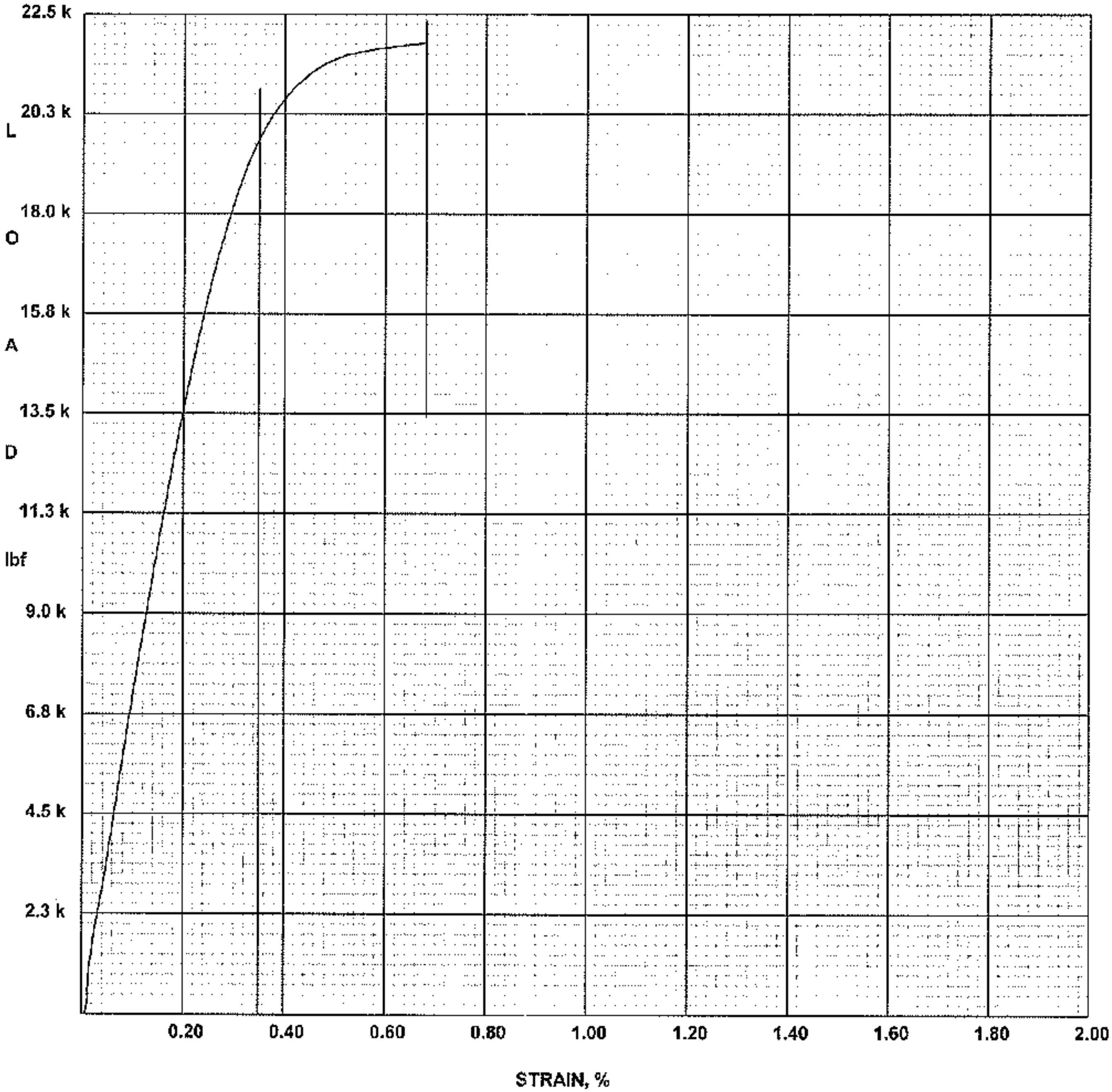
Concrete Reinforcements Inc.
13450 West Peoria Avenue
Surprise, AZ 85379

Tensile Test

Job No.:	.372 /.378
Wire Size:	W11
Rod Mfg./Heat:	1290010433
Rod Size/Carb. Content:	1010
Operator:	ML
Weight, lbf:	0.0000
Area, in²:	0.1100
Ultimate, lbf:	11230
Ultimate, psi:	102000
YIELD .35, psi:	84900

RA=.63

Aug 7, 2012 3:17:53 PM
SN: 207004-R0 V7.01.17



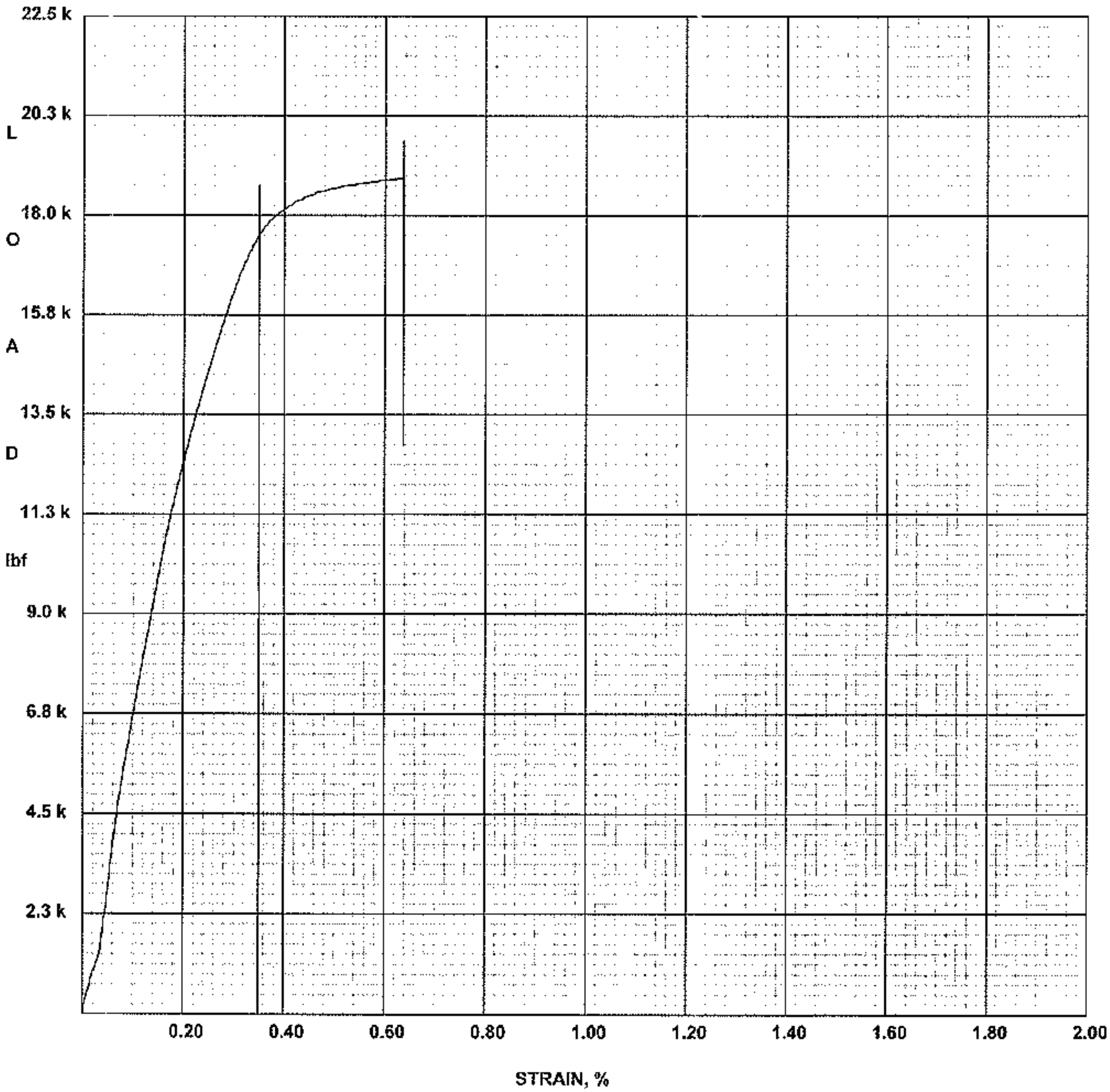
Concrete Reinforcements Inc.
13450 West Peoria Avenue
Surprise, AZ 85379

Tensile Test

Job No.:	.547/.560
Wire Size:	W24
Rod Mfg./Heat:	1290008743
Rod Size/Carb. Content:	1010
Operator:	JL
Weight, lbf:	0.0000
Area, in²:	0.2400
Ultimate, lbf:	22300
Ultimate, psi:	93100
YIELD .35, psi:	82100

RA = .62

Jul 12, 2012 7:36:50 AM
SN: 207004-R0 V7.01.17



Concrete Reinforcements Inc.
13450 West Peoria Avenue
Surprise, AZ 85379

Tensile Test

Job No.:	.501/.511
Wire Size:	W20
Rod Mfg./Heat:	1290010450
Rod Size/Carb. Content:	1010
Operator:	ML
Weight, lbf:	0.0000
Area, in²:	0.2000
Ultimate, lbf:	19700
Ultimate, psi:	98500
YIELD .35, psi:	87800

RA=.64

Aug 10, 2012 1:36:07 PM
SN 207004-R0 V7.01.17

SOLD TO: CONCRETE REINFORCEMENTS INC
13450 W PEORIA AVE
SURPRISE, AZ 85379-

NUCOR
NUCOR STEEL KINGMAN, LLC

CERTIFIED MILL TEST REPORT

Ship from:
Nucor Steel Kingman, LLC
3000 WEST OLD HIGHWAY 66
KINGMAN, AZ 86413
(928) 718-7035

SHIP TO: CONCRETE REINFORCEMENTS INC
13450 W PEORIA AVE
SURPRISE, AZ 85379-

Date: 12-Jul-2012
B.L. Number: 311190
Load Number: 111387

Material Safety Data Sheets are available at www.nucorbar.com or by contacting your inside sales representative.

NBMG-08 January 1, 2012

LOT # / HEAT #	DESCRIPTION	PHYSICAL TESTS					CHEMICAL TESTS						
		YIELD P.S.I.	TENSILE P.S.I.	ELONG % IN 8"	BEND	WT% / DEF	C / Ni	Mn / Cr	P / Mo	S / V	Si / Cb	Cu / Sn	C.E.
PO# =>	0009662												
KG1290010433	Nucor Steel - Kingman LLC		64,763				.12	.45	.012	.033	.13	.29	
PL11106244	7/16(.437) WireRodCoil		447MPa				.11	.12	.030				
	1010IQ tensile =62-68ksi												
	ASTM A510-08												
	ROA% = 65												

I hereby certify that the material described herein has been manufactured in accordance with the specifications and standards listed above and that it satisfies those requirements.
1.) Weld repair was not performed on this material.
2.) Melted and Manufactured in the United States.
3.) Mercury, Radium, or Alpha source materials in any form have not been used in the production of this material.

QUALITY ASSURANCE: Vijay Choksi

.D KING STEEL CORP
: 5225 E COOK RD
GRAND BLANC, MI 48439-0423

NUCOR
NUCOR STEEL KINGMAN, LLC

CERTIFIED MILL TEST REPORT

Page: 1

ɔ KING STEEL CORP - KINGMAN AREA
3000 WEST OLD HWY 66
KING STEEL LOCATION
KINGMAN, AZ 86413-

Ship from:
Nucor Steel Kingman, LLC
3000 WEST OLD HIGHWAY 66
KINGMAN, AZ 86413
(928) 718-7035

Date: 23-Jan-2012
B.L. Number: 308529
Load Number: 108756

ıterial Safety Data Sheets are available at www.nucorbar.com or by contacting your inside sales representative.

NBMG-08 January 1, 2012

LOT # / HEAT #	DESCRIPTION	PHYSICAL TESTS					CHEMICAL TESTS						
		YIELD P.S.I.	TENSILE P.S.I.	ELONG % IN 8"	BEND	WT% / DEF	C / Ni	Mn / Cr	P / Mo	S / V	Si / Cb	Cu / Sn	C.E.
PO# =>	010864												
G1290008739	Nucor Steel - Kingman LLC		62,656				.11	.48	.015	.027	.17	.26	
L11107010	5/8(.625) WireRodCoil		432MPa				.09	.13	.010				
	1010IQ tensile =58-65ksi												
	ASTM A510-08												
	ROA% = 62												
PO# =>	010864												
G1290008740	Nucor Steel - Kingman LLC		62,557				.09	.42	.011	.025	.14	.30	
L11206969	5/8(.625) WireRodCoil		431MPa				.10	.09	.020				
	1010IQ tensile =58-65ksi												
	ASTM A510-08												
	ROA% = 65												
PO# =>	010864												
G1290008741	Nucor Steel - Kingman LLC		61,240				.09	.45	.010	.032	.14	.28	
L11206968	5/8(.625) WireRodCoil		422MPa				.09	.09	.010				
	1010IQ tensile =58-65ksi												
	ASTM A510-08												
	ROA% = 65												
PO# =>	010864												
G1290008742	Nucor Steel - Kingman LLC		64,881				.11	.44	.012	.033	.14	.29	
L11206967	5/8(.625) WireRodCoil		447MPa				.10	.11	.020				
	1010IQ tensile =58-65ksi												
	ASTM A510-08												
	ROA% = 62												
PO# =>	010864												
G1290008743	Nucor Steel - Kingman LLC		62,591				.09	.47	.010	.014	.14	.29	
N11102299	5/8(.625) WireRodCoil		432MPa				.12	.13	.030				
	1010IQ tensile =58-65ksi												
	ASTM A510-08												
	ROA% = 68												

ıereby certify that the material described herein has been manufactured in accordance with
: specifications and standards listed above and that it satisfies those requirements.

SOLD TO: CONCRETE REINFORCEMENTS INC
13450 W PEORIA AVE
SURPRISE, AZ 85379-

NUCOR
NUCOR STEEL KINGMAN, LLC

CERTIFIED MILL TEST REPORT

SHIP TO: CONCRETE REINFORCEMENTS INC
13450 W PEORIA AVE
SURPRISE, AZ 85379-

Ship from:

Nucor Steel Kingman, LLC
3000 WEST OLD HIGHWAY 66
KINGMAN, AZ 86413
(928) 718-7035

Date: 12-Jul-2012
B.L. Number: 311183
Load Number: 111400

Material Safety Data Sheets are available at www.nucorbar.com or by contacting your inside sales representative.

NBMG-08 January 1, 2012

LOT # / HEAT #	DESCRIPTION	PHYSICAL TESTS					CHEMICAL TESTS						
		YIELD P.S.I.	TENSILE P.S.I.	ELONG % IN 8"	BEND	WT% / DEF	C / Ni	Mn / Cr	P / Mo	S / V	Si / Cb	Cu / Sn	C.E.
PO# =>	0009662												
KG1290010449	Nucor Steel - Kingman LLC		66,425				.13	.50	.008	.019	.15	.14	
SE11105439	9/16(.562) WireRodCoil		458MPa				.05	.08	.010				
	1010IQ tensile =58-66ksi												
	ASTM A510-08												
	ROA% = 61												
PO# =>	0009662												
KG1290010450	Nucor Steel - Kingman LLC		65,325				.09	.45	.014	.017	.16	.34	
PL12102723	9/16(.562) WireRodCoil		450MPa				.12	.11	.020				
	1010IQ tensile =58-66ksi												
	ASTM A510-08												
	ROA% = 65												

I hereby certify that the material described herein has been manufactured in accordance with the specifications and standards listed above and that it satisfies those requirements.
1.) Weld repair was not performed on this material.
2.) Melted and Manufactured in the United States.
3.) Mercury, Radium, or Alpha source materials in any form have not been used in the production of this material.

QUALITY ASSURANCE: Vijay Choksi

Section 1.2.13

Item 1.2.13 - Summary table of input parameters used with (e.g., MSEW) computer design program.

See attached table.

Table – Summary of MSEW Program Input Parameters for MSEPlus System

Inextensible Soil Reinforcement:											
Data\Type		3W11 x 0.5W11	4W11 x 1.0W11	5W11 x 1.5W11	6W11 x 2.0W11	4W20 x 2.5W11	5W20 x 3.0W11	6W20 x 3.0W11	6W24 x 3.0W11	7W24 x 3.0W11	8W24 x 3.0W11
$T_{long\text{-}term}$ (lb) (F_y*A_c) (75 years)		17,925	23,903	29,873	35,850	47,475	59,348	71,213	87,315	101,865	116,423
$T_{long\text{-}term}$ (lb) (F_y*A_c) (100 years)		15,368	20,490	25,605	30,728	42,608	53,265	63,915	79,215	92,415	105,615
Coverage Ratio (R_c)		0.27	0.40	0.53	0.67	0.40	0.53	0.67	0.67	0.80	0.93
Reinforcement width (b, in)		16	24	32	40	24	32	40	40	48	56
$T_{long\text{-}term\ per\ unit\ length\ of\ wall}$ (lb/ft) [(F_y*A_c)*R_c/b] (75 years)		3,585	4,781	5,975	7,170	9,495	11,870	14,243	17,463	20,373	23,285
$T_{long\text{-}termper\ unit\ length\ of\ wall}$ (lb/ft) [(F_y*A_c)*R_c/b] (100 years)		3,074	4,098	5,121	6,146	8,522	10,653	12,783	15,843	18,483	21,123
Pullout resistance factor, F*	Top of Wall	1.06	0.53	0.35	0.27	0.21	0.18	0.18	0.18	0.18	0.18
	Depth of 20 ft below top of wall	0.53	0.27	0.18	0.13	0.11	0.09	0.09	0.09	0.09	0.09
Friction Angle along reinforcement-soil interface ρ	Top of Wall	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Depth of 20 ft below top of wall	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scale-effect correction factor, α		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Connection Strengths:	σ^a (lb/ft^2)	$CRcr^b = F_{yc}/F_y$									
		3W11 x 0.5W11	4W11 x 1.0W11	5W11 x 1.5W11	6W11 x 2.0W11	4W20 x 2.5W11	5W20 x 3.0W11	6W20 x 3.0W11	6W24 x 3.0W11	7W24 x 3.0W11	8W24 x 3.0W11
		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

F_y = Yield strength of reinforcement

F_{yc} = Yield strength of connection between reinforcement and precast panel

A_c = Area of reinforcement at the design service life (i.e., 75 or 100 years)

[a] Normal pressure (lb/ft^2); [b] MSEW program term

Section 1.3.1

Item 1.3.1 - Does the system have a HITEC Evaluation? If so, provide a copy, and summarize what has changed with the system since that evaluation.

See attached report in Appendix A. However, it should be noted that this IDEA evaluation is not providing a review of the past HITEC evaluation published. This IDEA evaluation consists only of the revised soil reinforcement to panel connection system shown in Section 1.2.5.

Section 2 - Design

Section 2.1

Item 2.1 - If the answer is yes to 1.1.2, or 1.1.4, or 1.2.2, describe how and provide typical plan and section detail drawings of the facing and reinforcement to handle vertical and horizontal obstructions in the reinforced zone.

In comparison to our original connection system the revised connection system does not alter the methods in the past since the line wires of the soil reinforcement are 8 inches on center. The details shown beginning on page 171 of the HITEC report in Appendix A still apply.

Section 4 – Quality Control

Section 4.1

Item 4.1 - If the answer is yes to 1.1.4, describe the quality control measures that are required for the manufacturing of connection devices. You may do this by providing a manufacturing QC manual.

See attached QC Manual.

Quality Control Manual

SSL Retaining Walls

4740 Scotts Valley Drive, Suite E
Scotts Valley, CA

Prepared By:
Steve Ruel, P.E.
Fransiscus Hardianto, P.E.
Scott Thompson Jr.

REGISTERED PROFESSIONAL ENGINEER
FRANSISCUS S HARDIANTO
C 60215
EXP. 6-30-18
CIVIL
STATE OF CALIFORNIA

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Table of Contents

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1. INTRODUCTION

SSL is an engineering design firm involved in the design and supply of Mechanically Stabilized Earth retaining walls. SSL's products employ welded wire mesh as soil reinforcement combined with a facing element that will either be precast concrete panels or welded wire mesh panels. The production of the welded wire mesh and precast concrete elements is performed by supplier organizations that specialize in those materials. SSL has coordinated and implemented an extensive Quality Control Program that will provide our customers with a superior product that meets or exceeds all applicable standards and specifications including those set forth by the American Association of State Highway and Transportation Officials (AASHTO), the American Society for Testing Materials (ASTM) and the Buy America Act.

This manual will outline the Quality Control procedures in place at SSL along with the procedures in place at our suppliers. The Quality Control measures required by SSL of the Contractor are listed in the Standard Details of our Shop Drawings. The Quality Control Program in its entirety is intended to provide several check points at which any potential production or manufacturing problems will become evident. Should any problems arise, the program is intended to isolate and correct the production process responsible.

SSL's Quality Control Program was developed with input from industry experts and reflects the latest in design and testing methods. Any changes to the Quality Control Program will be detailed in a numbered revision to the Quality Control Manual which will be re-submitted to Caltrans for review.

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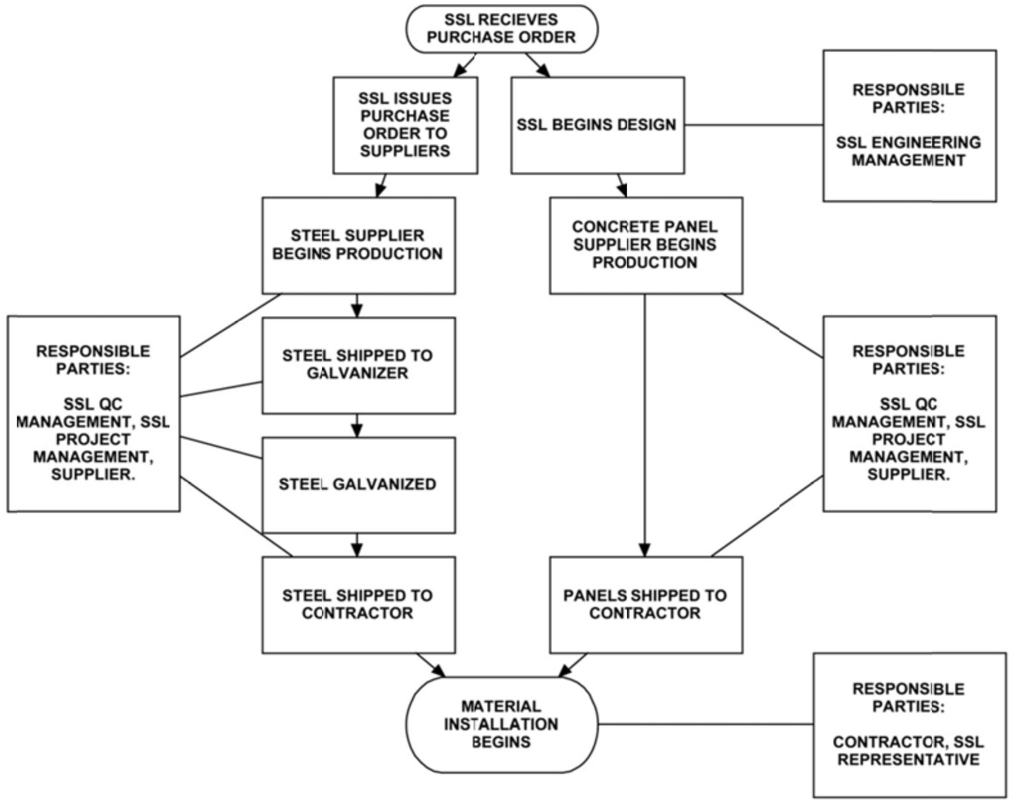
2. PRODUCTION PROCESS AND RESPONSIBLE PARTIES



3. SUPPLIER RESPONSIBILITES

Upon acceptance of SSL's purchase order, the material supplier agrees to perform all Quality Control procedures put forth in this manual and any others that may be required by the project Owner's specifications or the American Society for Testing Materials (ASTM). No welded wire soil reinforcement or precast concrete panels will be shipped to the jobsite without a Certificate of Compliance signed by a California Licensed PE from SSL.

Steel suppliers must ensure that all material is produced and fabricated according to ASTM guidelines (ASTM-A82 and ASTM-A185) along with any other requirements of the project Owner's specifications. All material must be properly identified and tagged. Steel suppliers shall provide *wire coupons* (wire rod samples, 1 from each spool) for *production go-ahead testing* prior to mesh fabrication, which will not proceed until wire coupons achieve a satisfactory result. *Production go-ahead testing* shall be performed by a qualified third party testing agency[1]. Steel suppliers shall provide *mesh coupons*

[1] Testing agency certified in accordance with ISO 17025, NADCAP AC-7101 or similar.

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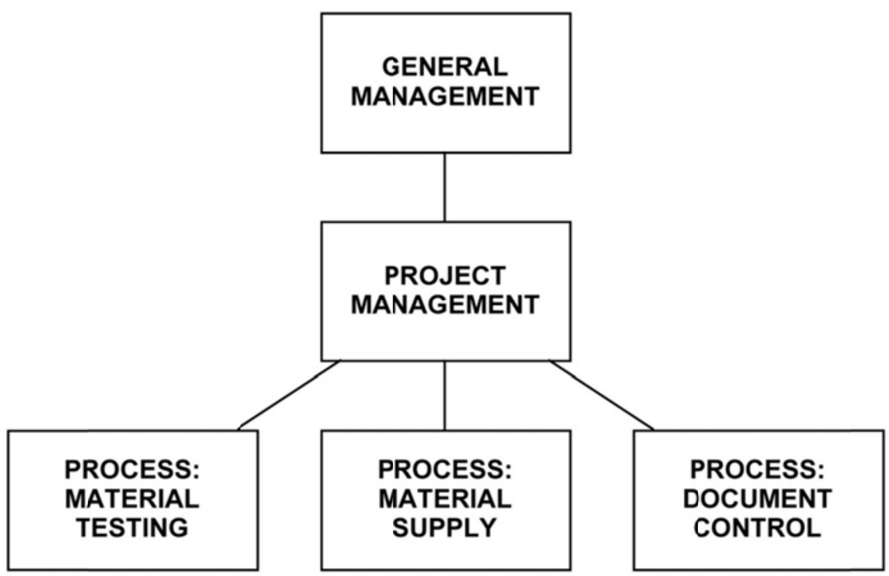
(fabricated mesh samples, 1 per change in wire size or change number of longitudinal wires per sheet) to be galvanized and sent to the contractor as a control lot.

Steel galvanizers must ensure that all material is coated according to ASTM-A123 guidelines and tested according to ASTM-A143, along with any other requirements of the project Owner's specifications. All material must be properly identified and tagged to ensure proper installation at the jobsite.

Concrete panel suppliers must ensure that all material is produced according to the project Owner's approved Quality Control procedure along with any other requirements of the project Owner's specifications. Concrete panel supplier’s Quality Control Manager must complete and sign the Precast Quality Control Checklist included in Section 10.

For complete details, please see Section 10 containing the current Quality Control Programs for; Concrete Reinforcements, Inc; and AZZ Galvanizing Inc. An individual Quality Control Program for concrete panel suppliers has not been included because concrete suppliers are selected on a job by job basis. The individual Quality Control Program of the selected supplier will be subject to review and will comply with SSL's Quality Control Program.

4. SSL PERSONNEL RESPONSIBILITIES



General Management: The general managers are responsible for developing a Quality Control Policy that will ensure that each element of the product supplied to customers meets or exceeds all applicable standards. The general managers are responsible for allocating a sufficient amount of time and resources to the development and implementation of a Quality Control Program that will reflect the Quality Control Policy.

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Project Management: The Project Managers are responsible for the implementation and management of SSL's Quality Control Policy, this includes making material suppliers aware of the program and proficient with all aspects. The project managers will ensure each material supplier has their own Quality Control Program in place and that it reflects SSL's own Quality Control Policy. The project managers will provide a Certificate indicating Compliance (COC) with SSL's Quality Control Program for each load of material delivered to the jobsite, the COC must be signed by a Professional Engineer Licensed in the State of California. When specified, the project managers will coordinate with the contractor's Quality Control Manager.

Material Supply: At the direction of project management, the production and delivery of materials will be coordinated with the material supplier. Project management must ensure that all material is being produced in accordance with SSL's Quality Control Program and attain verification that all material is being produced in accordance with each supplier's own Quality Control Program. Project management may at any time in the production process, request changes to the supplier's Quality Control Program or request additional Quality Control or testing procedures to be performed by the supplier.

Document Control: At the direction of project management, any and all necessary or requested material compliance certifications and testing logs will be collected from material suppliers. All records will be stored on a project specific basis such that information can be quickly and easily verified or distributed as needed.

Material Testing and Inspection: At the direction of project management, specific material components or elements of the entire system may be tested by SSL's material testing personnel. Testing may be performed as proof of design concept or as production compliance verification. Inspection may be performed at the job-site or at each material supplier's location.

5. MATERIAL TESTING AND INSPECTION PERFORMED BY SSL

SSL personnel have the option to perform different testing and inspection methods on the material elements of the system at any stage of production or installation. These tests are in addition to those required by ASTM and AASHTO. These tests were designed to reflect those prescribed by ASTM but modified to allow for on-site testing performed outside of a lab. When specified, SSL will coordinate with a qualified third party[2] to perform additional testing. A report detailing any results will be distributed to the parties involved.

[2] Testing agency with expertise in metallurgy, galvanization or precast concrete.

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The list below contains methods that are currently being employed, SSL is not limited to these methods and may adopt others at any point in time. If other methods are employed at a later date, SSL will revise the Quality Control Program to reflect the changes. SSL will determine which tests will be employed and the frequency of testing on a project specific basis, a summary and outline of the project specific program will be included in Shop Drawings that are submitted for approval at the beginning of the project.

Connection Test: SSL has developed a test procedure that verifies the load capacity of the concrete panel to soil reinforcement connection elements. Please see the attached Test Procedure for more details. This test will be performed for System Qualification and for evaluation of Steel Suppliers.

Bend Test: A bend test verifies the ductile strength of the steel and identifies embrittlement. This test can be performed either on single wire coupons both before and after the galvanizing process, and on welded-wire mesh after fabrication. This test may be performed at any point in the production process or on samples selected from material that has been shipped and is ready for installation. Questionable results will require further evaluation and may be cause for rejection of material. SSL may submit questionable material to a qualified independent testing laboratory for further evaluation.

If the wire has not been bent during mesh fabrication, a single wire is isolated and restrained by a vice or clamps, the wire is bent (max 1 inch bend radius) through 90˚ and back so that the straightened piece will be examined. The steel must complete the bend test without exhibiting any visible cracking at the bend.

If the wire has been bent during mesh fabrication, a single wire is isolated and restrained by a vice or clamps leaving the bent portion free. Using a minimum 3' long section of 1" metal pipe, the wire is bent to straight so that the straight piece is examined. The steel must complete the bend test without any visible cracking occurring at the bend.

Production Go-Ahead Testing: The bend test discussed above will be performed at a rate of 1 sample per wire spool for all wire produced. Samples will be taken from a recently drawn spool, galvanized and bend tested prior to mesh fabrication. Mesh fabrication will not proceed without satisfactory results.

Unsatisfactory results will require that the material in question be removed from production pending further evaluation.

Impact Test: An impact test is performed at room temperature on steel samples that have been bent then galvanized and is intended to identify embrittlement.

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This test will be performed once for each project during site-visits by SSL personnel, and may also be performed at any time during the production or installation process. Questionable results will be cause for further evaluation.

As detailed in Figure 1 below, a single wire is isolated and restrained by a vice or clamp. Using a small metal mallet or hammer (20 oz or larger), the wire sample is struck up to three times directly on the bent portion: The first strike will be a light tap with the swing initiated at the Tester's wrist, if no cracking occurs continue on to the second strike; The second strike will be stronger and initiated at the Tester's elbow, if no cracking occurs repeat the strike with the same strength. The steel must complete the impact test without any visible cracking occurring at the bend.

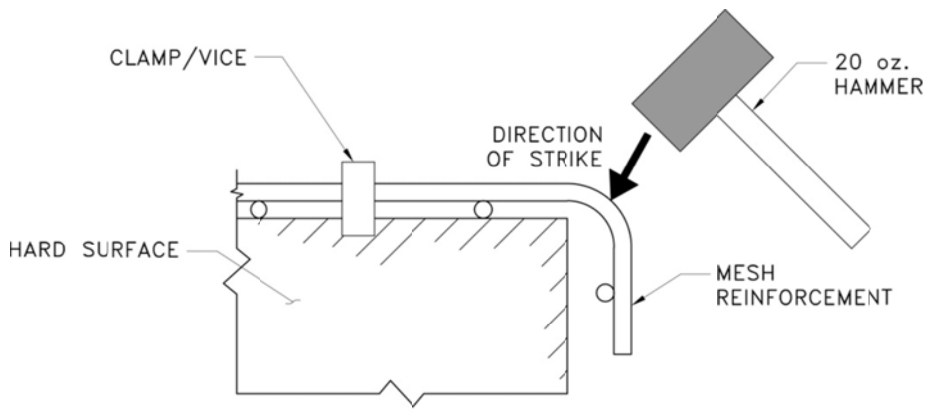

FIGURE 1

Visual Inspection at Jobsite: A thorough visual inspection of any SSL supplied material on site is performed during SSL 's onsite technical representation or by the contractor. The inspection is intended to verify that no deformations or broken bends or welds are visibly present in the reinforcing mesh. This test will only identify those issues that are readily apparent as some of the material is typically obscured by packaging or not accessible.

In the absence of an SSL representative, any material found by the Contractor to be out of SSL tolerances shall be tagged and removed from the installation process. The contractor shall notify SSL immediately for further evaluation of the questionable material.

The steel identification tags attached by the galvanizer are checked against actual sizes and styles of reinforcing mesh. If discrepancies exist, the actual size

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and styles of the reinforcing mesh can be determined by the contractor by measuring the wire size, longitudinal wire quantity and the distance of transverse wire spacing. Proper identification labels should be attached to ensure proper installation.

If any broken wires or welds are present they will be flagged and the mesh sheet will be evaluated by an SSL engineer for integrity. If SSL determines that the integrity of the mesh sheet is compromised, the sheet will be removed from the installation process and tagged.

Process Audit at Steel Supplier: SSL personnel may elect at any time during the production process to perform an on-site inspection of the entire production process at each steel supplier's location. *Process Audits will take place a quarterly (minimum of four times a year)*. The inspection is intended to verify that the production process is in compliance with all aspects of both SSL's and the Supplier's QCP. SSL personnel may decide to include as an agent, an industry expert not affiliated with the supplier in the inspection to provide an independent opinion. A detailed report of the audit will be generated by SSL and kept as a record by SSL and the reinforcement supplier facility. A copy will be supplied to Caltrans upon request.

If SSL's personnel or agent determines that changes to the production process are necessary, the Supplier in question will implement the necessary changes without any delays to the production process.

First-Article Inspection and Process Audit at Precast Supplier: For Quality Validation, SSL personnel will perform at least four First-Article Inspection and Process-Audits per year and at the start of production for a specific project if required by the Project Specifications. SSL may also elect at any time during the production process to perform an on-site inspection of the any aspects of the entire production process at the concrete panel supplier's location.

The inspection will involve an examination of the casting and testing process for one representative panel from each potential type of panel for the manufacturing period or project (e.g. “A” panels, “X” panels, top-panels, L/R panels or corner-panels) and any unique product/architectural finish as well. The inspection will focus on the following items: embed loop clearance and spacing, panel identification and tracking, verification of concrete strength, process documentation and general condition of formwork. The inspection is intended to verify that the production process is in compliance with all aspects of both SSL's and the Supplier's QCP and that the Supplier can produce material in accordance with SSL Shop Drawings and Project Specifications.

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A report of the inspection will be kept on file at the precast facility and submitted along with the Certificate of Compliance (COC) that accompanies the material to the jobsite (see sample First Article Inspection and Process Audit Report in). A copy will be supplied to Caltrans upon request.

SSL personnel may decide to include as an agent, an industry expert not affiliated with the supplier in the inspection to provide an independent opinion. If SSL's personnel or agent determines that changes to the production process are necessary, the Supplier in question will implement the necessary changes without any delays to the production process.

6. QUALITY CONTROL PROGRAM FLOWCHART

Below is a flowchart summarizing the entire QC process as required by SSL's QCP and the individual QCP's of the material suppliers. This chart combines the steps taken by SSL along with the steps taken at each supplier’s location. For detailed flowcharts that cover the procedures of the material suppliers, please see Section 7.

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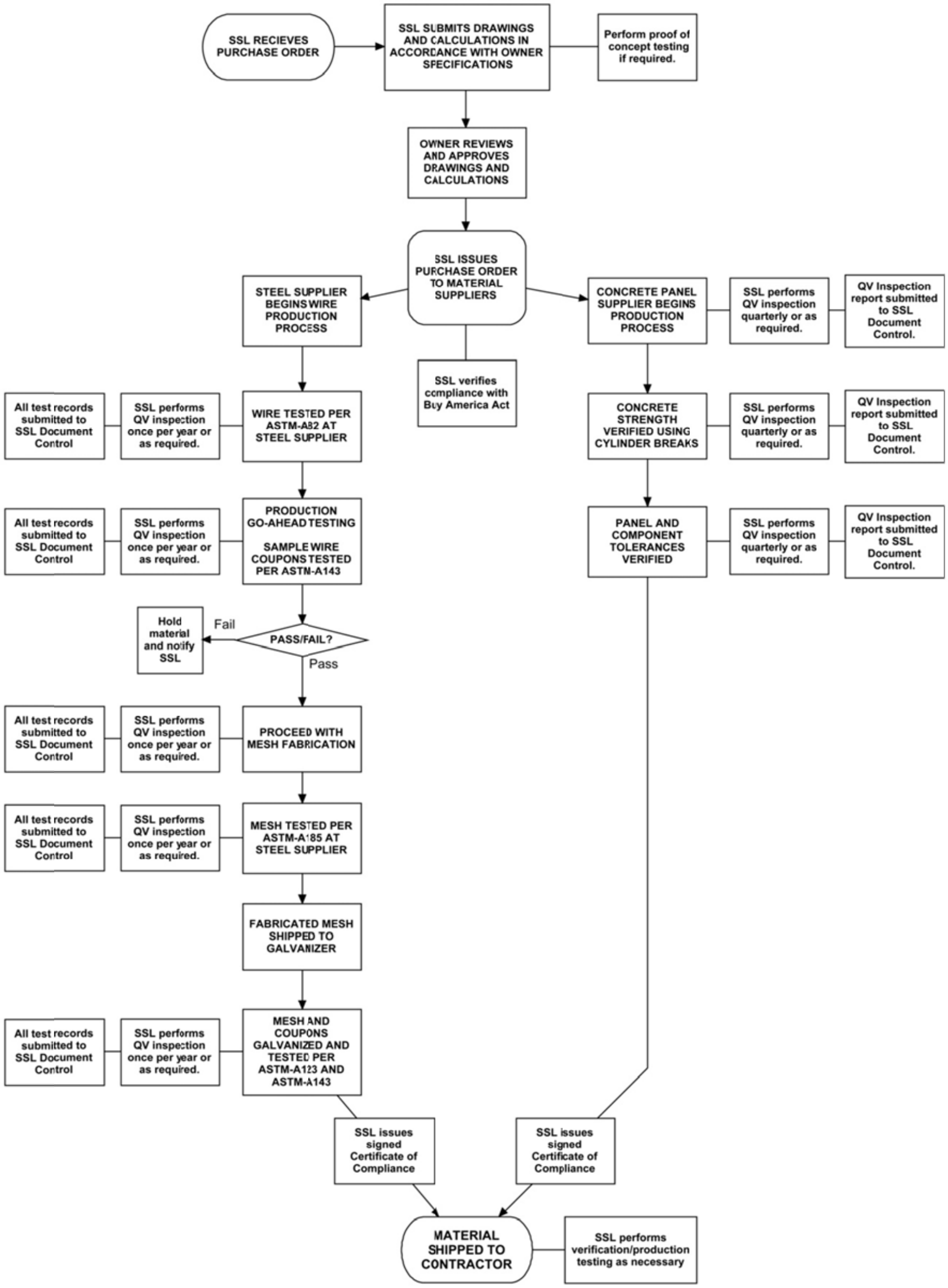
SSL RECIEVES PURCHASE ORDER
SSL SUBMITS DRAWINGS AND CALCULATIONS IN ACCORDANCE WITH OWNER SPECIFICATIONS
Perform proof of concept testing if required.
OWNER REVIEWS AND APPROVES DRAWINGS AND CALCULATIONS
SSL ISSUES PURCHASE ORDER TO MATERIAL SUPPLIERS
STEEL SUPPLIER BEGINS WIRE PRODUCTION PROCESS
SSL verifies compliance with Buy America Act
CONCRETE PANEL SUPPLIER BEGINS PRODUCTION PROCESS
SSL performs QV inspection quarterly or as required.
QV Inspection report submitted to SSL Document Control.
All test records submitted to SSL Document Control
SSL performs QV inspection once per year or as required.
WIRE TESTED PER ASTM-A82 AT STEEL SUPPLIER
CONCRETE STRENGTH VERIFIED USING CYLINDER BREAKS
SSL performs QV inspection quarterly or as required.
QV Inspection report submitted to SSL Document Control.
All test records submitted to SSL Document Control
SSL performs QV inspection once per year or as required.
PRODUCTION GO-AHEAD TESTING
SAMPLE WIRE COUPONS TESTED PER ASTM-A143
PANEL AND COMPONENT TOLERANCES VERIFIED
SSL performs QV inspection quarterly or as required.
QV Inspection report submitted to SSL Document Control.
Hold material and notify SSL
Fail
PASS/FAIL?
Pass
All test records submitted to SSL Document Control
SSL performs QV inspection once per year or as required.
PROCEED WITH MESH FABRICATION
All test records submitted to SSL Document Control
SSL performs QV inspection once per year or as required.
MESH TESTED PER ASTM-A185 AT STEEL SUPPLIER
FABRICATED MESH SHIPPED TO GALVANIZER
All test records submitted to SSL Document Control
SSL performs QV inspection once per year or as required.
MESH AND COUPONS GALVANIZED AND TESTED PER ASTM-A123 AND ASTM-A143
SSL issues signed Certificate of Compliance
SSL issues signed Certificate of Compliance
MATERIAL SHIPPED TO CONTRACTOR
SSL performs verification/production testing as necessary

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7. MATERIAL TESTING AND INSPECTION PERFORMED BY SUPPLIERS

Below are the QC Procedure Flowcharts for two of SSL's Suppliers, they reference the attached individual QC Programs in place at those Suppliers and are made part of SSL's QC Program. Should SSL elect to use a different supplier as a substitute, SSL will examine their QC program and perform the necessary QV inspections to ensure that it meets or exceeds the requirements laid out below.

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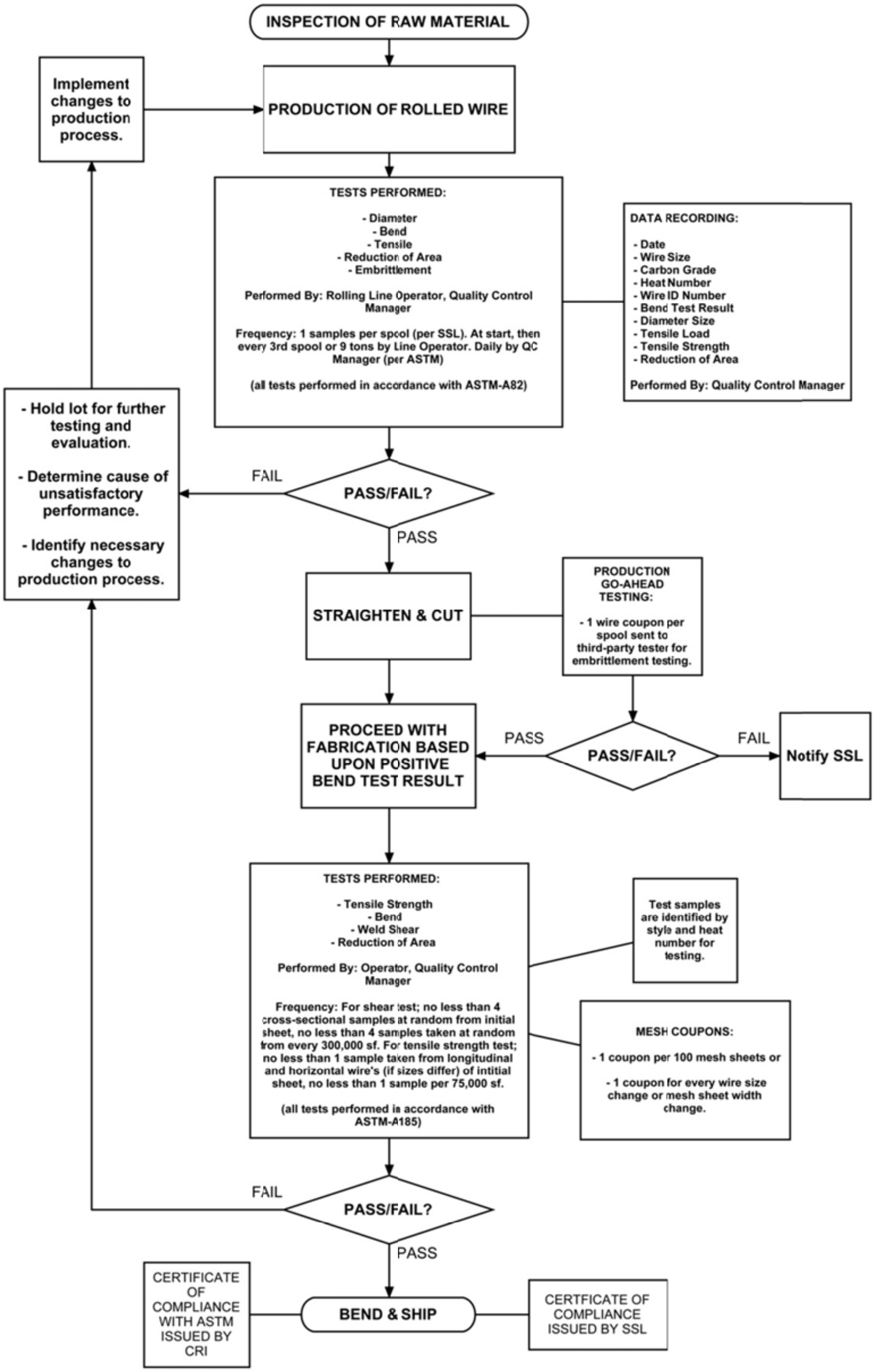
Concrete Reinforcements, Inc: QC Process Flowchart for SSL Soil Reinforcing



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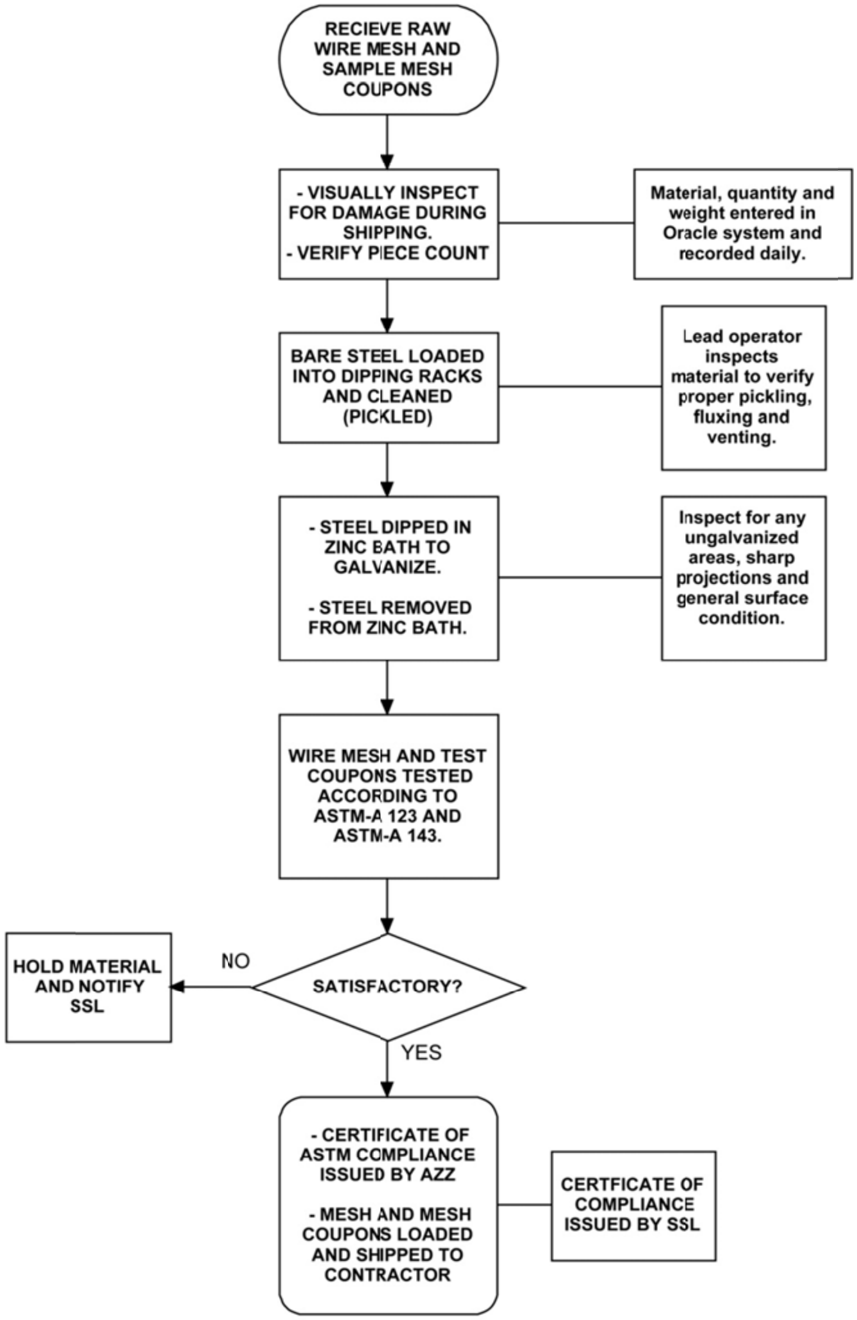
AZZ Galvanizing Services: QC Process Flowchart for SSL Soil Reinforcing



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8. CONCLUSION

SSL feels that our QCP in conjunction with the QCP's in place at our Material Suppliers, will ensure that the products we provide meet or exceed all applicable standard and specifications. If after review, any aspects of our QCP or the individual QCP's of our Material Suppliers are found to be insufficient, SSL will make any necessary changes to our QCP and notify our Material Suppliers of any necessary changes. Should SSL become aware of any additional requirements, SSL's and the individual QCP's of our Material Suppliers will be revised to reflect those requirements.

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CRI
Concrete Reinforcements, Inc.
13450 W. Peoria Ave. Surprise, Az. 85379 Ph. 623-975-2970 Fax. 623-975-2790

3/7/2012

Scott Thompson Jr.
SSL LLC
4740 Scotts Valley Dr. STE E
Scotts Valley, CA. 95066

Regarding: Increase Quality Practices for SSL Soil Reinforcing Mesh

Mr. Scott Thompson

Attached is Concrete Reinforcements General Quality Plan as well an Enhanced Quality Plan designed for production of SSL Soil Reinforcing Mesh. This plan was implemented February 2012.

Best Regards,

JT Wright
Concrete Reinforcements, Inc.

Raw Material Inspection for Wire Rod

Purpose: This Raw Material Inspection is designed to verify materials strength and dimensional properties as well as verifying the chemical properties are within specification.

Frequency: One sample for every different heat number from the steel mill

Method:

1. As a shipment is received, verify that Mill Certificates have been provided for each heat number that has been delivered.
2. Obtain one sample (approx. 12") for each different heat number for testing the diameter. Refer to ASTM A510 Table 8 for diameter conformance. Refer to ASTM A510 Section 11 if material does not meet the requirements. Otherwise, proceed to step 3.
3. Using the same sample from the diameter test, test the tensile strength per ASTM A370. Verify it to be within the range specified on the Mill Cert
4. Verify that the chemical composition of each heat is within the parameters required by A510 using Table 3. Material ½" or greater must be Grade 1010. Material less than ½" will either be 1010 or 1008.

If the tests and inspections are within limits, all material within the heat shall be tagged with a color code. If anything is out of limit, the material shall be put through further processing tests to verify it will meet ASTM Standards for welded wire reinforcing as well as passing the galvanized embrittlement per ASTM A143

Recorded Data:

1. Material Tensile noted on Mill Cert
2. Chemical verification signed off
3. Diameter noted on Mill Cert

Rolled Wire Inspection - SSL Specific Requirements

Purpose: This inspection is designed to verify material conformance to ASTM A82 and A143 for Embrittlement

Frequency: One sample (approx 2 ft) per spool.
Note: additional samples may be requested for outside testing

Method:

1. Check the diameter around the entire wire using Venier Calipers to verify the wire is within range according to ASTM A82 Table 4 & section 6
2. Perform a Bend Test on each sample per A82 section 5.2
3. Perform a Tension Test on each sample per A82 section 5.1
4. Perform a Reduction of Area Test Per A82 section 5.3
5. Label the bent portion of each sample with the Heat Number, Wire Size & Date and submit them to the galvanizer for the appropriate Embrittlement Test. Wire sizes that do not get bent prior to galvanizing are not required to be tested for Embrittlement.

If the tests and inspections are within limits, material may be staged and tagged for the Straighten and Cut Process. If anything is out of limit, the material shall be placed in a non-conforming area and may not be used for SSL Soil Reinforcing unless additional testing validates the quality of the finished product

Recorded Data:

1. Date of Rolling
2. Diameter Min & Max
3. Rod Size & Heat Number
4. Carbon Content
5. Wire Size
6. Lbs on spool
7. Bend Test Verification
8. Reduction of Area
9. Tensile Strength
10. Embrittlement Test Verification / Certification

Weld Shear and Tensile Test Across Welds - SSL Specific Requirements

Purpose: This test is designed to verify weld shear integrity and tensile strength of wire that has been welded

Frequency: One sample sheet for every different width and/or wire size.

Method:

1. Before each style change (width, wire size or machine positioning) weld a replica test sample of the sheets to be succeeded by this test.
2. Perform a Weld Shear Test per ASTM A185 Section 7 & 10 for each intersection across the width of the test sample
3. Perform a Tensile Test across the welded intersections per ASTM A185 Section 7.1 for every different wire size or 75,000 square feet. If the fractured section is of sufficient distance from the weld to measure diameter, perform a reduction of area test per A185 Section 7.2
4. Bend the remaining portion of the replica sample in the same manner as its job requires. Tag it accordingly and ship it with the order in which it corresponds. (this is intended for further process testing if required by the purchaser)

If the tests and inspections are within limits, material may be staged for bending. If anything is out of limit, the material shall be placed in a non-conforming area and may not be used for SSL Soil Reinforcing unless additional testing validates the quality of the finished product

Recorded Data:

1. Date of Weld
2. Job Number and Styles Tested
3. Wire Size
4. Weld Shear Ultimate PSI
5. Tensile Ultimate PSI

Bend Setup Inspection

Purpose: The purpose of this inspection is to verify accuracy of the bender setup according to the job requirement

Frequency: Once for each bend diagram provided with each job.

Method:

1. Check the vertical and horizontal dimensions to ensure the jig pins adjusted correctly.
2. Verify Mandrel size is correct
3. Verify the angle adjustment is correct

If any of the preceding inspections are incorrect, make the necessary adjustments before proceeding

Recorded Data: N/A

Concrete Reinforcements Inc.

QUALITY CONTROL PLAN
(IMPLEMENTED 11/98)

ROLLED WIRE:

1. FREQUENCY OF SAMPLING AND TESTING

A. Each rolling line operator will initially cut a 12" sample coupon from the start of the rolling process and continue to every third spool of wire produced of the same size to ensure it meets all weight, deformation and tensile spec's required. Operators will repeat the same process after each change over to a different wire size's to meet all required specifications.

2. TESTING SMOOTH WIRE SAMPLES

   A. Smooth wire is tested in accordance with ASTM-A82.
   The following tests are performed.
   - Diameter
   - Bend Test
   - Tensile
   - Reduction of Area

3. RECORDED DATA OF SMOOTH WIRE

   A. Sample coupons are tested daily by Quality Control to ensure all wire samples conform to ATMS-A82 steel welded wire specification for yield, weight and tensile.

   B. Internal data recorded is as follows:
   - Date
   - Wire Size
   - Carbon Grade
   - Heat Number
   - Bend Test

- Wire ID Number
- Diameter Size
- Tensile Load
- Tensile Strength
- Reduction of Area

4. SAMPLE TESTING OF DEFORMED WIRE

A. Deformed wire is tested in accordance with ASTM-A 496.

B. Tests performed are as follows:
- Weight per Linear Foot
- Tensile
- Bend Test
- Height of Deformations

5. RECORDED DATA OF DEFORMED WIRE SAMPLES

A. Sample coupons are tested daily by Quality Control to ensure all wire samples conform to ASTM A-496 steel welded wire specification for yield, weight and tensile and filed.

B. Data recorded is as follows:
- Date
- Wire Size
- Heat Number
- Bend Test
- Tag Number
- Weight per Foot
- Tensile Load
- Tensile Strength
- Deformation Height

Concrete Reinforcements Inc.

WELDED WIRE FABRIC

1. FREQUENCY OF TESTING WELDED WIRE FABRIC

   A. Shear testing of welded wire fabric will constitute of no less than four cross sectional welded samples cut out staggered through out the initial sheet to ensure welded consistency is achieved. No less than four test samples are taken for every 300,000 square feet to conform to the weld shear strength requirements for the welded wire fabric to conform to A-497.

   B. Tensile testing of welded wire fabric will constitute a minimum of one sample taken from the longitudinal and horizontal wire's if differs in wire sizes from welded fabric being tested. Testing of samples will be taken at intervals of no less than $75,000^2$ of welded fabric to conform to ASTM A-497 & A185.

   C. The samples are identified by style, order number, and tested in accordance with ASTM-A185 or A497.

   D. Test performed are as follows:
      - Tensile Strength
      - Bend
      - Wels Shear
      - Reduction of Areas (Smooth Fabric Only)

2. RECORDED DATA OF DEFORMED WIRE SAMPLES

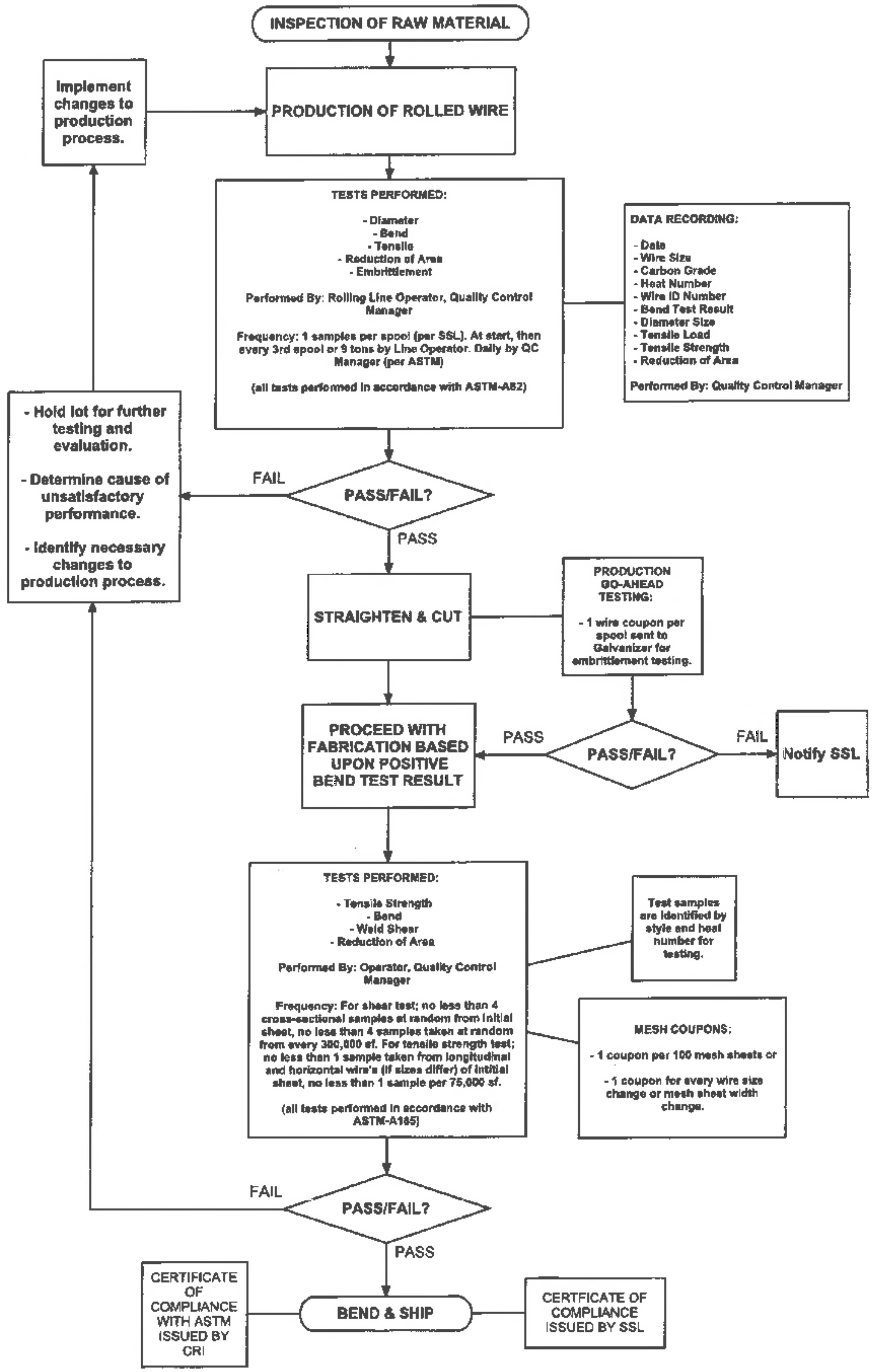
   A. Sample coupons are tested daily by Quality Control to ensure all wire samples conform to ATMS-A82 496 and 497 steel welded wire specification for yield, weight and tensile.

   B. Data recorded is as follows:
      - Customer
      - Mesh Style
      - Date
      - Bend Test
      - Tensile Strength

- Pass Value of Weld Shear Test
- Weld Shear Load
- Reduction of Area (Smooth Wire Fabric Only)

3. FINAL CERTIFICATION

Final job order certifications are signed only by the Quality Control Manager, certifying the material ordered adheres to the designated ASTM specification, and domestic origin.


INSPECTION OF RAW MATERIAL
PRODUCTION OF ROLLED WIRE
Implement changes to production process.
TESTS PERFORMED:
- Diameter
- Bend
- Tensile
- Reduction of Area
- Embrittlement
Performed By: Rolling Line Operator, Quality Control Manager
Frequency: 1 samples per spool (per SSL). At start, then every 3rd spool or 9 tons by Line Operator. Daily by QC Manager (per ASTM)
(all tests performed in accordance with ASTM-A82)
DATA RECORDING:
- Date
- Wire Size
- Carbon Grade
- Heat Number
- Wire ID Number
- Bend Test Result
- Diameter Size
- Tensile Load
- Tensile Strength
- Reduction of Area
Performed By: Quality Control Manager
FAIL
PASS/FAIL?
PASS
- Hold lot for further testing and evaluation.
- Determine cause of unsatisfactory performance.
- Identify necessary changes to production process.
STRAIGHTEN & CUT
PRODUCTION GO-AHEAD TESTING:
- 1 wire coupon per spool sent to Galvanizer for embrittlement testing.
PROCEED WITH FABRICATION BASED UPON POSITIVE BEND TEST RESULT
PASS
PASS/FAIL?
FAIL
Notify SSL
TESTS PERFORMED:
- Tensile Strength
- Bend
- Weld Shear
- Reduction of Area
Performed By: Operator, Quality Control Manager
Frequency: For shear test; no less than 4 cross-sectional samples at random from initial sheet, no less than 4 samples taken at random from every 300,000 sf. For tensile strength test; no less than 1 sample taken from longitudinal and horizontal wire's (if sizes differ) of intitial sheet, no less than 1 sample per 75,000 sf.
(all tests performed in accordance with ASTM-A185)
Test samples are identified by style and heat number for testing.
MESH COUPONS:
- 1 coupon per 100 mesh sheets or
- 1 coupon for every wire size change or mesh sheet width change.
FAIL
PASS/FAIL?
PASS
CERTIFICATE OF COMPLIANCE WITH ASTM ISSUED BY CRI
BEND & SHIP
CERTFICATE OF COMPLIANCE ISSUED BY SSL

Quality Management System
Quality Manual
FACILITIES:

CROWLEY
200 NORTH BEVERLY
CROWLEY, TX

JACKSON
125 AZTEC DR
RICHLAND, MS

HOUSTON
7407 CE KING PKWY
HOUSTON, TX

MOSS POINT
4212 DUTCH BAYOU RD.
MOSS POINT, MS

ARKANSAS
998 ESCUE DRIVE
PRAIRIE GROVE, AR

WASKOM
990 E. TEXAS AVE
WASKOM, TX

MOBILE
17640 INDUSTRIAL PARK
CITRONELLE, AL

HOBSON
2402 ENGINEERS RD
BELLE CHASSE, LA

ARIZONA
15775 ELWOOD ST
GOODYEAR, AZ

BEAUMONT
5898 INDUSTRIAL RD.
BEAUMONT, TX

WESTSIDE
3520 S. RIVERVIEW
PORT ALLEN, LA

CINCINNATI
4454 STEEL PLACE
CINCINNATI, OH

MUNCIE
2415 S. WALNUT ST
MUNCIE, IN

DIXON
310 E. PROGRESS DRIVE
DIXON, IL

CHELSEA
6022 S INDUSTRIAL RD
CHELSEA, OK

PLYMOUTH
2631 JIM NEU DR
PLYMOUTH, IN

PEORIA
6718 PLANK RD
PEORIA, IL

HAMILTON
7825 HOMESTEAD DR
HAMILTON, IN

JOLIET
625 MILLS RD
JOLIET, IL

WINSTED
800 6TH ST
WINSTED, MN

BRISTOL
14871 INDUSTRIAL PARK RD
BRISTOL, VA

PILOT
MANILA CREEK RD
POCA, WV

DENVER
4400 EAST 61ST AVE.
COMMERCE, CO

TULSA
1800 W. 21ST ST
TULSA, OK

CANTON
1723 CLEVELAND AVE. S.W.
CANTON, OH

HOUSTON WEST
9103 FAIRBANKS N HOUSTON RD
HOUSTON, TX

ST. LOUIS
1461 KIN ARK CT
ST. LOUIS, MO

RSI - CATOOSA
5101 BIRD CREEK
PORT OF CATOOSA, OK

NASHVILLE
200 32ND AVE. N.
NASHVILLE, TN

LOUISVILLE
6310 KENJOY DR.
LOUISVILLE, KY

HURST
625 W. HURST BLVD
HURST, TX

KANSAS CITY
7700 E. 12TH ST.
KANSAS CITY, MO

WHEELING
748 MCMECHEN ST SUITE 11
BENWOOD, WV

Contents

0.0 Introduction

AZZ Galvanizing Services is committed to a policy of conformance to quality requirements for each function and product of the organization. The policy has been instituted to ensure client confidence, that its services and products are as requested and meet the rigorous specification requirements. This policy is enhanced with an added degree of excellence attributed to the inclusion of substantial control on the administration, procurement, engineering, operation and quality functions of the organization.

The policy is implemented with the adoption of a Quality Management System (QMS) which ensures the organizational structure, responsibilities, processes and resources consistently provide product meeting customer, statutory and regulation requirements. If procedures are found to be in need of improvement, measures will be initiated to revise officially the anomaly to an acceptable level of clarity and resolution.

AZZ Galvanizing Services has planned for the long-term, a strategy utilizing continuous quality improvement, combined with responsive, near-term actions to enable it as an organization, to be a quality leader.

1.0 Duties of Personnel

Senior Vice President and Chief Operating Officer, Galvanizing Services
The Senior Vice President and COO of Galvanizing is responsible for the overall operation of the Galvanizing Services segment. The Senior Vice President and COO of Galvanizing has been assigned the overall responsibility to plan, implement and maintain the Quality Management System.

Vice President of Operations
The Galvanizing Vice President of Operations is responsible for administration, customer relations, safety and quality of the plant under their division.

Galvanizing Regional Manager
The Galvanizing Regional Manager is responsible for administration, customer relations, safety and quality of the plant under their region.

Plant Manager
The Galvanizing Plant Manager is responsible for administration, customer relations, production, maintenance, safety, and quality of service and coating. The Plant Manager is responsible for seeing that all materials are galvanized in accordance with the applicable specifications.

Office Manager

The Office Manager analyzes, organizes and implements office procedures involving accounting payroll, human resources, information management, filing systems, requisition of supplies and other clerical services.

Plant Supervisor

The Plant Supervisor is responsible for production, maintenance and quality of products produced under shift supervision.

Maintenance Supervisor

The Maintenance Supervisor analyzes and resolves work and production problems, performs preventative maintenance, and troubleshoots equipment failures.

Quality Management/Customer Service Representative

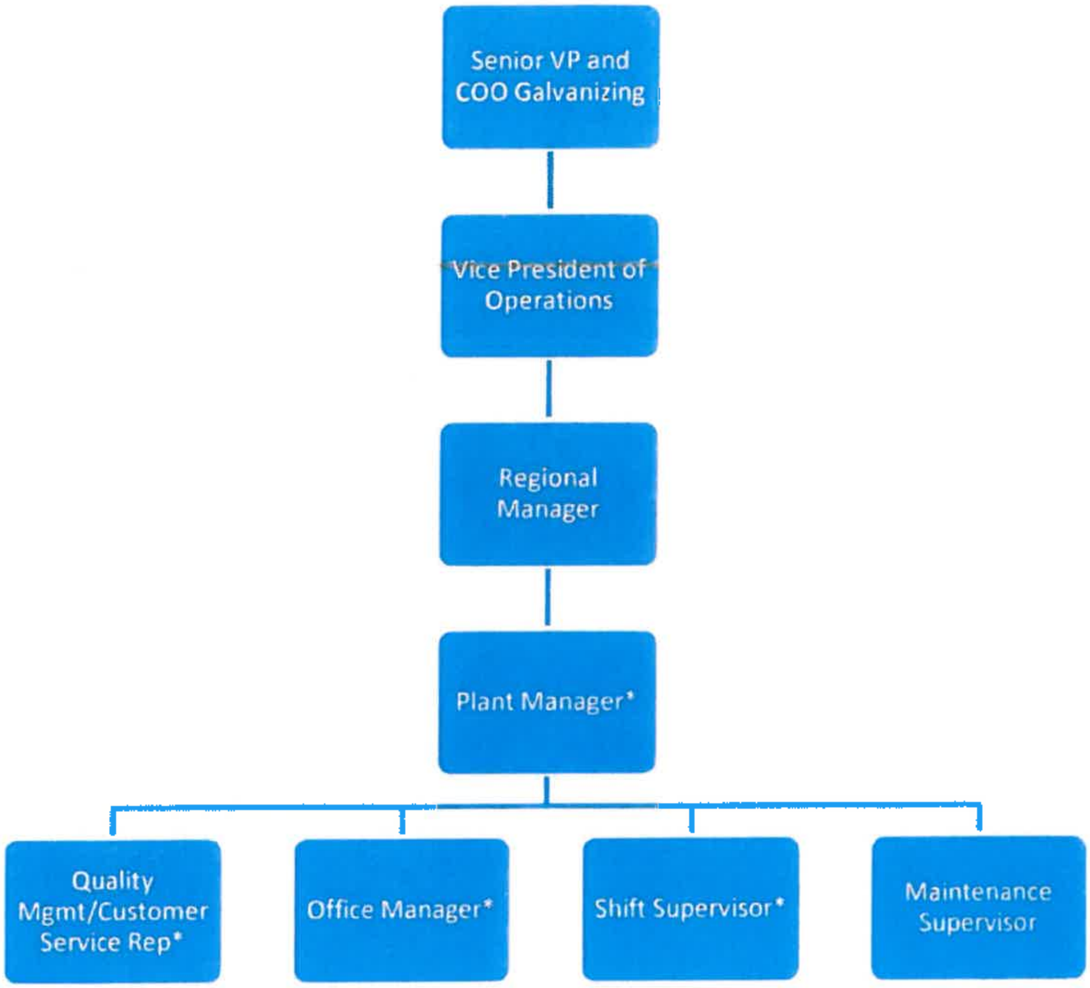
The Quality Management/Customer Service Representative is responsible for proper quality training, document control, document review and adherence monitoring.

2.0 Quality Management

The AZZ Galvanizing Services Quality Manual addresses the requirements of the quality standard and defines the company Quality Management System (QMS). This is the overall responsibility of the Quality Management/Customer Service Representative with input and help from all Quality Management team members, and overseen by the Plant Manager.

2.1 Quality Management Team

This chart is an example of the plant management organization. Actual organization and number of employees may vary at each plant.



*Quality Management Team

2.2 General Requirements

The Quality Management Team implements and maintains the effectiveness and efficiency of the organization's performance by considering the needs of customers through the following steps:

a. Determine the processes needed for the QMS and their application throughout the organization.
b. Determine the sequence and interaction of these processes.
c. Determine criteria and methods needed to ensure that both the operation and control of these processes are effective.

d. Ensure the availability of resources and information necessary to support the operation and monitoring of these processes.
e. Monitor, measure where applicable, and analyze these processes.
f. Implement actions necessary to achieve planned results and continual improvement of these processes. Through the use of the Quality Management Team, all quality related issues are resolved in a timely and efficient manner.

The Quality Management Team directs the Quality Management System. It establishes and reviews all quality policies and is the main policy setting body within the plant. The team interprets the quality policy, and develops quality system objectives, and measures quality performance and institutes corrective action when necessary. The Quality Management Team also controls manufacturing resources and ensures the Quality Management System is in compliance with required regulatory standards.

When chosen to outsource any process that affects product conformity to requirements control over such processes will be ensured. Control of such processes will be identified within the Quality Management System by request for quote, quotation, purchase request, and purchase order. Any required sketches, drawings, specifications, explanations, or standards, will be included with the communications for the outsourced vendor.

2.3 Document Control

The Quality Program Manual and all documents and records required by the manual are controlled and are to be maintained and retained by the appropriate Plant Manager or Vice President, as defined by the manual.

The Quality Program Manual is prepared and distributed by the Manufacturing Engineer Galvanizing Services.

- All controlled manuals will be numbered prior to distribution.
- Controlled in-company distribution of quality manuals will include the Senior Vice President Galvanizing Services, Vice President of Operations, Director of Engineering, Manufacturing Engineer, Galvanizing Marketing Manager, Galvanizing Sales Manager, Galvanizing Regional Manager, Galvanizing Plant Manager, and Sales Manager, each of whom will acknowledge receipt by signature of record to the Senior Vice President.
- Distribution outside the company will be as appropriate and necessary, with receipt acknowledged by signature to the Plant Manager. Manuals distributed outside of the company are considered uncontrolled copies of the Plant Manager's Quality Manual.
- The Plant Manager will maintain records of the distribution of all uncontrolled manuals and receipt signatures.

Revisions of the Quality Program Manual will originate with the Vice President of Operations, and be distributed with a revised contents page to each manual holder of record.

- In-company receipt of revisions will be acknowledged by signature after discussions of the revisions with the Vice President of Operations and return of superseded pages.
- Uncontrolled manuals held outside the company will be acknowledged by signature and return of superseded pages to the Plant Manager.

3.0 Management Responsibility

The Quality Management Team implements the Quality Management System and continually improves its effectiveness by:

a) Communicating the importance of meeting customer and regulatory requirements.

b) Establishing the quality policy.

c) Ensuring that quality objectives are established.

d) Conducting management reviews as necessary.

e) Ensuring the availability of resources.

The Quality Policy, Quality Objectives/Goals and the Quality Management Team support the development, management and continuous improvement in effectiveness of the Quality Management System.

3.1 Management Commitment

The Quality Management Team will formally review the QMS at a minimum of once per year to ensure its continuing suitability and assess opportunity improvements.

3.2 Customer Focus

AZZ Galvanizing Services depends on its customers and focuses to understand current and future customer needs. To that end, customer requirements are determined and fulfilled with the aim of enhancing customer satisfaction.

3.2.1 Customer Requirements

Upon receiving the customer's material, the receiving supervisor or designee will review the customer designated requirements. If customer requirements surpass specifications by statutory or regulatory standards such as ASTM A123 and/or ASTM A153, it is the Plant Manger's responsibility to review these requirements with the customer prior to plant commitment to perform any galvanizing service.

3.3 Quality Policy

AZZ Galvanizing is committed to continually improve the effectiveness of the Quality Management System. This commitment is expressed by:

- Absolute Quality Provider
- Zero Injuries
- Zero Customer Complaints

3.3.1 Quality Policy Communication and Framework for Quality Objectives

The Quality Policy provides the framework for the company Quality Objectives. This Quality Policy is communicated and understood throughout the organization. The policy is posted on bulletin boards, posted at work stations, posted in the offices, posted in the lunchroom and reception area.

3.4 Quality Planning

The Quality Management/Customer Service Representative manages and develops quality objectives, measures quality performance and institutes corrective action when quality objectives are not consistent with the quality policy. The Quality Management Team manages manufacturing resources and ensures that quality objectives, including those needed to meet requirements for product are established at relevant functions and levels within the organization.

The quality objectives are measurable and consistent with the quality policy:

- Pounds shipped
- External/Internal Rework
- Customer Complaints
- Pounds per man hour
- OSHA Accidents
- Sales per month

- Lifts per hour
- Kettle Analysis

4.0 Product Specification

The drive for continual improvement of the organization's performance focuses on the improvement of the effectiveness and efficiency of processes, to achieve increased benefits, increased customer satisfaction, improved use of resources and reduction of waste. The standard specification is in accordance with ASTM A123 unless otherwise specified.

4.1 Planning of Product Specification

In planning of product specification, the Quality Management Team plans and develops the processes needed for product realization and evaluates planning of product specification to be consistent with the requirements of the other processes of the Quality Management System.

In planning product specification, the organization shall determine the following, as appropriate:

- Quality objectives and requirements for the product.
- The need to establish processes, document and provide product specific resources.
- Required verification, validation, monitoring, inspection and test activities specific to the product and the criteria for product appearance.

4.2 Customer-Related Processes

The Quality Management Team shall have a full understanding of the process requirements of the customer before initiating its action to comply.

4.2.1 Determination of Requirements Related to the Product

It is a combined effort between AZZ Galvanizing Services and the customer to determine product requirements:

- There are requirements specified by customer including packing and shipping instructions plus delivery instructions.
- The requirements not stated by customer but necessary for specific products to be processed with the required zinc thickness and appearance such as ASTM A123 standards.

- Statutory and regulatory requirements related to the products and processes.
- Any additional requirements determined by AZZ Galvanizing Services

4.2.2 Review of Requirements Related to the Product

Prior to the AZZ Galvanizing Services' commitment to supply a product to the customer, the review process of requirements related to the product, includes verification of:

- Product requirements are defined.
- Contract or order requirements differing from those previously expressed are resolved.
- That AZZ Galvanizing has the ability to meet the defined requirements.

Where the customer provides no documented statement of requirement, AZZ Galvanizing confirms the customer requirements before acceptance as default to ASTM A123. Changed requirements are identified during review process and evaluated in order to understand the effect on other processes and the needs and expectations of customers. This understanding and its impact need to be mutually acceptable. Relevant documents are amended and relevant personnel are made aware of the changed requirements.

4.3 Customer Communication

The Quality Management Team determines and implements ways for communicating to the customer in relation to:

- Product information.
- Inquiries, contracts or order handling, including amendments.
- Customer feedback, including customer complaints.

Customer communications include quotes, purchase orders, phone calls, fax documents, e-mails, visits, letters, bill of ladings and packing slips.

4.4 Purchasing

4.4.1 Purchasing Process

Products will be purchased from approved vendors unless it is a one-time only purchase. The Quality Management Representative or the Plant Manager must approve one-time-only purchases.
Selection criteria for approved vendors are based on:

- Cost
- Product/Service quality

- Availability/Delivery
- Terms
- Recommendations
- Reputation

Records of approved vendors will be maintained on the approved vendor list.

Approved Vendor Lists exist for

- Bath Metals and Tank Chemicals

4.4.2 Purchasing Information

Purchasing information will describe the product to be purchased.
The purchasing process is:

- Fill out purchasing order requisition form and/or update purchase order log regarding items to be purchased.
- Plant Manager or designee must approve the purchase order.
- Once the order is placed a copy is given to the requestor and the original is filed in purchasing A/P files.

4.5 Production and Service Provisions

4.5.1 Control of Production and Service Provisions

Controlled conditions for production and service provisions include:

- Availability of information that describe the product characteristics.
- Use of suitable process equipment.
- Control of process equipment by monitoring and measurement equipment where applicable.
- Availability and use of monitoring and measuring devices.
- Implementation of release, delivery and post-delivery activities.

4.5.2 Customer Property

Care will be exercised when handling customer-supplied product. Incoming material will be checked visually for damage in transit. The customer will be notified of any damage prior to unloading damaged material. Permission from the customer to unload damaged material must be confirmed and documented. Digital pictures shall be taken prior to unloading damaged material and kept on file. If customer property is lost, damaged or otherwise found unsuitable for use, this will be reported to the customer and records maintained.

4.6 Control of Monitoring and Measuring Equipment

Each Galvanizing Plant Manager is responsible for all testing equipment and all records relating to testing equipment.

4.6.1 Instruments

Thickness gauge

- Gauge will be calibrated and/or tested for accuracy according to the manufacturer's recommendations against standards traceable to the National Institute of Standards and Technology (NIST).

The zinc bath temperature probes will be checked for accuracy and/or calibrated annually.

Weight scales will be checked for accuracy and/or calibrated annually.

5.0 Measurement, Analysis and Improvement

The Quality Management Team ensures that an effective and efficient monitoring, measurement, collection, analysis, improvement and validation of data are in place, to ensure that AZZ Galvanizing Services' performance achieves satisfaction of customer by:

- Demonstrating conformity of the product.
- Ensuring conformity of the QMS.
- Continually improve the effectiveness of the QMS.

5.1 Monitoring and Measurement

5.1.1 Customer Satisfaction

It is the responsibility of the Plant Manager to ensure customer satisfaction. The Quality Management Team monitors information related to customer perception of having needs met.

Appropriate actions are to be taken to correct any complaints and to guard against in the future.

5.2 Internal Audit

Internal audits are conducted at planned intervals to determine whether the QMS conforms to planned arrangements in product realization and is effectively implemented and maintained.

The internal audit program is planned on the basis of the status and importance of the processes and areas to be audited, as well as the results of the previous audit (except for the initial audit). The audit criteria, scope frequency and methods are defined. Selection of auditors and performance of audits will ensure the objectivity and impartiality of the audit process. Auditors shall not audit their own work.

The Quality Management Team is responsible to ensure that actions are taken without undue delay to eliminate detected nonconformities and their causes. Follow-up activities will include the verification of the actions taken and the reporting of the verification results.

5.3 Control of Nonconforming Product

Product that does not conform to requirements is identified and controlled to prevent its unintended use or delivery..

Nonconforming product is managed by one or more of the following ways:

- By taking action to eliminate the nonconformity.
- By authorizing its use, release or acceptance under concession by the Plant Manager and where applicable customer consent.
- By taking action to prohibit its original intended use or application, unless authorized by the customer.
- Records of the nature of the nonconformities and any subsequent action taken, including concession obtained, are maintained.
- When nonconforming product is corrected it will be re-verified to demonstrate conformity to requirements.
- When nonconforming product is detected after delivery or use has started, actions will be taken appropriate to the effects, or potential effect, of the nonconformity.

5.4 Improvement

5.4.1 Continual Improvement

The Quality Management Team continually seeks to improve the effectiveness of the Quality Management System through the use of the quality policy, quality objectives, audit results, analysis of data, corrective and preventive actions and management review.

5.4.2 Corrective Action

In order to prevent reoccurrence of nonconformities, the following actions are taken to eliminative nonconformities:

- Reviewing nonconformities (including customer complaints).
- Determining the causes of the nonconformities.
- Evaluating the need for action to ensure that nonconformities do not reoccur.
- Determining and implementing action needed.
- Records of the results of action taken.
- Reviewing the effectiveness of corrective action taken.

5.4.3 Preventive Action

Preventive action is taken to eliminate the causes of potential nonconformities in order to prevent their occurrence. The preventive action requirements are:

- Determining potential nonconformities and their causes.
- Evaluating the need for action to prevent the occurrence of nonconformities.
- Determining and implementing action needed.
- Reviewing the effectiveness of the preventive action taken.

6.0 Work Instruction

6.1 Receiving

Incoming material will be checked visually for damage in transit. The customer will be notified of any damage prior to unloading damaged material. Permission from the customer to unload damaged material must be confirmed and documented. Digital pictures should be taken prior to unloading damaged material and kept on file.

Incoming paperwork will be checked for customer identification. Piece counts will be verified when deemed feasible by the Plant Manager.

Material will be removed carefully from the trucks with forklifts or cranes.

Material is inspected for drainage provisions and mounting holes. If these items are not properly addressed the customer will be called and arrangements made to correct the materials.

The material, number of pieces and weights are entered into the Oracle computer system and recorded on daily shipping and receiving sheets.

Any special galvanizing instructions or requests for fast turnaround times are communicated to the Plant Manager and/or Production Supervisor.

6.2 Racking

Bare steel is loaded into pickle baskets or affixed to a fixture via wire, brackets, chains, pins, hooks, etc.

Products are to be oriented in such that they will gravity drain liquids when removed from the different baths. A lead person or supervisor must be contacted for instruction if products are noticed without drainage provisions.

6.3 Pickling

All tanks are to be monitored per the SOP for temperature and chemical strength. Records of temperature, chemical strength and remedial action will be kept per the SOP.

Alkaline cleaning tank or Acid Degreasing tank - when required, material will be immersed in the cleaning solution to remove oils, greases and paints.

Acid Tank

Material may be chemically cleaned in either:

Hydrochloric Acid (or)

Sulfuric Acid

Material is submerged until all scale, rust or coatings are removed.

Abrasive cleaning may be used as an alternative cleaning method to acid cleaning.

Rinse tanks for the removal of cleaning chemicals will contain water.

Pre-flux tank (zinc ammonium chloride) to prevent oxidation until material is galvanized

Hoisting Procedure:

- Material is lowered slowly into tanks.
- Material is moved onto the next tank only after a minimum amount of drips are present falling from the lowest point of the load.

6.4 Galvanizing

- The zinc bath temperature will be maintained per the SOP and may be varied to meet the requirement of products being galvanized.
- Kettle lead person will inspect material to verify proper pickling, fluxing, and venting, prior to its entering the kettle.
- All material will remain in the kettle zinc bath until it reaches the temperature of the bath.
- All material will be withdrawn from the zinc bath in a manner that will minimize ash inclusion.
- Major uncoated areas are cause for rejection and return to pickling for regalvanizing if the bare spots are larger than 1 inch in the narrowest dimension (ASTM A123). Minor uncoated areas, one inch or less in the narrowest dimension, will be repaired according to ASTM A780 (latest revision). See the *Inspection of Products Hot Dip Galvanized After Fabrication* (published by American Galvanizers Association).

6.5 Control and De-racking

- Operators remove materials from fixtures or baskets while inspecting for ungalvanized areas, sharp projections and or surface condition.
- If needed, materials are cleaned using files or grinders, and any needed repairs are conducted in accordance to the ASTM A123 standards.
- Product is weighed and the weights recorded.

6.6 Shipping

- Product is prepared for shipment and thoroughly banded and or shrink wrapped if applicable.
- Final product count, identification, weighing, orientation etc must be checked for compliance with customer specifications.
- Customer is contacted for pickup.
- Materials should be loaded as they were received unless noted not feasible.
- Careful loading and tight bundling is important.

- Carrier is responsible for product once it is loaded and must inspect the load.

PRECAST QUALITY CONTROL CHECKLIST

SUPPLIER:

PROJECT:

DATE:

WALL NO:

CASTING DATES:

RELEASE DATE:

PANEL QTY:

Quality Control Checklist Included?

Concrete Strength Test Results Included?

Quality Control Manager:____

Signature:____

PRE-POUR
DATE:
PROJECT/WALL ID:
INSPECTOR:

PANEL ID	COMMENTS	READY TO CAST?	CASTING

*For a panel to be ***READY TO CAST*** it must be checked for the following:
Length, width, square, level, clean, oil, rebar size, rebar qty, cover, lifting inserts, embed size, embed placement, embed clearance.

*For a panel to ***CAST*** properly it must be witnessed that the concrete is placed, finished, vibrated and cured per all applicable Specifications.

POST-POUR
DATE:
INSPECTOR:

COMMENTS	READY TO SHIP?

*For a panel to be ***READY TO SHIP*** it must be checked for the following:
Front and back finish, cracks, spalls, broken edges, lifting inserts, embed placement, length, width, square.

Section 5 – Performance

Section 5.1

Item 5.1 - If the answer is yes to 1.1.2, or 1.1.4, or 1.2.2, provide a description of the updated system's development and usage history.

The new connection system was developed in 2003 for use on Caltrans projects. Once the approval was completed in 2003 SSL used the revised connection in all other states. Attached is the latest list of projects which used the revised connection system.

SSL Project List

SSL Job No.	Job Name	State	Wall Area - SF	Contractor	Address
1305	Horizon Oil Sands	AB	19,778	Kiewit Industrial Canada Co.	P.O. Box 5478, Fort McMurray, Alberta T9H-3G5 Canada
0317	Glacier Hwy Reconstruction	AK	2,153	Secon	PO Box 32159, Juneau, AK 99801
0511	Jenny Creek Bridge	AK	9,700	Southeast Road Builders, Inc	HC60 Box 4800, Haines, AK 99827
0615	Parks Highway	AK	13,005	Knik Construction	
1006	Ship Creek	AK	22,611	Wilder Construction	11301 Lang Street, Anchorage, AK 99515
1007	Glenn-Bragaw	AK	18,371	Wilder Construction	11301 Lang Street, Anchorage, AK 99515
1104	Parks Crusey	AK	11,303	Sustina Rose	1651 West Parks Hwy, Ste. 2 Wasilla, AK 99687
1408	48th Avenue Extension	AK	3,235	AIC	601 W 5th Avenue, Ste 400, Anchorage, AK 99501
2005	Abbot Loop	AK	7,930	Wilder Construction	1301 Lang Street, Anchorage, AK 99515
0611	Bella Vista-Hwy 71/72	AR	15,744	Prime Contracting, Inc.	P.O. Box 744, Republic, MO 65738
0116	US 60 Bell Road	AZ	98,545	Coffman Specialties, Inc.	9685 Via Excelencia, Ste 200, San Diego, CA 92126
0218	US 191-B Hill Realignment	AZ	7,151	Contech Engineered Solutions L	12550 West Butler Dr, El Mirage, AZ 85335
0320	I-40 4th Street Butler	AZ	1,404	FNF Construction	115 South 48th Street, Tempe, AZ 85281
0913	Vistancia Blvd-CAP Canal Bridge	AZ	8,510	Skanska USA Civil West RMD	14050 N. 83rd Ave, Ste 280, Peoria, AZ 85381
0920	I-17 Central Ave	AZ	7,546	Pulice Construction, Inc.	8660 E. Hartford Dr, Ste 305, Scottsdale, AZ 85255
1105	Jake's Corner Hwy	AZ	19,936	FNF Construction	P.O. Box 5005-115 South 48th St., Tempe, AZ 85280
1118	American Mountain	AZ	3,300	Contech Engineered Solutions L	12550 West Butler Dr, El Mirage, AZ 85335
1218	Northern Parkway	AZ	48,464	Pulice Construction, Inc.	2033 W. Mountain View Rd, Phoenix, AZ 85021
1220	I-10 Tucson -Benson Hwy (Houghton Rd)	AZ	13,621	Ames Construction	8333 E Hartford Dr, Scottsdale, AZ 85255
1820	SR24 Gateway Freeway	AZ	61,974	FNF Construction	115 S. 48th Street, Tempe, AZ, 85281
2006	Litchfield Road	AZ	37,648	Sundt Construction	P.O. Box 20687, Phoenix, AZ 85036
2209	Manzanita Village	AZ	2,088	Bobcat Wizards Construction	P.O. Box 19868, Fountain Hills, AZ 85269
2309	Rice Ave/Hwy 101	AZ	7,657	Security Paving Co, Inc.	P.O. Box 1489, Simi Valley, CA 91353
2406	Lowes -Bullhead	AZ	3,036	Becho Incorporated	10700 W. Jomax, Peoria, AZ 85383
03-016	SR 260	AZ	18,027	KLB Construction	3405 121st St. SW, Mukilteo, WA 98275
03-031	Globe Show Low	AZ	5,040	Stronghold Contracting, Inc.	822 E. Union Hills , Suite PMB#404 Pheonix AZ 85024
03-040	Red Mountain Fwy	AZ	32,240	FNF Construction	P.O. Box 5005 Tempe, AZ 85280
2706	London Bridge Beach	AZ	3,675	Valdez & Son Construction	264 S. Phelps Drive, Apache Junction, AZ 85220
0409	Skytrain Storage Yard	BC	4,211	Tybo Contracting Ltd	PO Box 34147-17790 Hwy #10, Surrey, BC V3S-8C4
1009	Hwy 14-Sombrio #3	BC	9,127	Hazelwood Const. Services Inc	1940 Bollinger Rd, Nanaimo, BC V9S-5W9
1306	Hwy 15 Crossing	BC	24,893	West Shore Constructors Ltd	150-1000 Roosevelt Cres., North Vancouver, BC V7P-3R4
1308	Kicking Horse Canyon	BC	9,656	Ledcor Civil/Mining Limited	1500-1055 West Hastings St., Vancouver, BC V6E 3X1
1611	South Fraser Perimeter	BC	436,000	FTG Constructors	8100 Nordel Way, Delta, BC V4G-8A9
2205	Sea to Sky	BC	736,154	Peter Kiewit & Sons Co.	1410-1111 W. Georgia Street, Vancouver, BC V6E 4M3
2310	Hwy 97	BC	33,573	Ledcor Civil/Mining Limited	1200-1067 Cordova St. W, Vancouver, BC V6C-1C7
3504	Mt. Lehman I/C	BC	7,981	Western Versatile Constr.	19635 Telegraph Trail Langley, B.C. V1M 3E6
0104	5th to Bay #2	CA	4,555	Tutor-Saliba	15901 Olden Street Sylmar, CA 91342-1093
0107	New Hall Ranch Road	CA	2,005	Oberg Contracting Corp.	P.O. Box 630519, Simi Valley, CA 93063
0112	Rt 101-Petaluma	CA	15,123	Ghilotti Construction Co., Inc.	246 Ghilotti Ave, Santa Rosa, CA 95407
0113	Old Redwood Hwy	CA	15,588	Ghilotti Construction Co., Inc.	246 Ghilotti Ave, Santa Rosa, CA 95407
0114	Broadway Brommer Multi Use Path	CA	4,887	ProVen Management	712 Sansome Street, San Francisco, CA 94111
0115	I-10 Jefferson St Interchange	CA	28,726	Riverside Construction Co, Inc.	4225 Garner Rd, PO Box 1146, Riverside, CA 92502
0119	I-5 Oso Parkway	CA	36,112	SRK Engineering	2615 Auto Park Way, Escondido, CA 92029
0120	Rt 5 Avery Parkway	CA	12,617	SRK Engineering	2615 Auto Park Way, Escondido, CA 92029
0206	Pier S Berths	CA	22,163	Ortiz Enterprises, Inc.	6 Cushing, Suite 200, Irvine, CA 92618
0208	Watt Avenue II	CA	5,745	Viking Construction	P.O. Box 1508, Rancho Cordova, CA 95741
0211	N Stockton RR Grade Sep	CA	40,500	RGW Construction	550 Greenville Rd, Livermore, CA 94550
0213	Rt 5/74-Ortega Hwy	CA	6,630	Flatiron Construction Corp	1770 La Costa Meadows Dr, San Marcos, CA 92078
0214	SR 91 Corridor Interchange Improvements	CA	802,230	Atkinson/Walsh	2455 Anselmo Drive, Ste 201, Corona, CA 92879
0215	11th Street	CA	82,000	Teichert Construction	PO Box 1118, Stockton, CA 95201
0216	Rt 57/60 @ Grand Ave	CA	7,578	Powell Constructors	8555 Banana Ave, Fontana, CA 92335
0220	Veterans Blvd	CA	18,165	Granite Construction	2716 Granite Court, Fresno, CA 93706
0306	Brittania Oyster Pt. II	CA	24,337	Prime: Hathaway Dinwiddie	400 Oyster Point Blvd. Suite 335, So. San Fran., CA 94080
0307	Rt 152/156	CA	20,475	RGW Construction	P.O. Box 2910, Livermore, CA 94551
0310	Seventh Standard PH 2	CA	13,228	Granite Construction	P.O. Box 5127, Bakersfield, CA 93388
0312	Price Canyon Rd	CA	13,836	Souza Construction, Inc.	P.O. Box 3810, San Luis Obispo, CA 93403
0313	Tustin Ave	CA	47,146	USS Cal Builders, Inc	8051 Main Street, Stanton, CA 90680
0314	Marin High School	CA	1,432	Ghilotti Construction Co., Inc.	246 Ghilotti Ave, Santa Rosa, CA 95407
0316	Harney Lane Separation	CA	5,584	DeSilva Gates Construction	11555 Dublin Blvd, Dublin, CA 94568
0407	Paseo Padre	CA	28,572	DeSilva Gates Construction	11555 Dublin Blvd, Dublin, CA 94568
0408	Rt 52-Santee	CA	17,834	Skanska USA Civil West	1995 Agua Mansa Rd, Riverside, CA 92509
0412	Iowa Ave Grade Separation	CA	43,069	Security Paving	P.O. Box 1489, Simi Valley, CA 91353
0413	Rt 126-Commerce Center Drive	CA	29,282	C.A. Rasmussen, Inc.	28548 Livingston Ave, Valencia, CA 91355
0417	Rt 101/114 Interchange -Willow Road	CA	15,512	OC Jones & Sons, Inc	1520 Fourth Street, Berkeley, CA 94710
0418	Rt 65 Widening?	CA	1,000	DeSilva Gates Construction	
0419	Laguna Nigel	CA	9,376	Reyes Construction	1383 South Signal Drive, Pomona, CA 91766
0506	Rt 1/17 Seperation	CA	29,960	Pavex Construction	411 Walker St, Watsonville, CA 95077
0509	Mid City Expo Light Rail	CA	94,000	FCI/Flour/Parsons, JV	707 Wilshire Blvd, Ste 3400, Los Angeles, CA 90017
0510	Sly Creek Dam	CA	24,028	Teichert Construction	4401 Duluth Ave, Roseville, CA 95678
0512	Hunts Lane	CA	55,215	Skanska USA Civil West	1995 Agua Mansa Rd, Riverside, CA 92509
0513	Glen Helen Parkway Grade Separation	CA	17,443	Skanska USA Civil West	1995 Agua Mansa Rd, Riverside, CA 92509
0515	Quint St Bridge Replacement	CA	2,873	Shimmick Construction Co, Inc.	8201 Edgewater Dr, Ste 202, Oakland, CA 94621
0516	Clinton Keith Road -Phase 2	CA	11,662	Sukut Construction	4010 W. Chandler Ave., Santa Ana, CA 92704
0518	Crittenden Lane Trailhead Improvements	CA	2,598	Ghilotti Construction Co., Inc.	
0604	Chandler	CA	6,110	Chandler Aggregates	P.O. Box 78450 Corona, CA 92877
0607	Rt 101-San Mateo	CA	111,023	DeSilva Gates Construction	11555 Dublin Blvd, Dublin, CA 94568
0609	Lewis Rd Widening	CA	9,283	Security Paving	P.O. Box 1489, Simi Valley, CA 91353
0612	Rt 880/Stevens Creek Blvd Interchange	CA	8,128	DeSilva Gates Construction	11555 Dublin Blvd, Dublin, CA 94568

SSL Project List

SSL Job No.	Job Name	State	Wall Area - SF	Contractor	Address
0614	Nelson Road	CA	3,517	Reber Construction	P.O. Box 273, Santa Cruz, CA 95061
0620	I-80 Southgate Road Realignment	CA	3,855	Gordon N Ball Inc	333 Camille Avenue, Alamo, CA 94507
0711	Harry Tracy Water Treatment	CA	7,442	R.A. Nemetz Construction Co, In	P.O. Box 5306, Galt, CA 95632
0713	6th Street Improvements	CA	15,999	OC Jones & Sons, Inc	1520 Fourth Street, Berkeley, CA 94710
0714	Rinconada Water Treatment Plant	CA	5,383	Preston Pipeline Inc	133 Bothelo Ave, Milpitas, CA 95035
0715	Rt 84-Livermore	CA	18,343	DeSilva Gates Construction	11555 Dublin Blvd, Dublin, CA 94568
0808	Rt 99-Chico	CA	10,427	Sierra Nevada Construction	9701 Dino Drive, Suite 190, Elk Grove, CA 95624
0811	San Diego Airport	CA	13,479	Kiewit/Sundt, J.V	3723 North Harbor Drive, San Diego, CA 92101
0812	I-10/605	CA	22,849	MCM Construction	P.O. Box 620, North Highlands, CA 95660
0813	Rt 5 Realignment - West Magnolia	CA	225,300	Security Paving	P.O. Box 1489, Simi Valley, CA 91353
0905	Nut Tree Overcrossing	CA	2,303	MCM Construction	P.O. Box 620, North Highlands, CA 95660
0906	Metro Goldline	CA	20,000	G & C Equipment Corporation	1875 West Redondo Beach Blvd, Suite 102, Gardena, CA 90247
0918	I-680 HOV	CA	51,139	Bay Cities Paving & Grading	1450 Civic Ct, Bldg B #400, Concord, CA 94520
0919	Centennial Corridor	CA	75,118	Sam's Equipment	PO Box 7797, Fresno, CA 93747
1010	SR 74/I-215 I/C	CA	6,741	Skanska USA Civil West	1995 Agua Mansa Rd, Riverside, CA 92509
1011	Butterfield Blvd South Extension	CA	37,516	RGW Construction	P.O Box 2910, 550 Greenville Rd, Livermore, CA 94550
1013	Gerald Desmond Bridge	CA	115,000	Shimmick/FCC/Impreglio JV	11 Golden Shore, Ste 330, Long Beach, CA 90802
1017	Monte Vista Grade Separation	CA	49,656	Pulice Construction, Inc.	3111 Camino Del Rio N. Suite 720, San Diego, CA 92108
1107	Hanson Crusher	CA	12,333	Hanson Permanente	
1113	Auto Center Drive	CA	17,633	Griffith Company	12200 Bloomfield Ave, P.O. Box 2150, Santa Fe Springs, CA 90
1117	The Exchange at Mission Bay	CA	2,030	McGuire & Hester (sub)	
1120	US 101/Blossom Hill Rd	CA	4,583	DeSilva Gates Construction	
1209	BART Fremont Station	CA	3,913	Shimmick/Skanska JV	1320 Stevenson Blvd, Fremont, CA 94538
1213	5th Street-Sac Railyards-Phase 2	CA	11,864	OC Jones & Sons, Inc	1520 Fourth Street, Berkeley, CA 94710
1219	Rt 132/99	CA	37,637	Bay Cities Paving & Grading	1450 Civic Ct, Bldg B #400, Concord, CA 94520
1313	Rt 11/905 Separation	CA	55,449	Coffman Specialties, Inc.	9685 Via Excelencia, Ste 200, San Diego, CA 92126
1317	25th Ave Improvements	CA	128,650	Shimmick Disney JV	8201 Edgewater Dr, Ste 202, Oakland, CA 94621
1410	San Bruno	CA	109,789	Granite Construction Co.	715 Comstock St, Santa Clara, CA 95054
1413	Rt 12-80-280 Interchange	CA	49,107	DeSilva Gates Construction	11555 Dublin Blvd, Dublin, CA 94568
1506	Watt Ave Bridge	CA	5,940	Mitchell Engineering	5109 Florin Perkins Rd, Sacramento, CA 95826
1507	La Sierra Ave	CA	40,256	Ortiz Enterprises	6 Cushing, Suite 200, Irvine, CA 92618
1511	Rt 47/103-Schulyer Heim Bridge	CA	18,427	MCM Construction	P.O. Box 620, North Highlands, CA 95660
1513	Rt 4 & 5	CA	38,276	Brosamer and Wall	
1604	SR 76	CA	22,000		
1605	Stanford Stadium	CA	71,700	Vance Brown Builders	3197 Park Boulevard, Palo Alto, CA 94306
1705	Tunnel Ave	CA	4,306	RGW Construction	P.O. Box 2910 Livermore, CA 94551
1706	Poway Road	CA	31,642	FCI Constructors	1770 La Costa Meadows Drive, San Marcos, CA 92078
1709	I-405	CA	350,000?	Kiewit Pacific Co.	6060 Center Drive, 4th Floor, Los Angeles, CA 90045
1717	OC 405	CA	252,302	OHL	
1719	Route 905	CA	3,526	Skanska	1995 Agua Mansa Rd, Riverside, CA 92509
1720	I-80/I-680/Rt 12- Contract 04--0A5394	CA	22,127	Kiewit	
1805	Hagador Canyon	CA	2,795	Beador Construction	26320 Lester Circle, Corona, CA 92883
1807	Rt 52/67/125	CA	14,412	Erreca's Inc	12570 Slaughterhouse Canyon Rd, Lakeside, CA 92040
1809	Pit River	CA	33,375	Barnard Construction Co, Inc.	P.O. Box 99, Bozeman, MT 59771
1904	SR 125	CA	125,000	Otay River Constructors	860 Harold Place, Chula Vista, CA 91914
1906	880/238/580	CA	46,777	FCI Constructors	2100 Goodyear Road, Benicia, CA 94510
1909	I-215-SanBag	CA	48,650	Skanska/Rados JV	1995 Agua Mansa Rd, Riverside, CA 92509
1910	Avalon Blvd. Interchange	CA	24,258	Powell Constructors	8555 Banana Ave, Fontana, CA 92335
1911	12th Street Reconstruction	CA	3,300	McGuire & Hester	
1920	SR91 Corridor Operation	CA	8,202	OHL USA, Inc.	1920 Main Street, Suite 310, Irvine, CA 92614
2007	Orange Show Rd	CA	9,095	MCM Construction	6413 32nd St, North Highlands, CA 95660
2010	Rt 405-Bolsa Chica	CA	52,043	Atkinson Construction	27422 Portola Parkway, Ste 250, Foothill Ranch, CA 92610
2211	Expo Phase 2	CA	Sub	G&C Equipment Corp	1875 W. Redondo Beach Blvd #102, Gardena, CA
2304	880/237 Freemont	CA	34,460	FCI Constructors	2100 Goodyear Rd. Benicia, CA 94510
2405	Pacific Street Bridge	CA	2,785	FCI Constructors	2585 Business Park Drive, Vista, CA 92081
2409	Riverside Ave/I-10	CA	35,089	CC Myers, Inc.	1822 South Lewis Street, Anaheim, CA 92805
2410	Central Galt Interchange	CA	14,944	Teichert Construction	8811 Kiefer Blvd, Sacramento, CA 95826
2411	Colton RR Crossing	CA	244,449	Skanska USA Civil West	1995 Agua Mansa Rd, Riverside, CA 92509
2505	Cemex Truck Pump	CA	2,315	Applied Industrial Design Inc	
2510	SR 140	CA	31,000	RGW Construction	550 Greenville Rd, Livermore, CA 94550
2604	Leisure Town Road	CA	9,123	RGW Construction	550 Greenville Road, Livermore, CA 94550
2804	Blue Rock	CA	12,686	Granite Construction	715 Comstock Street Santa Clara, CA 95054
2810	SR 5	CA	19,972	Security Paving	P.O. Box 1489, Simi Valley, CA 91353
2906	Rt 90-Yorba Linda	CA	52,364	Brutoco Engineering	P.O. Box 310189, Fontana, CA 92331
2910	Antelope Valley	CA	5,666	Hillside Retaining Walls	5256 S. Mission #703-002, Bonsall, CA 92003
3010	Santa Monica Diversion	CA	235	Blois Construction Inc.	P.O. Box 672, Oxnard, CA 93032
3104	SR 22	CA	407,521	GMR	4000 Metropolitan Dr. Suite 201 Orange, CA 92868
3204	Rt.116/101	CA	16,534	Diablo Contractors	7 Crow Canyon Court Suite 100 San Ramon, CA 94583
03-030	101 Ralston	CA	3,541	O.C. Jones	1520 Fourth Street Berkeley, CA 94710-1774 02-026
03-034	Brokaw	CA	8,276	Pavex Construction	411 Walker St, Watsonville, CA 95076
03-043	Oroville-Quincy Fwy	CA	40,000	Viking Construction	11315 Sunrise Gold Circle, Ste A Rancho Cordova, CA 95742
03-047	Arch Rd./Viking Wire	CA	612	Viking Construction	P.O. Box 1508, Rancho Cordova, CA 95741
0519	Rt 101- Carpinteria	CA	4,449	Security Paving	13170 Telfair Ave, Sylmar, CA 91342
1318	Sky Park	CA	6,380		
0806	SR 8 (I-10)	FL	89,841	Anderson Columbia Co., Inc.	2316 Highway 71, Marianna, FL 32448
2320	Stark Rd	FL	7,800	Randall Construction	
2511	Kathleen Road	FL	19,224	RWH Construction Services	1314 Oxbridge Dr, Lutz, FL 33549
1405	Spirit Lakes	IA	2,429	Graves Construction	P.O. Box 208, Melvin, IA 51350
0308	East Parkcenter	ID	7,331	McAlvain Construction, Inc.	5559 W. Gowen Road, Boise, ID 83709
0610	Twin Falls Flyover	ID	12,172	W.W. Clyde & Co	P.O. Box 350, Springville, UT 84663
0617	SH-62 Holes Creek	ID	1,376	Crea Construction	1508 Tammany Creek Rd, Lewiston, ID 83501
0809	I-86 Chubbuck to Pocatello	ID	25,990	Knife River	5450 W. Gowen Rd, Boise, ID 83709
0818	Zachary Road to Goose Creek	ID	2,112	Crea Construction	1508 Tammany Creek Rd, Lewiston, ID 83501

SSL Project List

SSL Job No.	Job Name	State	Wall Area - SF	Contractor	Address
0908	Sand Creek Byway	ID	146,918	Parsons RCI Inc.	1216 140th Avenue Ct. E., Sumner, WA 98390
0909	I-84 Orchard Street	ID	23,916	McAlvain Construction, Inc.	5559 W. Gowen Road, Boise, ID 83709
0910	I-84 Franklin Blvd	ID	8,955	Concrete Placing Co., Inc.	6451 West Gowen Road, Boise, ID 83709
0917	US 95 Curve Flattening	ID	5,920	Crea Construction	1508 Tammany Creek Rd, Lewiston, ID 83501
1704	St. Leon I/C	ID	22,398	Concrete Placing Company	6451 W. Gowen Boise, ID 83709
1710	US20 New Menan-Lorenzo	ID	8,747	Build, Inc.	5190 W. 700 S., Salt Lake City, UT 84104
0718	US-12 Maggie Creek	ID	4,512	Braun-Jensen, Inc.	509 S. 9th Street, Payette, ID 83661
1020	I-294 Archer	IL	32,613	Lorig Construction Co.	250 East Touchy Ave, Des Plaines, IL 60018
1320	Adams & Jackson St Interchange	IL	10,270	Lorig Construction Co.	250 East Touchy Ave, Des Plaines, IL 60018
1520	43rd St Pedestrian Bridge	IL	6,654	FH Paschen	
2020	I-294 Ramps C-4495	IL	8,842	Dunnet Bay	4300 Enterprise Drive, Unit B, Joliet, IL 60431
2120	I-294 Ramps D-4520	IL	2,878	Dunnet Bay	4300 Enterprise Drive, Unit B, Joliet, IL 60431
2220	I-294 Roadway and Bridge, 4431	IL	12,392	Walsh Construction	929 West Adams, Chicago, IL, 60607
03-020	I-80 Cook County	IL	9,000	D Construction, Inc.	1488 S. Broadway, Coal City, IL 60416
03-022	I-57 Jefferson Co.	IL	3,400	E.T. Simonds Construction, Inc.	1500 N. Oakland Carbondale, IL 62901
03-025	I-74 Peoria	IL	12,000	Walsh Construction of Illinois	619 Water Street Suite 3C
0104	Geist Res./Fall Creek	IN	20,538	Walsh Construction	2749 N. State Rd.39 La Porte, IN 46350
0404	I-69 Allen Co.-Leesburg	IN	4,028	Walsh Construction	2749 N. State Rd.39 La Porte, IN 46350
0904	Road 70/ US 231	IN	6,110	Smith and Johnson	1745 E. Main Street Columbus, OH 43205
1404	17 to 26 Elkhart	IN	25,951	Primco, Inc	7107 Smith Rd., Ft. Wayne, IN 46809
1504	Salisbury Road	IN	5,015	Milestone Contractors	824 Dillon Drive Richmond, IN 47374
2004	Gary Marina Access	IN	28,673	Superior Construction Co.	2045 E Dunes Hwy Gary, IN 46401
2404	79th Over I-465	IN	19,112	Beaty Construction	5292 West 100 North Boggstowm, IN 46110
03-005	I-94/80 Lake Co.	IN	7,500	Superior Construction Co. Inc.	2045 E. Dunes Hwy, Gary, IN 46401
03-006	Allen County	IN	4,500	R. L. McCoy	7898 E. Lincoln Highway Columbia City IN 46725
03-010	17 Elkhart County	IN	2,000	Primco, Inc	7107 Smith Rd., Ft. Wayne, IN 46809
03-017	Six Point Rd	IN	37,255	Weddle Bros. Const. Co. Inc.	1201 W. Third Street, Bloomington, IN 47402-11330
03-019	SR66 Warrick Co.	IN	5,815	Blankenberger Brothers	11700 Watertank Rd., Cynthania, IN 47612
03-024	I-70 Marion Co.	IN	8,600	American Contract Services	6200 E. Highway 62, Suite 200 Jeffersonville, IN 47130
03-046	Spencer County	IN	3,900	Ragle, Inc.	P.O. Box 444/5266 Vann Road Newburgh, IN 47629
03-048	Grant Street Call 300	IN	25,463	Superior Construction	2045 E. Dunes Hwy, Gary, IN 46401
0504	Kraft to Thornapple	MI	14,533	Davis Construction	616 South Creyts Road. Ste. A Lansing,MI 48917
1304	I-96 Beck Road	MI	2,747	Dan's Excavating	12955 23 Mile Road Shelby Township MI 48315
2104	Kennet Road	MI	2,904	Anlaan Corporation	424 Oak Street Spring Lake, MI 49456
3304	Square Lake Road	MI	9,677	TAC Construction	2231 N. Channel Dr. Harsens Island, MI 48028
03-011	Canal Rd	MI	9,985	Anlaan Corporation	424 Oak Street Spring Lake, MI 49456
03-018	M-26/US-41	MI	4,048	Thomas J. Moyle Jr Inc.	46702 Highway M-26, Houghton, MI 49931
03-035	Tulip City	MI	18,122	Kamminga & Roodvoets, Inc.	3435 Broadmoor Ave SE, Grand Rapids, MI 49512
03-049	Livingston Co.-US 23	MI	25,562	Dan's Excavating	12955 23 Mile Road , Shelby Township, MI 48315
0907	Crosstown	MN	329,648	Ames Construction	2000 Ames Drive, Burnsville, MN 55306
0106	Beardsley Rd Bridge	MO	7,781	Radmacher Bros. Excavating	501 South Route 7, Pleasant Hill, MO 64080
0204	Rt. 63 Howell	MO	4,755	Chester Bross Construction	P.O. Box 430 8965 Hwy 35 Hannibal, MO 63401
1106	New Madrid Pump	MO	7,830	Hill Brothers Construction	20831 Highway 15 North, Falkner, MS 38629
1509	Rt 60-Call 801	MO	17,316	JLA Construction	6088 West Farm Road 164, Brookline, MO 65619
1510	Call 403 Rte 9 to Rte 5	MO	41,669	Prime Contracting, Inc.	P.O Box 744, Republic, MO 65738
2704	I-64 Sarah Ave.	MO	4,521	Kozeny-Wagner	951 W. Outer Road Arnold, MO 63010
03-012	RT13/Ray Co.	MO	14,610	Hilty Quarries	190 North West 251 Rd., Clinton, MO 64735
03-013	US 60/Howell Co.	MO	6,733	H.R. Quadri Construction, Inc.	HC-2 Box 2437, Van Buren, MO 63965
0606	Vic White Coyote Rd	MT	29,060	Riverside Contracting Inc.	5571 Alloy South, Missoula, MT 59808
0804	Westfork Bitteroot	MT	7,671	Westway Construction, Inc.	P.O. 519 Airway Heights, WA 99001
1206	Medicine Tree	MT	7,828	MA Deatley Construction	P.O. Box 490, Clarkston, WA 99403
1208	Billings Airport Rd	MT	11,030	Riverside Contracting Inc.	5571 Alloy South, Missoula, MT 59808
1804	Missouri River	MT	1,093	Morgen & Oswood	1321 8th Ave. N- Ste. 204 Great Falls, MT 59403
0110	Spaceport America	NM	14,530	FNF Construction	115 South 48th Street, Tempe, AZ 85281
0109	Tenaya Way Overpass	NV	12,042	Southwest Iron LLC	5050 E Russell, Las Vegas, NV 89122
0209	US 95 Horse Drive	NV	76,111	Capriati Construction Corp	3097 E Warm Springs Rd, Ste 300, Las Vegas, NV 89120
0311	US 95 Summerlin Parkway	NV	12,804	Las Vegas Paving	4420 South Decatur Blvd. Las Vegas, NV 89103
0420	I-15 Northern Beltway	NV	21,553	Fisher Sand and Gravel	1302 W. Drivers Way, Tempe, AZ 85284
0507	Lamb Blvd-Phase 2	NV	99,956	Las Vegas Paving	4420 South Decatur Blvd. Las Vegas, NV 89103
0705	Hacienda Ave	NV	10,500	Las Vegas Paving	4420 South Decatur Blvd. Las Vegas, NV 89103
0706	SR 146 St. Rose	NV	101,800	Frehner Construction Co. Inc.	3920 W Hacienda Ave., North Las Vegas, NV 89118
0707	Galena Creek	NV	32,000	Fisher Sand and Gravel	500 Damonte Ranch Pkwy, Suite 1056, Reno, NV 89501
1008	Eastgate Rd Improvements	NV	61,854	Capriati Construction Corp	3097 E Warm Springs Rd, Ste 300, Las Vegas, NV 89120
1109	Harmon Ave Replacement	NV	1,453	Las Vegas Paving	4420 South Decatur Blvd. Las Vegas, NV 89103
1204	Rainbow Wire	NV	1,225	Frehner Construction Co. Inc.	4040 Frehner Road No. Las Vegas NV 89030
1508	North 5th Street	NV	35,223	Capriati Construction Corp	3097 E Warm Springs Rd, Ste 300, Las Vegas, NV 89120
1606	Silverado Ranch Rd	NV	57,331	Frehner Construction Co. Inc	4040 Frehner Road, North Las Vegas, NV 89030
1707	City Center	NV	30,227	Las Vegas Paving	4420 South Decatur Blvd. Las Vegas, NV 89103
1810	SR207	NV	2,121	Peek Construction	
2105	US 95 Rainbow Blvd	NV	28,309	Las Vegas Paving	4420 South Decatur Blvd. Las Vegas, NV 89103
2206	USA Parkway	NV	2,434	Q & D Construction	P.O. Box 10865, Reno, NV 89510
2306	I-580 Reno	NV	269,523	Fisher Sand and Gravel	500 Damonte Ranch Parkway, Suite 1056
2504	Durango Drive	NV	11,668	Frehner Construction Co. Inc.	4040 Frehner Road No. Las Vegas NV 89030
2610	US 95 @ Rainbow Ave	NV	36,623	Capriati Construction Corp	1020 Wigwam Parkway, Henderson, NV 89074
03-026	US 395 Carson Cty	NV	644	Ames Construction	3737 West 2100 S. West Valley City, UT 84120
03-029	Rainbow Widening	NV	3,184	Frehner Construction Co. Inc.	4040 Frehner Road No. Las Vegas NV 89030
03-039	Avairy Way	NV	10,544	American Asphalt & Grading	3624 Goldfield St. N.Las Vegas, NV 89032
03-041	I-580 Freeway	NV	27,043	Ames Construction	909 Hotsprings Rd. Carson City, NV 89706
03-045	I-15 Lamb Blvd.	NV	9,827	Las Vegas Paving	4420 South Decatur Blvd. Las Vegas, NV 89103
0105	I-77 Stark Cty	OH	3,806	The Ruhlin Company	6931 Ridge Road, Sharon Center, OH 44274
0210	Mill Street Bridge	OH	16,669	Kenmore Construction, Co. Inc.	700 Home Ave, Akron, OH 44310
0704	I-75 West Sandusky	OH	3,206	E.S. Wagner	840-Patchen Road Oregon, Ohio 43616
3404	West Road Bridge	OH	3,606	Sunesis Construction	2610 Crescentville Road West Chester, OH 45069
0608	Belrose Bridge	ON	770	Armtec Limited Parnership	370 Speedvale Ave. W., P.O. Box 3000
0118	Nestucca River Back Country Byway	OR	12,537	Laskey-Clifton Corporation	PO Box 50, 75355 Hwy 101, Reedsport, OR 97467

SSL Project List

SSL Job No.	Job Name	State	Wall Area - SF	Contractor	Address
0207	Weaver Bundle	OR	15,980	Prime: Hamilton Construction	P.O. Box 659, Springfield, OR 97477
00304	Hwy 62- Crater Lake	OR	4,955	James W. Fowler Co.	12775 Westview Dr. P.O. Box. 489 Dallas, OR 97338
0405	Rt 101: Fort to Sea	OR	1,206	Thompson Bros. Excavating	18211 NE Fourth Plain Rd., Vancouver, WA 98682
0410	Wyeth Columbia River Treaty	OR	8,977	Goodfellow Bros.	6135 NE 80th Ave, Ste A3, Portland, OR 97218
0505	Isthmus Slough Bridge	OR	1,210	LTM Incorporated	3055 Ocean Blvd., Coos Bay, OR 97420
0911	I-205 to Redland Road	OR	2,594	Nutter Corporation	7211 NE 43rd Ave, Vancouver, WA 98661
1210	North Fork Santiam	OR	12,924	K&E Excavating, Inc.	3871 Langley St SE, Salem, OR 97317
1519	OR 569-Beltline @ Delta Hwy	OR	4,833	Hamilton Construction	PO Box 659, Springfield, OR 97477
1711	I-5 SW Iowa Street	OR	21,906	Wildish Standard Paving Co	P.O. Box 7428, Eugene, OR 97401
1806	I-5 Exit 99	OR	10,470	James W. Fowler Company	12775 Westview Drive, Dallas, OR 97338
1905	NE 33rd Ave	OR	1,636	James W. Fowler Co.	12775 Westview Drive, Dallas, OR 97338
2806	Multorpor Overpass	OR	29,552	Holm II, Inc	618 2nd Street, P.O. Box 453, Stayton, OR 97383
03-042	N. Lombard RR	OR	11,560	Cascade Bridge	7601 NE Hazel Dell Ave., Ste D Vancouver, WA 98665
0618	Salmon River Bridge	OR	788	JAL Construction	123 SE 4th St, PO Box 6269, Bend, OR 97708
0717	Columbia Hwy Trailhead	OR	4,252	Stellar J	1363 Down River Drive, Woodland, WA 98674
03-037	Saluda Dam W/W	SC	20,000	Barnard Construction Co. Inc.	1892 North Lake Drive, Lexington, SC 29072
03-038	Railroad W/W	SC	600	Barnard Construction Co. Inc.	1892 North Lake Drive, Lexington, SC 29072
2305	Minnehaha Cty	SD	17,313	South Dakota DOT	5316 West 60th Street North, Sioux Falls, SD 57107
03-021	I-29 Minnehaha Co.	SD	3,000	Sioux Falls Construction	800 South Seventh Ave, Soiux Falls, SD 57104
0305	Provo Canyon	UT	119,865	Ames Construction	3737 W 2100 S, West Valley, UT 84120
2506	Legacy-Segment 1	UT	18,642	Ames Construction	3737 West 2100 South, West Valley, UT 84120
2606	Legacy-Segment 2	UT	58,714	Ames Construction	3737 West 2100 South, West Valley, UT 84120
2904	Cottonwood St.	UT	2,717	Edward Kraemer & Sons, Inc.	
0108	Parrish Lane Rd	UT	29,633	Ames Construction	3737 West 2100 South, West Valley, UT 84120
0111	SR 114 (Geneva Rd)	UT	57,240	Kiewit Infrastructure West Co	2302 Presidents Dr, Ste F, West Valley City, UT 84120
0117	I-15 Brigham Road to Dixie Dr	UT	11,061	Meadow Valley Contractors, Inc	PO Box 60726, Phoenix, AZ 85082
0219	I-15-Exit 16	UT	3,559	Ralph L Wadsworth Constructio	166 East 14000 South,
0414	BYU Test Wall	UT	1,405	BYU	
0708	Mid-Jordan/Draper Lt Rail	UT	1,200	Kiewit Herzog Parsons	669 West 200 South, Salt Lake City, UT 84101
0810	US 189-Heber to Provo	UT	4,301	W.W. Clyde & Co	P.O. Box 350, Springville, UT 84663
0820	Lehi Pedestrian Bridge	UT	12,167	Granite Construction	
1119	SR 179-Mid Valley	UT	13,725	Ames Construction	3737 West 2100 South, West Valley, UT 84120
1608	West Valley LRT	UT	12,383	Stacy and Witbeck Inc/Kiewit W	2264 South 900 West, Salt Lake City, UT 84119
1808	Pioneer Crossing	UT	65,000	Kiewit/Clyde JV	3738 West 2340 South, Ste C, West Valley City, UT 84120
1908	SR 89 State St. RR	UT	46,122	Ralph L Wadsworth Constructio	166 E 14000 South Ste 200, Draper, UT 84020
0411	I5-Grand Mound to Maytown	WA	10,727	Tri-State Construction, Inc.	P.O. Box 3686, Bellevue, WA 98009
0508	Consoldiated Car Rental	WA	10,480	Mowat Construction	P.O. Box 1330, 20210 142nd Ave NE
0605	US Hwy 2	WA	5,200	KLB Construction	3405 121st St. SW, Mukilteo, WA 98275,
0616	Burlington Northern Overpass	WA	62,810	Cascade Bridge, LLC	14215 NW 3rd Court, Vancouver, WA 98685
0709	Peace Arch	WA	7,212	Mowat Construction	P.O. Box 1330, 20210 142nd Ave NE
0710	I-90 Two Way Transit	WA	14,249	Gary Merlino Construction	9125 10th Ave South, Seattle, WA 98108
0720	SR 167/70th Ave E Vicinity Bridge	WA	14,474	Atkinson Construction	
0805	NW 119th Street	WA	7,984	ERI	P.O. Box 1059, Vancouver, WA 98666
0807	SR 502	WA	21,057	Castle Walls	#2595 1420 NW Gilman Blvd, Suite 2. Issaquah WA 98027
0817	S. 224th St Improvements	WA	23,611	SB Structures, LLC	PO Box 68847, Seattle, WA 98168
1005	York Bridge	WA	37,404	Mowat Construction	20210 142nd Ave. NE, P.O. Box 1330
1018	I-5 Steilacoom-Dupont Rd to Thorne Lane	WA	70,000	Guy F. Atkinson Construction, L	707 S. Grady Way #500, Renton, WA 98057
1110	Alaska Way Viaduct	WA	16,015	Skanska USA Civil West	221 Yale Ave. North, Ste 400, Seattle, WA 98109
1205	Aurora Ave	WA	18,859	Gary Merlino Construction	9125 10th Ave South, Seattle, WA 98108
1211	Lakewood Triangle Access	WA	27,082	Atkinson Construction	707 South Grade Way, Ste 500, Renton, WA 98057
1307	High Street	WA	8,844	KLB Construction	P.O. Box 158, Mukilteo, WA 98275
1309	SeaTac	WA	22,000	Gary Merlino Construction	9125 10th Ave, South Seattle, WA 98108
1310	SeaTac-#3	WA	15,000	Mid Mountain Contractors	P.O. Box 2909, Kirkland WA 98083
1406	Lexington Bridge	WA	6,280	Cascade Bridge	14215 NW 3rd Court, Vancouver, WA 98685
1407	SR 509	WA	24,083	Tri-State Construction	350 106th Ave NE, Bellevue, WA 98004
1409	S. Spokane Viaduct	WA	5,740	Marshbank Construction, Inc	P.O. Box 97, Lake Stevens, WA 98258
1420	SR 520 Montlake Design Build	WA	37,749	Graham Contracting Ltd	13555 SE 36th St, Bellevue, WA 98006
1505	Maple Valley	WA	899	Sanders General Construction	
1517	South Lander Grade Seperation	WA	12,396	Flatiron Constructors	2100 Goodyear Rd, Benicia, CA 94510
1610	SR522- US2 I/C Flyover	WA	30,485	Scarsella Bros, Inc.	8404 S. 196th Street, Kent, WA 98031
1617	SR 99-Alaska Way Viaduct	WA	13,524	SB Structures, LLC	PO Box 68847, Seattle, WA 98168
1619	Waterfront Seattle Alaskan Way	WA	3,500	Granite Construction	
1811	George Sellar	WA	57,514	KLB Construction	P.O. Box 158, Mukilteo, WA 98275
1819	SR410 Improvement Project	WA	2,778	Ceccanti Inc	4116 Brookdale Rd E, Tacoma, WA 98446
2011	Airport Way South	WA	33,000	Mowat Construction	P.O. Box 1330, Woodinville, WA 98072
2106	Powerhouse Bridge	WA	6,081	Cascade Bridge	14215 NW 3rd Court, Vancouver, WA 98685
2109	SR 501-Ridgefield Interchange	WA	4,551	Tapani Underground, Inc.	1904 SE 6th Place, PO Box 1900, Battle Ground, WA 98604
2110	SR 161/SR 18	WA	54,131	Mowat Construction	P.O. Box 1330, Woodinville, WA 98072
2204	Federal Way	WA	37,654	ICON Materials	P.O. Box 88050 Tukwila, WA 98138
2210	196th Street (SR 524)	WA	31,152	Northwest Construction, Inc.	1408 140th Place NE, Ste 101, Bellevue, WA 98007
2311	212th Street	WA	6,409	Northwest Construction, Inc.	1408 140th Place NE, Ste 101, Bellevue, WA 98007
2710	Tukwilla Urban Access Improv	WA	24,129	Atkinson Construction	707 South Grade Way, Ste 500, Renton, WA 98057
3004	Rainer Valley	WA	6,000	RCI Herzog	9136 MLK Jr. Way South, Seattle, WA 98118
03-007	Lynnwood Park	WA	48,792	Mowat Construction	20210 - 142nd Ave NE, Woodinville, WA 98072-1330
03-008	Ashway	WA	44,952	Tri-State Construction Inc.	320 - 106th Ave NE, Bellevue, WA 98009-3686
03-014	I-405 Bellevue	WA	27,889	KLB Construction	3405 121st St. SW, Mukilteo, WA 98275
03-033	Gher Rd	WA	23,531	Tapani Underground Inc.	1904 SE 6th Place Battle Ground, WA 98604
03-036	Weyerhauser	WA	33,572	Tri-State Construction Inc.	320 - 106th Ave NE, Bellevue, WA 98009-3686
03-050	South 277th	WA	6,806	Arm Construction	2615 SW 151st Place, Seattle, WA 98166
03-023	Whitewater Bypass	WI	15,000	Mann Bros., Inc.	N. 6147 Hwy 12 & 67 Elkhorn, Wisconsin 53121
0416	Grand Loop Road	WY	3,300	Eagle Peak Rock	PO Box 161898, Big Sky, MT 59716
1217	Grand Loop #2	WY	5,099	HK Contractors Inc.	6350 S Yellowstone Hwy, Idaho Falls, ID 83402
			10,374,672		

Section 5.1.1, 5.1.2 and 5.1.3

Item 5.1.1, 5.1.2 and 5.1.3 - If the answer is yes to 1.1.2, or 1.1.4, or 1.2.2, provide a description of the updated system's development and usage history. Then describe the following, for the updated system.

5.1.1 - Our MSEPlus^{TM} system was developed in 1997 and SSL received our first approval in California by Caltrans. With the completion of our HITEC evaluation in 1999 SSL received approvals by most state department of transportation agencies. The connection system evaluated in the 1999 HITEC reports was for our internal connection.

In 2003 SSL revised the internal connection system to a more conventional external system using embed connector cast into the panel by joining the soil reinforcement using a connector pin. This connection was first approved by Caltrans with many other states providing their approvals of the new system thereafter.

In 2012 our current connection systems required a reevaluation by Caltrans for LRFD purposes. Testing was performed for Caltrans in December 2012 SSL received LRFD approval shortly thereafter.

5.1.2 - Three of the oldest structures using this new connection system are in California. They the SR 22 Project in Orange County, SR 101 Ralston in San Mateo County and Route 116 / 101 in San Ramon. All these projects were for Caltrans.

5.1.3 - Two of the tallest structures using the connection system are in California. The tallest structure was of the SR 91 Widening Project in Corona California. Wall 115C was 52 feet tall with 115B in similar height.

The third tallest structure was a project for the Nevada Department of Transportation on the I 580 Realignment Project constructed south of Reno, Nevada. One of the MSE walls was on this project was 65.0 feet tall.

Section 5.1.4

Item 5.1.4 - Provide a list of private- and public sector users who have approved the use of the system. Also provide the contact information for a person at the user agency who may be contacted regarding the wall system's performance.

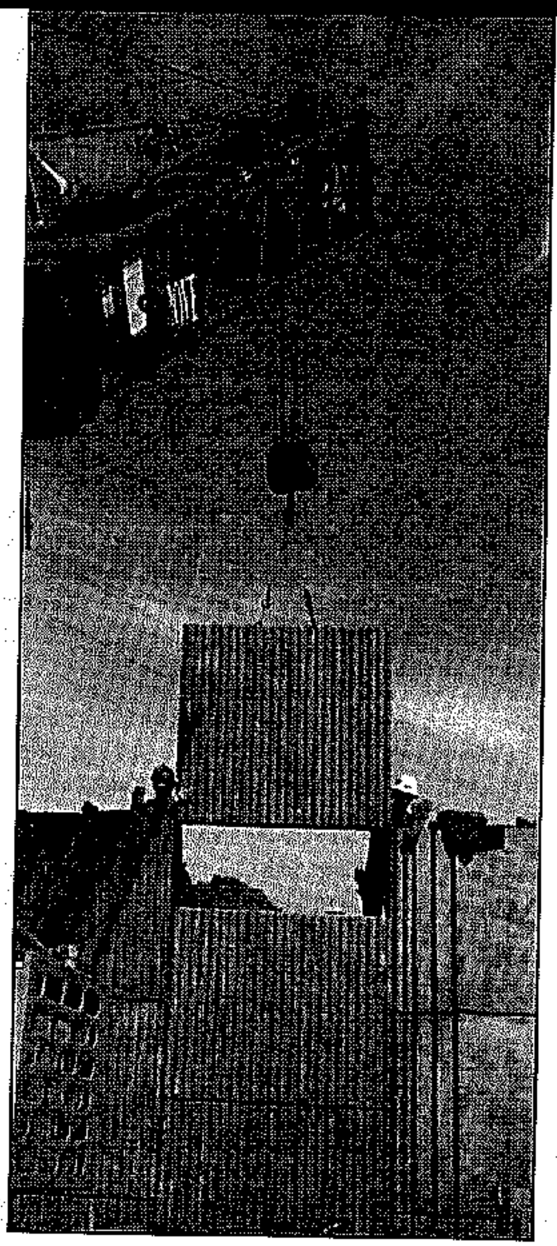
SSL System Approval by State

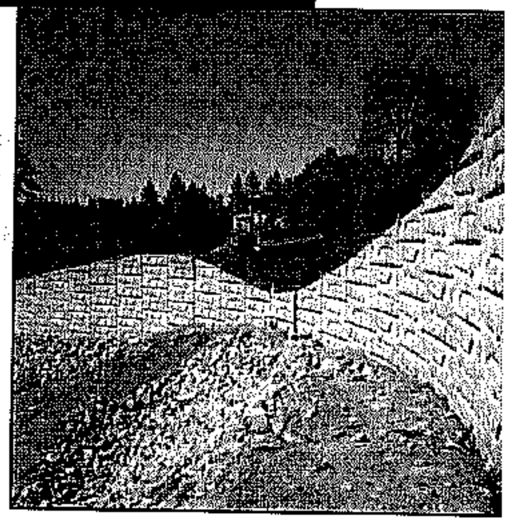
State	Approval	Letter Dated	Contact	Position	Phone
Alabama	Y	28-Aug-2006	B.E. Cox Jr, P.E.	Geotechnical Engineer, AK DOT	(334) 206-2270
Alaska	Y	Letter not issued	Kieth Korri	Materials and Testing Headquarters, AK DOT	(907) 269-6243
Arizona	Y	13-Jul-1998	Muhannad M.A. Zubi, P.E.	Product Evaluation Engineer, AZ DOT	(602) 407-3134
Arkansas	Y	27-Sep-2001	Jim Gee	Materials Engineer, AR DOT	(501) 569-2400
California	Y	14-Aug-2012	Kathryn Griswell	Earth Retaining System Specialist, Caltrans	(916) 227-7330
Colorado	Y	Letter not issued	David Kotzer	Product Evaluation Coordinator	(303) 757-9421
Connecticut	N				
Delaware	Y	Letter not issued	John V Eustis Jr.	Competitively Bid Contracts Manager	(302) 760-2030
Florida	Y	10-Dec-2012	Barry Smith	Product Evaluation Administrator	(850) 414-4353
Georgia	N		Brennan Roney	New Product Evaluation Engineer, GA DOT	(404) 608-4816
Hawaii	Y	Letter not issued	Clarence Miyashiro	Highways Division, Materials Testing, HI DOT	(808) 832-3409
Idaho	Y	22-Dec-1998	Jon Ingram	Geotechnical Engineer, Headquarters Construction/Materials	208-334-8436
Illinois	Y	17-Sep-1999	Ralph E Anderson	Engineer of Bridges and Structures, IL DOT	(217) 785-1462
Indiana	Y	31-Aug-2020	Aamir Turk, PE	Geotechnical Engineer, IN DOT	(317) 522-9728
Iowa	N				
Kansas	Y	10-Oct-2000	Lon S Ingram, P.E.	Chief, Bureau of Materials and Research, KS DOT	(785) 296-3008
Kentucky	Y	Letter not issued	William H Phillips	T.E. Specialist, Division of Bridge Design, KY DOT	(502) 564-4560
Louisiana	N				
Maine	N				
Maryland	N				
Massachusetts	Y	Letter not issued	Richard Carpenito	Technical Services Engineer, Mass DOT	(617) 951-1348
Michigan	Y	Letter not issued	Rich Endress	Office of Construction & Technology	(517) 322-1207
Minnesota	Y	Letter not issued			
Mississippi	N				
Missouri	Y	Letter not issued	Judy Kempker	Executive Director, Division of Professional Registration, MO DOT	(573) 751-0047
Montana	Y	Letter not issued	Robert Tholt	Administrator, Geotechnical Section, MT DOT	(406) 444-6008
Nebraska	Y	24-Apr-2008	Omar A Qudus, P.E.	Geotechnical Engineer, Materials & Tests Division, NE DOT	(402) 471-4567
Nevada	Y	17-Feb-2000	Alan R Hilton	Research Division Chief, NV DOT	(775) 888-7220
New Hampshire	N				
New Jersey	Y	1-Jun-2008	Robert F Baker	Project Engineer, New Technologies & Products, NJ DOT	(609) 530-5290
New Mexico	Y	20-Jul-2011			(505) 476-3116
New York	N				
North Carolina	N		Scott Hidden	Geotechnical Engineering Unit	(919) 707-6856
North Dakota	Y	Letter not issued	Paul Murdoff		(701) 328-2569
Ohio	Y	15-Nov-2006	Tim Keller, P.E.	Administrator, Office of Structural Engineering, OH DOT	(614) 728-2057
Oklahoma	Y	15-Apr-2002	Robert J. Rusch, P.E.	Bridge Engineer, OK DOT	(405) 521-2606
Oregon	Y	21-Nov-2012	Jon Guido, P.E., G.E.	State Bridge Engineer, Bridge Engineering Section, OR DOT	(503) 986-3993
Pennsylvania	N		Michael McGonagle	New Products Coordinator, PennDOT	(717) 214-4035
Rhode Island	N				
South Carolina	N				
South Dakota	Y	3-Jan-2002	Lawrence L. Weiss	Chief Engineer, Division of Engineering, SD DOT	(605) 773-3174
Tennessee	Y	19-Jun-2002	Edward P Wasserman	Civil Engineering Director, Division of Structures, TN DOT	(615) 741-3351
Texas	Y	3-Nov-2000	Mark P McClelland, P.E.	Geotechnical Branch Manager, Bridge Design Section, TX DOT	(512) 416-2226
Utah	Y	6-Oct-2004	Jim McMinimee P.E.	Project Development Director, UT DOT	(801) 965-4000
Vermont	N				
Virginia	Y	14-Mar-2008	D. Ashton Lawler, P.E., M.E.	Program Manager, Geotechnical Design of Structures, VA DOT	(804) 786-2355
Washington	Y	5-Aug-2013	Monique Pawelka, P.E.	Division of Bridge and Structure Design, WA DOT	(360) 705-7754
West Virginia	Y	17-Apr-2002	Barney C. Stinnett, P.E.	Director, Materials Control, Soils and Testing Division, WV DOT	(304) 558-3505
Wisconsin	Y	5-Feb-2004	Lee J Schuchardt, P.E.	Bridge Research and Automation Engineer, WI DOT	(608) 266-8494
Wyoming	Y	Letter not issued	B. Patrick Collins, P.E.	Bridge Program, WY DOT	(307) 777-4427

Appendix A

TECHNICAL EVALUATION REPORT

EVALUATION OF THE SSL MSE *PLUS*™ RETAINING WALL SYSTEM





Prepared by the
Highway Innovative Technology Evaluation Center (HITEC), a service center of the Civil Engineering Research Foundation (CERF)

CERF REPORT: #40441
August 1999

HITEC

Abstract

The Highway Innovative Technology Evaluation Center (HITEC), a service center of the Civil Engineering Research Foundation (CERF), serves as a clearinghouse for implementing highway innovation by conducting nationally focused, collaborative evaluations of new products and technologies. This report, *Evaluation of the SSL MSE Plus™ Retaining Wall System*, was prepared as part of the HITEC evaluation for earth retaining systems (ERS). This evaluation was performed on the MSE *Plus*™ Retaining Wall System (MSE Plus System), a mechanically stabilized earth (MSE) structure developed, designed, and supplied by SSL, LLC.

This report describes a HITEC evaluation designed to determine the basic capabilities and limitations of the MSE Plus System for use as a technically viable precast MSE retaining wall system. The evaluation was conducted based on material, design, construction, performance, and quality assurance information outlined in the HITEC Protocol.

The MSE Plus System features rectangular segmental precast concrete facing panels and galvanized welded wire, grid-type soil reinforcement.

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The Highway Innovative Technology Evaluation Center (HITEC), a service center of the Civil Engineering Research Foundation (CERF), prepared this report and wishes to acknowledge the contributions of individuals whose efforts and suggestions have significantly influenced the content of this report. Notably, this report is based on work by members of a technical evaluation panel (Panel) who volunteered to develop the evaluation plan for this project and carry out its objectives. The HITEC Panel is composed of Chairman Terry Shike, David Evans & Associates, Inc.; Tony Allen, Washington State Department of Transportation; Todd Dickson, New York State Department of Transportation; Jerry DiMaggio, Federal Highway Administration; Chris Dumas, Federal Highway Administration; David Dundas, Ontario Ministry of Transportation; Randy Cannon, South Carolina Department of Transportation; Dov Leshchinsky, University of Delaware; Mark McClelland, Texas Department of Transportation; and James Moore, New Hampshire Department of Transportation. Additionally, D'Appolonia served as the consultant to the Panel and was instrumental in producing this report.

CERF also wishes to thank the employees of SSL, LLC for their cooperation during the evaluation process.

Among the staff who worked on this project, I wish to acknowledge the efforts of HITEC Director and CERF Senior Vice President, J. Peter Kissinger and HITEC Senior Program Manager, Scott Edwards. Also, the assistance of CERF Project Manager, Nicole Testa in managing the production of this report is appreciated.

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- Parsons Brinckerhoff, Inc.
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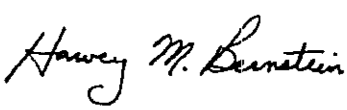

Harvey M. Bernstein
President, Civil Engineering Research Foundation

Disclaimer

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Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the Highway Innovative Technology Evaluation Center and do not necessarily reflect the view of the Federal Highway Administration.

This report is the result of an impartial, consensus-based approach to evaluating innovative highway technology in accordance with the HITEC Technical Protocol. The data presented are believed accurate and the analyses credible. The statements made and conclusions drawn regarding the product evaluated do not, however, amount to an endorsement or approval of the product in general or for any particular application.

Preface

When a manufacturer is introducing a new or innovative technology to the highway community, it is often necessary to demonstrate the product to many, if not all, state highway agencies to prove that it performs as claimed. This practice is inefficient, time consuming, and often costly. To overcome these barriers, the Highway Innovative Technology Evaluation Center (HITEC) was established in 1994 in cooperation with the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and the Transportation Research Board (TRB). HITEC's mission is to accelerate the process of introducing technological advances to the highway community.

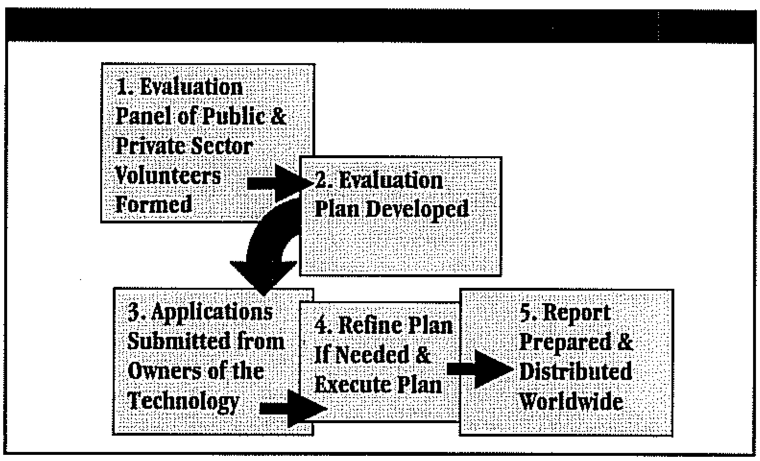
HITEC facilitates the conduct of consensus-based, nationally accepted performance evaluations of new or innovative technologies for the highway community. HITEC is available to evaluate products, systems, services, materials, equipment, or other technologies that the owners believe can be used beneficially on the nation's highways.

The HITEC earth retaining system (ERS) program was initiated at the request of federal and state highway officials and was established through a collaborative relationship with FHWA. It is an ongoing program to evaluate the performance of proprietary ERS technologies against a common evaluation plan. It is believed that the development of up-to-date evaluation criteria and performance information will help reduce the time and efforts required of suppliers and user agencies, and eliminate the inefficiency associated with the current agency-by-agency approval process. The figure below illustrates the step-by-step group evaluation process pioneered by HITEC and used for this ERS program.

The key feature of the HITEC process is the formation of the Technical Evaluation Panel (Panel), a group of key representatives from the user community, academia, and the private sector. The Panel, with the cooperation and assistance of the ERS technology suppliers, identified the specific performance issues and concerns requiring resolution for these products to be adopted by the highway community. The Panel oversaw the development and execution of the evaluation plan, and ultimately, reviewed the evaluation findings.

As a result of their participation in this ERS program, many system suppliers have taken advantage of the process to modify and improve their retaining wall systems so they conform to HITEC protocol and AASHTO design methods. Consequently, it is important to verify that the retaining wall system currently provided by a supplier is the same as that evaluated in this HITEC program.

HITEC is accepting applications for this ERS program on an ongoing basis and will publish the results of each evaluation. Evaluation reports will be developed to provide an analysis of each of the ERS technologies participating in this HITEC evaluation program. Currently, there are several reports scheduled for publication within the HITEC ERS program. Additionally, HITEC created the *Guidelines for Evaluating Earth Retaining Systems* report, which fully describes the scope and details of the HITEC evaluation program. This report is currently available from ASCE at 800.548.2723 or pubs@asce.org.



Contents

Executive Summary

This evaluation was performed on the SSL MSE *Plus*™ retaining wall system (MSE Plus System), a mechanically stabilized earth (MSE) structure, based on data submitted by the developer, designer, and supplier, SSL, LLC, Scotts Valley, California.

The evaluation was conducted based on material, design, construction, performance, and quality assurance information provided by SSL. The information was evaluated for conformance with the state-of-practice criteria as outlined in the HITEC Protocol. As of April 1999, three projects had been completed using this system.

As shown in Figures 1 and 2, the MSE Plus System consists of rectangular segmental precast concrete facing panels and galvanized welded wire, grid-type soil reinforcement. Soil reinforcements are shop pre-bent, hot dipped after bending, and are connected to the panel using a newly developed connection scheme totally within the concrete panel. The design of this type of structure is fully governed by Article 5.8 of the AASHTO Standard Specifications (AASHTO, 1998).

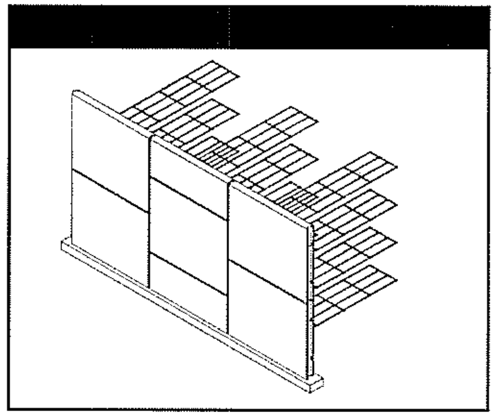


Figure 1. Isometric View of MSE *Plus*™ – Front Face

The design methods submitted for external and internal stability are in accordance with the requirements in AASHTO (1998) except for the variations noted in this evaluation.

With respect to the submitted system details and design parameters, the following are noted:

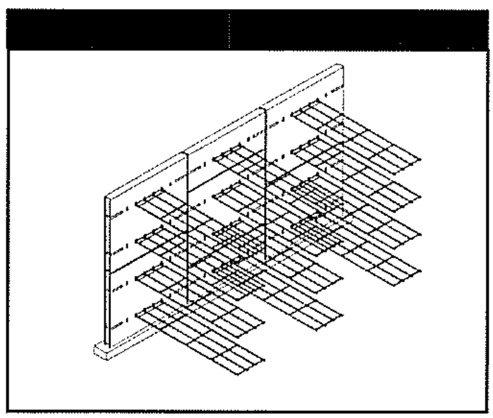


Figure 2. Isometric View of MSE *Plus*™ – Rear Face

- It is essential that the concrete adjacent to the precast slot in each panel be carefully inspected to make sure that no cracks develop in the concrete during removal from the mold and subsequent handling in this critical area.
- To achieve the design connection capacity with the W24 soil reinforcement longitudinal bars, the panel must be cast to a minimum compressive strength of 34.5 MPa (5 ksi). Structural design considerations require a panel thickness of 178 mm (7 in).
- For consistency with current AASHTO, the calculations should utilize a normalized friction coefficient F* rather than the older Anchorage Factor no longer used by AASHTO. The correct use of the Anchorage Factor should result in identical designs. Note that the default AASHTO F* has been developed based on laboratory data from pullout tests with a transverse grid spacing of 305 mm (12 in) and confirmed with limited field data with transverse spacing of 610 mm (24 in). The successful use of wider transverse spacing, as shown in the typical designs submitted, has not been demonstrated by laboratory or field pullout data.

The construction materials and methods specifications submitted are in substantial agreement with current practice and AASHTO (1998). SSL relies on its precasters to inspect and provide quality control for the panels.

The MSE Plus System is a technically viable MSE retaining wall system. The in-place costs for the MSE Plus System are based on very few projects, but should be in the range of costs of other MSE systems for the same design heights.

Technical Evaluation Panel Key Contacts

Product: **MSE *Plus*™ Retaining Wall System**

Chair: **Terry Shike**
Senior Bridge Engineer
David Evans & Associates, Inc.

Panelists:

Tony Allen
State Geotechnical Engineer
Washington State Department of Transportation

Randy Cannon
Bridge Design Engineer
South Carolina Department of Transportation

Todd Dickson
Civil Engineer II
New York State Department of Transportation

Jerry DiMaggio
Senior Geotechnical Engineer
Federal Highway Administration

Chris Dumas
Geotechnical Engineer
Federal Highway Administration
Eastern Resource Center

David Dundas
Senior Foundation Engineer
Ministry of Transportation, Ontario

Dov Leshchinsky
Professor of Civil Engineering
University of Delaware

Mark McClelland
Technical Branch Manager
Texas Department of Transportation

James Moore
Administrator, Bureau of Bridge Design
New Hampshire Department of Transportation

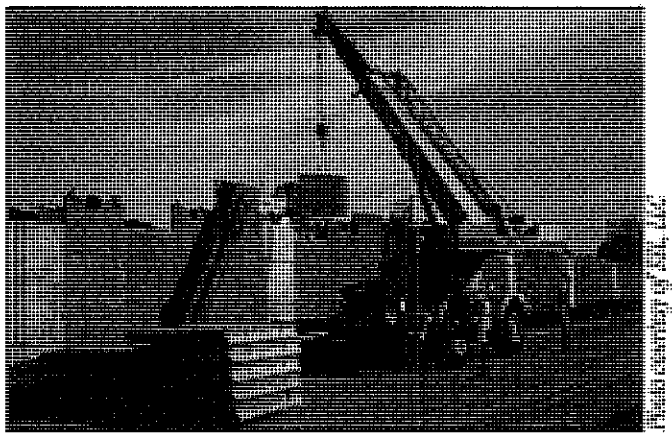
HITEC Project Manager: **Scott Edwards**

Consultant: **D'Appolonia**
Barry Christopher
Victor Elias
Jim Withiam

Client: **SSL, LLC**
4740 Scotts Valley Drive
Suite E
Scotts Valley, CA 95066
Phone: 408.430.9300
Fax: 408.430.9340

CHAPTER 1

Introduction



Construction of fractured fin wall with custom-beveled column panels.

1.1 Purpose, Scope, and Basis for Evaluation

This evaluation was conducted for the SSL MSE *Plus*™ retaining wall system (MSE Plus System) developed by SSL, LLC of Scotts Valley, California. The essential elements of this mechanically stabilized earth (MSE) structure are rectangular precast concrete panels, galvanized steel welded grid soil reinforcing elements, a horizontal locking bar connection method within the facing panel, and a select granular backfill. Figures 1 and 2 in the Executive Summary show front and rear isometric views of the MSE Plus System.

The evaluation was conducted using material, design, construction, performance, and quality assurance information provided by SSL, and evaluated for conformance to the latest state-of-the-practice criteria outlined in the HITEC Protocol. The Protocol document substantially incorporates the AASHTO Standard Specifications for Highway Bridges (AASHTO 1998) and FHWA-SA-96-071, Demonstration Project 82 Guidelines (Elias and Christopher, 1996), referred to as Demo 82. Where no applicable criteria in the above documents exist, evaluations were based on state-of-the-practice as indicated in the technical literature or documentation submitted by the developers.

This evaluation is intended for readers who have a working knowledge of the design and construction specification requirements in AASHTO (1998), Article 5.8 for MSE Walls and Demo 82 design guidelines and construction specification manual. The submittal by SSL for the MSE Plus System was evaluated relative to the Protocol developed by the HITEC Panel and the Consultant. The Protocol (see Appendix A) was further reviewed and commented on by industry in a public forum prior to being finalized.

The results of this evaluation do not constitute an approval or a rejection of the system and/or its components. Further, any recommendations for modifications and/or conformance to specific evaluation criteria should not be construed as mandatory. The potential effects are noted, and each approval agency must determine its own requirements for implementation.

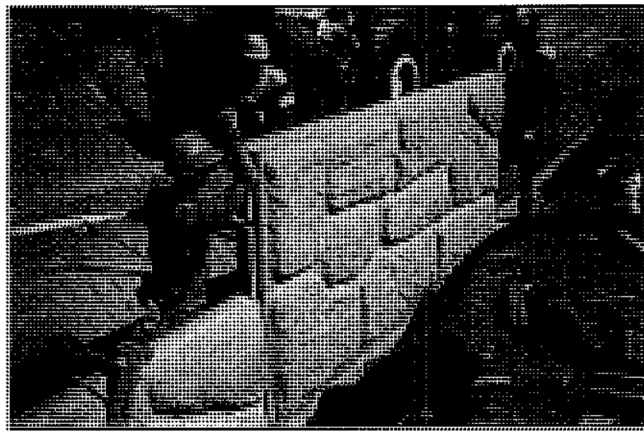
1.2 Documents Reviewed

The supporting documents were initially submitted in May 1998. An initial review indicated the need for additional information and verification testing to complete the submittal. This information was requested in June 1998 and received in September 1998. During the course of this evaluation additional information or clarification was requested and was subsequently submitted for the record in November and December 1998 and in February and March 1999.

A complete set of the submitted data is available from HITEC, which maintains the-chain-of-custody for all data reviewed and used in this evaluation, including all revisions to the initial submittals.

CHAPTER 2

History and System Concept



Placement of first lift of panels on leveling pad.

The MSE Plus System is an MSE retaining wall system comprised of precast segmental concrete panels and metallic grid-type soil reinforcements. The design of this type of structure is, therefore, fully governed by applicable design criteria in AASHTO (1998).

The MSE Plus System features a full-sized, rectangular-shaped facing panel (2.72 m^2 [29.3 ft^2] face area), with the connection to the soil reinforcement located within the concrete panel in a cast internal slot. The connection is secured by inserting the pre-bent mesh loop reinforcement end in the panel's recessed pockets and locking it in place with a galvanized connector inserted through slots on either side of the panel (See Appendix B for details and photograph). Soil reinforcement consists of welded, high-strength wire mesh (metallic grid) type of reinforcement, which is shop pre-bent. Half-size panels in the first course and special size panels near final grade are used to match the required design final grade.

SSL has asserted a patent pending claim for the connection between the soil reinforcement grid and the panel.

The precast panels are 152 mm (6 in) thick when W11 and W20 longitudinal soil reinforcement wires are used and 178 mm (7 in) thick when W24 longitudinal soil reinforcement wires are used. This latter thickness further requires higher strength concrete. The panels are manufactured by commercial precasters under a project contract to SSL, who becomes the supplier of record.

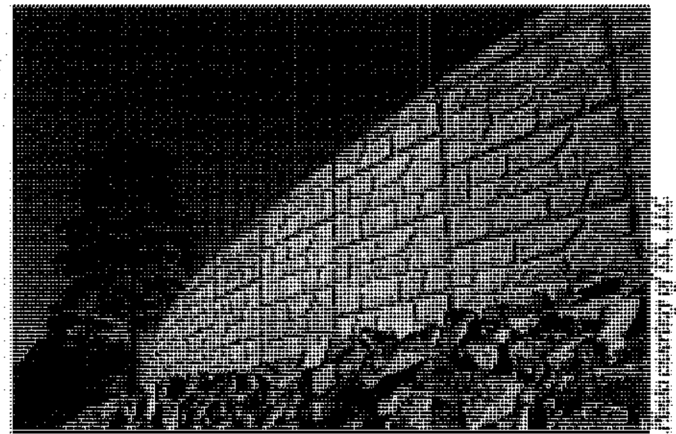
The soil grid reinforcement can be supplied with 3, 4, 5, or 6 longitudinal wires per grid, spaced at 203 mm (8 in) and with transverse spacings of 152 mm (6 in), 305 mm (12 in), 457 mm (18 in), or 610 mm (24 in). The transverse wire size is a constant W11.

SSL markets the system in North America and provides design, technical construction assistance, precast panels, soil reinforcement materials, and other miscellaneous construction materials.

As of April 1999, 3 projects totaling 3,980 m^2 (42,840 ft^2) had been completed and 21 other projects were under construction or contract. Additional system details, including key contacts, are provided in Appendix E.

CHAPTER 3

Design Method Evaluations



Contoured MSE *Plus*™ retaining wall with 5' x 12' Natural Stone panels.

3.1 Performance Criteria

The methodology submitted, supported by typical computations, indicates a design practice which conforms to AASHTO criteria with respect to Factors of Safety (FS) for external and internal stability, foundation embedment, bearing pressure computations, minimum reinforcement length, and vertical reinforcement spacing (Article 5.8, AASHTO, 1998).

With respect to overall vertical tolerances during erection, no complete project data were submitted to indicate that the system can be erected to the specified tolerances of MSE systems constructed with inextensible reinforcements. However, the MSE Plus System specification by reference includes tolerances in conformance with AASHTO requirements.

With respect to the facing unit tolerance to differential settlement along the wall face, the 19 mm (3/4 in) joint is assumed to be able to tolerate differential settlements of 1/100. No verification is available, as only three projects have been completed.

3.2 External Stability

The submitted methodology for external stability computations under static and dynamic loading (dead and live load) conforms to AASHTO (1998) criteria.

The project owner is responsible for providing strength parameters for the retained fill as well as allowable foundation bearing pressures, anticipated foundation settlement, and global stability determinations for each structure.

Global Stability

SSL considers global stability to be the total responsibility of the owner.

3.3 Internal Stability

The submitted methodology for internal stability computations under static and seismic loading conforms with AASHTO (1998) and Demo 82 criteria with respect to:

- Assumed failure surface for internal stability calculations and calculations for effective length, L_e.
- Horizontal stress computations using 2.5 K_a at the top of the wall (depth z = 0) and 1.2 K_a at depths z below the top of the wall of greater than 6.1 m (20 ft).
- Distribution of surcharge and concentrated loads.

- Development of seismic loads and calculations to preclude pullout or rupture.
- Distribution of supplemental loads due to traffic barrier impact.

The normal vertical spacing of mesh reinforcement is 762 mm (30 in), which is less than the AASHTO (1998) allowable maximum vertical spacing of 800 mm (31.5 in). The horizontal spacing varies as the mesh may have 3, 4, 5, or 6 longitudinal bars, depending on design requirements.

With respect to design parameters needed to determine spacing and sizing of the reinforcement to preclude pullout or rupture, the submitted data for interaction coefficients and allowable strength are described in the following sections.

Interaction Coefficient

Pullout test data was not supplied. Therefore, the interaction coefficients used in design are based on AASHTO (1998) and Demo 82 default values for metallic grid reinforcements as follows:

$$F^* \text{ (at } z = 0) = 20t/S_t$$

$$F^* \text{ (at } z = 6 \text{ m}) = 10t/S_t$$

where t is the diameter of the transverse wire and S_t is the spacing of the transverse bars. For the MSE Plus System, transverse bars are spaced from 152 mm (6 in) to 610 mm (24 in) and are 9.5 mm (3/8 in) (W11) in thickness. Longitudinal bars are spaced at 203 mm (8 in) and vary in thickness from W11 (9.5 mm) (3/8 in) to W24 (14 mm) (9/16 in). The above default expression assumes $\alpha = 1.00$.

It should be further noted that the AASHTO (1998) default values were primarily based on pullout data developed on grids with a longitudinal spacing of 152 mm (6 in) or less. The effect of the somewhat wider longitudinal spacing 203 mm (8 in) should be insignificant when the transverse spacing is 610 mm (24 in) or less. The default coefficients at larger transverse spacing, with the W11 transverse bars have not been verified by data in the literature, and may not apply without additional confirmation testing.

The calculations submitted used the older Anchorage Factor nomenclature and computation methods, rather than the current normalized friction coefficient F*. It should be noted that the two formulations are identical provided the "n" (i.e., number of transverse bars behind the failure surface) is correctly and consistently evaluated and $\alpha = 1.00$.

Allowable Strength of Reinforcement

The yield strength of the specified welded high-strength wire steel grid is 448.2 MPa (65 ksi) with an allowable tensile strength 215.1 MPa (31.2 ksi), which represents 48 percent of yield.

Corrosion

The MSE Plus System uses galvanized wire mesh for soil reinforcement. All mesh components are fabricated, cut, and bent as black steel. After fabrication the metal components are hot-dip galvanized. The galvanization is applied to a minimum thickness of 86 mm (3.4 mils) in conformance with the AASHTO requirements. The design wire size is based on the additional sacrificial steel calculated to provide the required cross sectional area of steel at the end of the project's design life (75 or 100 years). The rate of degradation is calculated based on the corrosion rates in AASHTO (1998) for the specified non-aggressive soil backfill.

Connection Capacity

Limited connection capacity testing was performed in 1997 and 1999 to quantify connection capacity as a function of longitudinal wire size, panel compressive strength, and concrete thickness at the connection.

Article 5.8.7.1 (AASHTO, 1998) requires that the connector capacity be checked by test in accordance with Article 8.3.1 (AASHTO, 1998), and that the design between the structural elements meet the requirements of Article 10.32 (AASHTO, 1998). Article 8.31 (AASHTO, 1998) requires that the connection test develop "the strength of reinforcement without damage to the concrete used as anchorage." Using working stress concepts, this requirement is met when the test capacity has a Factor of Safety of at least 1.82 (i.e., $1/0.55\ F_y$) with respect to the maximum design load carried by the reinforcement. Further, with respect to concrete integrity as measured by an allowable concrete bearing stress, it requires that this bearing stress be limited in accordance with the provisions of Article 8.15.2.1.3 (AASHTO, 1998).

The pullout test data submitted suggests that the connection can develop more than the yield strength of the steel at the reduced cross section for corrosion, for the W11 and W20 longitudinal wire without damage to the concrete. For the W24 wire section reduced for corrosion, the limited data submitted indicates no concrete cracking at a longitudinal wire test load of 46.7 kN (10.5 kips), but cracking was observed at a load of 56.0 kN (12.6 kips). No information was provided for the target load of 49 kN (11 kips) to reflect the required Factor of Safety to meet the provisions of Article 8.31 (AASHTO, 1998). It can therefore be reasonably assumed that the W24 grid would likely meet the required safety criteria as demonstrated by test.

Article 10.32 (AASHTO, 1998) requires that the allowable bearing stress on pins subject to rotation be limited to 0.40 F_y. The maximum design tensile load on the connector pin in accordance with Article 10.32 (AASHTO, 1998) is 29.4 kN (6.6 kips), which is less than the allowable design tensile loads for the W11, W20, and W24 longitudinal grid bars.

With respect to the allowable bearing stress along the concrete at the pin interface, the applied maximum stress is less than the allowable bearing stress calculated in accordance with Article 8.15.2.1.3 (AASHTO, 1998). Computations are presented in Appendix B.

Backfill in Reinforced Zone

Select granular fill in accordance with the grain size and soundness requirements in AASHTO Division II AASHTO (1998) is specified in the MSE Plus System specifications.

3.4 Design Computations

The submitted design computations for four typical cases (i.e., horizontal and sloping backfill, seismic loading, and bridge abutment), plus special conditions for traffic loading, were checked and found in compliance to AASHTO (1998) criteria. External stability calculations for static and seismic design comply with the methodology for the typical cases submitted. Internal stability methodology is in compliance with respect to methodology.

Typical computations for the horizontal backfill case are enclosed in Appendix B. The computer program or spread sheet calculations supplied for the three retaining wall cases agree with the hand calculations. Only hand computations were submitted for the abutment case.

SSL internal stability design computations are based on determining the required soil reinforcement for a defined unit width and height equal to the area of one panel. Therefore, coverage ratios consistent with designs based on a unit width are not used.

A typical mesh arrangement is shown in Appendix C.

3.5 Limitations

Current limitations in AASHTO (1998) with respect to applications should be observed. The major limitations are:

- Use in the presence of stray electrical currents.
- Placement of utilities within the select fill volume.
- Use in regimes exposed to acidic runoff or industrial pollution characterized by low pH and high concentrations of chlorides and sulfates.
- In flood plain areas above potential scour depth.

3.6 Design Details

Facing Design

Structural design calculations and finite element modeling to determine panel stress have been submitted and are enclosed in Appendix B. The finite element modeling used reasonable values for the assumed soil modulus. The values used by the designers are included in Appendix B.

The calculations indicate that a 152 mm (6 in) thickness panel with W11 and W20 longitudinal soil reinforcements requires a concrete strength of 27.6 MPa (4 ksi) and that the 178 mm (7 in) thick panel normally connected to a W24 longitudinal wire requires a concrete strength of 34.5 MPa (5 ksi). The calculations conform to AASHTO (1998) criteria for concrete design.

Where raised architectural finishes are indicated, a minimum solid panel thickness of 152 mm (6 in) must be used. Color and anti-graffiti treatments can be implemented.

Typical calculations are presented in Appendix B. Details for standard panels, connections, and corner elements are provided in Appendix C.

The inside corner detail furnished is not consistent with corner details that have provided satisfactory performance.

Slip-joint details were not provided for review. SSL believes that because their panels do not interlock, sufficient differential settlement tolerance is provided with the 19 mm (3/4 in) full-height vertical joint at each panel interval.

Leveling Pad

A cast-in-place concrete pad, as presented in Demo 82, has been specified.

Wall Drainage

Drainage is provided at the face through the joints. A 305 mm (12 in) wide geotextile strip as shown in Appendix C backs all joints. A non-woven geotextile meeting the requirements of AASHTO M 288 (1997) is specified.

Barriers and Copings

Coping details have been developed and are presented in Appendix C. Traffic and pedestrian barrier details have been developed and are also presented in Appendix C. The overturning leg dimensions must be considered as conceptual and must be designed on a project specific basis. Crash impact testing has not been performed to substantiate performance.

Horizontal Joint Bearing Pads

Two horizontal joint bearing pads per panel are used. Equistar Chemicals, using a blow molding process, manufactures the serrated HDPE copolymer pads of stress crack (ESCR) resistant HDPE. A low Melt Flow (0.38 g/10 min.), high density (0.9540 g/cm^3), and a Shore Hardness of 66 characterize the material.

The stress strain characteristics indicate that this pad is very stiff when compared to the EPDM or neoprene pads with a Hardness of 55 used by competing systems. Therefore, it may not provide sufficient compression to re-level horizontal joints, which is a secondary function of horizontal pads.

Obstruction Avoidance Details

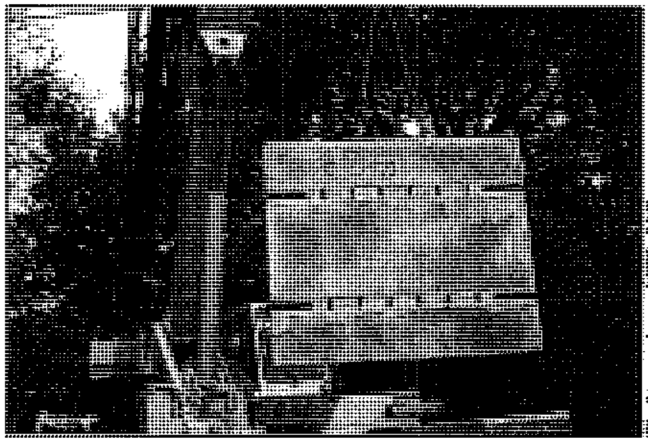
The submittals demonstrated an understanding of AASHTO requirements. Major obstructions to the normal placement of the metallic grid reinforcement will be individually designed with the reinforcement capacity downgraded or a structural bypass system designed as required.

Slot Design, Finishing Panels

Special details must be developed to allow insertion of the grid-locking bar when the wall is topped out with panels other than the standard one-half height panel. This is necessary to ensure that adjoining panels have co-linear slots allowing the insertion of the full-length locking bar.

CHAPTER 4

Construction Specifications



Rear of standard 5' x 6' panel, showing recessed mesh connection pockets.

The MSE Plus System submittal for materials and construction specifications indicates general conformance with the applicable provisions of the specifications for MSE Walls with Segmental Concrete Precast Facings, Section 8.8 from Demo 82, except as noted. Some editorial and technical revisions to the base specifications, Section 8.8, would be necessary to produce an appropriate specification. These items are summarized as follows:

4.1 Materials

Reinforced Concrete Facing Panels

- Compressive strength. Provide appropriate specification changes for 178 mm (7 in) panels requiring 34.5 MPa (5 ksi) concrete compressive strength.

Soil Reinforcement and Attachment Devices

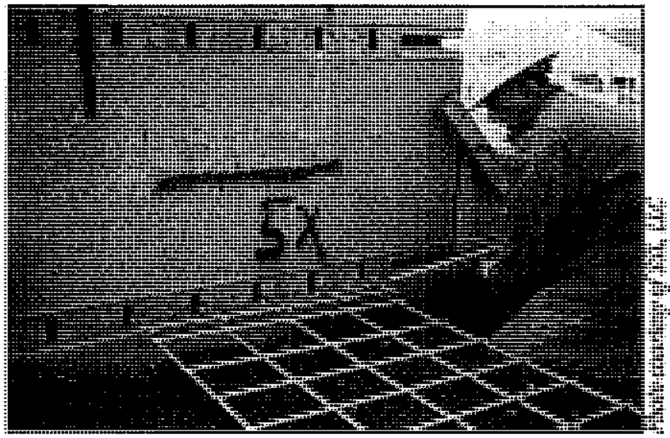
- Provide appropriate specifications with respect to shop bending of the grid reinforcement and material specifications for the locking bar.

Joint Materials

Indicate the appropriate material specification for the HDPE pads. (Density, Hardness).

CHAPTER 5

Quality Control/ Quality Assurance Systems



Connection of reinforcing mesh to panel with galvanized connector bar.

QA/QC programs have been developed for the manufacture of all supplied materials, erector training and assistance, and design. The QA/QC data developed for each project is assembled and reviewed by SSL staff and then transmitted to the Owner.

Each component of the QA/QC program was reviewed and is discussed separately below.

5.1 Metallic Grid Manufacturing

The plant program for welded wire mesh composed of smooth drawn wire manufactured in accordance with ASTM A-82 (ASTM, 1998b) and welded wire fabric manufactured in accordance with ASTM A-185 (ASTM, 1998b) has been reviewed and found consistent with current industry practice. The manufacturer (presently Ivy Steel and Wire) issues a compliance (mill) certificate with each shipment of steel.

Galvanization

The galvanizing plant, presently North American Galvanizing Company, Houston, TX, will galvanize in accordance with ASTM A-123 (ASTM, 1998b) and issue a mill certificate as to the thickness of galvanizing applied with each shipment of steel. No plant QA/QC plan was submitted for review.

5.2 Precast Concrete Panels

The QA program for the manufacture of the concrete panels was reviewed and found to be consistent with industry practice. Compressive testing of cylinders and visual inspection is the responsibility of the project precasters. QC data is reviewed by SSL who is responsible for submission of all data to the owner.

5.3 Construction and Quality Control Manual (Erection Manual)

An erection manual was submitted, which details the erection procedures for the system and the materials supplied to the erection contractor. This manual is generally in accordance with industry practice, although it lacks any documentation requirements for erection tolerance checks and records to be maintained by the erection contractor or SSL when on site.

SSL has stated that it is their practice to have a representative and/or trained employee on site at the start of erection to train and assist the contractor and the owner inspection staff and to be available for "unlimited" technical assistance.

As with all MSE wall systems, it is important that the construction specifications under "Backfill Placement" be strictly enforced. Specifically the following must be enforced:

> *At each reinforcement level, the backfill shall be placed to the level of the connection. Backfill placement methods near the facing shall assure that no voids exist directly beneath the reinforcing elements.*

Failure to strictly enforce this specification may introduce bending forces in the grid reinforcement and significantly increase the difficulty of maintaining the required overall verticality. It is further noted that lack of enforcement of the above provision and less than careful construction practices may partially fill the open panel slots. These slots must be cleaned out prior to the insertion of the locking bar.

The manual is presented in Appendix D.

5.4 Design QA/QC

System design for internal stability only (i.e., size, length, and spacing of geogrids) is the responsibility of SSL, which may use either their staff or outside consultants. Quality control is the responsibility of the Chief Engineer or other SSL principal, although no formal plan was submitted. On request, a registered professional engineer is available to seal all drawings and calculations relative to the wall design.

5.5 Warranties and Insurance

SSL does not maintain a blanket policy for professional liability (errors and omissions) insurance. SSL can provide coverage on a project-to-project basis as required by the owner. Evidence of insurability is enclosed in Appendix E.

General liability insurance to the limits indicated in the certificate enclosed in Appendix E is provided. No evidence of product liability insurance maintained by SSL or any of their suppliers has been submitted.

CHAPTER 6

Performance Review

Backfilling of panels and reinforcing mesh.

Three projects have been completed to date. No performance data is available.

6.1 Costs

Limited cost data is enclosed in Appendix E as part of a User list. It is not clear what is included in the total bid cost data provided.

References

- American Association of State Highway and Transportation Officials (AASHTO). 1998. *Interim Standard Specifications for Highway Bridges*, American Association of State Highway and Transportation Officials, Washington, D.C., 16th Edition.

- American Association of State Highway and Transportation Officials (AASHTO). 1997. "Standard Specification for Geotextiles – M 288," *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*, American Association of State Highway and Transportation Officials, Washington D.C., pp.745-755.

- American Society for Testing and Materials (ASTM) 1998a. *Annual Books of ASTM Standards, Volume 4.08 (I), Soil and Rock; Geosynthetics and Volume 4.08 (II), Soil and Rock;* Geosynthetics, American Society for Testing and Materials, West Conshohocken, PA.

- American Society for Testing and Materials (ASTM) 1998b. ASTM A-82-95, "Standard Specifications for Welded Wire Fabric, Plain, for Concrete Reinforcement" *Volume 01.03, Steel-Plate, Sheet, Strip, Wire; Stainless Steel Bar,* American Society for Testing and Materials, West Conshohocken, PA.

- American Society for Testing and Materials (ASTM) 1998b. ASTM A-123-89, "Standard Specifications for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products" *Volume 01.03, Steel-Plate, Sheet, Strip, Wire; Stainless Steel Bar,* American Society for Testing and Materials, West Conshohocken, PA.

- American Society for Testing and Materials (ASTM) 1998b. ASTM A-185-94, "Standard Specifications for Steel Wire, Plain, for Concrete Reinforcement" *Volume 01.03, Steel-Plate, Sheet, Strip, Wire; Stainless Steel Bar,* American Society for Testing and Materials, West Conshohocken, PA.

- Elias, V. and B.R. Christopher. 1996. Federal Highway Administration (FHWA) SA-96-071 (Demonstration Project 82) *Mechanically Stabilized Earth Walls and Reinforced Soil Slopes, Design & Construction Guidelines,* Office of Technology Applications, Federal Highway Administration, Washington, D.C.

Appendices

Appendix A

Submittal Protocol Check List

Appendix B

Connection Data
Facing Panel Computations
Typical Wall Designs

Appendix C

Standard Panel Details
Grid Reinforcement Details
Connector Details
Drainage Details
Corner Details
Pedestrian Parapet
Traffic Barrier
Obstruction Avoidance Details

Appendix D

Concrete Panel Manufacturing Quality Control Manual
Construction and Quality Control Manual

Appendix E

Cost Data
Users List
Insurance Certificates

Appendix A

Submittal Protocol Check List

HITEC Earth Retaining Systems Evaluation for MSE Wall Systems: Submittal Requirements

INSTRUCTIONS

To expedite the HITEC evaluation process for MSE earth retaining system technologies, Applicants are requested to furnish the following list of detailed information as a supplement to the descriptive materials in the standard HITEC Application Form. The requested information expands on Section E.3 of the Application Form ("Performance History") to include queries bearing on each of the technical issues/evaluation elements that will be considered in the overall assessment of the product by the HITEC Technical Evaluation Panel.

Accordingly, to help the Panel understand the functioning and performance of the technology and thereby facilitate the Technical Audit, Applicants are urged to spend the time necessary to provide clear, complete and detailed responses. A response on all items that could possibly apply to the system or its components, even those where evaluation protocol has not been fully established, would be of interest to the Panel. Any omissions should be noted and explained.

Responses should be organized in the order shown and referenced to the given numbering *system. Additionally, duplication of information is not needed or wanted. A simple statement referencing another section is adequate.*

Part One: Materials and Material Properties

Provide a sample of the reinforcement material and material specifications describing the material type, quality, certifications, lab and field testing, acceptance and rejection criteria along with support information for each of the following material items. Include representative test results (lab and/or field) clearly referencing the date, source and method of test, and, where required, the method of interpretation and/or extrapolation. Along with the source of the supplied information, include a listing of facilities normally used for testing (i.e., in-house and independent).

1.1 Facing Unit

Yes	No	N/A	
☒	☐	☐	• standard dimensions and tolerances
☒	☐	☐	• joint sizes and details
☒	☐	☐	• concrete strength (minimum)
☐	☐	☒	• wet cast concrete % air (range)
☐	☐	☒	• dry cast concrete density (minimum or range)
☐	☐	☒	• moisture absorption (percent and by weight)
☐	☒	☐	• salt scaling
☐	☒	☐	• freeze thaw durability factor
☐	☐	☒	• facing unit to facing unit shear resistance
☒	☐	☐	• bearing pads (joints)

Yes	No	N/A	
☒	☐	☐	• spacers (pins, etc.)
☒	☐	☐	• joint filter requirements: geotextile or graded granular
☒	☐	☐	• aesthetic choices (texture, relief, color, graffiti treatment)
☐	☒	☐	• other facing materials

1.2 Earth Reinforcement

1.2.1 Metallic

			• manufacturing sizes, tolerances and lengths
☒	☐	☐	- ultimate and yield strength of steel
☒	☐	☐	- minimum galvanization thickness for 75 year design life
☒	☐	☐	• sacrificial steel thickness for 75 and 100 year design life
☒	☐	☐	• corrosion resistance test data
☒	☐	☐	• pullout interaction coefficients for range of backfill

1.2.2 Geosynthetics

			• polymer type and grade
☐	☐	☒	- HDPE: resin type, class, grade & category
☐	☐	☒	- PP: resin type, class, grade & category
☐	☐	☒	- PET: minimum intrinsic viscosity correlated to number average molecular weight and maximum carboxyl end groups
☐	☐	☒	- post-consumer recycled material, if any
☐	☐	☒	- weight per unit area
			• minimum average roll value for ultimate strength
☐	☐	☒	- coefficient of variation for ultimate strength
☐	☐	☒	• minimum average roll value for QC strength (e.g. single rib, grab, or strip)
☐	☐	☒	• creep reduction factor for 75 and 100 year design life, including effect of temperature (20°C to 40°C)
☐	☐	☒	• durability reduction factor (chemical, hydrolysis, oxidative) for 75 and 100 year design life
☐	☐	☒	• additional durability reduction factor for high biologically active environments
☐	☐	☒	• installation damage reduction factor for range of backfill (i.e., sand, sandy gravel, gravel, coarse gravel)
☐	☐	☒	• junction strength for quality control
☐	☐	☒	• seam strength
☐	☐	☒	• pullout interaction coefficients for range of backfills
☐	☐	☒	• embedment scale factor
☐	☐	☒	• coatings (type and amount)
☐	☐	☒	• UV inhibitors, coatings, etc.
☐	☐	☒	• UV resistance

1.3 Facing Connection(s)

Yes	No	N/A	
☒	☐	☐	• mode (i.e., structural, frictional or combined)
☒	☐	☐	• connection strength as a % of reinforcement strength at various confining pressures for each reinforcement product and connection type submitted
☒	☐	☐	• composition of devices, dimensions, tolerances
☒	☐	☐	• full scale connection test method/results

1.4 Range of Backfill

- reinforced

☒ ☐ ☐ - soil classification, gradation, unit weight, friction angle

- facing

☐ ☐ ☒ - soil classification, gradation, unit weight, friction angle

1.5 Leveling Pad

☒ ☐ ☐ • cast-in-place
☐ ☒ ☐ • precast
☐ ☐ ☒ • granular

1.6 Drainage Elements

☐ ☒ ☐ • weep holes
☐ ☐ ☒ • base
☒ ☐ ☐ • backfill
☒ ☐ ☐ • surface

1.7 Coping

☒ ☐ ☐ • precast
☒ ☐ ☐ • precast attachment method/details
☒ ☐ ☐ • cast-in-place

1.8 Traffic Railing/Barrier

☐ ☒ ☐ • precast
☒ ☐ ☐ • cast-in-place

1.9 Connections to Appurtenances

☒ ☐ ☐ • precast

1.10 Other Materials

☒ ☐ ☐ • corner elements
☐ ☒ ☐ • slip-joint elements

1.11 Quality Control/Quality Assurance Systems

- material suppliers

☒ ☐ ☐ - metallic reinforcement
☐ ☐ ☒ - polymeric reinforcement

Yes	No	N/A	
☒	☐	☐	- concrete products
☐	☐	☒	- backfill
☒	☐	☐	• fabricator(s)
☐	☒	☐	• test facilities (internal and external)

Part Two: Design

Provide design assumptions and procedures with specific references (e.g., design code section) for each of the following items. Clearly show any deviations from the AASHTO 1997 Interim provisions, along with theoretical or empirical information which support such deviations.

2.1 External Stability

Yes	No	N/A	
☒	☐	☐	• sliding
☒	☐	☐	• overturning (including traffic impact)
☒	☐	☐	• bearing capacity (overall and local)
☒	☐	☐	• seismic
☒	☐	☐	• settlement (total and differential)
☒	☐	☐	• recommended wall embedment

2.2 Internal Stability

Yes	No	N/A	
☒	☐	☐	• assumed failure surface
☒	☐	☐	• distribution of horizontal stress
			• surcharge
☒	☐	☐	- concentrated dead load
☒	☐	☐	- sloped surcharge
☒	☐	☐	- broken-back surcharge
☒	☐	☐	- live load
☒	☐	☐	- traffic impact
☒	☐	☐	- lateral loads from piles, drilled shafts within reinforced backfill
☒	☐	☐	• allowable tensile strength of the reinforcement
☒	☐	☐	• pullout
☒	☐	☐	• facing connections
☒	☐	☐	• vertical and horizontal spacing (including traffic impact requirements)
			• facing design
☒	☐	☐	- connections
☒	☐	☐	- concrete strength requirements
☐	☒	☐	• effective face batter
☐	☒	☐	• compound/global stability
☒	☐	☐	• seismic considerations
☒	☐	☐	• design modification for tiered structures, acute corners and obstructions

2.3 Performance Criteria

Yes No N/A

☒ ☐ ☐ • ultimate strength of reinforcement
- • service limit
☒ ☐ ☐ - for steel, F_y
☐ ☐ ☒ - for polymeric, strength at % strain
☒ ☐ ☐ • long-term allowable design strength
☒ ☐ ☐ • material properties, requirements and test standards
☒ ☐ ☐ • horizontal/vertical deflection limits

2.4 Plan Sheets

Provide representative plan sheets showing all standard details along with any alternate details, including the following:

☒ ☐ ☐ • details for wall elements
☒ ☐ ☐ • connection details
☒ ☐ ☐ • appurtenance connection details
☒ ☐ ☐ • obstruction detail (utilities, parapet/sidewalk connection, light standard and box)
☒ ☐ ☐ • corrosion/durability protection details
☒ ☐ ☐ • construction details
☐ ☐ ☒ • optional details

2.5 Specifications

Provide sample specifications for:

☒ ☐ ☐ • materials
☒ ☐ ☐ • installation
☒ ☐ ☐ • construction
☐ ☒ ☐ • maintenance

2.6 Aesthetic Compliance

Detail the provisions in material specifications for aesthetics compliance, including:

☒ ☐ ☐ • texture
☒ ☐ ☐ • color
☐ ☒ ☐ • graffiti treatment for facing panels
☐ ☒ ☐ • durability of aesthetic features

2.7 Limitations

List any and all design limitations, including:

☐ ☒ ☐ • seismic loading
☐ ☒ ☐ • environmental restraints
☐ ☒ ☐ • wall height, external loading
☐ ☐ ☐ • other ______________________

2.8 Example Calculations

Provide detailed (hand) design calculations for the four problems shown in Figure 1 in conformance with your practice or the AASHTO 1997 Interims. The calculations should address the technical review items listed above. List deviations from the AASHTO 1997 Interims.

Yes No N/A

☒ ☐ ☐

2.9 Computer Support

If a computer program is used for design or distributed to customers, provide representative computer printouts of design calculations for the above typical applications demonstrating the reasonableness of computer results.

☒ ☐ ☐

2.10 Quality Control/Quality Assurance Systems

Include the system designer's Quality Assurance program for evaluation of conformance to the quality control program.

☒ ☐ ☐

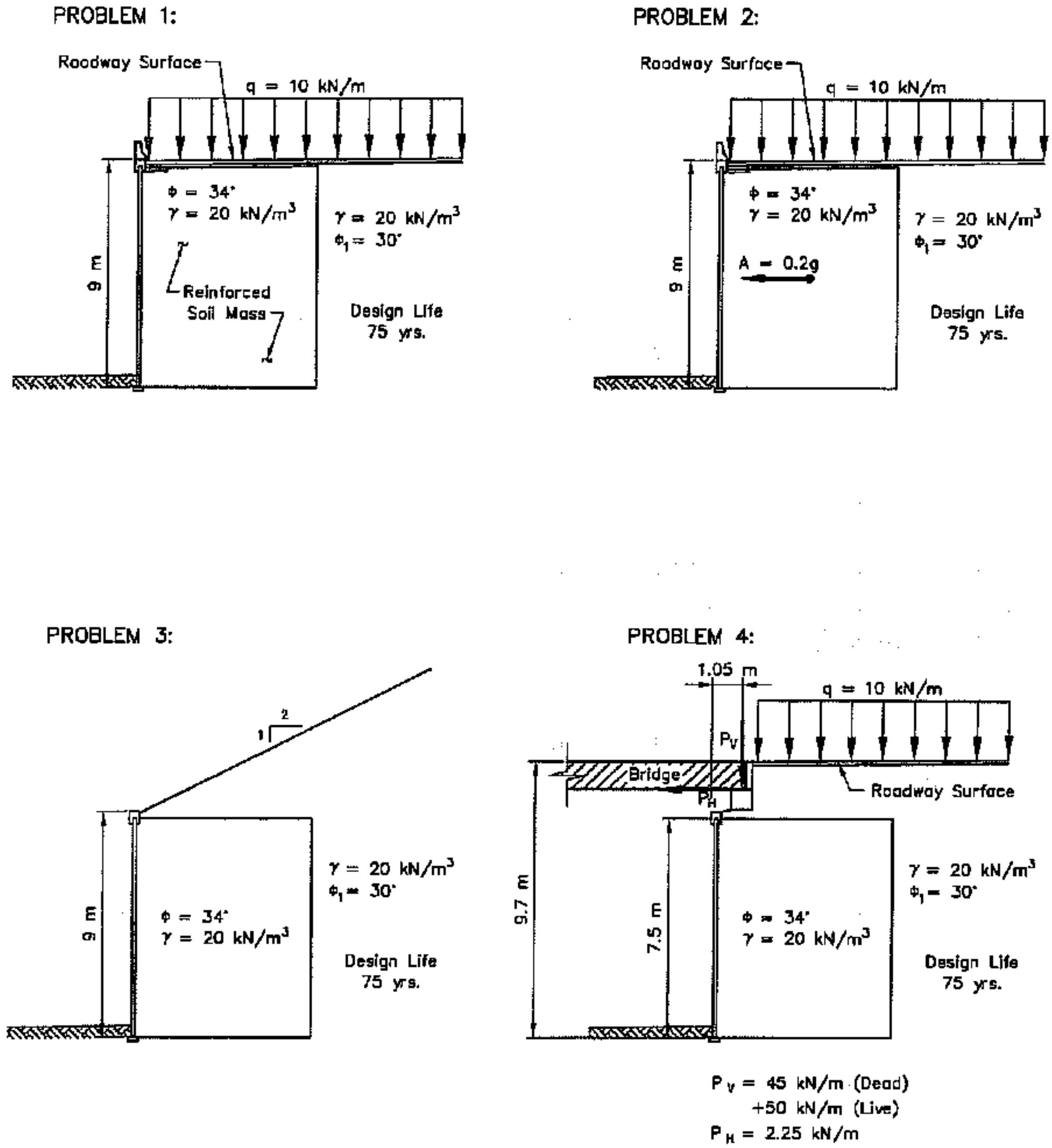


Figure 1
Example Design Problems

Part Three: Construction

Provide the following information related to the construction of the system:

3.1 Fabrication of Facing Units

Yes No N/A

☐ ☒ ☐ • curing times

☐ ☒ ☐ • form removal

☒ ☐ ☐ • concrete surface finish requirements

3.2 Field Construction Manual

Provide a documented field construction manual describing in detail and with illustrations as necessary the step-by-step construction sequence, including requirements for:

☒ ☐ ☐ • foundation preparation

☒ ☐ ☐ • special tools required

☒ ☐ ☐ • leveling pad

☒ ☐ ☐ • facing erection

☐ ☒ ☐ • facing batter for alignment

☐ ☒ ☐ • steps to maintain horizontal and vertical alignment

☒ ☐ ☐ • retained and backfill placement/compaction

☐ ☐ ☒ • erosion mitigation

☒ ☐ ☐ • all equipment requirements

3.3 Construction Specifications

Include sample construction specifications, showing field sampling, testing and acceptance/rejection requirements.

☒ ☐ ☐

3.4 Construction Case Histories

Provide construction case histories and photos/videotapes from projects illustrating the construction process.

☒ ☐ ☐

3.5 Contractor or Subcontractor Prequalification Requirements

List any contractor or subcontractor prequalifications.

☐ ☐ ☒

3.6 List of Contractors and Subcontractors

Provide a list of installation contractors who have constructed this system, including contact persons, addresses and telephone numbers.

Provide a list of precasters.

☒ ☐ ☐

3.7 Quality Control/Quality Assurance of Construction

Describe the quality control and quality assurance measurements required during construction to assure consistency in meeting performance requirements.

☒ ☐ ☐

Part Four: Performance

Provide the following information related to the performance of the system:

4.1 Warranties

Provide a copy of any system warranties.

Yes No N/A

☐ ☒ ☐

4.2 Designated Responsible Party

☒ ☐ ☐ • system performance

☐ ☒ ☐ • material performance

☒ ☐ ☐ • project-specific design (in-house, consultant)

4.3 Insurance Coverage for Responsible Party

List insurance coverage types (e.g., professional liability, product liability, performance) limits, basis (i.e., per occurrence, claims made) provided by each responsible party

☒ ☐ ☐

4.4 Project Performance History

Provide a well-documented history of performance (with photos, where available), including

☒ ☐ ☐ • oldest

☒ ☐ ☐ • highest

☐ ☒ ☐ • projects experiencing maximum measured settlement (total and differential)

☐ ☒ ☐ • measurements of lateral movement/tilt

☒ ☐ ☐ • demonstrated aesthetics

☒ ☐ ☐ • project photos

☐ ☒ ☐ • maintenance history

4.5 Numerical Model Studies

Provide case histories on numerical model studies.

☐ ☒ ☐

4.6 Instrumented Structures

Provide case histories of instrumented structures.

☐ ☒ ☐

4.7 Field Tests

☐ ☒ ☐ • construction testing

☐ ☒ ☐ • pullout testing

☐ ☒ ☐ • crash-barrier testing

☐ ☒ ☐ • seismic load test

4.8 Construction/In-Service Structure Problems

Provide case histories of structures where problems have been encountered, including an explanation of the problems and methods of repair.

Yes No N/A

☐ ☒ ☐

4.9 Unit Costs

Provide typical unit costs in $\$/m^2$ of vertical face, supported by data from projects.

☒ ☐ ☐

4.10 Maintenance

Provide a listing of maintenance requirements to maintain performance and repair damage. If available, provide a maintenance manual.

☐ ☒ ☐

4.11 Quality Control History

Provide the history for the system and material quality along with improvements that have been made based on the experience with the system.

☐ ☒ ☐

4.12 List of Users

Provide a list of users, including contact persons, addresses and telephone numbers.

☒ ☐ ☐

Appendix B

SSL CONNECTION TEST

Date: 18 January 1999

Location: CPI Plant, Tracy, California

Attendees: Steve Ruel, SSL
Scott Thompson, SSL
Dave Swanson, SSL
Dennis Quashnick, Kleinfelder Associates

General: The SSL mesh-to-panel connection is the same for the three sizes of wire mesh [W 11 (3/8"), W 20 (1/2") and W 24 (0.6")] that SSL uses. The connection is a 5/8' diameter rod(ASTM A-82) passed into a 3/4" diameter preformed hole in the concrete face panel. The purpose of this test is to establish that the SSL mesh-to-panel connection meets all applicable specifications. The panel concrete strength at the time of testing was 3435 PSI.

Required Load:

AASHTO is not clear as to the required connection capacity for inextensible reinforcement. The 1998 AASHTO specifications requires that this connection for extensible reinforcement be capable of resisting 100% of the applied load. SSL's interpretation is that AASHTO requires the connection to resist the applied load factored by alpha and beta. Thus, the required load is 1.3x1.3 times applied load. The applied load is defined by the net section area (after 75 years of corrosion loss) times the allowable stress (.48 f '/y) 31.2 ksi. The following calculations establish this load level:

Wire Size -	Effective Area After 75 yr.life X	Design Stress X	Alpha &Beta X	Force -	Jack Pressure Average
#11(3/8")	0.080sq.in.	31.2 ksi	1.3x1.3	4.22 k	1600 psi
#20(1/2")	0.158sq.in.	31.2 ksi	1.3x1.3	8.33 k	3100 psi
#24(0.6")	0.194sq.in.	31.2 ksi	1.3x1.3	10.23 k	3800 psi

SSL ran the test to a safety factor of twice the applied load (Cal Trans requirement) which is also the approximate yield strength of the wire mesh after corrosion losses are considered. Thus, loads applied were 20% greater than shown above.

Test Setup: Three adjacent connections were loaded simultaneously with 20 k center hole jacks. Hand pumps were used to supply power. Jack extension was measured initially after all slack was out of the system and at 3000 psi, 4000 psi and maximum load.

W11 Test: This test was not run since loads of 2-3 times the required load would be applied to this connection, thus W11 is satisfactory by inspection.

W20 Test: Maximum load of 10.54 k @ 3900 psi was achieved.Connection extension at each jack was measured at 3/8" for maximum load.

Results :

After load release there were no concrete cracks.

The 5/8" connection pin was not removable.

W24 Test: Maximum load of 12.65 k @ 4700 psi was achieved. Connection extension was 3/8" at 4000 psi and 3/4" at maximum load.

Results:

After load release longitudinal concrete cracks were noted parallel to the line of connectors, one at 0.016" and one at 0.005". The 5/8" diameter pin was deformed and could not be removed.

Summary: The SSL mesh -to-panel connection was able to carry the test loads. The connection approached failure due to yielding in the 5/8" pin. The test demonstrates that the SSL mesh-to-panel connection meets or exceeds all known specifications.

Attachments:
1. Kleinfelder Associates report
2. Pictures of test
3. Jack calibration curves
4. Concrete cylinder breaks

KLEINFELDER
An employee owned company

File No. 20-1112-97
February 1, 1999

SSL Corporation
4740 Scotts Valley Drive, Suite E
Scotts Valley, California 95006

Subject: **MSE WALL PANELS**
W20 AND W24 WIRE LOAD TESTS
CONCRETE PRODUCTS
TRACY, CALIFORNIA

INTRODUCTION

This letter summarizes our observations on January 15, 1999, of tensile load tests performed on W20 and W24 longitudinal wire at Concrete Products in Tracy, California. Prior to performing the tests, our representative observed the reinforcing steel and concrete placement for the panels tested and cast compressive strength specimens for testing in our laboratory. The results of the compression tests will be submitted when they become available.

MSE PANEL CONNECTION

The mesh-to-panel connection consisted of a 5/8-inch diameter rod (ASTM A82) passed into a 3/4-inch diameter pre-formed hole in the concrete face panel. The purpose of the test was to establish that this connection will withstand the following loads provided by the design engineer.

Wire Size	*Effective Area After 75-Year Life*	*Design Stress*	*Alpha & Beta*	*Force*	*Jack Pressure Average*
#20 (1/2")	0.158 sq. in.	31.2 ksi	1.3 x 1.3	8.33 k	3,100 psi
#24 (0.6")	0.194 sq. in.	31.2 ksi	1.3 x 1.3	10.23 k	3,800 psi

The loads applied to the panel assemblies tested exceeded the above design loads by 20 percent.

TEST PROCEDURE

The tensile load tests were conducted by applying proof loads simultaneously to three longitudinal wires, transverse to the panels. The jack extension was measured initially after 2.8 kips was applied to the system to remove any slack and again at 8 kips, 11 kips, and the maximum load applied. The reinforcing mesh connector bar detail on Drawing No. CP1, attached, indicates the panel assembly and shows the wire connections as they were tested. The loads were applied with three rams calibrated on December 16, 1998 with reaction frames. The

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test loads were applied for approximately one minute in which the wires and assembly were visually inspected for signs of slippage or distress.

TEST RESULTS

1. **W20 test**

A maximum load of 10.54 kips at 3,900 psi was achieved with a 3/8-inch connection extension measured on each jack. At load release, there were no visible cracks in the panel, and the 5/8-inch connection pin had deformed but was not removable.

2. **W24 test**

A maximum load of 12.65 kips at 4,700 psi was achieved with the connection extension of 3/8 inch measured at 11K and 3/4 inch at the maximum load. At load release, longitudinal cracks were noted in the panel parallel to the line of connectors and were measured at 0.016 inches and 0.005 inches. The 5/8-inch diameter pin was deformed and could not be removed.

The meshed-panel connections tested were able to stand the test loads applied without failing. The connections approached failure due to yielding in the 5/8-inch diameter pin.

Should you have any questions regarding this report, please contact our office.

Respectfully submitted,

KLEINFELDER, INC.

Dennis A Quashnick

Dennis A. Quashnick, P.E.
Project Engineer

DAQ:lr
Attachment

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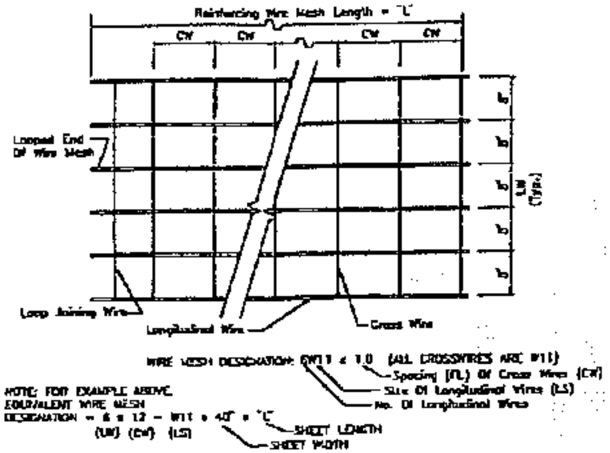
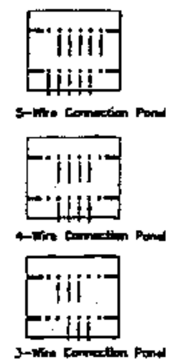
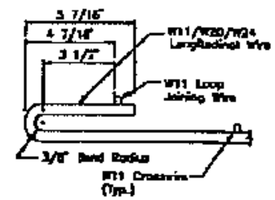


REINFORCING MESH DETAIL



NOTE:
Minimum Panel Connector is 3 Loop Connections Per Row.
The Number Of Loop Connections Per Row May Increase
As Dictated By The Design Condition. Panel Numbers Preceding
The Type Of Panel Indicate The Number Of Loop Connections Per Row.

PANEL NUMBER: 5TP11
- Connection Wire Size
- Type Of Panel
- Number Of Loop Connections Per Row

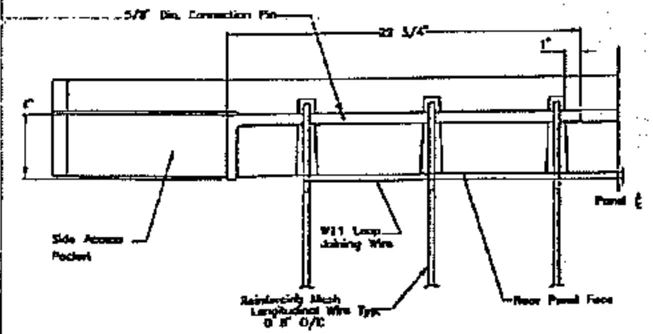


WIRE MESH LOOP DETAIL

CONFIDENTIAL:
The use of these plans, drawings, specifications is restricted. Any and all reproductions, reuse, and/or disclosures in whole or in part by any method is prohibited. These drawings contain proprietary information and as such the content remains the property of SSL.

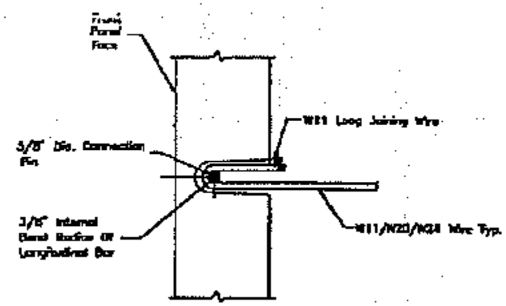
NOTES:

1. Panel Reinforcement Bars Shall Be Deformed Billet-Steel Bars For Concrete Reinforcement Conforming To The Specifications Of ASTM Designation A615, Grade 60, Including Supplementary Requirement S1 Or Low Alloy Steel Deformed Bars Conforming To The Specifications Of ASTM Designation A706.
2. W11, W20, & W24 Steel Wire Shall Conform To The ASTM Designation A82.
3. ... Be Galvanized In Accordance With ASTM Designation A123.
4. Concrete Panels To Have A 28 Day Compressive Strength Of 4000 Psi.
5. All Panel Reinforcement Shall Have A Minimum Of 1 1/4" Coverage With Concrete On All Sides.



REINFORCING MESH CONNECTOR BAR DETAIL

PLAN VIEW



PANEL LOOP POCKET DETAIL

Showing Wire Connection

THESE DRAWINGS ARE CONCERNED WITH RESPECT TO INTERNAL STABILITY OF MSE STRUCTURES ONLY.

SSL
Specializing in Construction Products

DRAWING NAME:
MSE WALL STANDARD DETAILS

DATE:		DWG. NO.:	S. NO.:
[illegible]	[illegible]	CP-1	2 of 2

KLEINFELDER
An employee owned company

File No. 20-1112-97
December 1, 1998

SSL Corporation
4740 Scotts Valley Drive, Suite E
Scotts Valley, California 95066

Subject: **REVISED REPORT**
MSE WALL PANELS
W11 AND W20 WIRE LOAD TESTS
CONCRETE PRODUCTS
TRACY, CALIFORNIA

This letter summarizes our observations on July 25, 1997 of tensile load tests performed on W 11 HB, and W 20 HB longitudinal wire at Concrete Products in Tracy, California. Prior to performing the tests, our representative observed the reinforcing steel and concrete placement for the panels and cast compressive strength specimens for testing in our laboratory. Results of the compression tests will be submitted as they become available.

The tensile load tests were conducted by applying proof loads simultaneously to three longitudinal wires, transverse to the panels. The reinforcing mesh connector bar detail on drawing No. CP-1, attached, indicates the panel assembly and shows the wire connections as they were tested. The loads were applied with three, 12-ton rams calibrated on July 23, 1997, with reaction frames. The test loads were applied for approximately one minute in which the wires and assembly were visually inspected for signs of slippage or distress. Following is a summary of the maximum loads applied for each of the test assemblies.

ASSEMBLY	MAXIMUM LOAD (lbs)
1) W 11 HB	4,570
2) W 20 HB	9,720
3) W 20 HB - Taken to W24 Loads	12,150
4) W20	Failure occurred at approximately 13,000 pounds in the 5/8-inch connection pin

With the exception of #4) W20, all of the longitudinal wires tested showed no visible evidence of slippage or distress.

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We have employed accepted engineering and testing procedures. However, we do not undertake the guarantee of construction, nor do we relieve the contractor of his primary responsibility to produce a completed project W20 conforming to project plans and specifications.

If you have any questions, please contact our office.

Respectfully submitted,

KLEINFELDER, INC.

Dennis A Quashnick

Dennis A. Quashnick, P.E.
Associate

DAQ:md
Attachment

© 1997, Kleinfelder, Inc.

SSL CONNECTION TEST

Date: 18 January 1999

Location: CPI Plant, Tracy, California

Attendees: Steve Ruel, SSL
Scott Thompson, SSL
Dave Swanson, SSL
Dennis Quashnick, Kleinfelder Associates

General: The SSL mesh-to-panel connection is the same for the three sizes of wire mesh [W 11 (3/8"), W 20 (1/2") and W 24 (0.6")] that SSL uses. The connection is a 5/8' diameter rod(ASTM A-82) passed into a 3/4" diameter preformed hole in the concrete face panel. The purpose of this test is to establish that the SSL mesh-to-panel connection meets all applicable specifications. The panel concrete strength at the time of testing was 8435 PSI.

Required Load:

AASHTO is not clear as to the required connection capacity for inextensible reinforcement. The 1998 AASHTO specifications requires that this connection for extensible reinforcement be capable of resisting 100% of the applied load. SSL's interpretation is that AASHTO requires the connection to resist the applied load factored by alpha and beta. Thus, the required load is 1.3x1.3 times applied load. The applied load is defined by the net section area (after 75 years of corrosion loss) times the allowable stress (.48 f 'y) 31.2 ksi. The following calculations establish this load level:

Wire Size	- Effective Area After 75 yr.life	X	Design Stress	X	Alpha &Beta	X	Force	- Jack Pressure Average
#11(3/8")	0.080sq.in.		31.2 ksi		1.3x1.3		4.22 k	1600 psi
#20(1/2")	0.158sq.in.		31.2 ksi		1.3x1.3		8.33 k	3100 psi
#24(0.6")	0.194sq.in.		31.2 ksi		1.3x1.3		10.23 k	3800 psi

SSL ran the test to a safety factor of twice the applied load (Cal Trans requirement) which is also the approximate yield strength of the wire mesh after corrosion losses are considered. Thus, loads applied were 20% greater than shown above.

Test Setup: Three adjacent connections were loaded simultaneously with 20 k center hole jacks. Hand pumps were used to supply power. Jack extension was measured initially after all slack was out of the system and at 3000 psi, 4000 psi and maximum load.

W11 Test: This test was not run since loads of 2-3 times the required load would be applied to this connection, thus W11 is satisfactory by inspection.

9859K @ FS=2

W20 Test: Maximum load of 10.54 k @ 3900 psi was achieved.Connection extension at each jack was measured at 3/8" for maximum load.

Results:

After load release there were no concrete cracks.

The 5/8" connection pin was not removable.

12.105

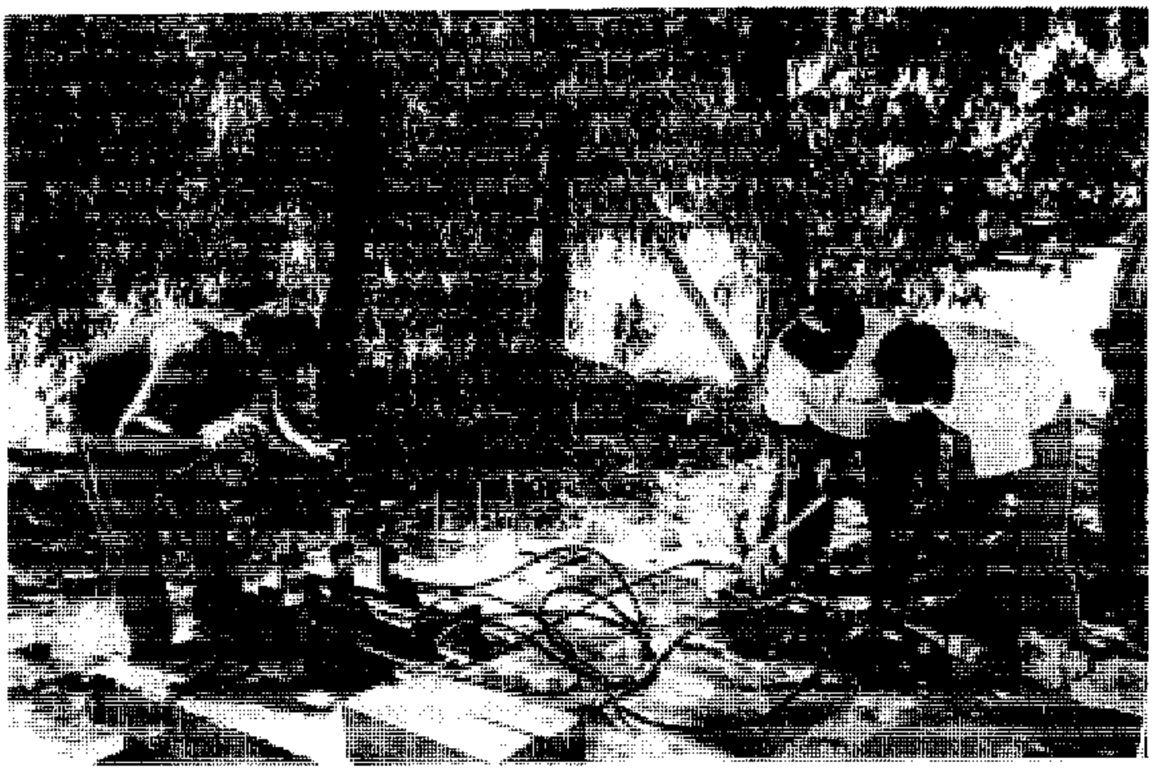
W24 Test: Maximum load of 12.65 k @ 4700 psi was achieved. Connection extension was 3/8" at 4000 psi and 3/4" at maximum load.

Results:

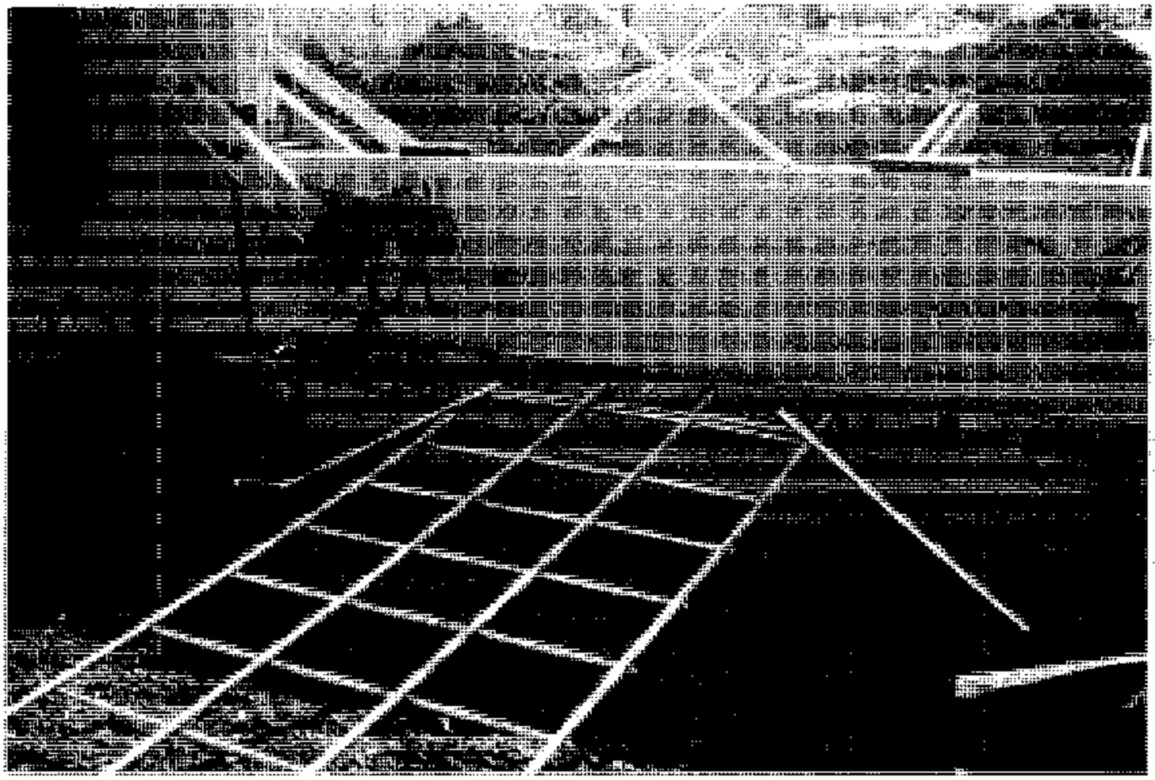
After load release longitudinal concrete cracks were noted parallel to the line of connectors, one at 0.016" and one at 0.005" The 5/8" diameter pin was deformed and could not be removed

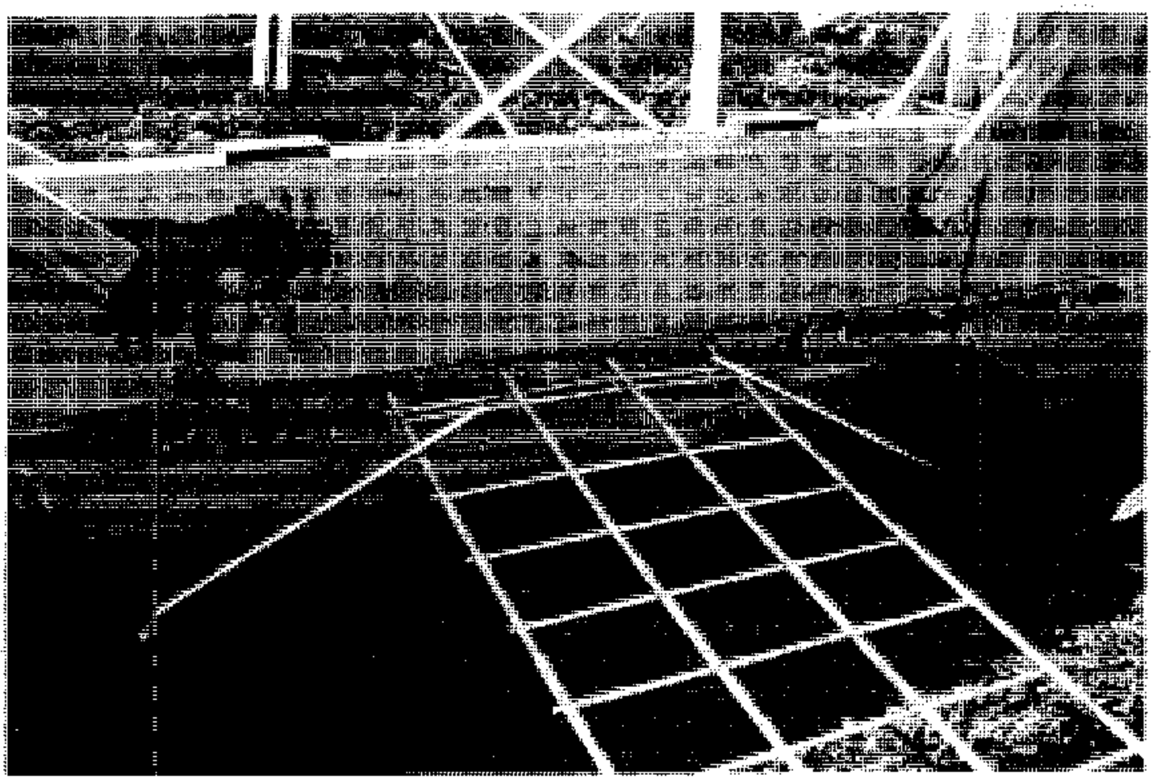
Summary: The SSL mesh -to-panel connection was able to carry the test loads. The connection approached failure due to yielding in the 5/8" pin The test demonstrates that the SSL mesh-to-panel connection meets or exceeds all known specifications.

Attachments:
1. Kleinfelder Associates report
2. Pictures of test
3. Jack calibration curves
4. Concrete cylinder breaks



Panel Mesh Connection Test





Part Two: Design - Internal Stability

SSL Standard Panel Reinforcing Calculations

The attached finite element analysis shows mesh types 6W24, 6W20 and 6W11 loading exceeds 4W24, 4W20 and 4W11 loading. Therefore, the calculations presented herein only address the 6W wire mesh configurations. The calculations presented use the Load Factor Design Method with β = 1.30 x Design Load. The design is taken as the net area of the wire mesh after 75 years of corrosion with consideration of an allowable stress of 31,200 psi ($0.48f_y$).

Loads

Wire Size	Net Area	Stress	Load	βLoad
W11	0.800 in^2	31.2 ksi	2.50 kips	3.25 kips (14.5 kN)
W20	0.158 in^2	31.2 ksi	4.93 kips	6.41 kips (28.5 kN)
W24	0.194 in^2	31.2 ksi	6.05 kips	7.87 kips (35.0 kN)

Panel Capacity

Vertical Rebar 6 – No 4's = 1.2 in^2, d = 4.5 inches (114 mm)
Horizontal Rebar 5 – No 4's = 1.0 in^2, d = 4.0 inches (102 mm)

φ = 0.90

6 inch Panel (152 mm)

M_s = 0.90 x 0.90 x 4.5 x 1.2 x 60 = 262.4 k-in (29.6 kN-m) – Vertical
M_s = 0.90 x 0.90 x 4.0 x 1.0 x 60 = 194.4 k-in (21.0 kN-m) – Horizontal

7 inch Panel (178 mm)

M_s = (0.90 x 0.90 x 4.5 x 1.2 x 60) x 5.5/4.5 = 320.7 k-in (36.2 kN-m) – Vertical
M_s = (0.90 x 0.90 x 4.0 x 1.0 x 60) x 5/4 = 243.0 k-in (27.4 kN-m) – Horizontal

Finite Element Results

See Attached Calculations

6W11

Condition	Load	M_X	M_Y
8 point	5.17 k (22.9 kN)	3.89 k-ft/ft (17.3 kN-m/m)	1.92 k-ft/ft (8.5 kN-m/m)
12 point	5.15 k (22.9 kN)	3.94 k-ft/ft (17.5 kN-m/m)	2.27 k-ft/ft (10.1 kn-m/m)

Adjust Moments for W20 and W24 Loading Conditions

6W20

M_x = 3.94 x (6.41 k/5.17 k) x 12 in x 6 in = 351.7 k-in (39.7 kN-m)

M_y = 2.27 x (6.41 k/5.17 k) x 12 in x 5 in = 168.8 k-in (19.0 kN-m)

Horizontal Rebar

Use 5 No. 4's → 194.4 k-in (21.0 kN-m) > 169 k-in (19.0 kN-m)

Vertical Rebar

Use 8 No. 4's → 262.4 k-in x (8/6) = 349.9 k-in (39.5 kN-m) = 351.7 k-in (39.7 kN-m)

6W24

M_x = 3.94 x (7.87 k/5.17 k) x 12 in x 6 in = 431.8 k-in (48.8 kN-m)

M_y = 2.27 x (7.87 k/5.17 k) x 12 in x 5 in = 207.3 k-in (23.4 kN-m)

Horizontal Rebar

Use 5 No. 4's → 243.0 k-in (27.5 kN-m) > 207.3 k-in (23.4 kN-m)

Vertical Rebar

Use 8 No. 4's → 320.7 k-in x (8/6) = 427.6 k-in (48.3 kN-m) > 431.8 k-in (48.8 kN-m)

Summary of Panel Reinforcing

Mesh	Panel Thickness	Vertical	Horizontal
4W11, 5W11, 6W11	6 inch (152 mm)	6 – No 4's	5 – No 4's
4W20, 5W20, 6W20	6 inch (152 mm)	8 – No 4's	5 – No 4's
6W24	7 inch (178 mm)	8 – No 4's	5 – No 4's

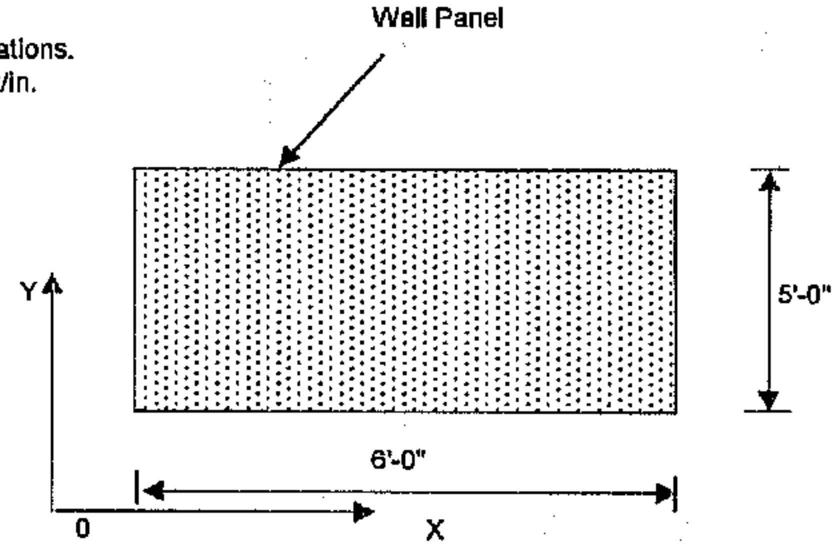
Assumptions:

Concrete:
Compressive Strength: 4,000 psi
Modulus of Elasticity: 3,600 ksi
Shear Modulus: 1,565 ksi

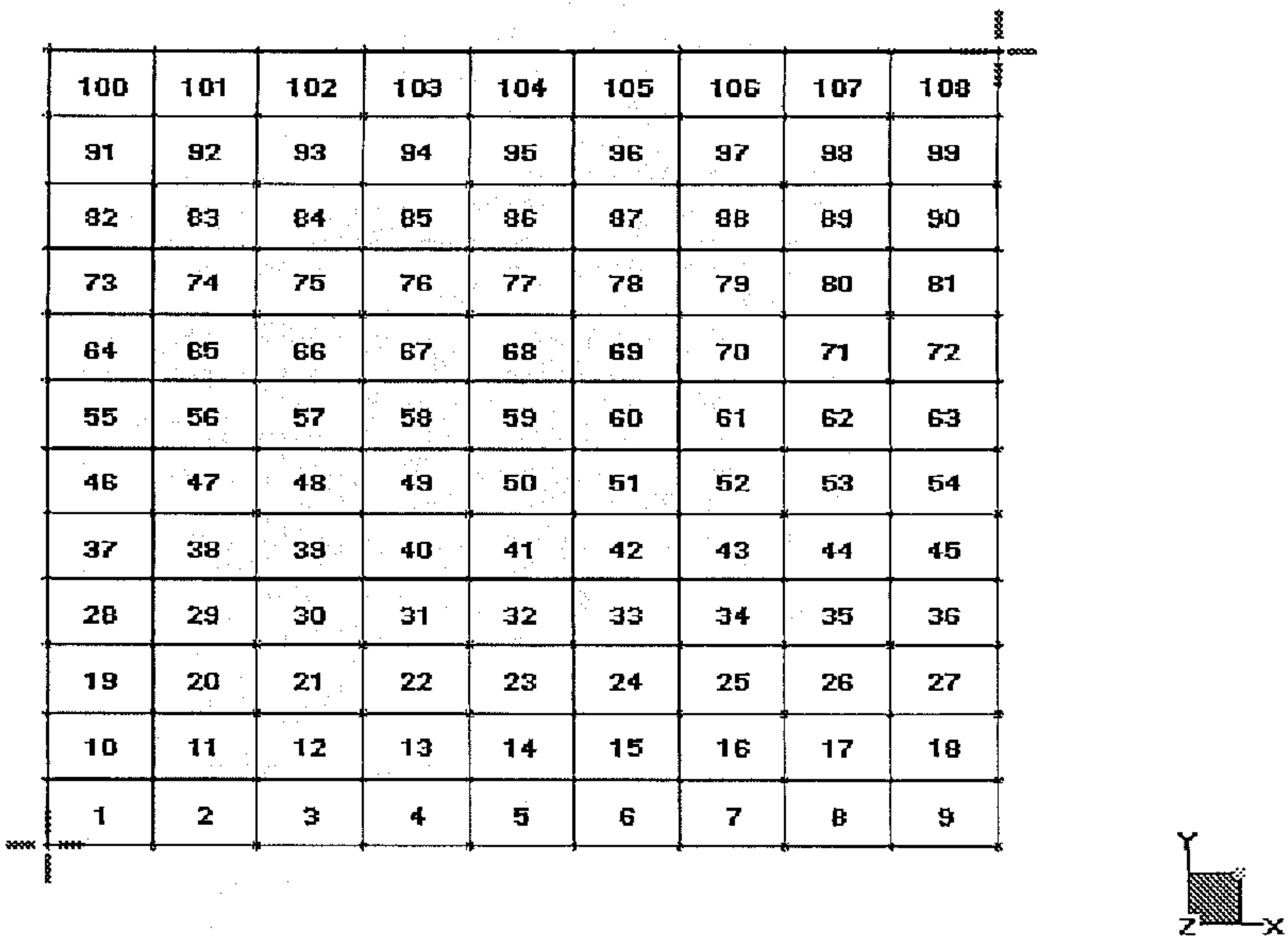
Soil:
Modulus of Subgrade 300 kcf

The load is applied as a concentrated load at the twelve/eight point locations.
Remaining panel points were restrained with a spring element k=6.95 k/in.

Load Condition	Load	Mx	My	Δ
6 Point Load	12.61	9.32	5.44	0.22
	10.27	7.61	4.46	0.179
	5.17	3.82	2.24	0.09
4 Point Load	12.61	9.17	4.62	0.155
	10.27	7.48	3.77	0.126
	5.17	3.78	1.9	0.063



Note:
1- Units for Mx & My are in FT-KIP/FT
2- The given loads are Ultimate Loads - Units are in KIPS
3- Deflection is in INCHES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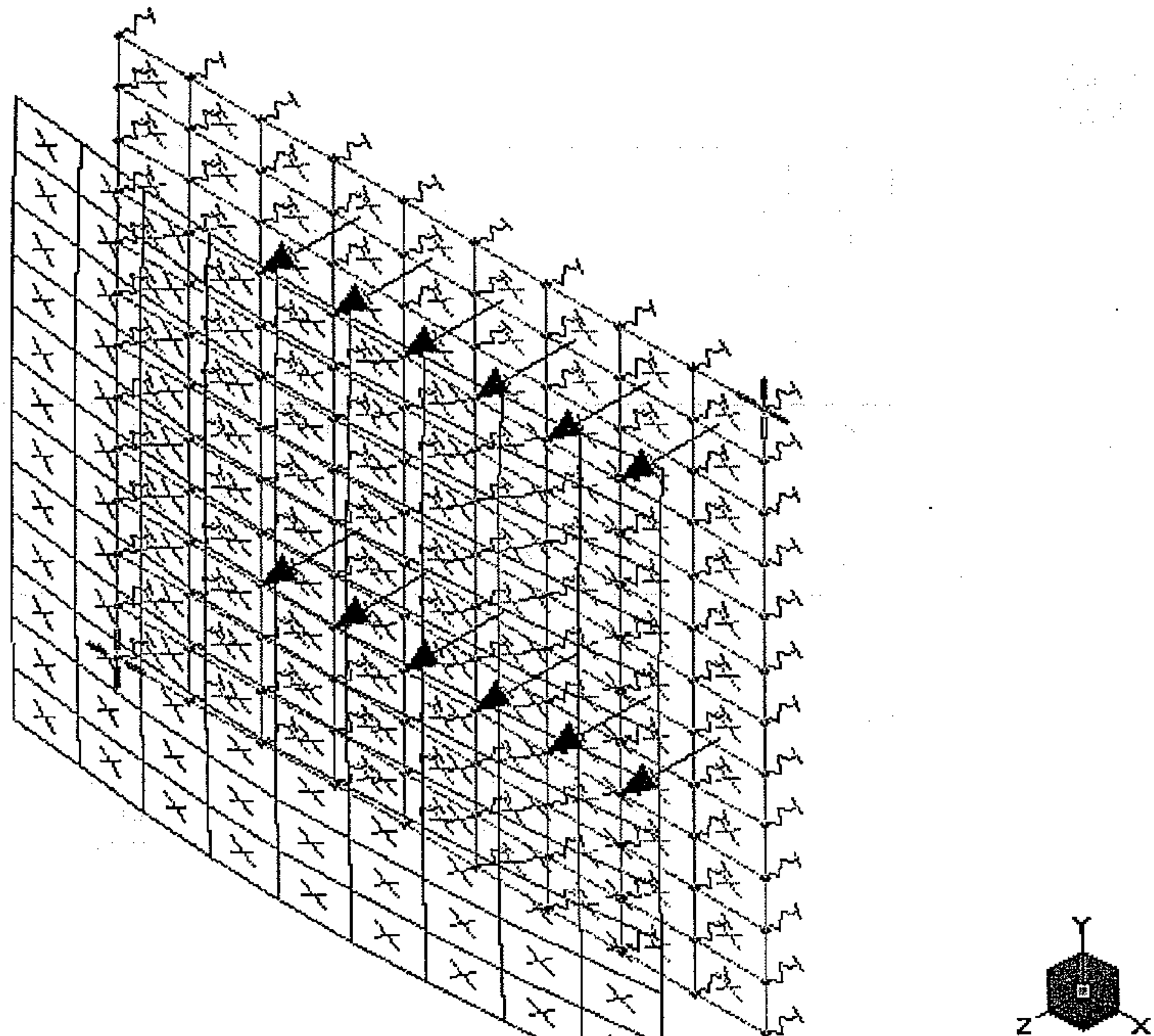
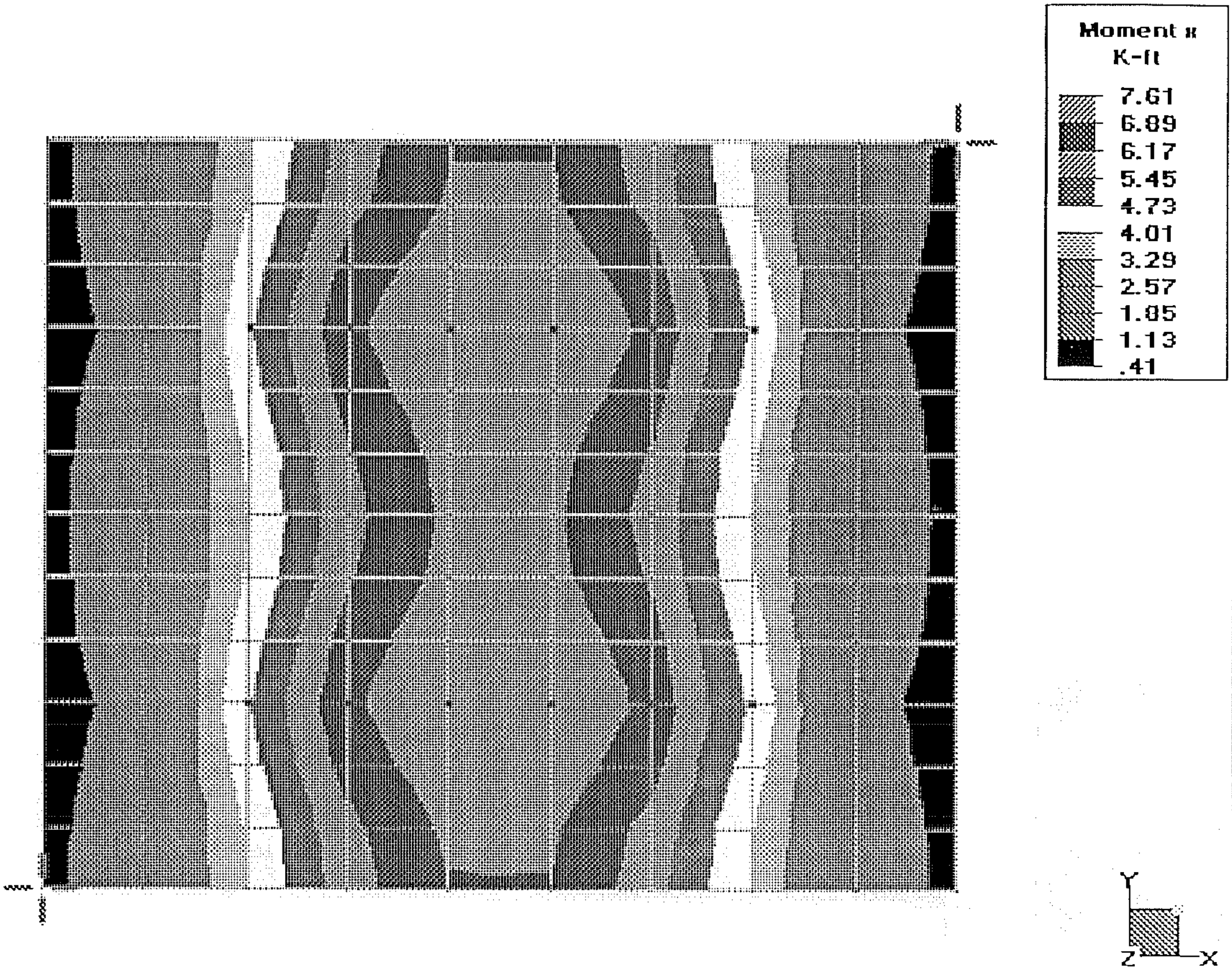
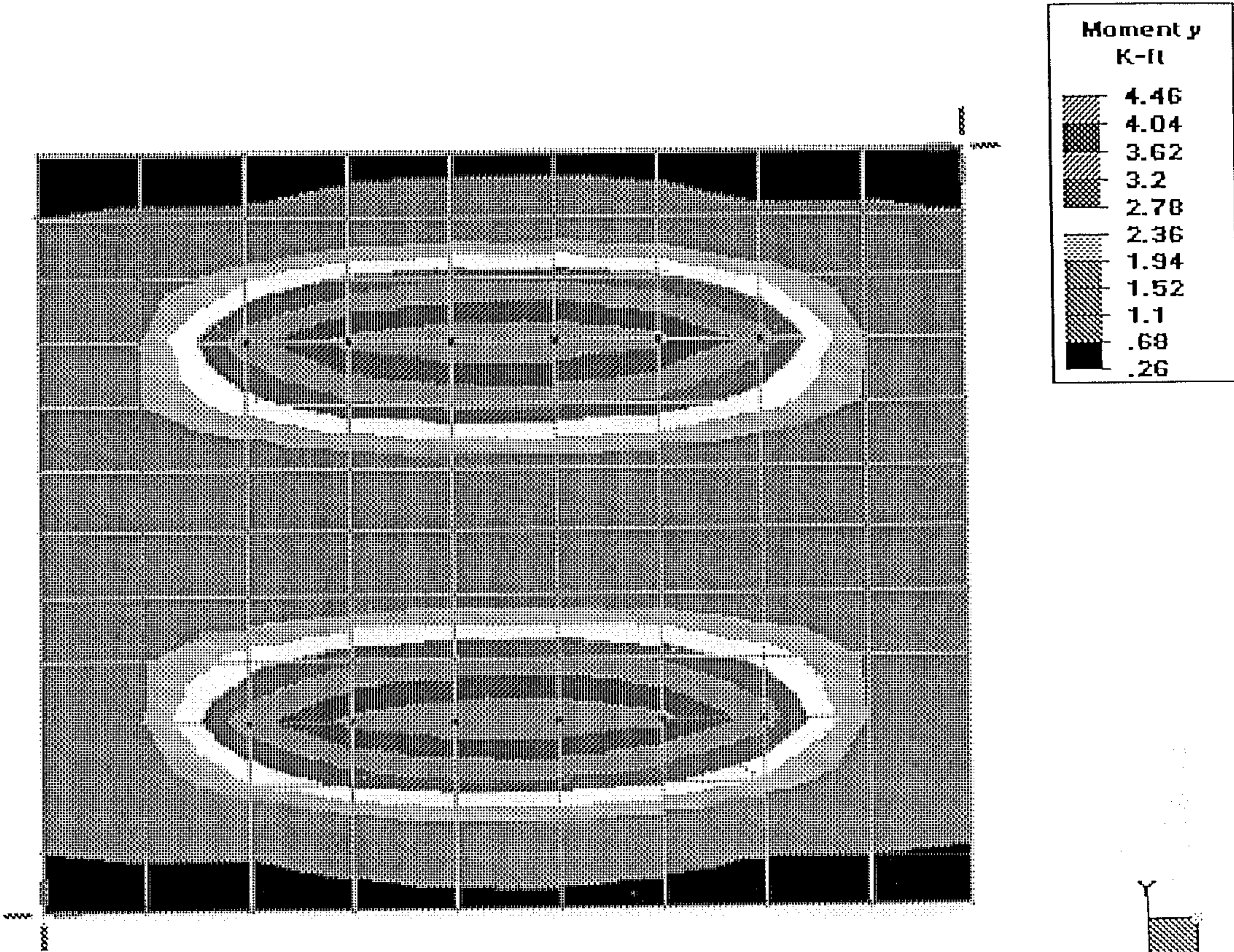
Y
Z
X



Solution: LC1 6 pnt ld 12 61



Solution: LC 2 6 Pnt Ld 10.27 k



Solution: LC 2 6 Pnt Ld 10.27 k

Part Two: Design - Internal Stability

SSL Standard Panel Shear Calculations

$\sigma = \sqrt{4{,}000} = 63.24$ psi (436.0 kPa)

$\sigma = \sqrt{5{,}000} = 70.71$ psi (487.5 kPa)

Available panel for shear strength

6 inch (152 mm) thick panel - $d = 6'' - 1\,¼'' - ¼'' = 4\,½''$

Gross area panel	= l x d = 6(12) x 4.5	= 324 in^2
Pin windows	= l x d = 2 x 11.126 x 4.5	= 100 in^2
	Net Area	= 224 in^2

Available shear strength -

4,000 psi concrete	= 63.24 psi x 224 = 14.17 kips (63.0 kN)
5,000 psi concrete	= 70.71 psi x 224 = 15.84 kips (70.5 kN)

7 inch (177 mm) thick panel - $d = 7'' - 1\,¼'' - ¼'' = 5\,½''$

Gross area panel	= l x d = 6(12) x 5.5	= 396 in^2
Pin windows	= l x d = 2 x 11.126 x 5.5	= 122 in^2
	Net Area	= 274 in^2

Available shear strength -

4,000 psi concrete	= 63.24 psi x 274 = 17.32 kips (77.0 kN)
5,000 psi concrete	= 70.71 psi x 274 = 19.37 kips (86.2 kN)

Applied Force

Based upon the yield strength of the mesh after design corrosion -

Mesh Size	Applied Mesh Force	Panel Size
6W11	6 x (0.0794) 31.2 / 2 = 7.4 kips (33.0 kN)	6 inch @ 4,000 psi
6W20	6 x (0.1580) 31.2 / 2 = 14.7 kips (65.4 kN)	6 inch @ 4,000 psi
6W24	6 x (0.1940) 31.2 / 2 = 18.1 kips (80.5 kN)	7 inch @ 5,000 psi

SNC, INC., STRUCTURAL ENGINEERS

December 4, 1998

Mr. David Swanson
SSL
4740-E Scotts Valley Drive
Scotts Valley, CA 95066

Subject: Wall Panels and Soil Properties

Dear Mr. Swanson:

This letter addresses the soil coefficients used in analyzing the earth retaining wall panels. The stress-strain modulus or the modulus of elasticity E_s is an important soil property in developing this computer model. It varies depending on type and density of soil (from 50 ksf for very soft clay to 4000 ksf for dense sand and gravel).

The concrete panels subjected to lateral soil pressure are analyzed using RISA-3D, a finite element program. The 5'-0"x6'-0" concrete panels are divided into finite 5"x8" rectangular elements. The steel mesh is modeled as applied tension forces of 12.6 kip/force acting at point of connection. The applied forces are equated to the yielding force of the connecting reinforcement. The soil lateral pressure is modeled as spring elements, which is a function of the modulus of elasticity of the soil.

The backfilled sand restrained by the concrete panels is assumed to be properly compacted (95% Proctor Test) with maximum Index of Plasticity Ip = 10. A typical range for the static stress-strain modulus for such dense sand is 1000 to 1700 ksf and a Poisson's ratio of 0.3. These values result in a lateral modulus of subgrade k_s ranging from 360 to 620 k/ft^3, which calculates a spring value ranging from 8.4 to 14.6 k/in. A conservative spring stiffness value of 7 k/in is used in the computer model.

The computer output was previously submitted. Should you have further questions, do not hesitate to contact us.

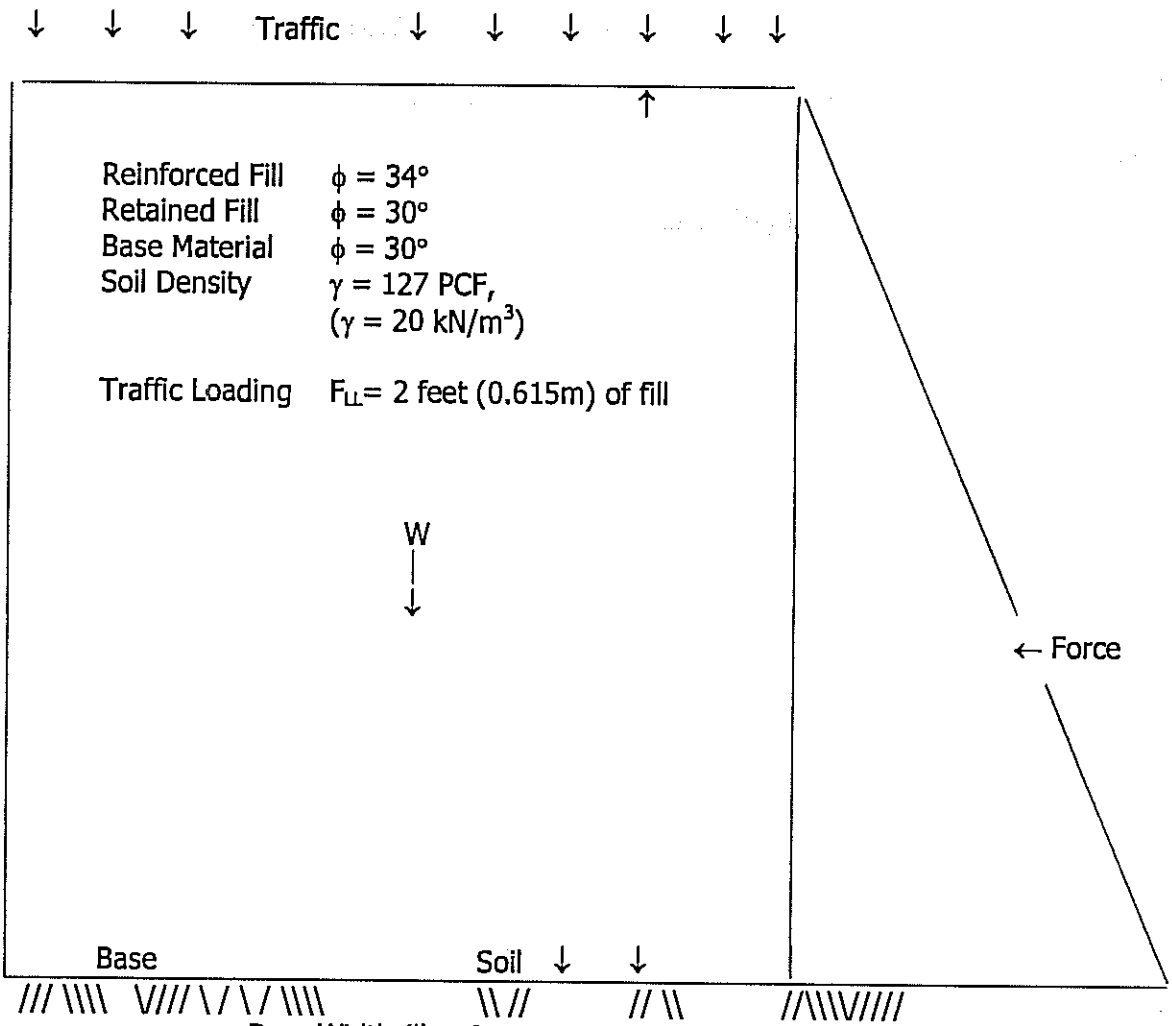
Sincerely,
SNC, Inc.

Khaled Nahlawi, PE
President

REGISTERED PROFESSIONAL ENGINEER
KHALED A. NAHLAWI
No: C053725
Exp. 06/30/02
CIVIL
STATE OF CALIFORNIA

3914 TRADE CENTER DRIVE, ANN ARBOR, MICHIGAN 48108 PHONE:(734)677-2990 FAX:(734)528-0180

HITEC Problem No. 1
External Stability



Base Width (l) = 20.47 Feet (6.24m)

$k_a = \tan^2(45-\phi/2) = \tan^2(45-30/2) = 0.3333$

Retained fill thrust, $F = k_a \times \gamma \times h^2/2 = 0.3333 \times 0.127 \times 29.25^2/2 = 18.09$ kips (80.5 kN)

LL thrust on RF, $F_{LL} = h_{LL} \times \gamma \times k_a \times h = 2 \times 0.127 \times 0.3333 \times 29.25 = 2.45$ kips (10.9 kN)

Overturning Moment $M_F = F \times h/3 = 18.09 \times 29.25/3 = 174.62$ k-ft (236.7 kN-m)

$M_{LL} = F_{LL} \times h/2 = 2.47 \times 29.25/2 = 35.83$ k-ft (48.6 kN-m)

Resisting Moment $M_R = \gamma \times h \times l^2/2 = \gamma \times 29.25 \times 20.47^2/2 = 778.3$ k-ft (1055.3 kN-m)

Check Sliding	$P_R = (\gamma \times h \times l) \times \tan\phi = 76.04 \times \tan 30° = 43.90$ kips (195.3 kN)
	$P_D = F + F_{LL} = 18.09 + 2.45 = 20.54$ kips (91.3 kN)
	$P_R/P_D > 1.5$, $43.90 / 20.54 = \underline{2.13}$ $\therefore$ OK
Check Overturning	$M_R/(M_F + M_{LL}) > 2.0$, $778.62 / (174.62 + 35.83) = \underline{3.69}$ $\therefore$ OK
Check Eccentricity	$e = M_o / W < l/6$, $210.45 / 76.04 = \underline{2.76 \text{ ft}}$ (0.85m) $\therefore$ OK
Check Bearing Stress	$\sigma_V = \sum V/(l - 2e) = (76.04 + (2 \times 0.127 \times 20.47))/(20.47 - 2 \times 2.76)$
	$= \underline{5.43 \text{ ksf}}$ (260.0 $kN\text{-}m^2$)

HITEC Problem No. 1
Internal Stability

Layer	Depth			
↓ ↓	↓	Traffic ↓	2 feet (0.615m) of fill ↓ ↓	
1	3.0	Reinforced Fill	$\phi = 34°$	Mesh ↓
2	2.5	Retained Fill	$\phi = 30°$	
3	2.5	Base Material	$\phi = 30°$	
4	2.5	Soil Density	$\gamma = 127$ PCF,	
5	2.5			
6	2.5			
7	2.5			Mesh ↓
8	2.5			
9	2.5			
10	2.5			
11	2.5			Mesh ↓
Base	1.25			Soil ↓

/// \\\\ V/// \ / \ / \\\\ \\ // // \\ //\\\V////

Base Width = 20.47 Feet (6.24m)

$K_a = \tan^2(45-\phi/2) = 0.2827$

K_a Factor Between Layers

$K_{Top} = 2.50$,

$K_{1\text{-}2} = 2.5 - 4.25\,(1.30)/20 = \underline{2.22}$

$K_{2\text{-}3} = 2.5 - 6.75\,(1.30)/20 = \underline{2.06}$

$K_{3\text{-}4} = 2.5 - 9.25\,(1.30)/20 = \underline{1.90}$

$K_{4\text{-}5} = 2.5 - 11.75\,(1.30)/20 = \underline{1.74}$

$K_{5\text{-}6} = 2.5 - 14.25\,(1.30)/20 = \underline{1.57}$

$K_{6\text{-}7} = 2.5 - 16.75\,(1.30)/20 = \underline{1.41}$

$K_{7\text{-}8} = 2.5 - 19.25\,(1.30)/20 = \underline{1.25}$

$K_{8\text{-}11} = \underline{1.20}$

Force Per Layer

At Row No 1, 2 kips/panel is added for crash load. To calculate the stress ½ way between each row of mesh, average the stresses above and below a row mesh and multiply by the area to obtain the applied force.

Row D Load x k_a x K_f x =

Row	D Load x	k_a x	K_f x =	x	Area =	Force
	0.254	0.2827	2.50			
1				0.3380	25.5 =	10.63 kips (47.28 kN)
	0.793	0.2827	2.22			
2				0.5720	15.0 =	8.58 kips (38.16 kN)
	1.111	0.2827	2.06			
3				0.7070	15.0 =	10.61 kips (47.19 kN)
	1.428	0.2827	1.90			
4				0.8130	15.0 =	12.20 kips (54.27 kN)
	1.746	0.2827	1.74			
5				0.8880	15.0 =	13.31 kips (59.20 kN)
	2.063	0.2827	1.57			
6				0.9325	15.0 =	13.99 kips (62.23 kN)
	2.381	0.2827	1.41			
7				0.9510	15.0 =	14.27 kips (63.47 kN)
	2.698	0.2827	1.25			
8				0.9880	15.0 =	14.82 kips (65.92 kN)
	3.016	0.2827	1.20			
9				1.0770	15.0 =	16.16 kips (71.88 kN)
	3.333	0.2827	1.20			
10				1.1850	15.0 =	17.78 kips (79.09 kN)
	3.651	0.2827	1.20			
11				1.2975	15.0 =	19.39 kips (86.25 kN)
	3.968	0.2827	1.20			

Corrosion Reduction

Galvanize coverage (ASTM A123)	=	20 oz per square foot
Rate of corrosion for zinc	=	15 μm / year (first 2 years) 4 μm / year (thereafter)
For residual carbon steel	=	12 μm / year (thereafter)
Galvanize thickness	=	$\frac{20 \text{ oz } (1{,}728)/16}{440 \text{ \#'s/CF } (144)}$ = 0.0341″ = 86.59 μm
First 2 years	=	2 (15) = 30 μm / year
Number of years of coating	=	$2 + \frac{(86.59 - 30.00)\ \mu m}{4\ \mu m / \text{year}}$ = 16.14 years
Steel loss	=	(75 – 16.14) years x (12 μm / year)
	=	706.23 μm = 0.0278 inches

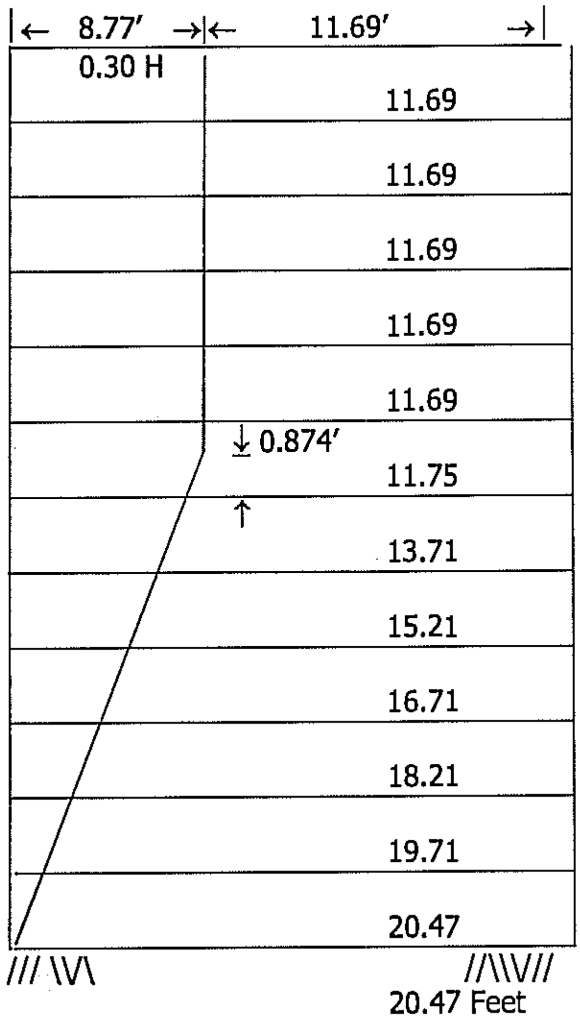
Mesh Reinforcement Properties 75 years

Wire Size	Effective Diameter		Effective Area	Force @ 0.48 f_y
11	0.374 – (2 x 0.0278)	0.318″ (8.07 mm)	0.794 in^2 (51.2 mm^2)	2.48 kips (11.0 kN)
20	0.504 - (2 x 0.0278)	0.448″ (11.38mm)	0.158 in^2 (101.9 mm^2)	4.93 kips (21.9 kN)

Pullout Calculations

Anchorage Factor A_c, varies from 40 at grade or H_z to 20 at 20 feet from H = 0.

Layer	Depth from Top		A_c
Top	0.0	=	40.0
1	3.0	40 – ((40-20) x 3/20) =	37.0
2	2.5	40 – ((40-20) x 5.5/20) =	34.5
3	2.5	40 – ((40-20) x 8.0/20) =	32.0
4	2.5	40 – ((40-20) x 10.5/20)=	29.5
5	2.5	40 – ((40-20) x 13.0/20)=	27.0
6	2.5	40 – ((40-20) x 15.5/20)=	24.5
7	2.5	40 – ((40-20) x 18.0/20)=	22.0
8	2.5	=	20.0
9	2.5	=	20.0
10	2.5	=	20.0
11	2.5	=	20.0
Base	1.25		



Mesh Pullout Capacity

Layer	Mesh	h x γ	x	A_c x	S x	t	x	l_e/S_t	= Force (kips) (kN)
1	5W11x0.50xW11	(3.0) 0.127		37.0	32	0.318		11.69/0.5	= 23.31 kips (103.7 kN)
2	4W11x1.00XW11	(5.5) 0.127		34.5	24	0.318		11.69/1.0	= 14.94 kips (66.5 kN)
3	5W11x1.00XW11	(8.0) 0.127		32.0	32	0.318		11.69/1.0	= 26.86 kips (119.5 kN)
4	5W11x1.00XW11	(10.5) 0.127		29.5	32	0.318		11.69/1.0	= 32.51 kips (144.6 kN)
5	6W11x2.00XW11	(13.0) 0.127		27.0	40	0.318		11.69/2.0	= 23.04 kips (102.5 kN)
6	6W11x2.00XW11	(15.5) 0.127		24.5	40	0.318		11.75/2.0	= 25.04 kips (111.4 kN)
7	6W11x2.00XW11	(18.0) 0.127		22.0	40	0.318		13.71/2.0	= 30.48 kips (135.6 kN)
8	6W11x2.00XW11	(20.5) 0.127		20.0	40	0.318		15.21/2.0	= 35.01 kips (155.7 kN)
9	4W20x1.50XW11	(23.0) 0.127		20.0	24	0.318		16.71/1.5	= 34.49 kips (153.4 kN)
10	4W20x1.50XW11	(25.5) 0.127		20.0	24	0.318		18.21/1.5	= 41.62 kips (185.1 kN)
11	4W20x1.50XW11	(28.0) 0.127		20	24	0.318		19.71/1.5	= 49.53 kips (220.3 kN)

Summary

Row	$F_{capacity}$ kips	F_{Actual} kips	FS	Mesh Area, in^2	Stress ksi	Stress kPa	Allowable ksi / kPa
1	23.31	10.63	2.19	0.3970	26.8	184.6	31.2 / 215.1
2	14.94	8.58	1.74	0.3176	27.0	186.3	"
3	26.86	10.61	2.53	0.3970	26.7	184.3	"
4	32.51	12.20	2.66	0.3970	30.7	211.8	"
5	23.04	13.31	1.73	0.4780	27.9	192.0	"
6	25.04	13.99	1.79	0.4780	29.3	201.8	"
7	30.48	14.27	2.13	0.4780	28.9	205.8	"
8	35.01	14.82	2.36	0.4780	31.0	213.8	"
9	34.49	16.16	2.13	0.6320	25.6	176.3	"
10	41.62	17.78	2.34	0.6320	28.1	193.9	"
11	49.53	19.39	2.55	0.6320	30.68	211.5	"

SSL

DESIGN CALCULATIONS

JOB NAME	**HITEC**	Wall Height=	29.25
DATE	06-Jul-98		
WALL NAME	Load Condition 1		

SOIL PARAMETERS

	Select	Base	Random	
ANGLE OF INTERNAL FRICTION	34	30	30	DEG
	0.5934	0.5236	0.5236	RAD
MAXIMUM BEARING CAPACITY			10.00	TSF
SOIL UNIT WEIGHT			127	PCF

KoSEL	KaSEL	Meyer/Stiffness	Ac @ TOP	Ac @ -20
0.7068	0.3393	S	40.0	20.0

	Ko	Ka @ H/2	Ac @ TOP	Ac @ -20
AASHTO 96	1.559	1.000	30.0	15.0
AASHTO 97	2.500	1.200	40.0	20.0

MESH DESIGN CHARACTERISTICS

	Sv (FT)	Sh (FT)	Si (FT)
MESH - Layout	2.50	6.00	0.67

	Design Life	Fy	Factor	F allow	Fa seismic
MESH DESIGN PARAMETERS	75	65,000	0.48	31,200	

	Galv	Coat Life	Xw	Lw	
CORROSION RATE	Y	16.0	12.0	12.00	uM/SURFACE/YEAR

(GALVANIZATION PER ASTM-A-123, 2 Oz. PER SQ.FT.)

MESH CHARACTERISTICS

	WIRE SIZE	W8	W11	W15	W20	W24
Nominal	DIA, In	0.319	0.374	0.437	0.504	0.553
(New)	AREA, in^2	0.080	0.110	0.150	0.200	0.240
	WT/LF	0.272	0.374	0.510	0.679	0.817
Effective	DIA, Tension	0.263	0.318	0.381	0.448	0.497
(After Loss)	AREA, in^2	0.054	0.080	0.114	0.158	0.194
75	DIA, Xbar	0.263	0.318	0.381	0.448	0.497

EXTERNAL LOADS

EQUIVALENT TRAFFIC LOAD	254	PSF	SEISMIC		Y
			ECCEL COEF		0.20
TRAFFIC BARRIER	Y	(2000 LB - TOP LAYER)	SCHG (Y/N	N	
LOAD CONDITION (1,2,3,4)	1				

WALL GEOMETRY

H panel FT	H design FT	Panel Type	L mesh FT	H+ FT	Heff FT	Hmax FT	H(Z) FT
29.25	29.25	A	20.47	0.00	29.25	29.25	29.25

Angle BF Deg / Rad	BF Slope L FT	No Mesh Layers	Depth of 1st Layer
0.00	0.00	11	3.00
0.0000			

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JOB NAME	**HITEC**					
DATE	06-Jul-98					
WALL NAME	Load Condition 1				Wall Height=	29.3

EXTERNAL STABILITY ANALYSIS
LOAD COMBINATION: STATIC (LL+EP)

			ARM		MOMENT	
ACTIVE E.P. COEF - Kar	0.3333					
THRUST - F1	18109	LB	9.75	FT	176567	FT-LB
THRUST - F1q	2477	LB	14.63	FT	36219	FT-LB
TOTAL THRUST - Ft	20586	LB				
HORIZONTAL THRUST - Fh	20586	LB	10.34	FT	212786	FT-LB
VERTICAL THRUST - Fv	0	LB	20.47	FT	0	FT-LB
RESISTING FORCES						
WEIGHT OF SOIL MASS - V1	76041	LB	10.24	FT	778279	FT-LB
WEIGHT OF SOIL MASS - V2	0	LB	0.00	FT	0	FT-LB
WEIGHT OF SOIL MASS - V3	0	LB	10.24	FT	0	FT-LB
TOTALS	76041	LB			778279	FT-LB
Q OVER FILL	5199	LB	10.24	FT.	53215.7	FT-LB

CHECK SLIDING

DRIVING FORCE - Pd	20586	LB	
RESISTING FORCE - Pr	43902	LB	(INCLUDING FV AND NO Q OVER FILL)
FACTOR OF SAFETY (>1.5)	**2.13**	**OK**	

CHECK OVERTURNING

OVERTURNING MOMENT - Mo	212786	FT-LB	
RESISTING MOMENT - Mr	778279	FT-LB	(INCLUDING FV AND NO Q OVER FILL)
FACTOR OF SAFETY (>2.0)	**3.66**	**OK**	

CHECK ECCENTRICITY (<L/6)

emax=	2.80	FT	**OK**	(NO Q OVER FILL)
e=	2.62	FT	**OK**	(INCLUDING Q OVER FILL)

CHECK BEARING

MAXIMUM BEARING STRESS	**5334**	**PSF**	**OK**	(INCLUDING Q OVER FILL)

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JOB NAME	**HITEC**
DATE	6-Jul-98
WALL NAME	Load Condition 1

Wall Height= 29.25

(S=STIFFNESS per 1997 AASHTO)
(M=MEYERHOF BY LAYER)
ANALYSIS (M or S) **S**
LOAD COMBINATION - STATIC (LL+EP)

LAYER No's	LAYER DEPTH FT	HORIZ. FORCE LBS	MESH PULLOUT CAPACITY	MESH PULLOUT SF >1.5		MESH STRESS PSI	MESH F ALLOW 31,200	MESH DESIGN T-Bars X-Bars	L mesh=
1	3.000	10,651	23,319	2.19	OK	26,780	OK	5W11X 0.50W11	20 Feet
2	5.500	8,599	14,949	1.74	OK	27,026	OK	4W11X 1.00W11	20 Feet
3	8.000	10,609	26,891	2.53	OK	26,673	OK	5W11X 1.00W11	20 Feet
4	10.500	12,181	32,537	2.67	OK	30,625	OK	5W11X 1.00W11	20 Feet
5	13.000	13,315	23,044	1.73	OK	27,898	OK	6W11X 2.00W11	20 Feet
6	15.500	14,012	26,050	1.86	OK	29,358	OK	6W11X 2.00W11	20 Feet
7	18.000	14,271	30,499	2.14	OK	29,901	OK	6W11X 2.00W11	20 Feet
8	20.500	14,820	35,030	2.36	OK	31,051	OK	6W11X 2.00W11	20 Feet
9	23.000	16,157	34,540	2.14	OK	25,596	OK	4W20X 1.50W11	20 Feet
10	25.500	17,773	41,730	2.35	OK	28,156	OK	4W20X 1.50W11	20 Feet
11	28.000	19,389	49,594	2.56	OK	30,715	OK	4W20X 1.50W11	20 Feet

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Connections Calculations – Concrete Bearing

Allowable Stress -

$$0.3 f_c^1 \sqrt{\frac{A^2}{A_1}} \; X\ .75 \; \text{(reduction Factor)}$$

A_2 = 2.52 (5.625) = 14.175 IN^2

A_1 = 6.625 X 0.625 = 3.517 IN^2

$$\sqrt{\frac{A_2}{A_1}} = \sqrt{\frac{14.175}{3.517}} = 2.007$$

Max. Allowable = 2

Allowable Stress – W20

W20 0.3 (4.000) (2) (0.75) = 1.80 ksi,

1.80 X 3.517 = 6.33k > 4.93k applied force

Concrete Bearing Does Not Control

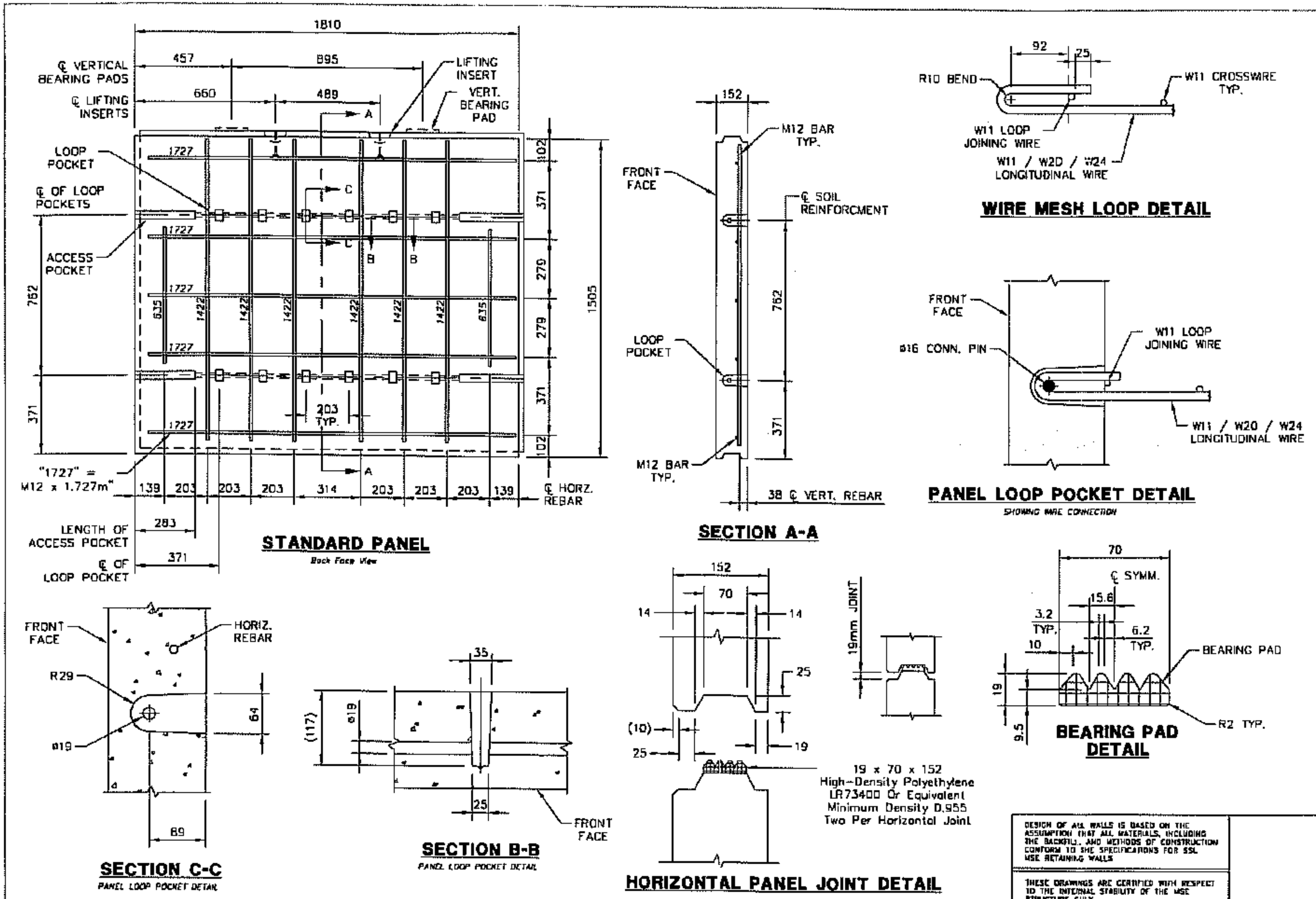
Allowable Stress – W24

W24 0.3 (5.000) (2) (0.75) = 2.25 ksi,

2.25 X 3.517 = 7.91k > 6.05k applied force

Concrete Bearing Does Not Control

Appendix C



DESIGN OF ALL WALLS IS BASED ON THE ASSUMPTION THAT ALL MATERIALS, INCLUDING THE BACKFILL, AND METHODS OF CONSTRUCTION CONFORM TO THE SPECIFICATIONS FOR SSL MSE RETAINING WALLS

THESE DRAWINGS ARE CERTIFIED WITH RESPECT TO THE INTERNAL STABILITY OF THE MSE STRUCTURE ONLY.

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1	2/11/98	PAD, PIN	

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STANDARD DETAIL SHEET 1 OF 2

HITEC

Date: 12/10/97
Scale: -
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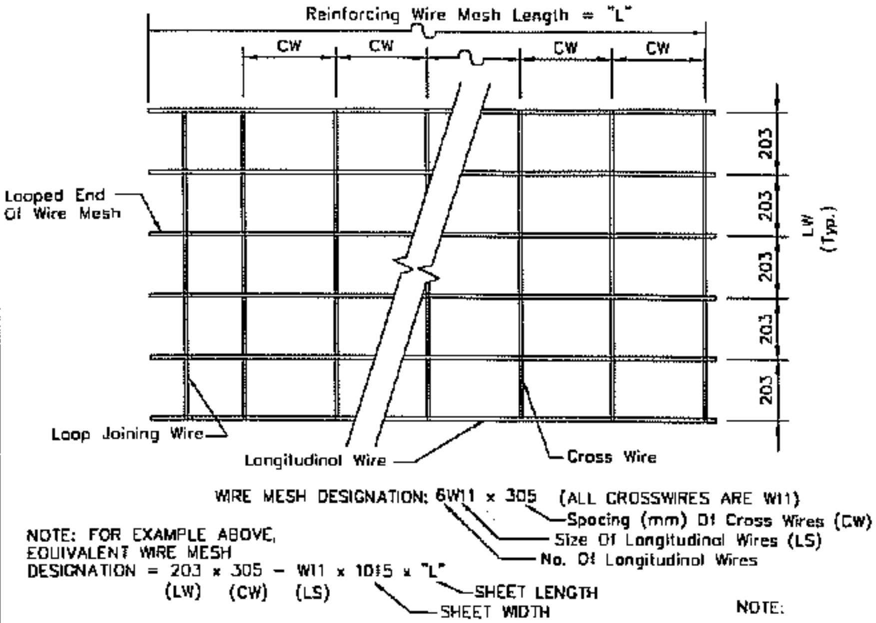
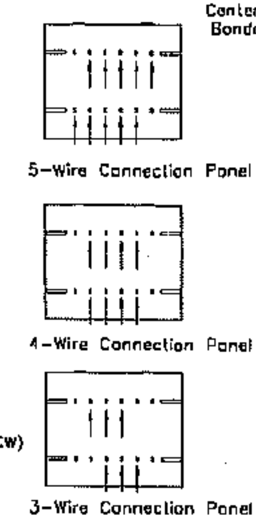
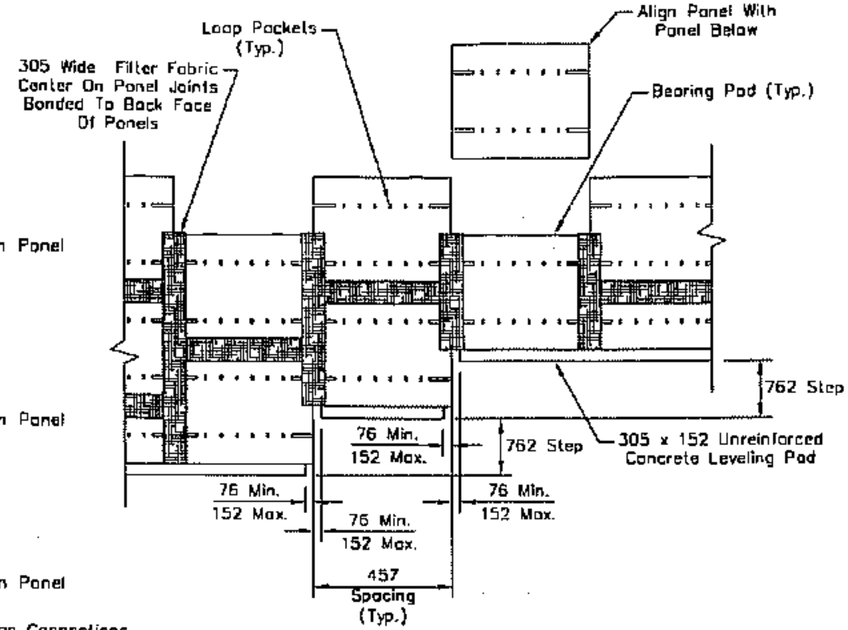
Job: 0000
Sheet: RW
Sheet 1 of 2



REINFORCING MESH DETAIL



NOTE:
Minimum Panel Connector is 3 Loop Connections Per Row. The Number Of Loop Connections Per Row May Increase As Dictated By The Design Condition.

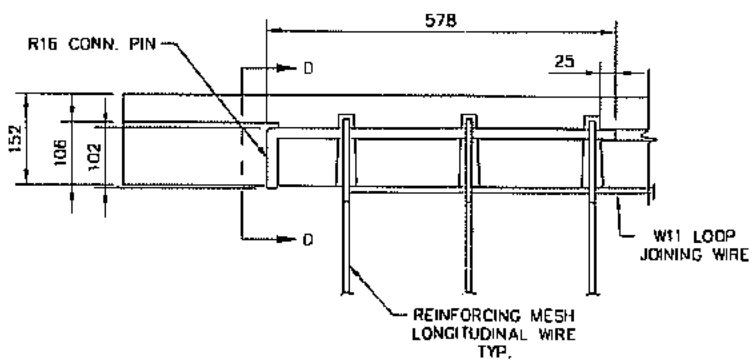


FILTER FABRIC DETAIL AND PANEL PLACMENT

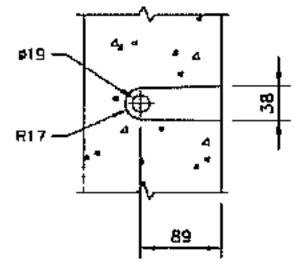
Back Face View

NOTES:

1. Panel Reinforcement Bars Shall Be Deformed Billet–Steel Bars For Concrete Reinforcement Conforming To The Specification Of ASTM Designation A615, Grade 60, Including Supplementary Requirement S1 Or Low Alloy Steel Deformed Bars Conforming To The Specifications Of ASTM Designation A706.
2. W11, W20, & W24 Steel Wire And Connector Pin Shall Conform To The ASTM Designation A82.
3. Reinforcing Mesh & Connector Bars Shall Be Galvanized In Accordance With ASTM Designation A123.
4. Concrete Panels To Have A 28 Day Compressive Strength Of 27.58mpa For Panels With W11, 4W20, And 5W20 Wire Mesh. For Panels With 6W20 Mesh Use 34.48mpa. For Panels With 6W24 Mesh Use 34.48mpa With A Panel Thickness Of 178.
5. All Panel Reinforcement Must Have A Minimum Of 32 Coverage With Concrete On All Sides.
6. When Cast In Place Coping Is Used In Conjuction With The MSE Wall, The Top Panels Shall Be Cast With 2 ea. M12 Dowel Bars Embedded A Minimum Of 305 Into The Top Surface Of The Panel For Attachment To The Coping Element.



REINFORCING MESH CONNECTOR BAR DETAIL



SECTION D-D

DESIGN OF A-1 WALLS IS BASED ON THE ASSUMPTION THAT ALL MATERIALS, INCLUDING THE BACKFILL, AND METHODS OF CONSTRUCTION CONFORM TO THE SPECIFICATIONS FOR SSL MSE RETAINING WALLS

THESE DRAWINGS ARE CERTIFIED WITH RESPECT TO THE INTERNAL STABILITY OF THE MSE STRUCTURE ONLY.

1	12/1/93 PAD, BN
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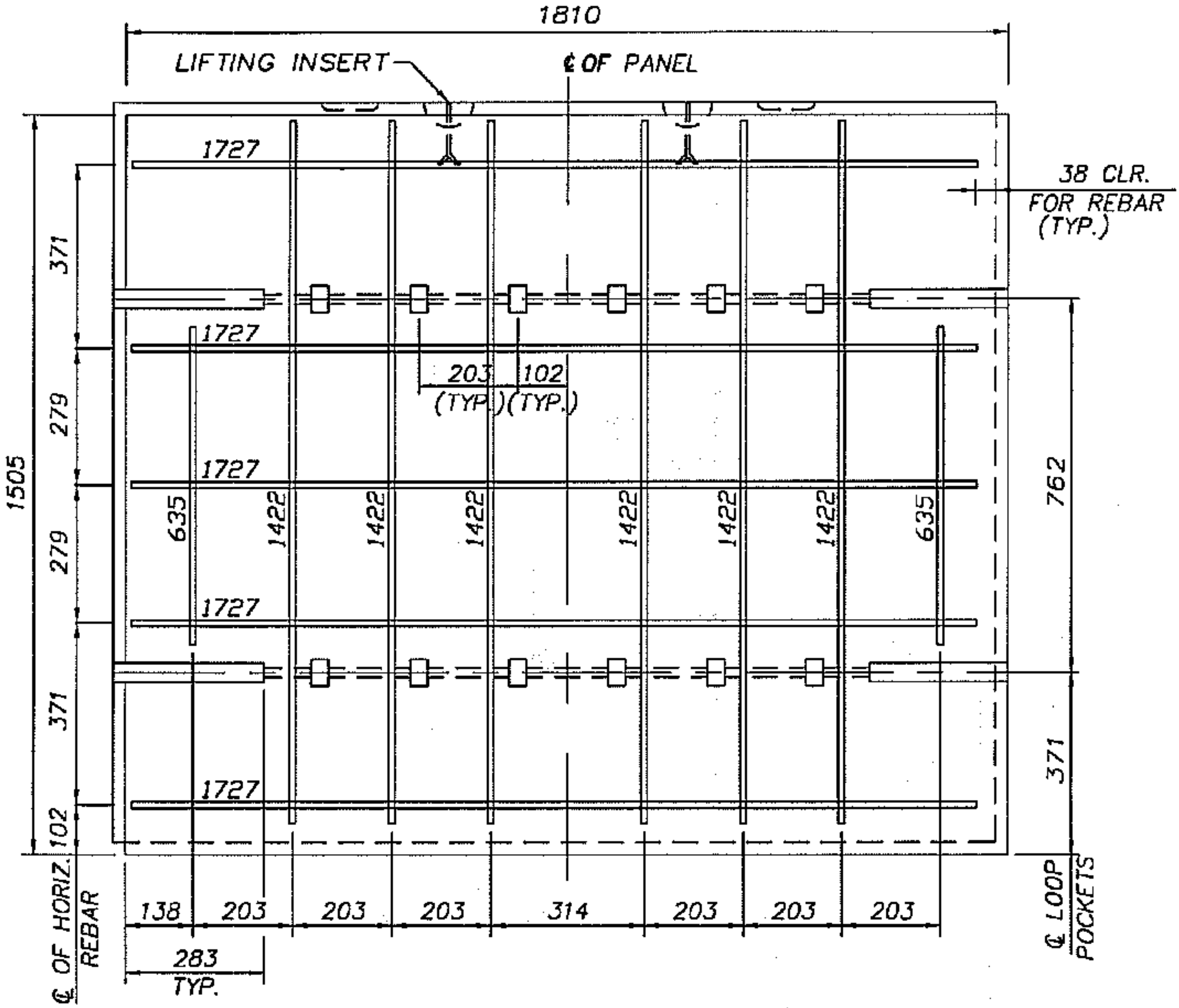
Date	11/10/9
Scale	-
Drawn By	JT
Job	0000
Sheet	RW
Sheet 4 of 2	

TYPE-A

SHOWN FROM BACK FACE



Qt.	Item	Description
2	Vertical Bar	M12 Bar – 635 Long
6	Vertical Bar	M12 Bar – 1422 Long
5	Horizontal Bar	M12 Bar – 1727 Long
2	Lifting Insert	1 Ton Burke

NOTE:
Concrete Panel Compressive Strength = 27.58mpa

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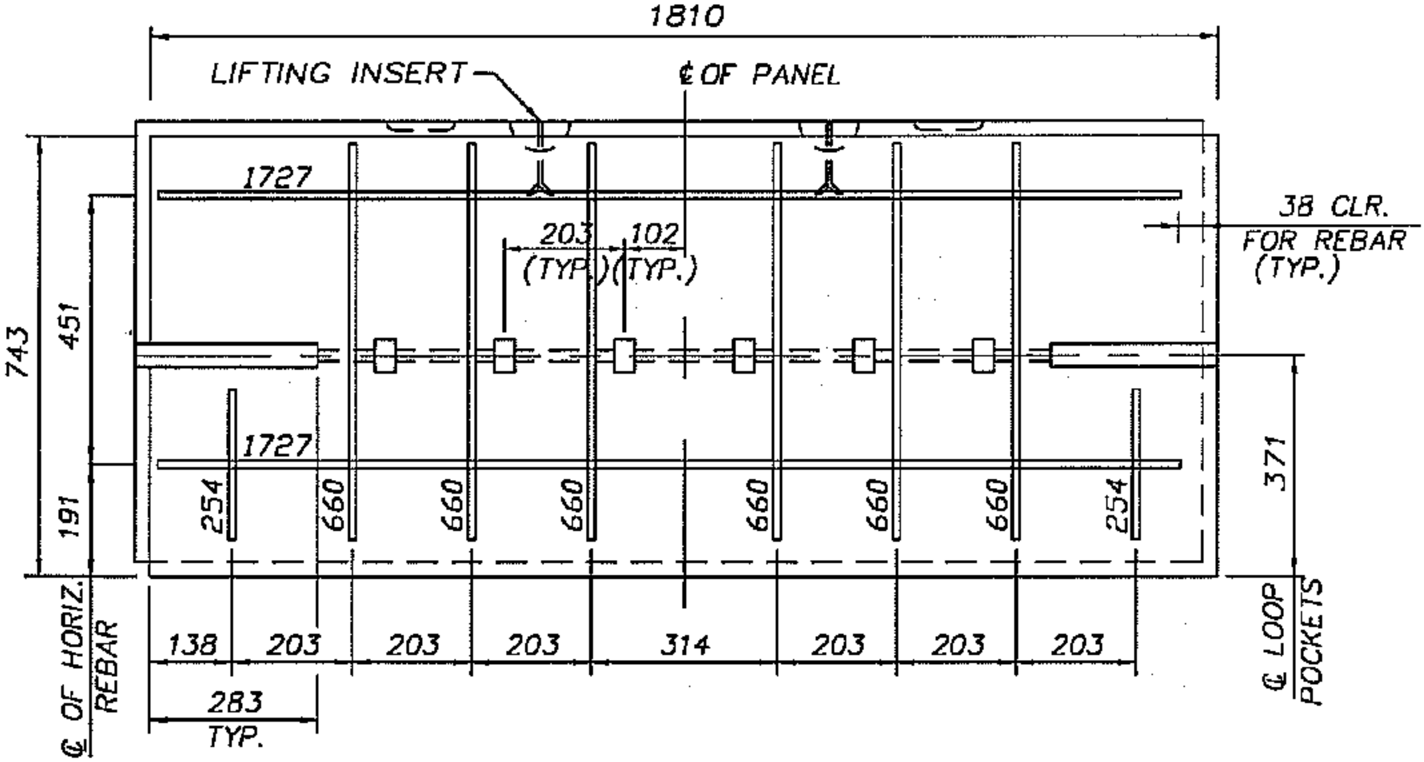
8/24/98 Designed by: JST Checked by:	PANEL REBAR DETAIL: A PANEL HITEC	SSL Specializing in Construction Products 4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 408 430 8300 Fax: 408 430 8340	Job. No. 0000 Of

TYPE–A2

SHOWN FROM BACK FACE



Qt.	Item	Description
2	Vertical Bar	M12 Bar – 254 Long
6	Vertical Bar	M12 Bar – 660 Long
2	Horizontal Bar	M12 Bar – 1727 Long
2	Lifting Insert	1 Ton Burke

NOTE:
Concrete Panel Compressive Strength = 27.58mpa

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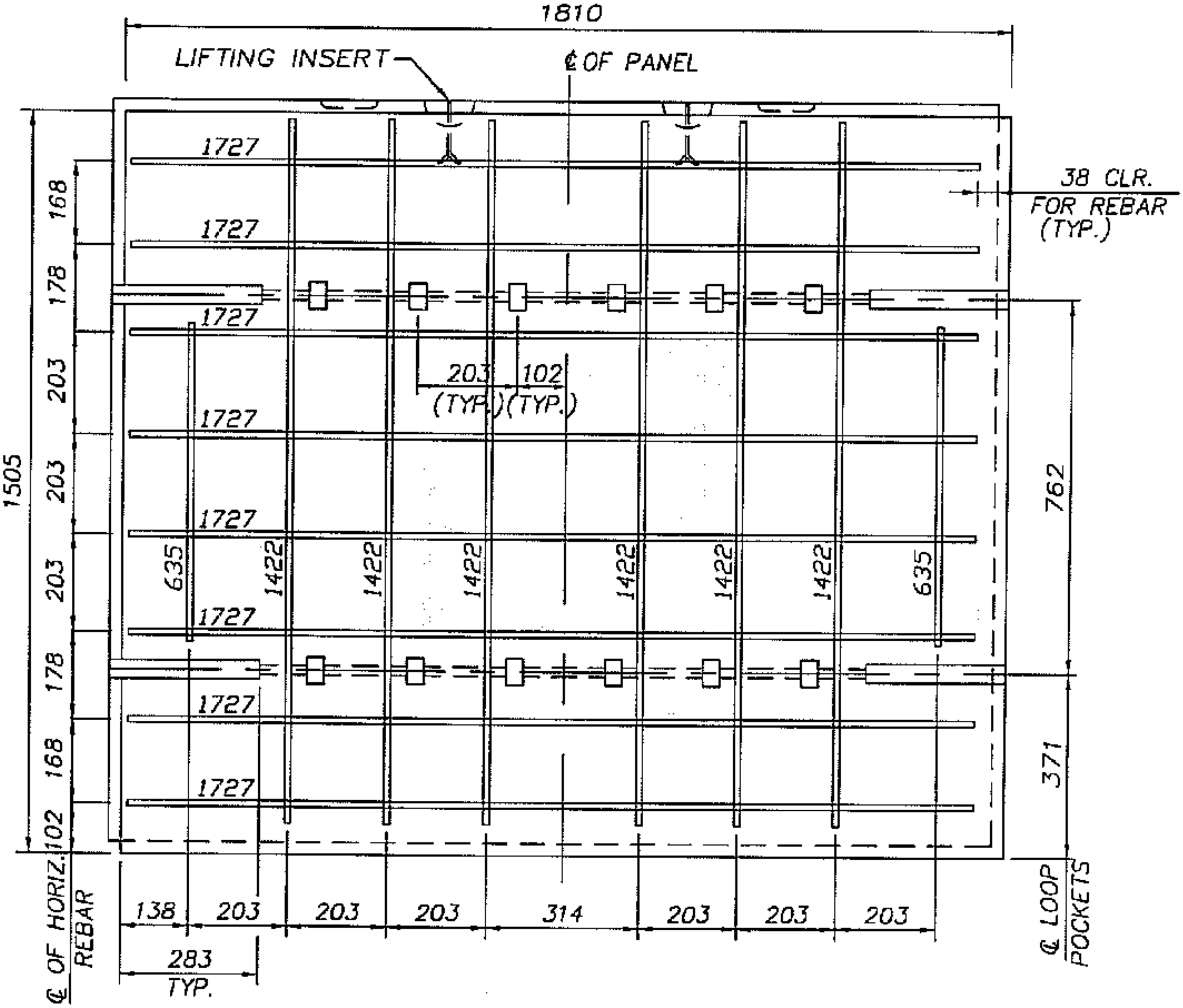
8/24/98 Designed by: JST Checked by:	PANEL REBAR DETAIL: A2 PANEL HITEC	SSL Specializing in Construction Products 4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 408 438 8300 Fax: 408 438 6540	Job. No. 0000 01

TYPE—X

SHOWN FROM BACK FACE



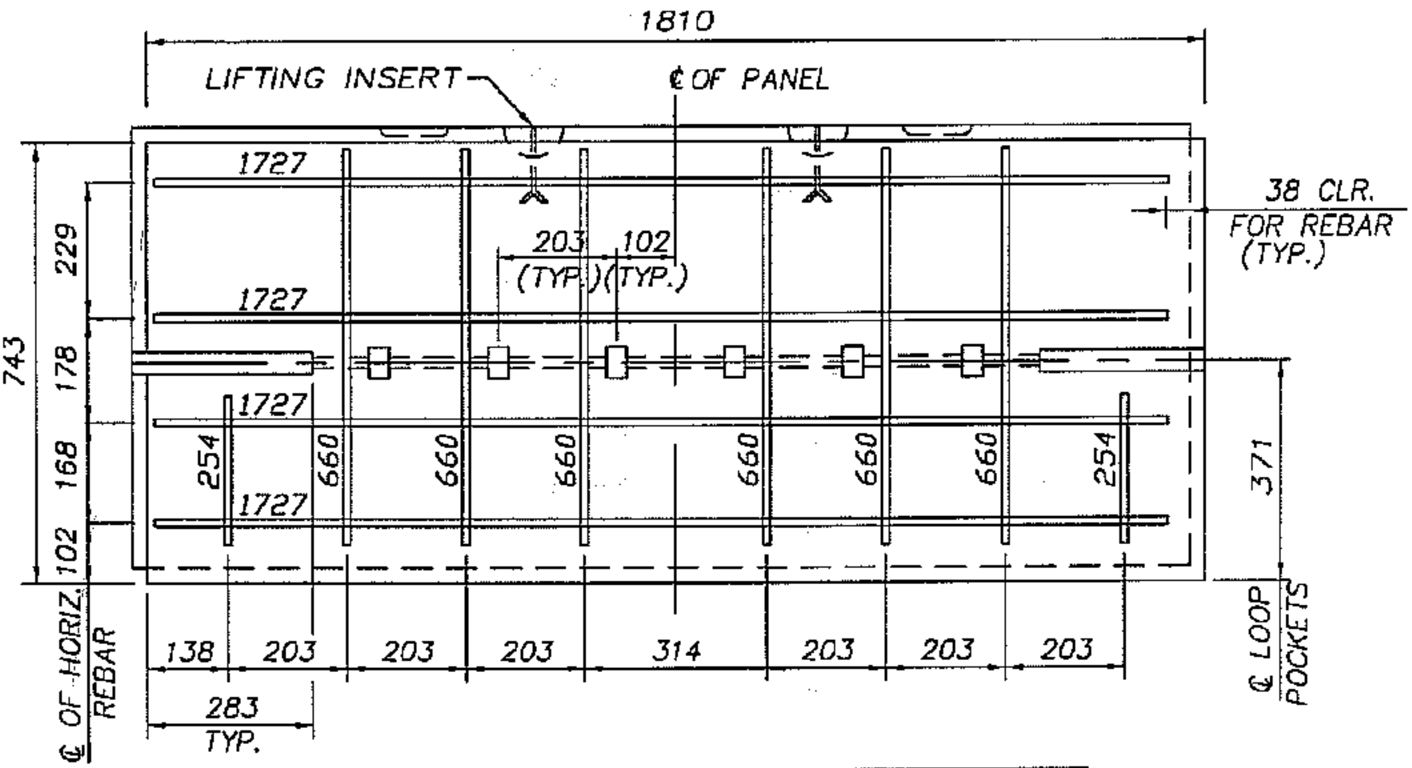
Qt.	Item	Description
2	Vertical Bar	M12 Bar — 635 Long
6	Vertical Bar	M12 Bar — 1422 Long
8	Horizontal Bar	M12 Bar — 1727 Long
2	Lifting Insert	1 Ton Burke

NOTE:
Concrete Panel Compressive Strength = 27.58mpa

5/4/98	RETAINING WALL X — PANEL DETAILS	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST	HITEC	4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone 408 430 8300 Fax 408 430 8340	01
Checked by:			

TYPE-X2

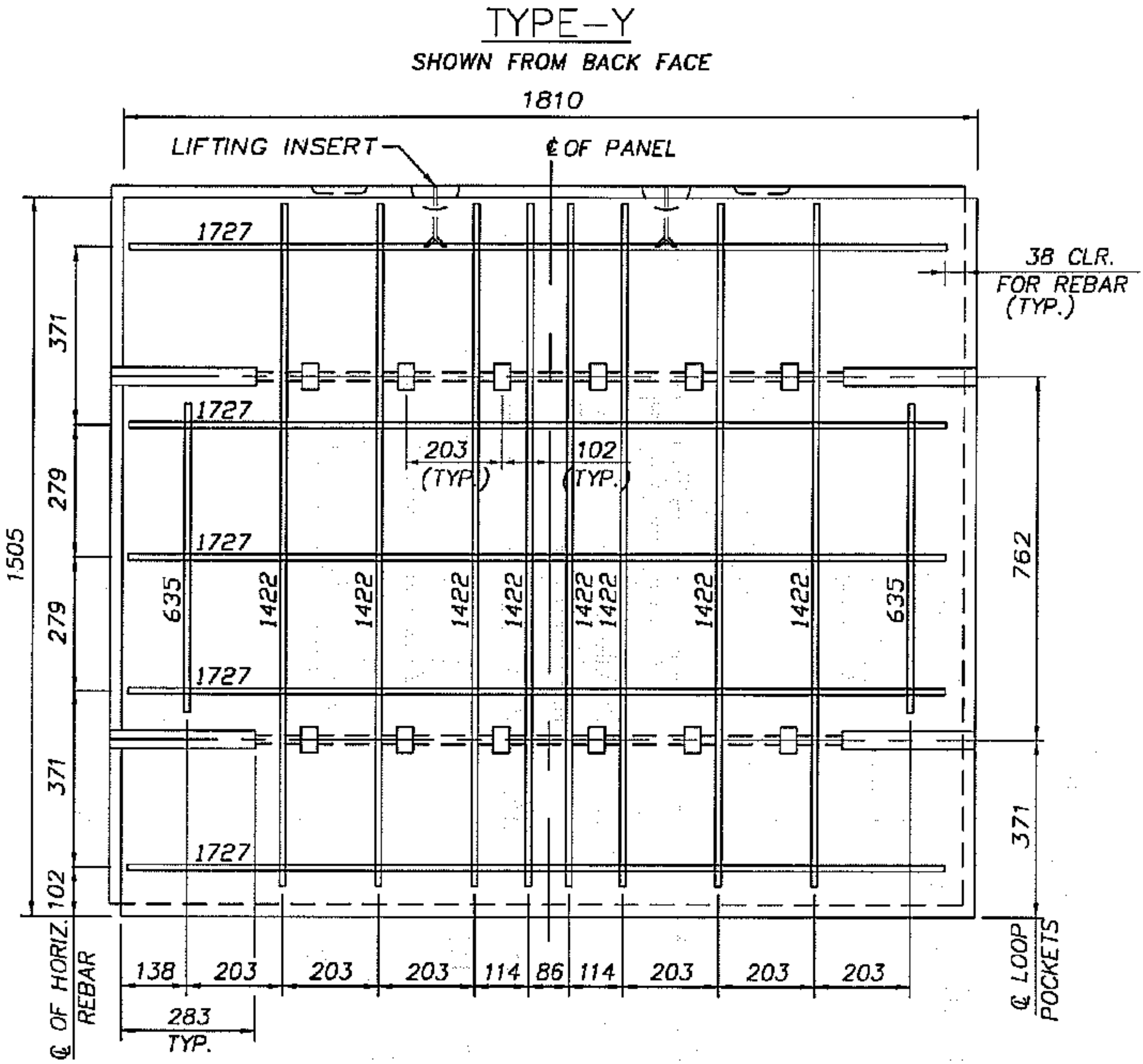
SHOWN FROM BACK FACE



Qt.	Item	Description
2	Vertical Bar	M12 Bar – 254 Long
6	Vertical Bar	M12 Bar – 660 Long
4	Horizontal Bar	M12 Bar – 1727 Long
2	Lifting Insert	1 Ton Burke

NOTE:
Concrete Panel Compressive Strength = 27.58mpa

5/4/98 Designed by: JST Checked by:	RETAINING WALL X2 – PANEL DETAILS HITEC	SSL Specializing in Construction Products 4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone 408 430 9300 Fax 408 430 9340	Job. No. 0000 Of



Qt.	Item	Description
2	Vertical Bar	M12 Bar – 635 Long
8	Vertical Bar	M12 Bar – 1422 Long
5	Horizontal Bar	M12 Bar – 1727 Long
2	Lifting Insert	1 Ton Burke

NOTE:
Concrete Panel Compressive Strength = 34.48mpa

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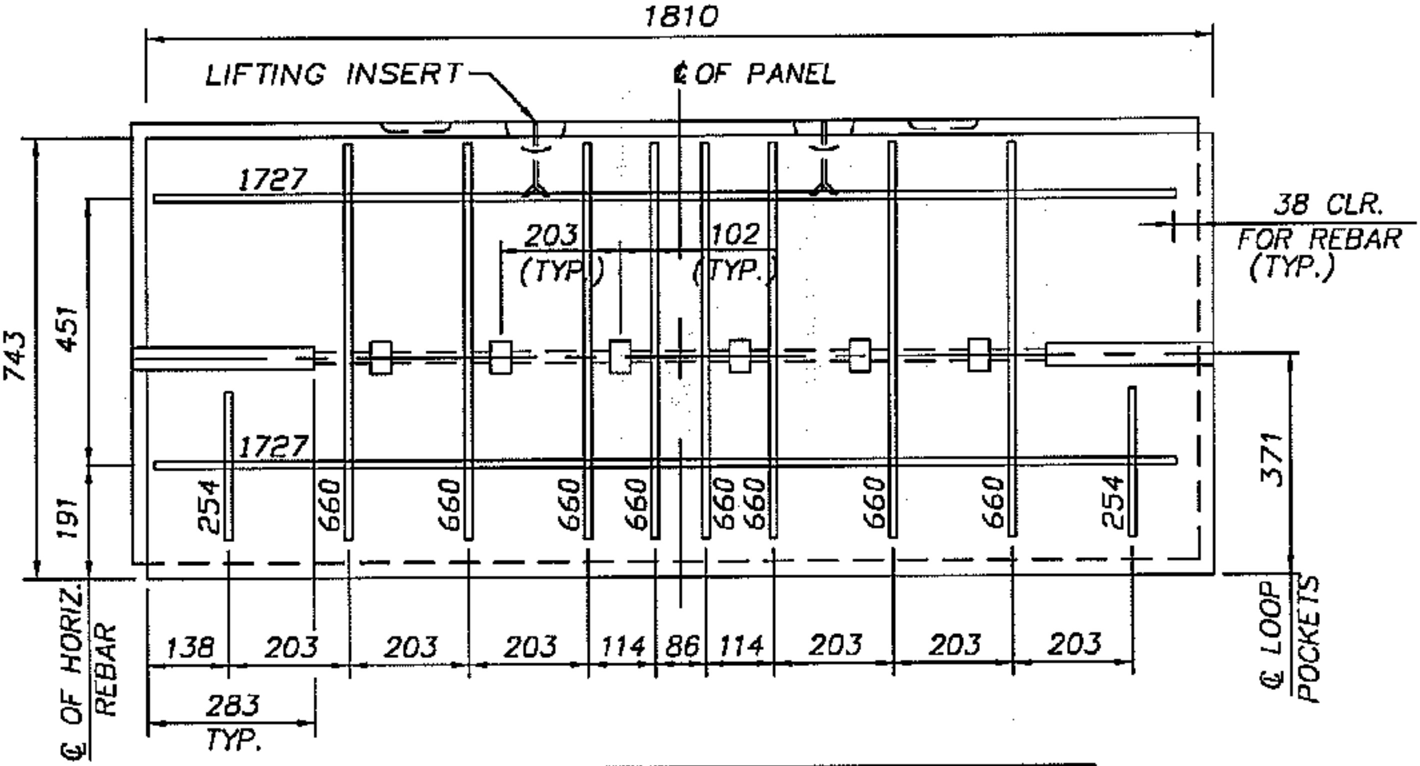
8/24/98	RETAINING WALL Y – PANEL DETAILS	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST			
Checked by:	HITEC	4710 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 408 430 8300 Fax: 408 430 8340	01

TYPE-Y2

SHOWN FROM BACK FACE



Qt.	Item	Description
2	Vertical Bar	M12 Bar – 254 Long
8	Vertical Bar	M12 Bar – 660 Long
2	Horizontal Bar	M12 Bar – 1727 Long
2	Lifting Insert	1 Ton Burke

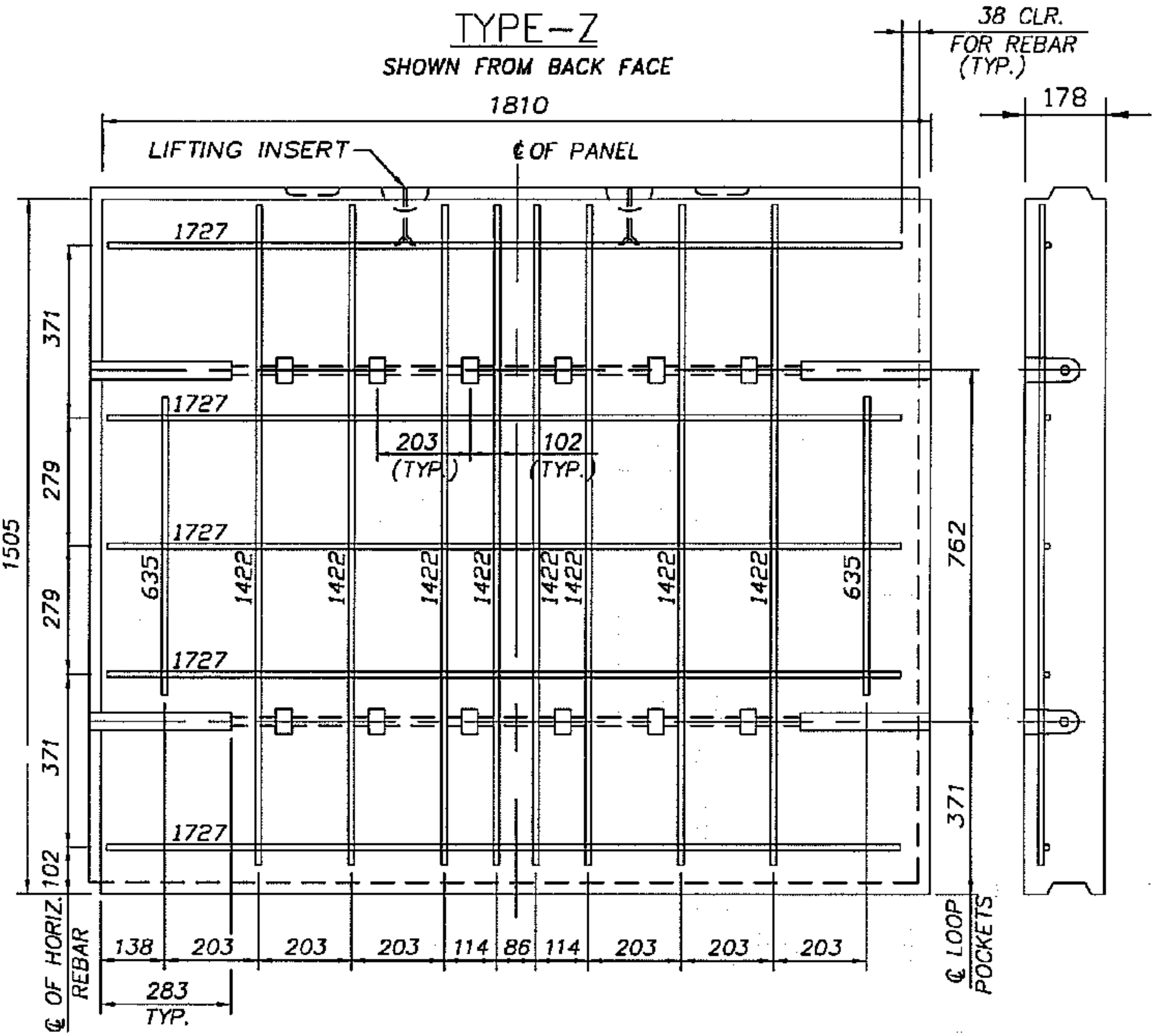
NOTE:
Concrete Panel Compressive Strength = 34.48mpa

THE USE OF THESE PLANS, DRAWINGS, SPECIFICATIONS IS RESTRICTED. ANY AND ALL REPRODUCTIONS, REUSE AND/OR DISCLOSURES IN WHOLE OR IN PART BY ANY METHOD IS PROHIBITED. THESE DRAWINGS CONTAIN PROPRIETARY INFORMATION AND AS SUCH THE CONTENT REMAINS PROPERTY OF SSL.

8/24/98	RETAINING WALL Y2 – PANEL DETAILS	SSL	Job. No. 0000
Designed by: JST	HITEC	Specializing in Construction Products 4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 408 430 5300 Fax: 408 430 5340	Of
Checked by:			

TYPE-Z

SHOWN FROM BACK FACE



Qt.	Item	Description
2	Vertical Bar	M12 Bar – 635 Long
8	Vertical Bar	M12 Bar – 1422 Long
5	Horizontal Bar	M12 Bar – 1727 Long
2	Lifting Insert	1 Ton Burke

NOTE:
Concrete Panel Compressive Strength = 34.48mpa

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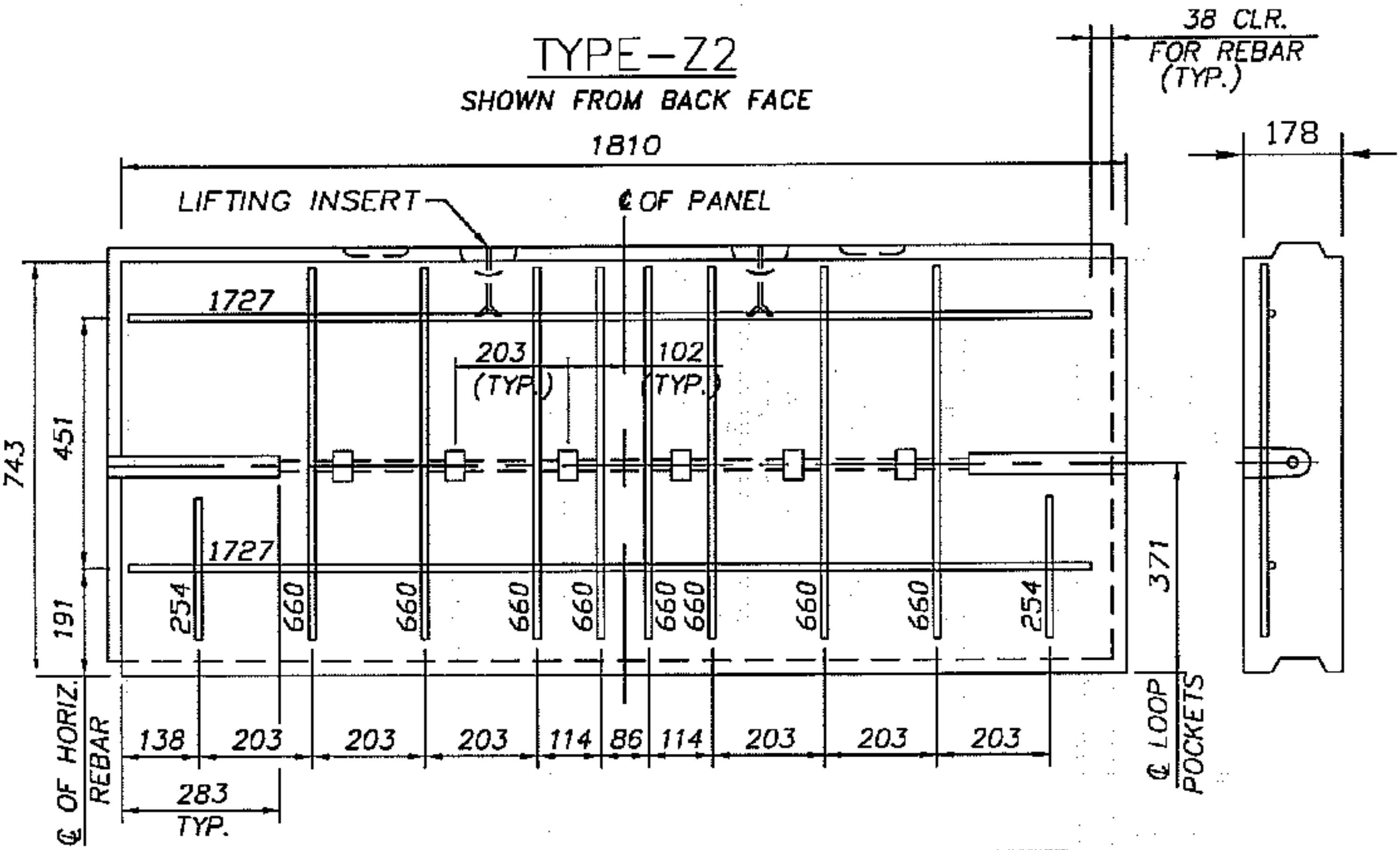
8/24/98	RETAINING WALL Z – PANEL DETAILS	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST	HITEC	4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 408 430 9300 Fax: 408 430 9340	Of
Checked by:			



Qt.	Item	Description
2	Vertical Bar	M12 Bar – 254 Long
8	Vertical Bar	M12 Bar – 660 Long
2	Horizontal Bar	M12 Bar – 1727 Long
2	Lifting Insert	1 Ton Burke

NOTE:
Concrete Panel Compressive Strength = 34.48mpa

THE USE OF THESE PLANS, DRAWINGS, SPECIFICATIONS IS RESTRICTED. ANY AND ALL REPRODUCTIONS, REUSE AND/OR DISCLOSURES IN WHOLE OR IN PART BY ANY METHOD IS PROHIBITED. THESE DRAWINGS CONTAIN PROPRIETARY INFORMATION AND AS SUCH THE CONTENT REMAINS PROPERTY OF SSL.

8/24/98
Designed by: JST
Checked by:

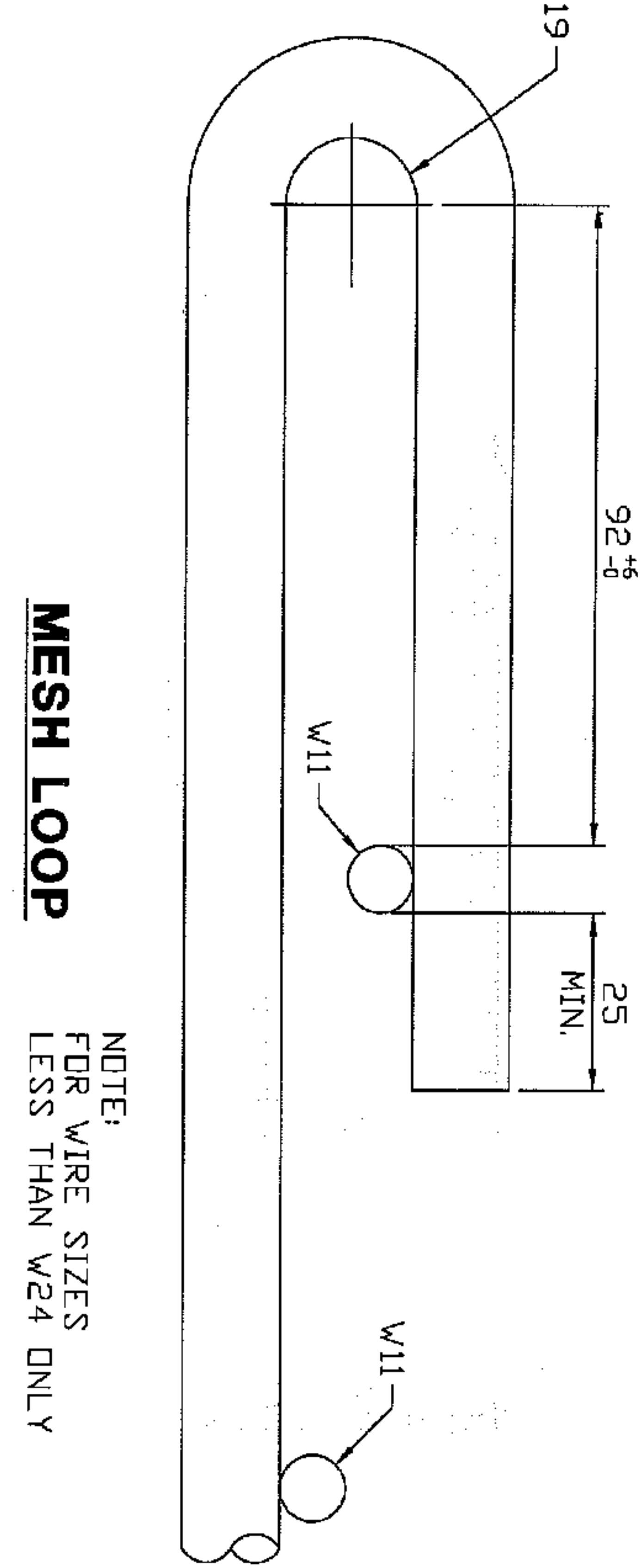
RETAINING WALL
Z2 – PANEL DETAILS

HITEC

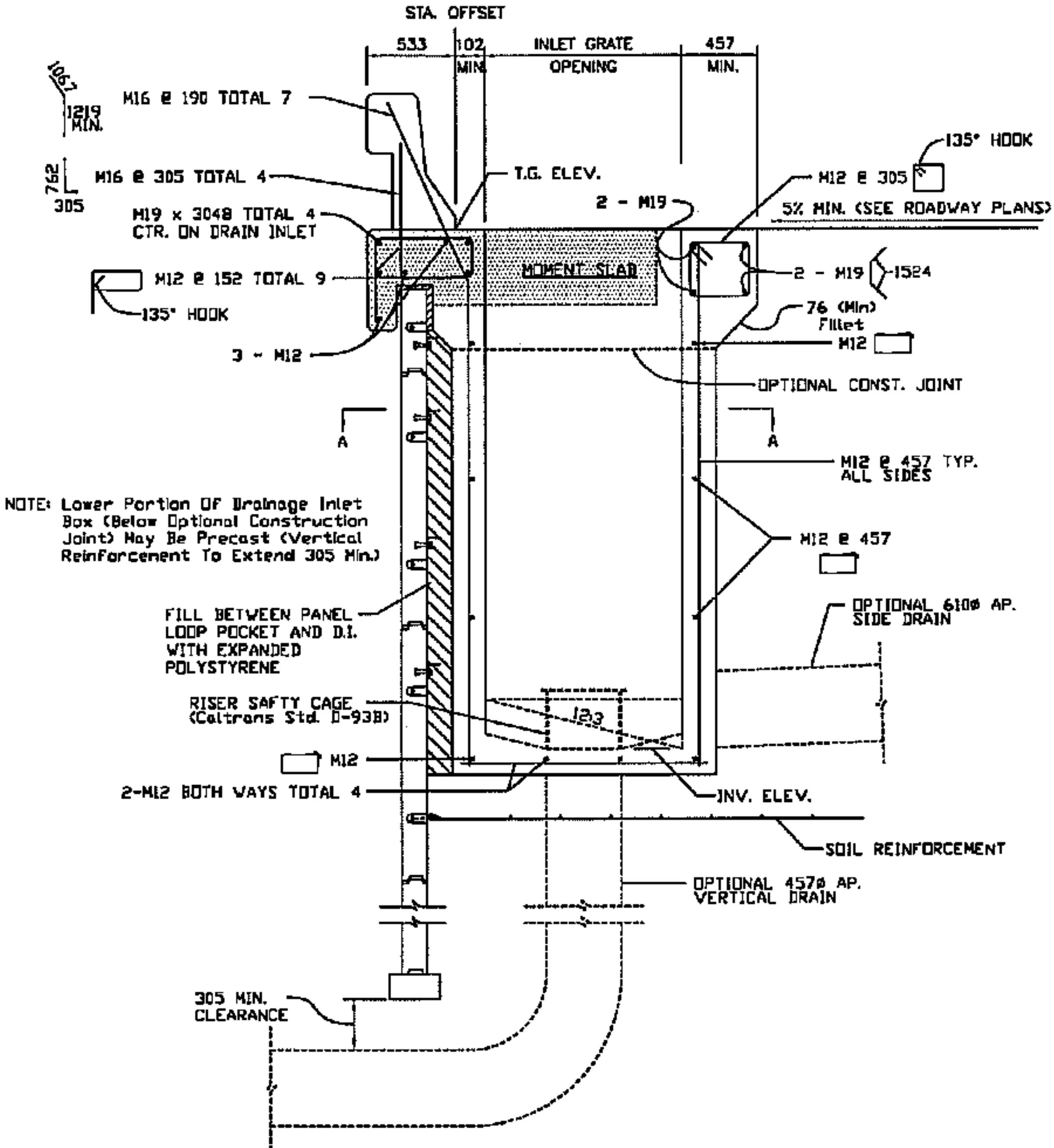
SSL
Specializing in Construction Products
4740 Suite E Scotts Valley Dr.
Scotts Valley, California 95066
Phone: 408 430 8300
Fax: 408 430 9340

Job. No.
0000

Of

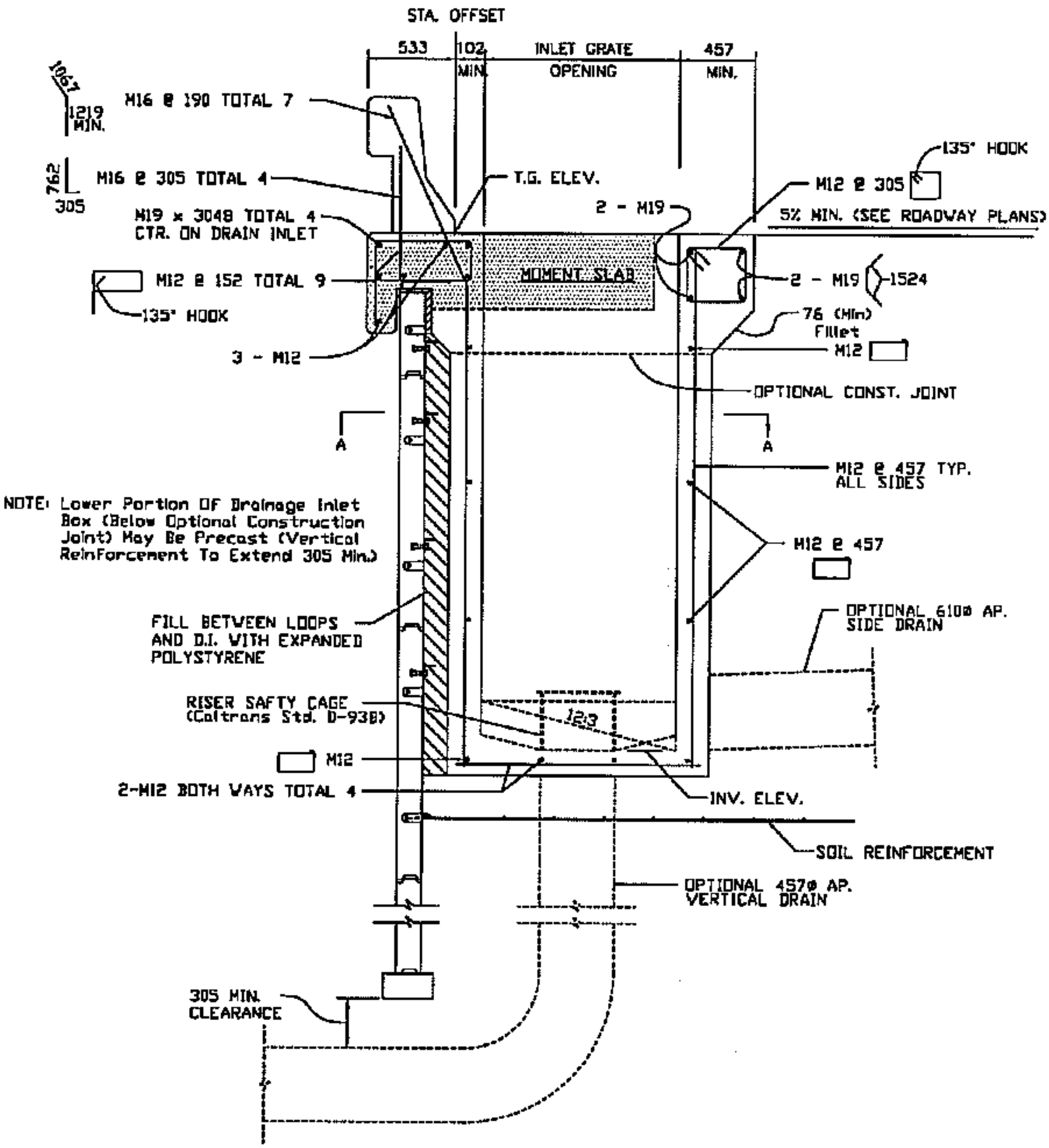


Date: 5/4/98	RETAINING WALL MESH LOOP DETAILS	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST			
Checked by:	HITEC	4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 408 430 8500 Fax: 408 430 8340	Of



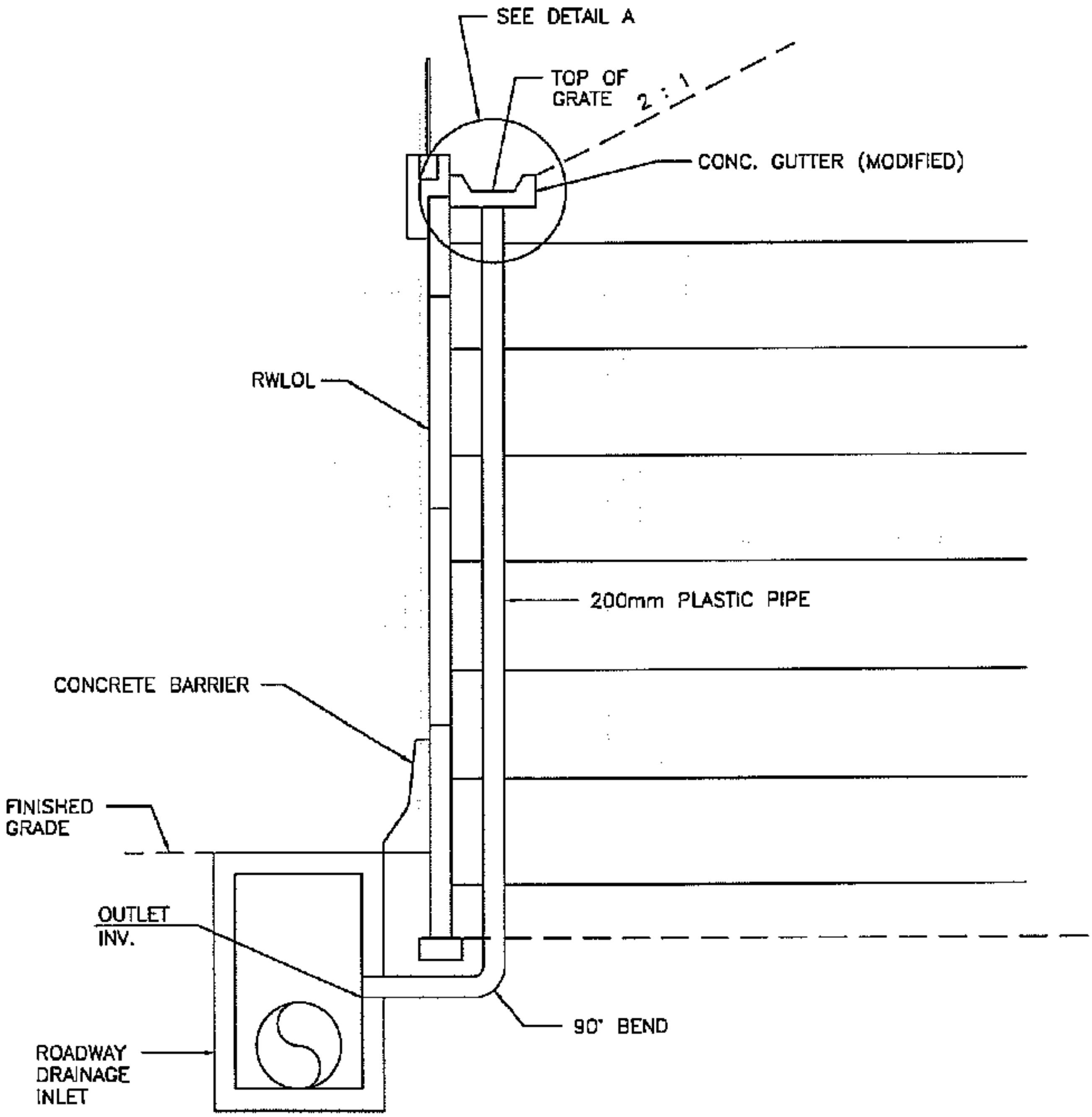
TYPICAL SECTION OF
DRAINAGE INLET BEHIND WALL

5/4/98 Designed by: JST Checked by:	RETAINING WALL DRAIN - SECTION HiTEC	SSL Specializing in Construction Products 4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 408 430 8300 Fax: 408 430 9340	Job. No. 0000 Of



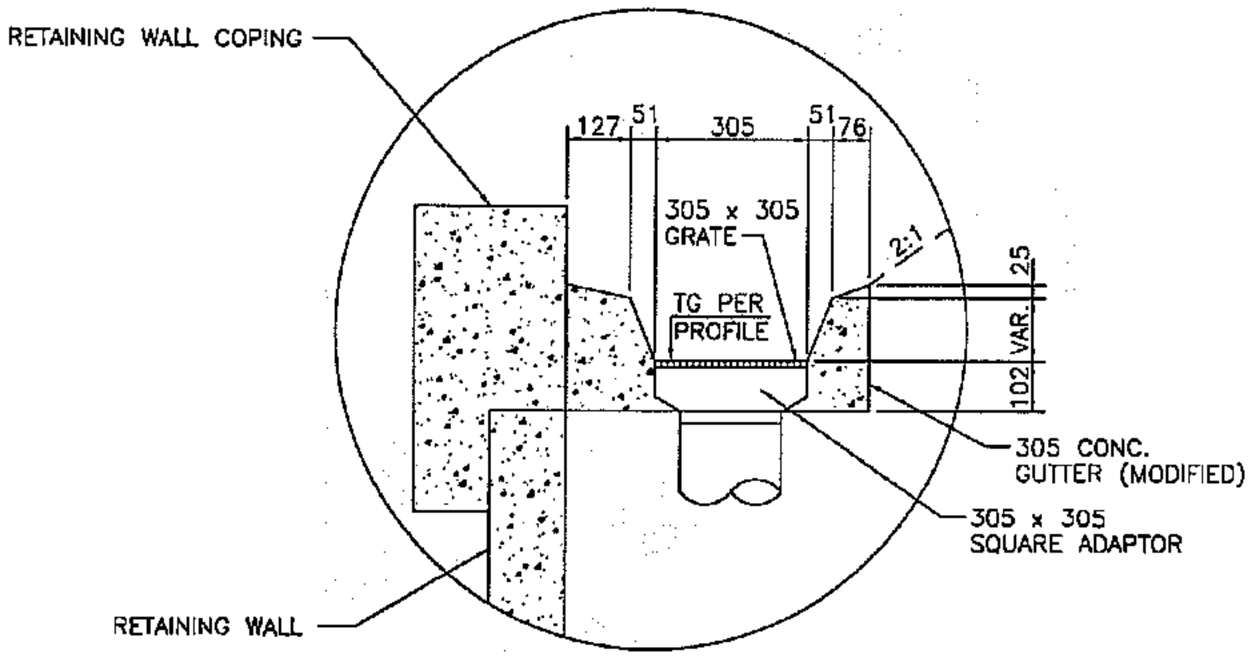
TYPICAL SECTION OF DRAINAGE INLET BEHIND WALL

5/4/98 Designed by: JST Checked by:	RETAINING WALL DRAIN – SECTION HITEC	SSL Specializing in Construction Products 4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 408 430 9000 Fax: 408 430 9340	Job. No. 0000 of



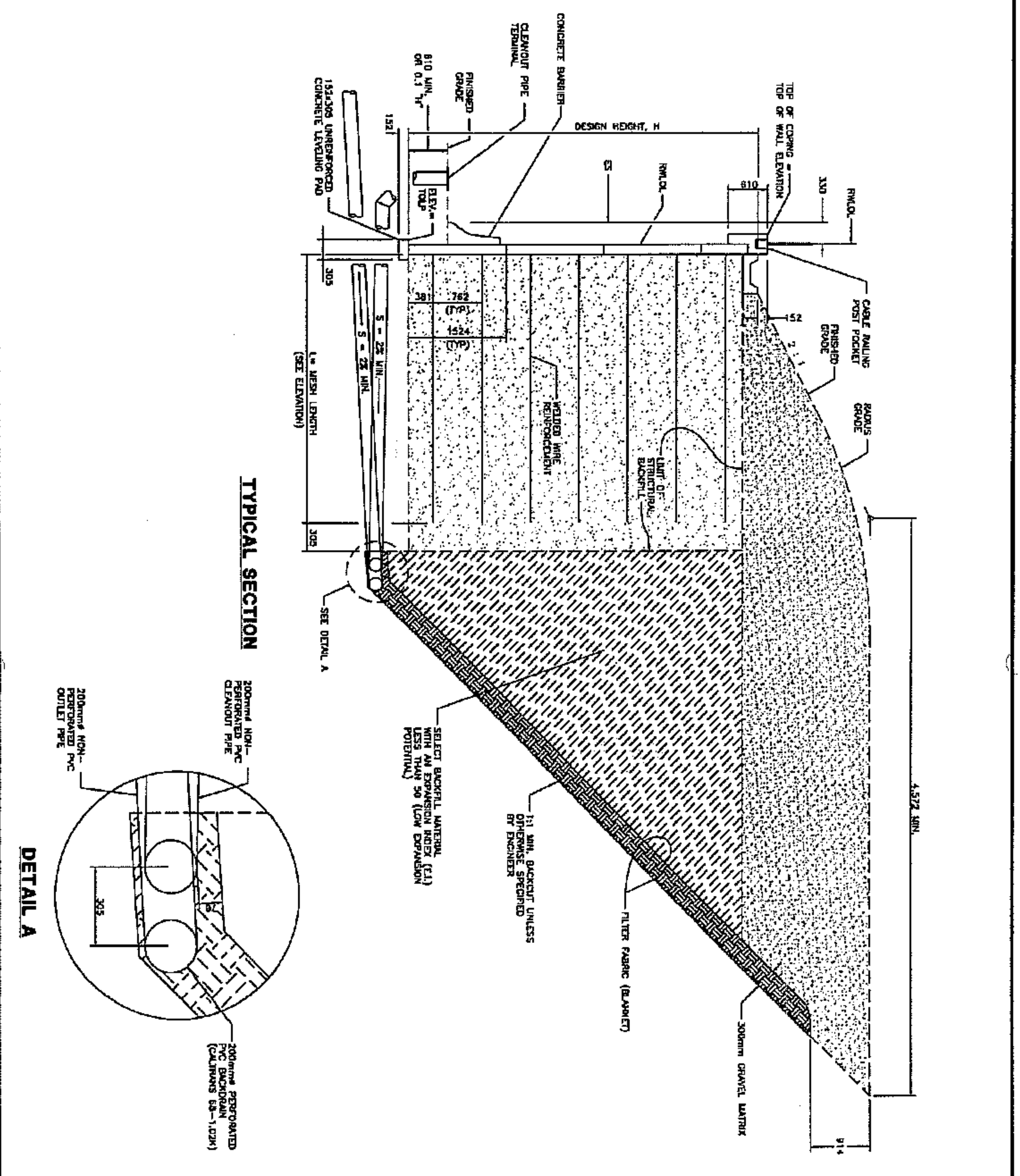
OUTLET DRAIN SECTION

5/4/98	RETAINING WALL DROP DRAIN DETAILS	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST	HITEC	4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 408 430 9300 Fax: 408 430 9340	Of
Checked by:			

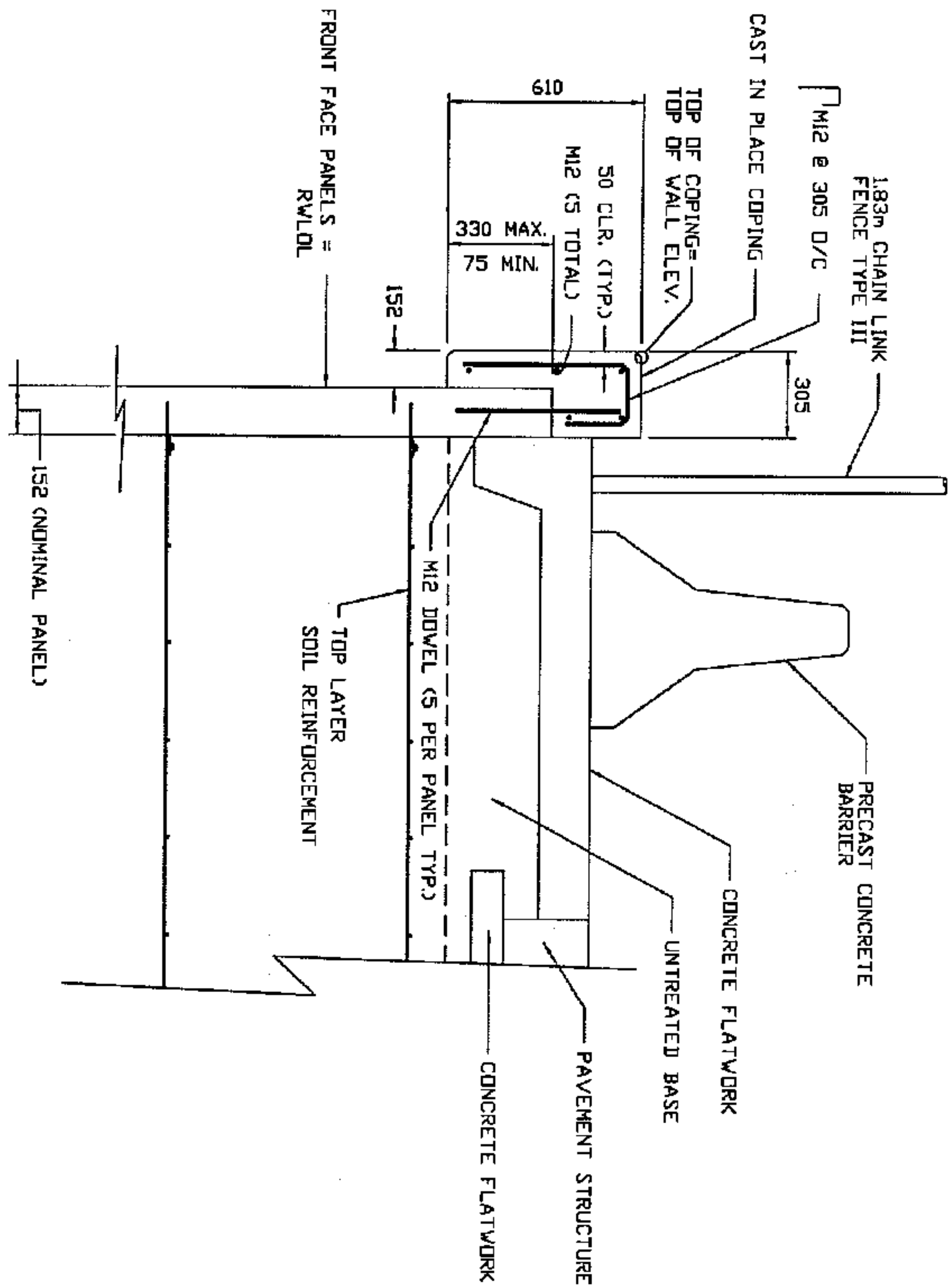


DETAIL A

5/4/98	RETAINING WALL DROP DRAIN DETAILS (DETAIL A)	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST	HITEC	4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 408 430 8300 Fax: 408 430 8340	Of
Checked by:			

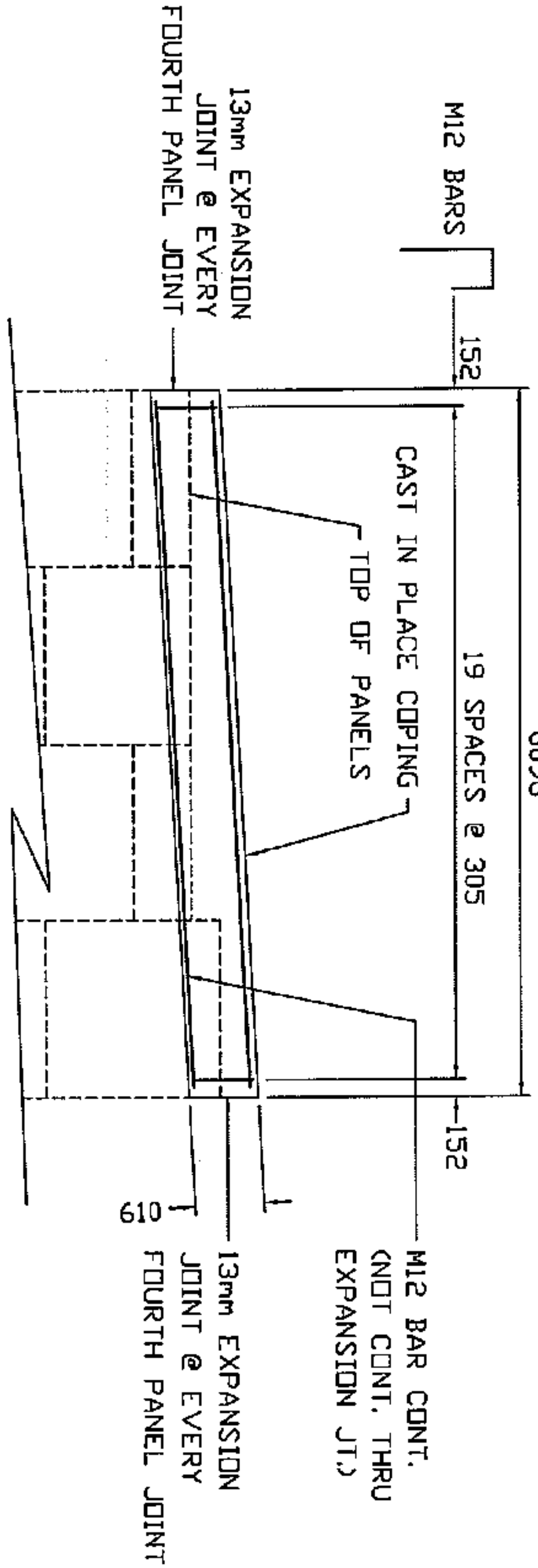


5/4/98	RETAINING WALL COPING SECTION WITH BACKDRAIN	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST	HITEC	4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 408 430 8300 Fax: 408 430 8340	01
Checked by:			



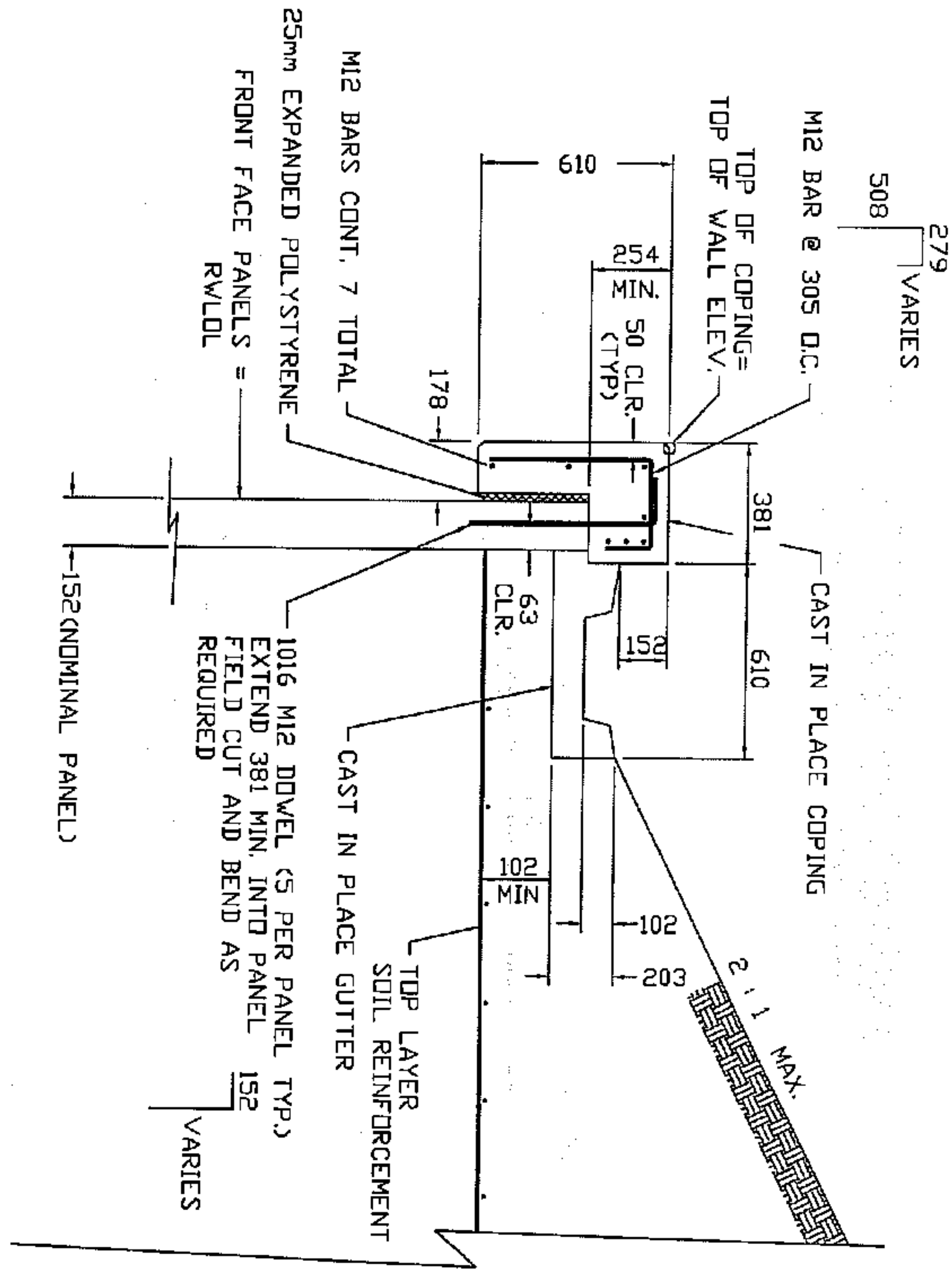
SECTION
CAST IN PLACE COPING WITH BARRIER

D. 5/4/98	RETAINING WALL CIP COPING WITH BARRIER	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST			
Checked by:	HITEC		of



PARTIAL ELEVATION
CAST IN PLACE COPING

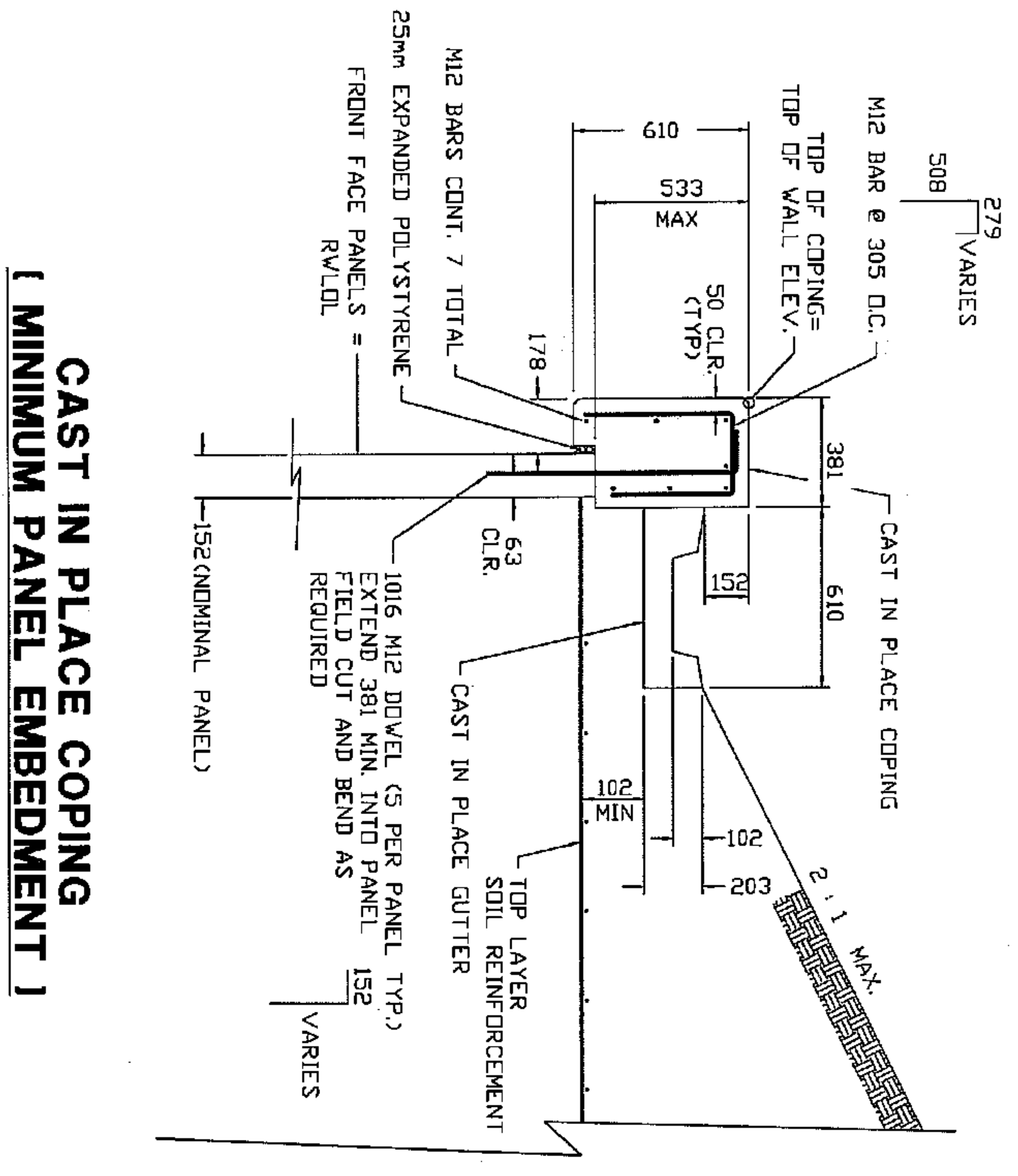
5/4/98	RETAINING WALL CIP COPING ELEVATION	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST	HITEC	4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 408 430 9300 Fax: 408 430 9340	Of
Checked by:			



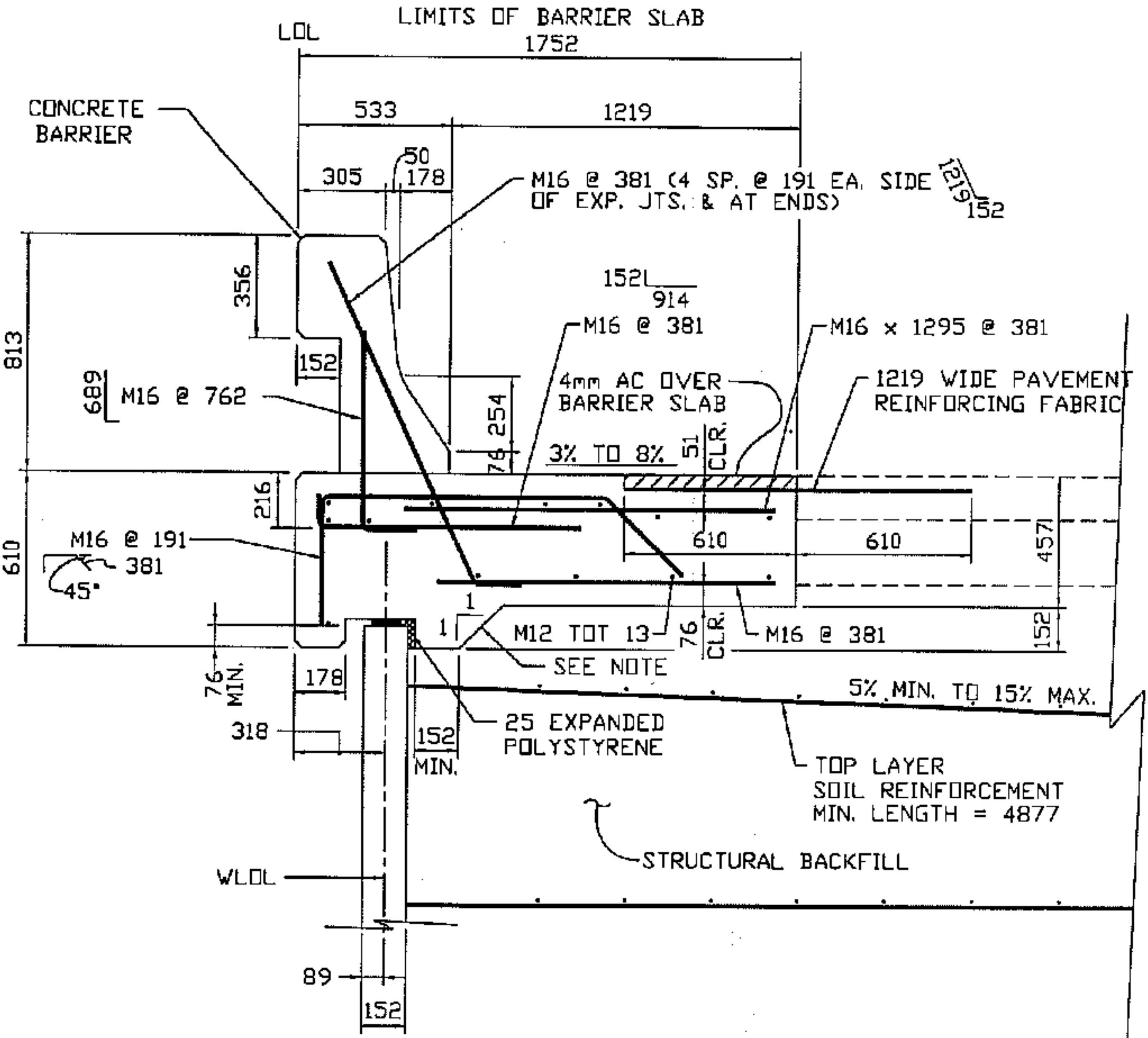
CAST IN PLACE COPING

(MAXIMUM PANEL EMBEDMENT)

5/4/98	RETAINING WALL CIP COPING W/ DRAIN (MAX.)	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST Checked by:	HITEC	4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 408 430 9300 Fax: 408 430 9340	Of



Date: 5/4/98	RETAINING WALL CIP COPING W/ DRAIN (MIN.)	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST	HITEC	4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 408 430 8300 Fax: 408 430 9340	Of
Checked by:			



B CAST IN PLACE BARRIER MINIMUM PANEL EMBEDMENT

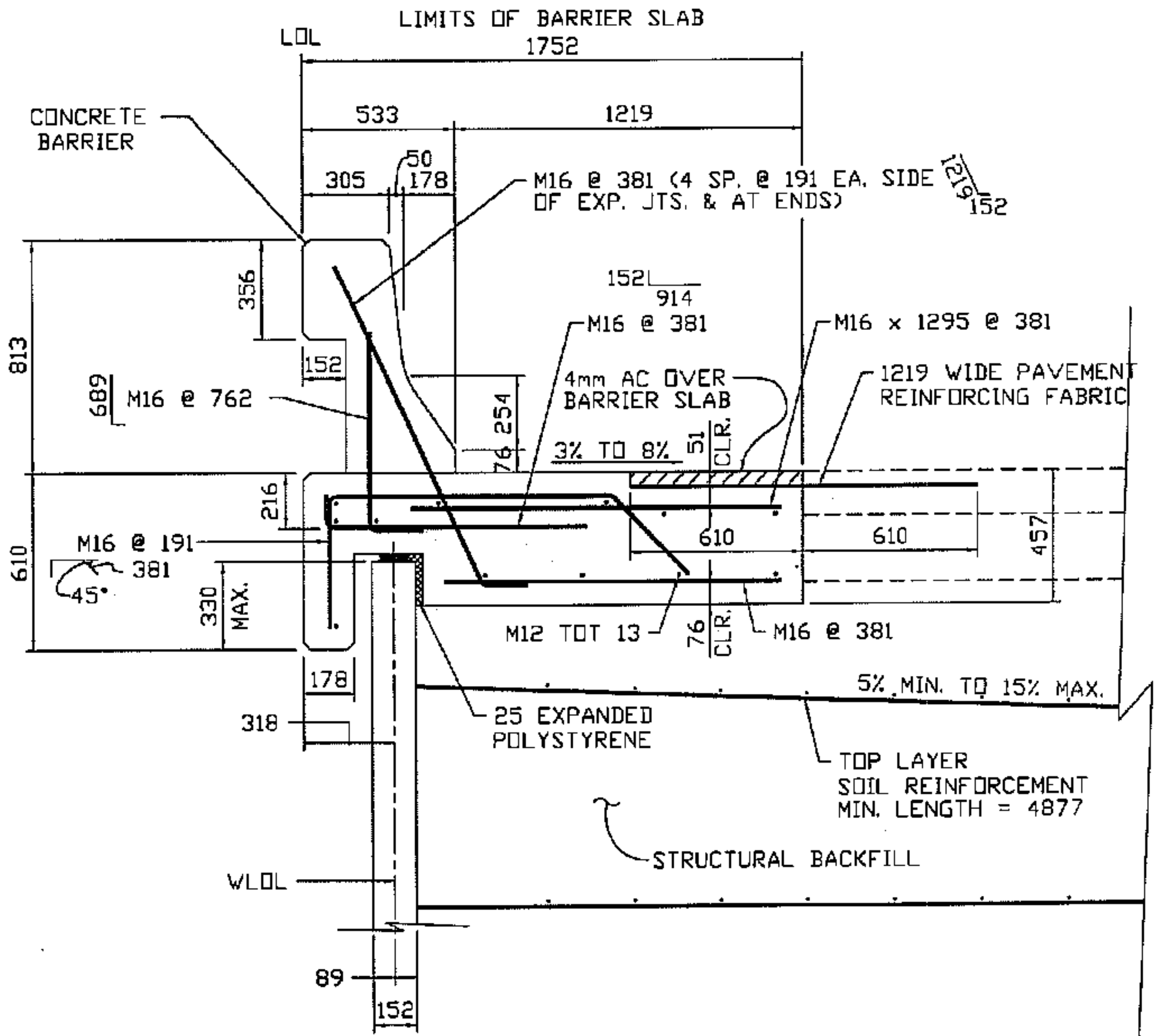
NOTES:

NOT ALL TRAFFIC BARRIER REINFORCEMENT SHOWN.

PROVIDE 13mm EXPANSION JOINT IN BARRIER/BARRIER SLAB AT 27.432m MIN. TO 41.148m MAX. SPACING.

PROVIDE HAUNCH @ LOCATIONS WHERE PANEL IS NOT EMBEDDED A MINIMUM OF 76mm INTO THE 457mm MOMENT SLAB

Dt. 5/4/98	RETAINING WALL CIP BARRIER - MIN. EMBEDMENT	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST			
Checked by:	HITEC	4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 408 430 9300 Fax: 408 430 9340	Of



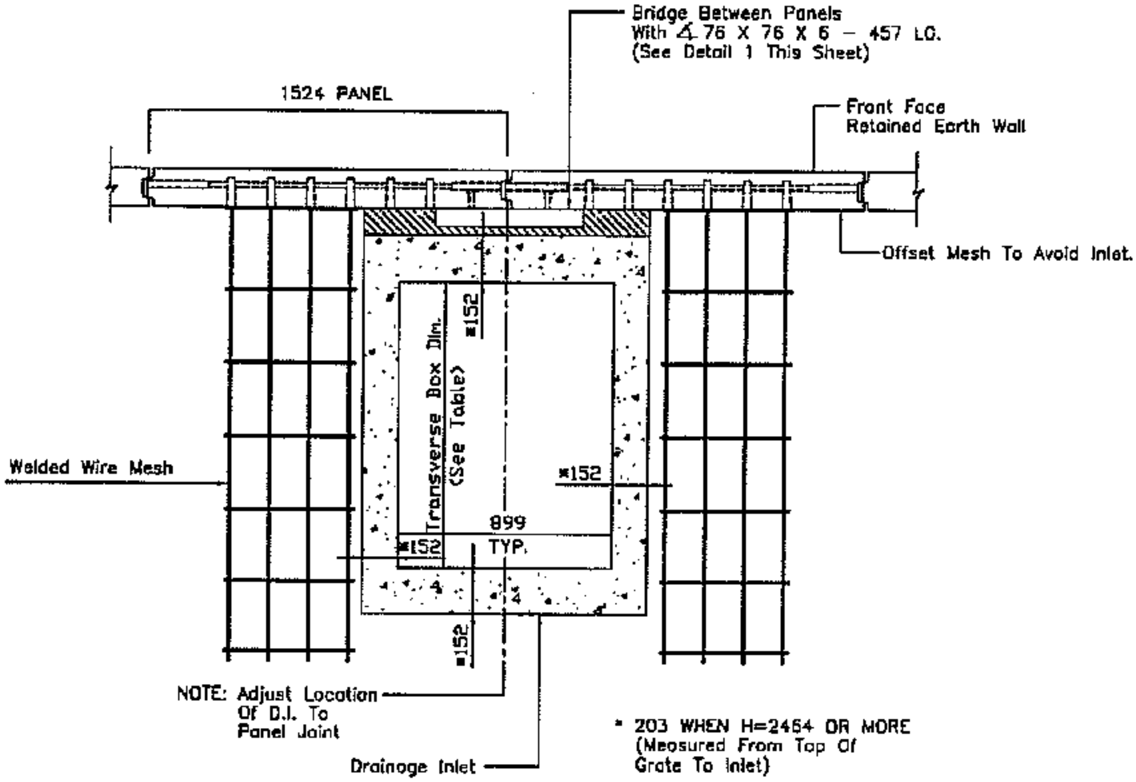
(A) CAST IN PLACE BARRIER MAXIMUM PANEL EMBEDMENT

NOTES:

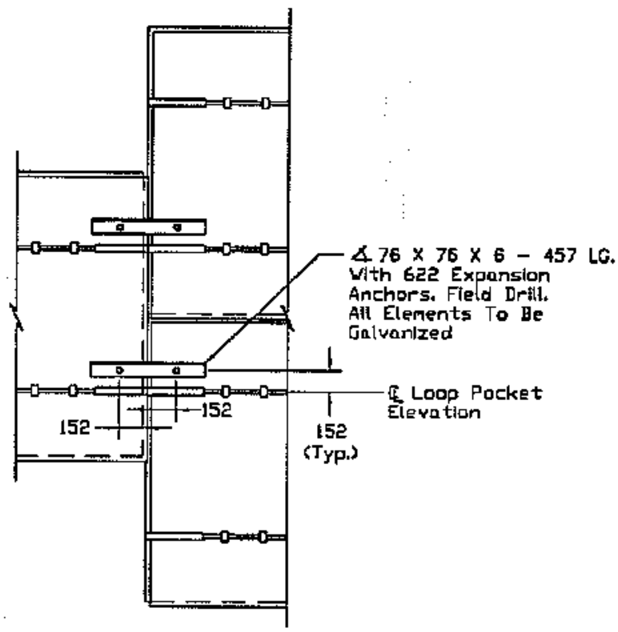
NOT ALL TRAFFIC BARRIER REINFORCEMENT SHOWN.

PROVIDE 13mm EXPANSION JOINT IN BARRIER/BARRIER SLAB AT 27.432m MIN. TO 41.148m MAX. SPACING.

Dt. 5/4/98	RETAINING WALL CIP BARRIER – MAX. EMBEDMENT	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST	HITEC	4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone 408 430 9300 Fax 408 430 9340	Of
Checked by:			

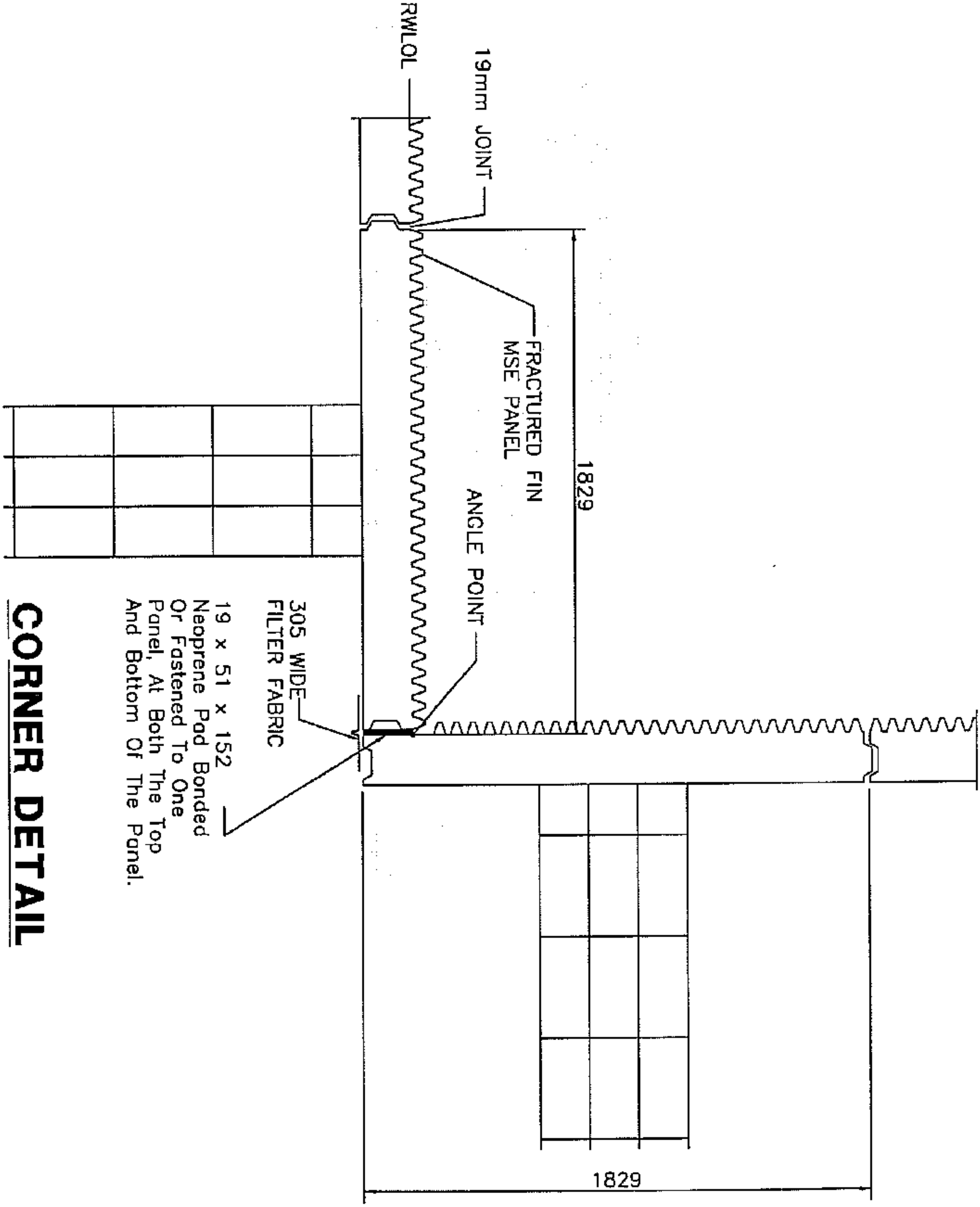


SECTION A-A

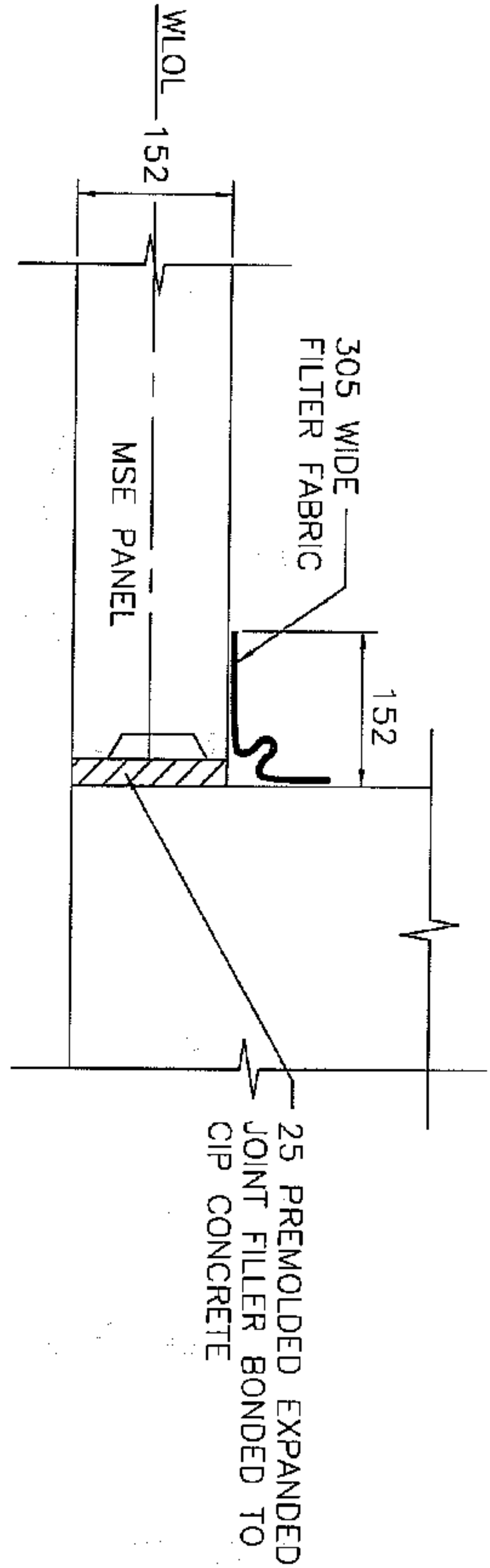


DETAIL 1

Date: 5/4/98	RETAINING WALL DRAIN – DETAILS	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST			
Checked by:	HITEC	4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone 408 430 9300 Fax 408 430 9340	Of

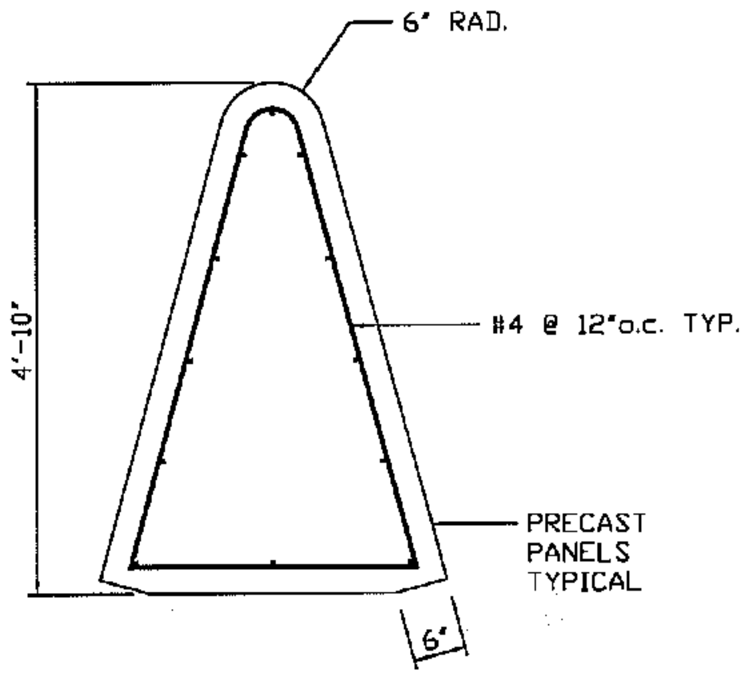


5/4/98	RETAINING WALL INSIDE CORNER DETAIL	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST	HITEC	4740 Suite E Scotts Valley Dr. Scotts Valley California 95066 Phone 408 430 9300 Fax 408 430 9340	Of
Checked by:			

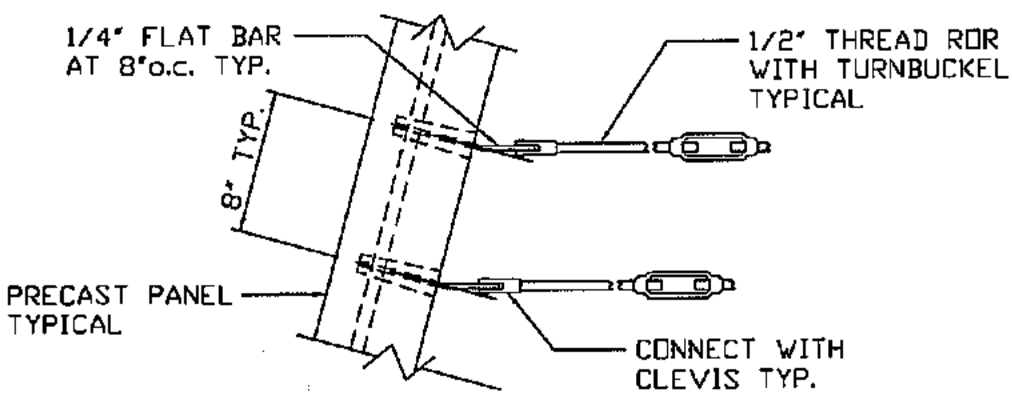


RETAINING WALL / WINGWALL
JOINT DETAIL

Date 5/4/98	RETAINING WALL ABUTMENT JOINT DETAILS	SSL	Job. No. 0000
Designed by: JST		Specializing in Construction Products	
Checked by:	HITEC	4240 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone: 408 430 9300 Fax: 408 430 9340	Of



DETAIL 1



DETAIL 2

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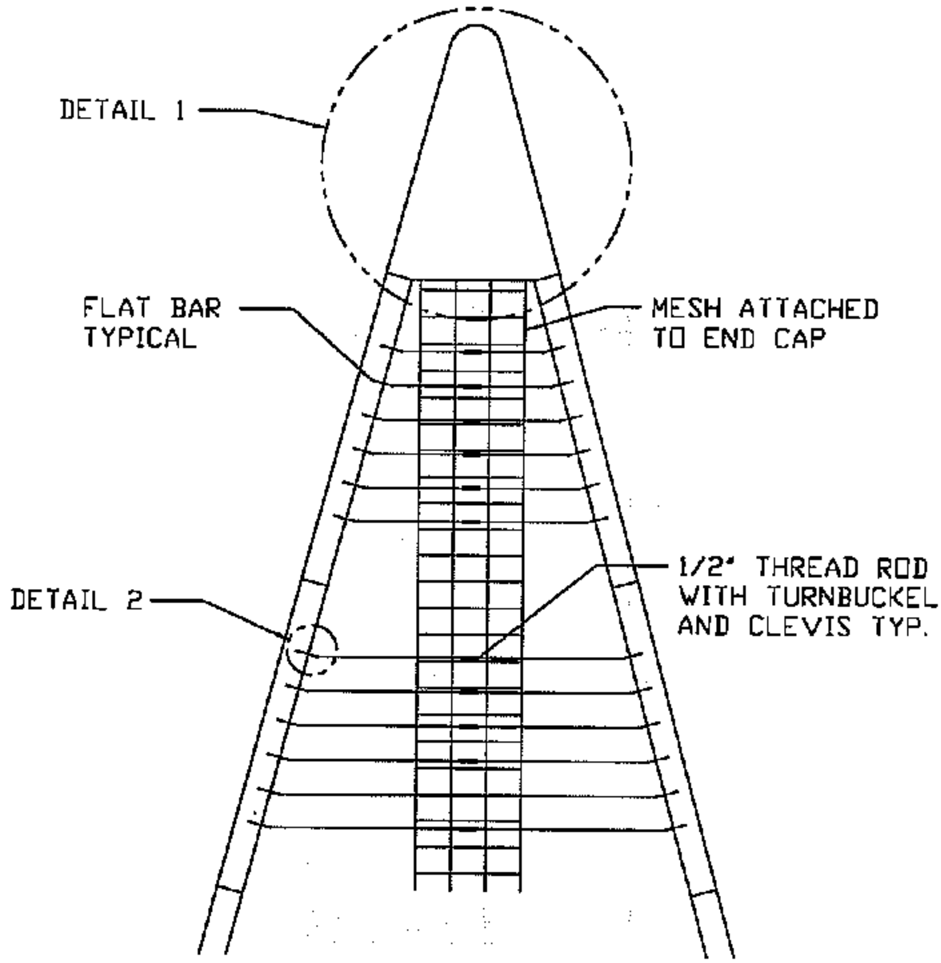
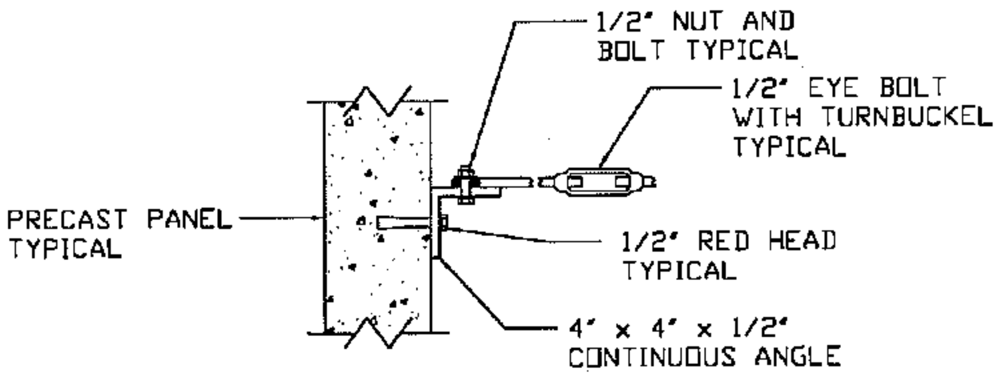
Date: 12/2/97	RETAINING WALL CORNER DETAIL, DETAILS	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST			
Checked by:		[illegible] Scotts Valley Dr. Scotts Valley, California [illegible] Phone: 408 [illegible] 5000 Fax: 408 [illegible]	Of



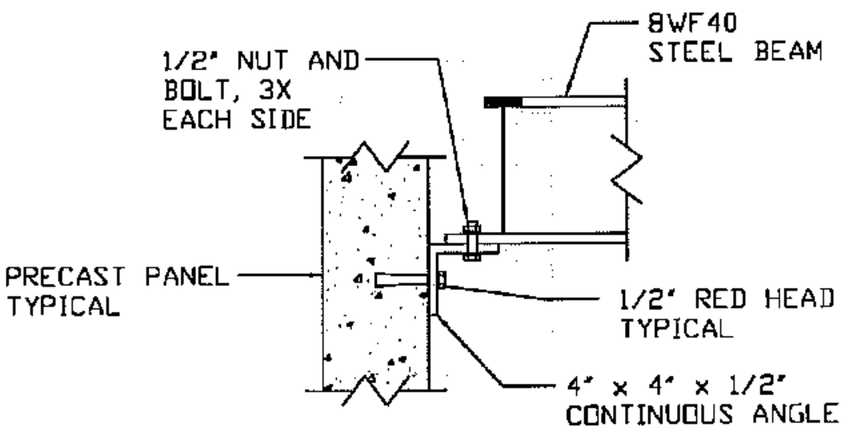
CORNER DETAIL

THE USE OF THESE PLANS, DRAWINGS, SPECIFICATIONS IS RESTRICTED. ANY AND ALL REPRODUCTIONS, REUSE AND/OR DISCLOSURES IN WHOLE OR IN PART BY ANY METHOD IS PROHIBITED. THESE DRAWINGS CONTAIN PROPRIETARY INFORMATION AND AS SUCH THE CONTENT REMAINS PROPERTY OF SSL.

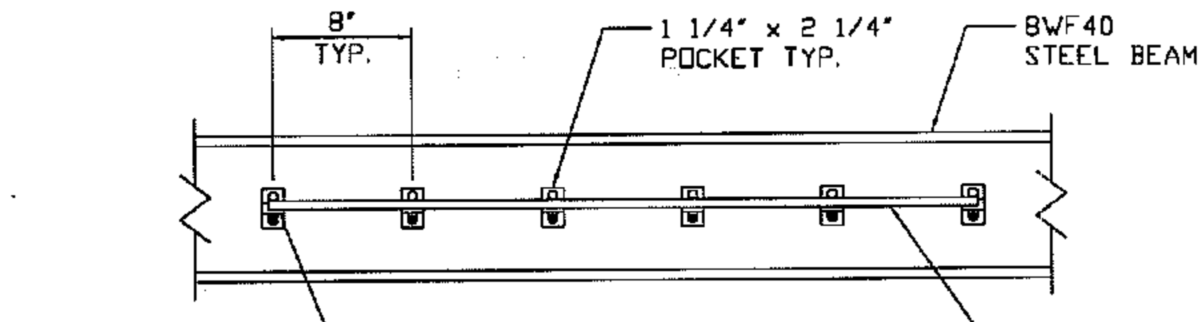
Date: 12/2/97	RETAINING WALL CORNER DETAIL	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST			
Checked by:		4740 Suite E Scotts Valley Dr. Scotts Valley, California 95066 Phone 408 430 9300 Fax 408 430 9340	Of



SECTION A-A



SECTION B-B



SECTION C-C

Date: 12/2/97	RETAINING WALL CORNER DETAIL, DETAILS	SSL Specializing in Construction Products	Job. No. 0000
Designed by: JST			
Checked by:			01

Appendix D

SSL

Specializing In Construction Products

1740-E Scotts Valley Drive

Scotts Valley, CA 95066

Phone: 408.430.9300

Fax: 408.430.9340

Email: ssi1@pacbell.net

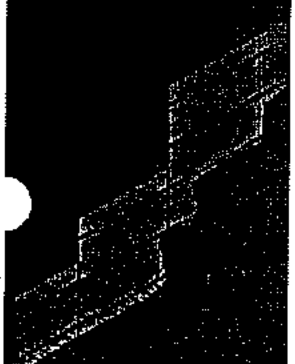
Precast Panel

Quality Control Specification

For

MSE *Plus*™

Retaining Walls



SSL is a California LLC

SSL MSE Plus™ Wall System-
Specification For SSL MSE Plus™ Precast Wall Panels

Project Name

Project No.:

I. Materials and Services Furnished by Precaster

A. Materials

The precaster shall furnish the concrete for the SSL MSE Plus facing panels. Cement shall conform to the requirements of AASHTO M-85 unless otherwise specified by SSL (portland cement Type II modified). Concrete shall have minimum compressive strength at 28 days of 4000 psi (27.58 MPA) or 5000 psi (34.48 MPA) when mesh is 6w20 0r 6w24. Airentraining, retarding, accelerating agents, or any additive containing chloride shall not be used without approval of the SSL engineer.

The precaster shall furnish rebar with mill certificates for SSL MSE Plus panels as shown on shop drawings for the project. Precaster shall furnish dunnage for storage and shipment. Precaster shall furnish all labor and other materials necessary to comply with this specification, except as noted. Unless specifically noted by SSL Corporation, precaster shall transport finished panels to jobsite.

B. Casting

The panels shall be cast on a flat area, the front face of the form at the bottom, the back face at the upper part. Rebar and lifting devices shall be set in place to the dimensions and tolerances shown on the drawings prior to casting. The concrete in each unit shall be placed without interruption and shall be consolidated by the use of an approved vibrator, supplemented by such hand-tamping as may be necessary to force the concrete into the corners of the forms and prevent the formation of stone pockets, air bubbles or cleavage planes. Clear form oil of the same manufacture shall be approved by the SSL engineer and used throughout the casting operation. Curing compound shall be applied, if necessary, immediately after pouring concrete to achieve proper curing of concrete. All panels should also be tarped immediately following pouring of concrete.

C. Curing

The units shall be cured (curing compound required) for a period of time such that they will not be damaged by moving (approximately 12 hours minimum). Any panel pour which does not reach specified strength within 28 days shall be rejected.

D. Removal of Forms

The forms shall remain in place until they can be removed without damage to the unit. The horizontal pin should be turned within 20 minutes of the pouring of concrete and removed when the concrete is between 3 hours and 24 hours old. The embed rack and pin should be removed once the concrete has taken initial set and only if integrity of void will be maintained.

E. Concrete Finish

Concrete surface for the front face shall have general (smooth) finish and for the rear face an unformed surface finish. Rear face of the panels shall be roughly screeded to eliminate open pockets of aggregate and surface distortions in excess of 1/4 inch.

F. Marking

The panel type and date of manufacture shall be clearly scribed on the rear face of each panel.

G. Quality Assurance

1. Testing and Inspection

Acceptability of the precast units will be determined on the basis of compression tests and visual inspection. The precast units shall be considered acceptable regardless of curing age when compression test results indicate strength will conform to 28-day specifications. The precaster shall perform all necessary testing and shall furnish test results to SSL in an expeditious and satisfactory manner. Panels shall be considered acceptable for installation in the wall when 7-day strengths exceed 75 percent of 28-day requirements.

2. Tolerances

All units shall be manufactured with the following tolerances:

a. All dimensions within 3/16 inch.
b. Angular distortions with regard to the height of the panel shall not exceed 0.125 inch in five feet.
c. Surface defects on formed surfaces measured on a length of five feet shall not exceed more than 0.125 inches.

3. Compressive Strength

a. Acceptance of the concrete face panels with respect to compressive strength will be determined on the basis of production lots. The production lot will consist of all batches of concrete or panels produced within one week. Production units shall be randomly sampled based upon quantities as contained in Table A and tested for compressive strength. Compressive tests shall be made on standard 6 inch by 12 inch test specimen prepared in accordance with AASHTO T-23. Compressive strength testing shall be conducted in accordance with AASHTO T-22.

TABLE A

Production Day Quantities	Number of samples
to 35 cubic yards (to 50 panels)	1
35 to 70 cubic yards (50 to 100 panels)	2

70 to 105 cubic yards (100 to 150 panels)	3
over 105 cubic yards (over 150 panels)	5

b. A minimum of four cylinders shall be cast for each production unit. Two of these specimens shall be cured in the same manner as the panels and tested at seven days. The remaining two cylinders shall be cured in accordance with AASHTO T-23 and tested at 28 days. A test result will be the average compressive strength of two cylinders.

c. Acceptance of the lot will be made if all acceptance tests in a lot are greater than 4000 psi (27.58 MPA) or provided no individual 28 day compressive strength test result falls below 3600 psi (24.82 MPA) and the average 28 day compressive strength of all test results for the lot equals or exceeds the acceptance limits set forth in Table B.

d. The acceptance limits of Table B shall also apply to core compressive strength test results.

TABLE B

Number of Lot Acceptance Tests	Average of all Lot Acceptance Test must equal or exceed these limits
3 – 7	4000 (27.58 MPA) plus 0.33 R*
8 – 15	4000 (27.58 MPA) plus 0.44 R*
16 plus	4000 (27.58 MPA) plus 0.46 R*

*Range: The difference between the largest and smallest acceptance test results.

Rejection

Units shall be subject to rejection because of failure to meet any of the requirements specified above. In addition, any or all of the following defects may be sufficient cause for rejection:

A. Defects that indicate imperfect moulding.

B. Defects indicating honeycombed or open texture concrete.

C. Panels cracked through the entire panel cross section or chipped panels.

D. Color variation on front of faced panel due to excess form oil or other reasons.

E. Dunnage marks on front face of panel.

H. Storage, Handling and Shipping

1. All units shall be handled, stored and shipped in such a manner as to eliminate the danger of discoloration, chipping, cracks, fractures and excessive bending stresses.

2. Units damaged during handling, storing or shipping may be rejected upon delivery at the option of the owner's representative, the buyer's representative or SSL's representative and shall be replaced at no additional expense to SSL.

3. SSL facing panels rejected by the owner, the buyer, or SSL may not be used for any purpose, without advance written consent of SSL.

II. MATERIAL AND SERVICES FURNISHED BY SSL

A. General

SSL will furnish the forms, lifting inserts and shop drawings necessary to manufacture the SSL panels. The precaster may not use SSL forms or material for any purpose other than the execution of the attached purchase order or subcontract.

B. Forms

SSL will ship to the precaster sufficient forms to manufacture the required facing panels in the specified time. The precaster shall notify SSL when he has finished casting panels.

C. The forms and materials furnished by SSL shall be used to produce SSL facing panels for use by SSL only.

III. DETAILS OF SSL FACING PANELS

A. For details of SSL facing panels and coping, see shop drawings for the project.

IV. SATISFACTION OF

A. All SSL precast panels supplied by precaster for this project must satisfy all requirements of:

____

____

____

____

____

in addition to the requirements of this specification.

V. FREQUENCY OF CASTING

A. Where possible, one panels per day minimum should be cast from each form provided to precaster.

VI. LENGTH OF WORK WEEK

A. Precaster shall perform casting operations as described in this specification five days per seven day, calendar week.

VII. NOTIFICATION

A. Precaster shall notify SSL when any facing panels are shipped. Such notification shall consist of:

1. A telephone call at time of shipment, detailing quantities and types of panels shipped.

2. A written invoice once per month detailing quantities and types of panels shipped as well as time and date of shipment and proof of delivery and acceptance at jobsite.

VIII. Form Ownership and control

SSL may remove its forms and other materials from the precaster's property at any time for repair or other purposes.

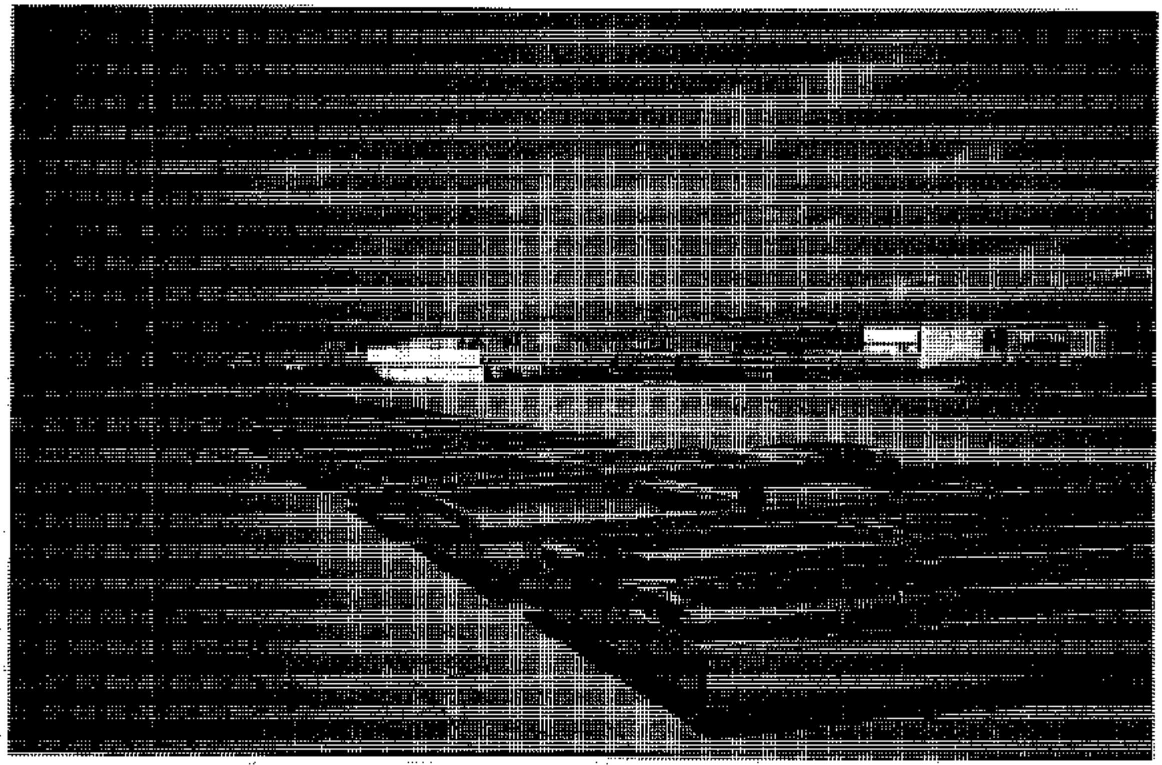
I HAVE READ THIS SPECIFICATION FOR SSL PRECAST WALL PANELS, AND I AGREE TO ALL OF ITS TERMS AND CONDITIONS.

COMPANY--

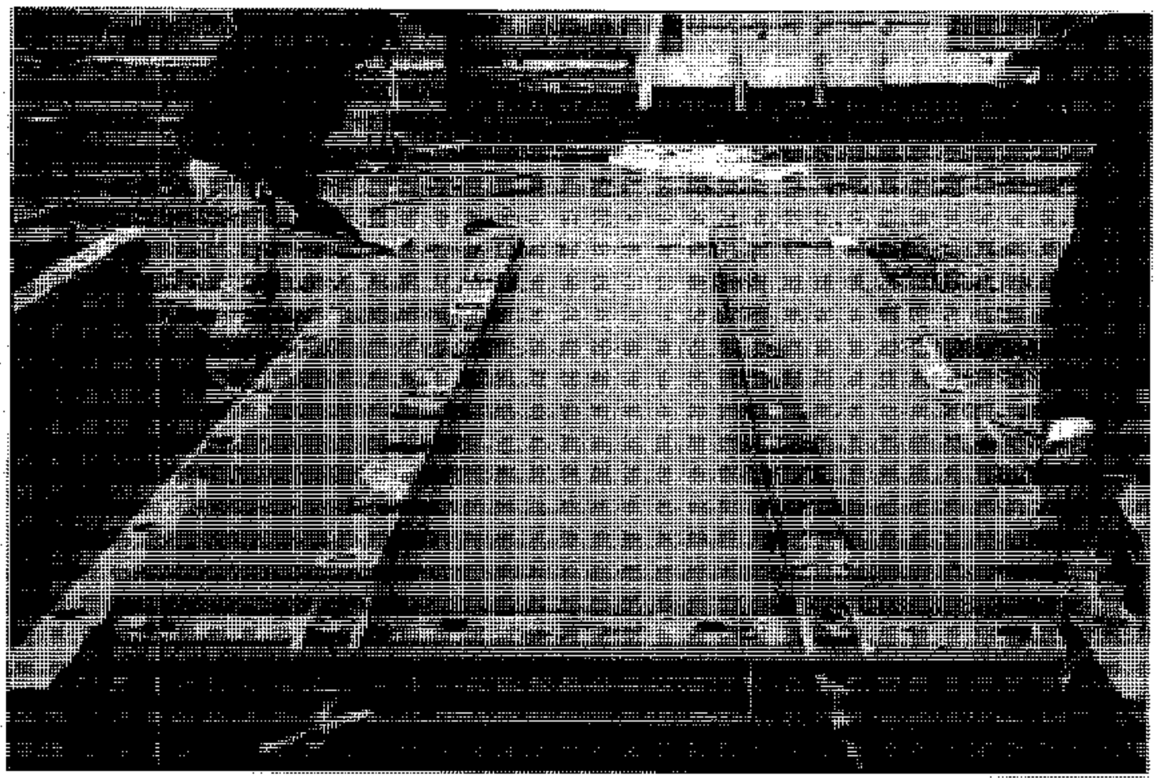
BY--

TITLE--

Date--



Casting yard layout for panel production.

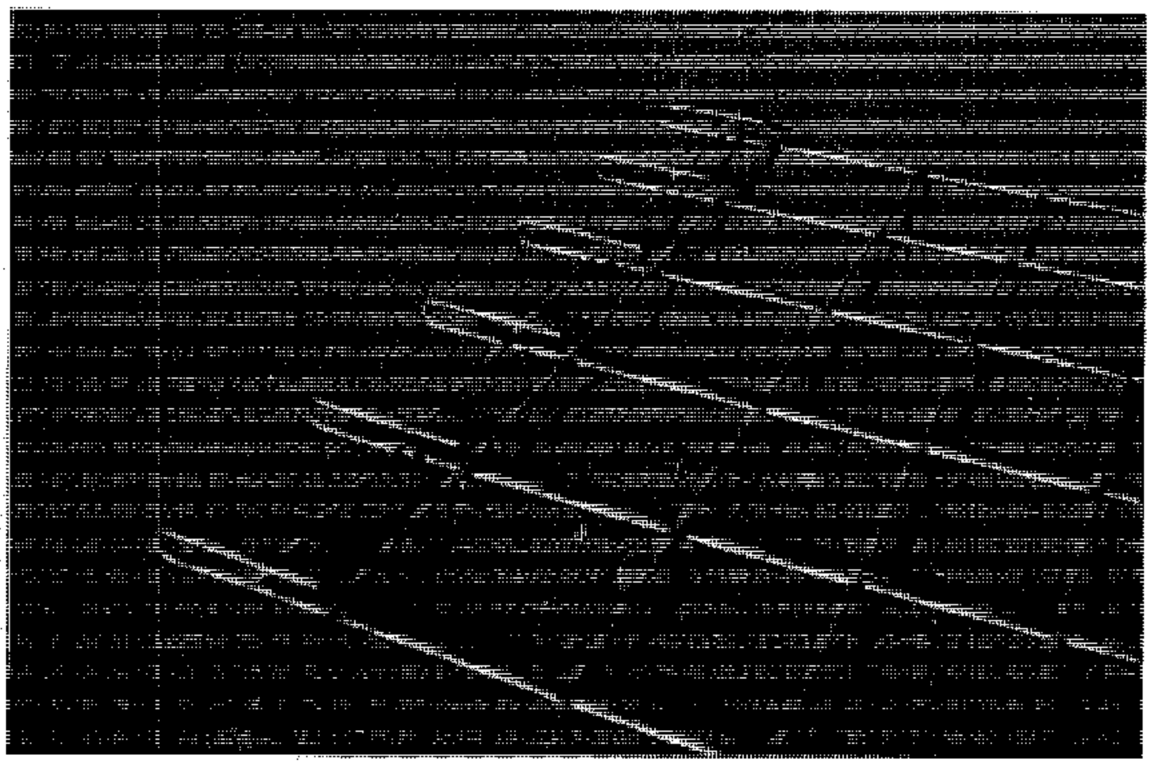


Concreting and finishing of panels with pocket imbed beams and channel rods.

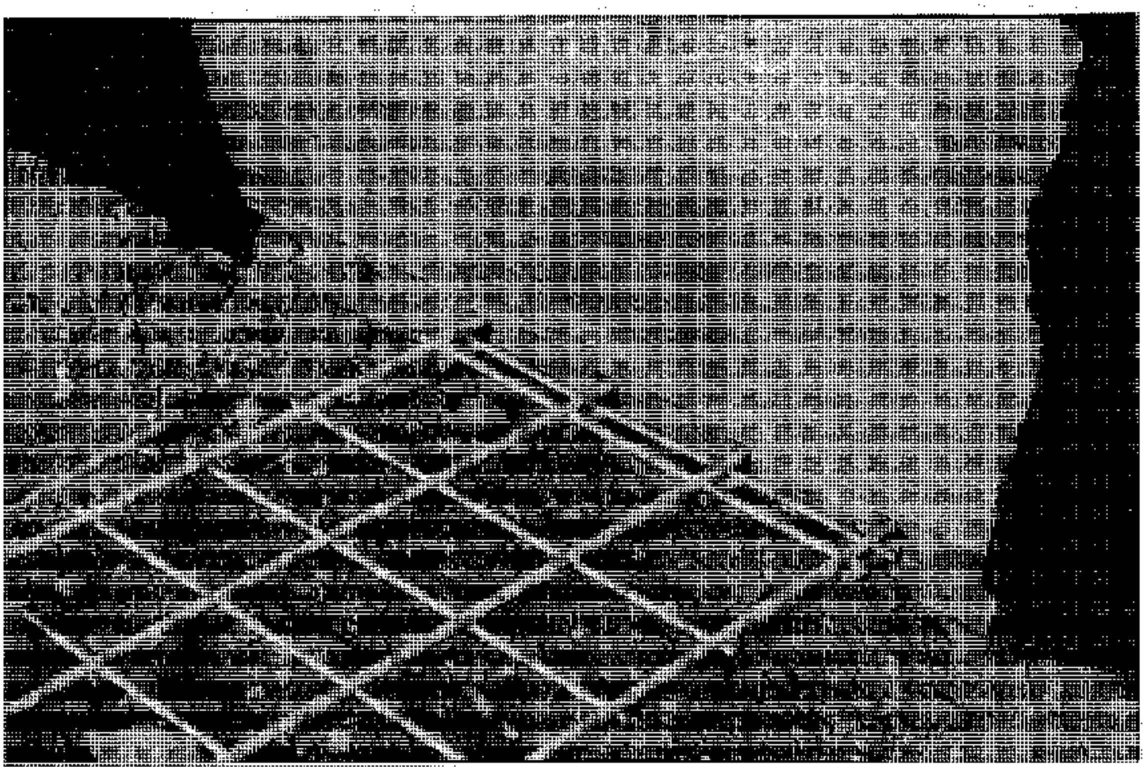
Hoisting of panel from stack with protective dunnage.

Placement of first lift of panels on leveling pad.

Typical bracing and clamping for first lift of panels.



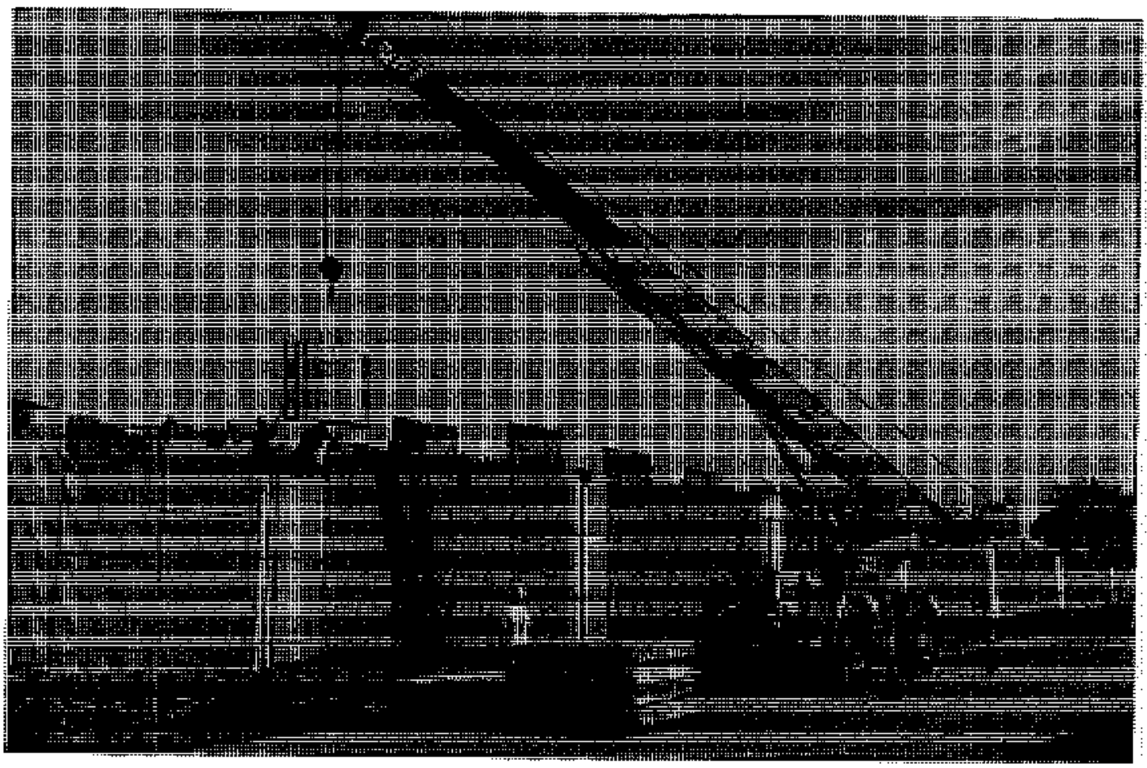
Reinforcing mesh with looped ends for interior panel connection.



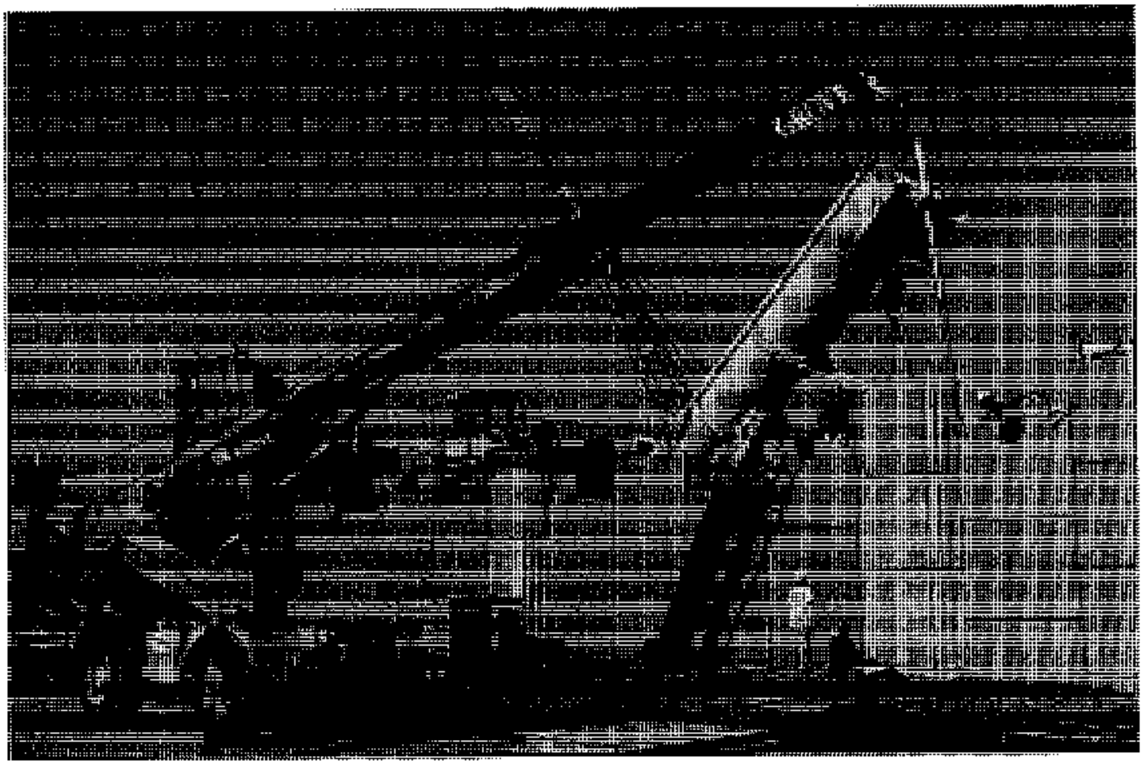
Reinforcing mesh inserted and connected inside panel pockets. Filter fabric installed at panel joints.

Spreading of backfill over installed reinforcing mesh.

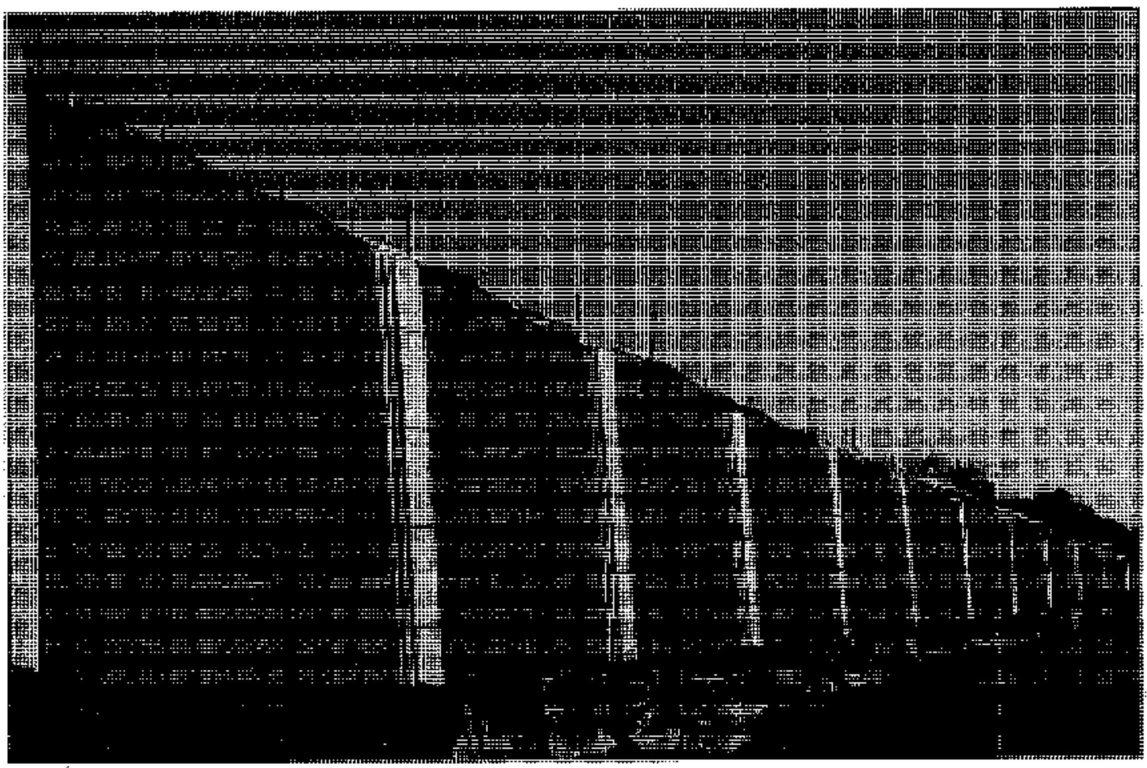
Typical panel alignment detail with wooden shims and clamps.



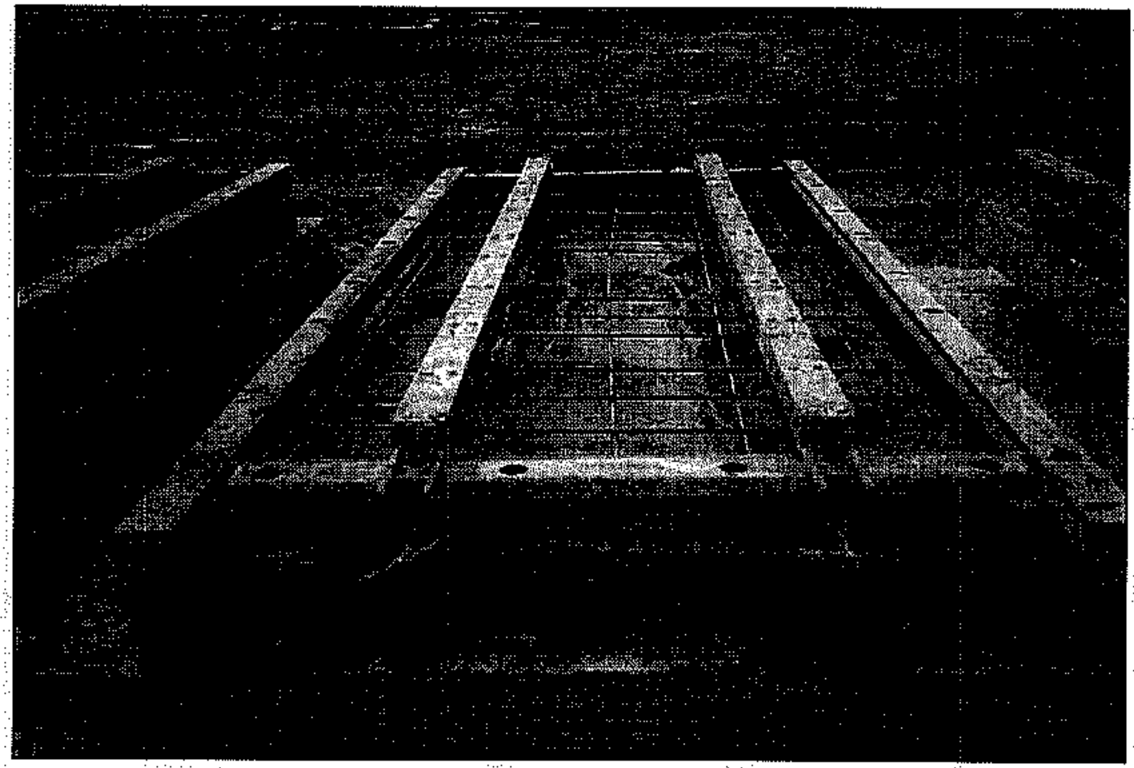
A standard light crane is typically utilized for panel placement.



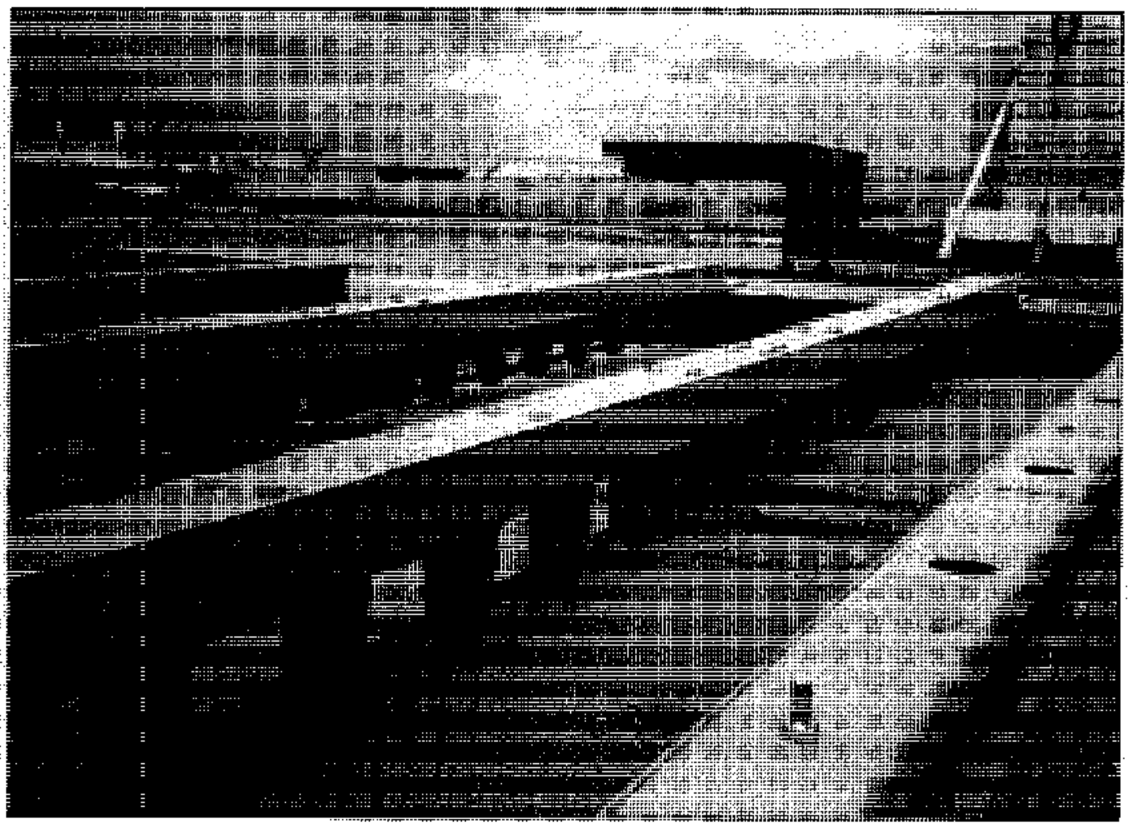
Panel placement, backfill delivery and spreading proceeding simultaneously.



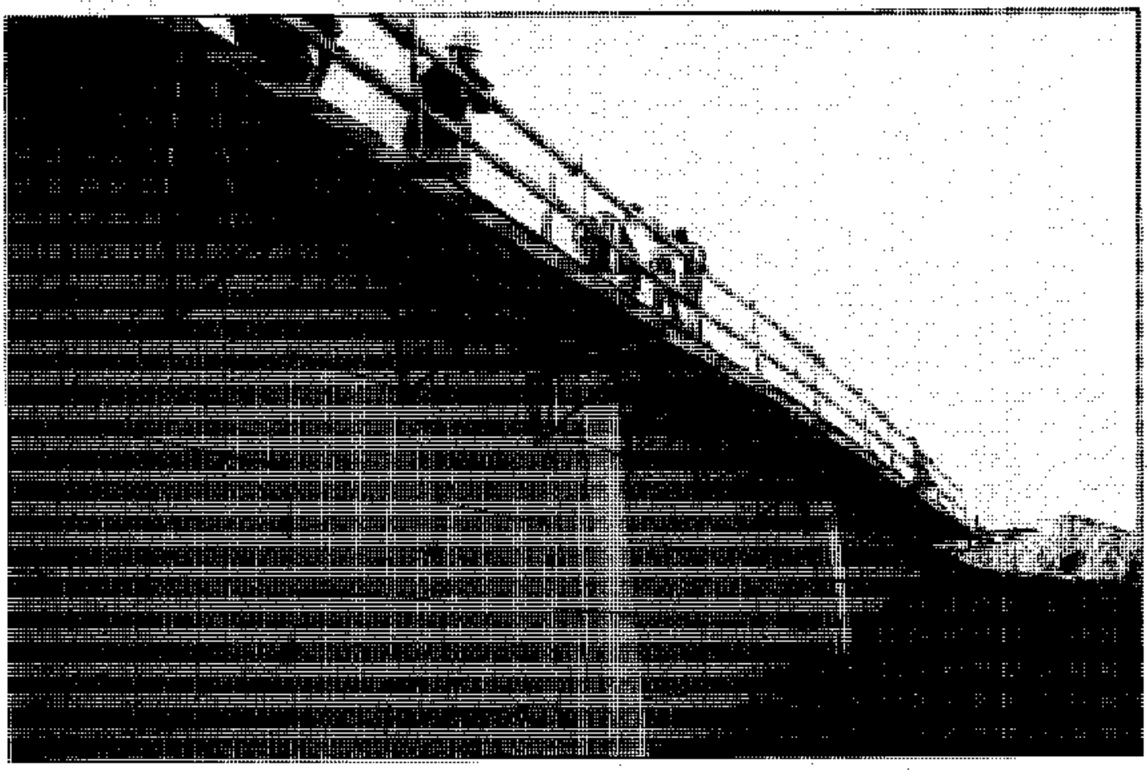
Topped out fractured fin wall.



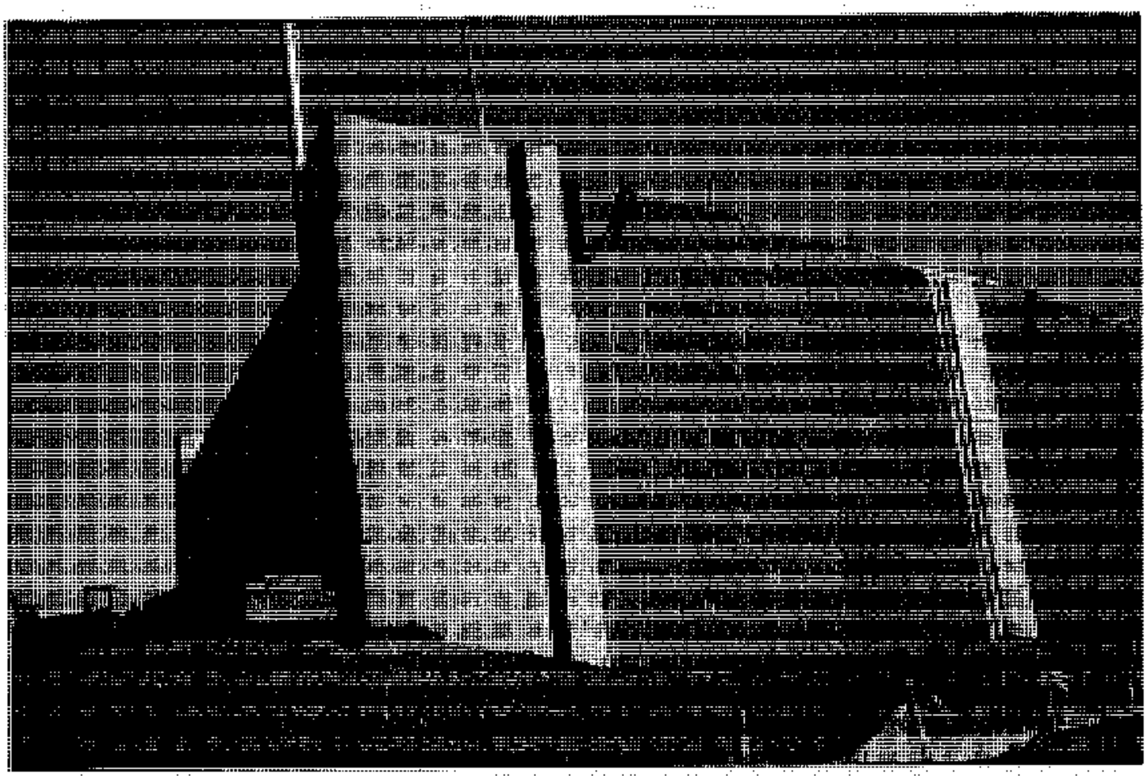
5' x 12' panel form with custom form-liner for architectural finish.



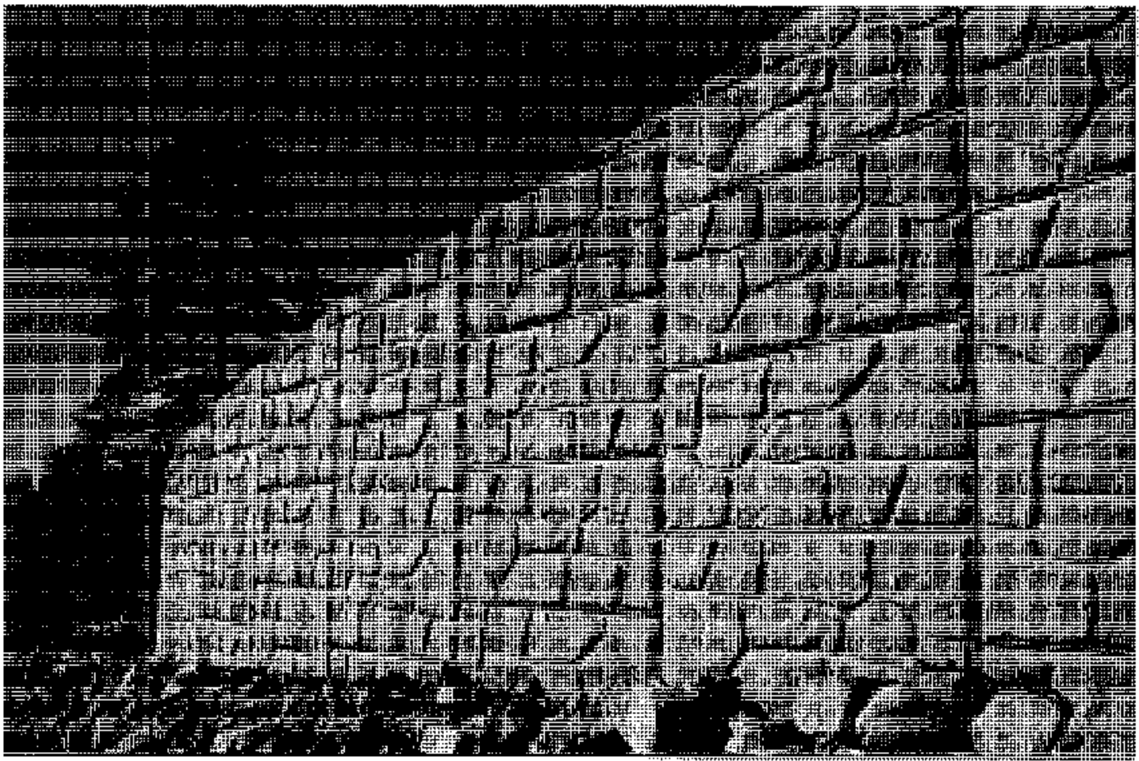
Close-up of recessed pocket formers with forming rod for internal connection channel.



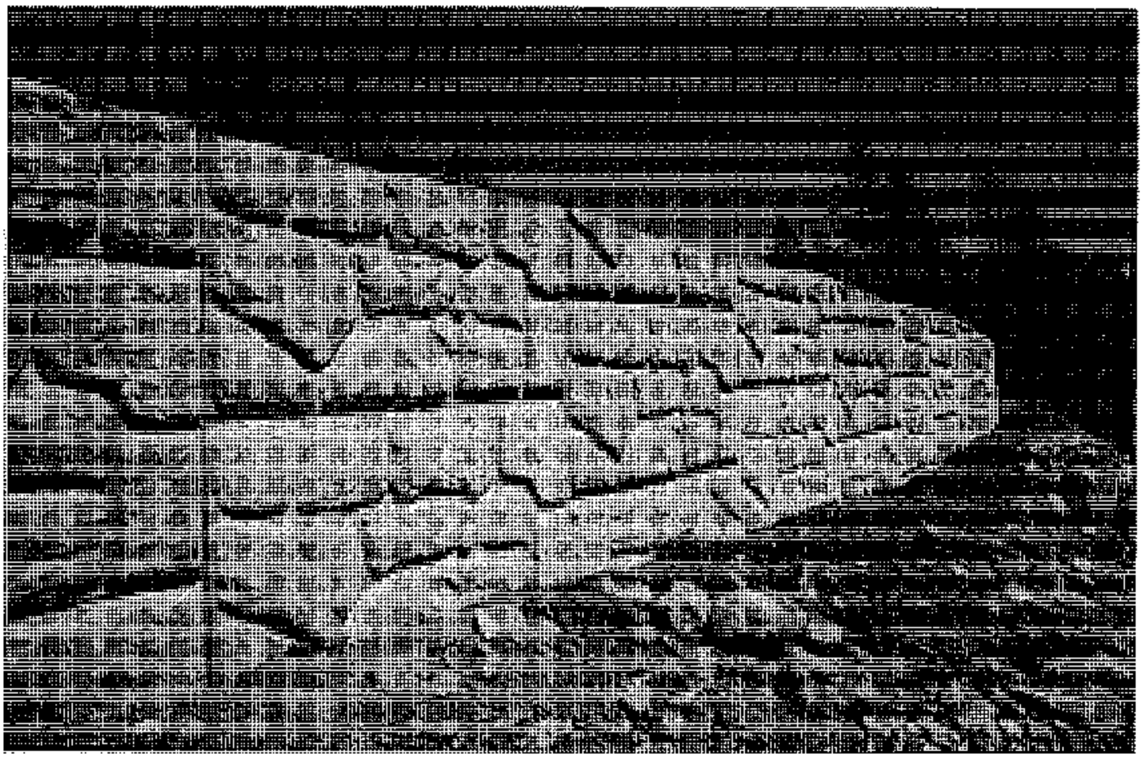
Formwork installed for cast-in-place coping at wall crown.



Typical abutment detail.



Completed Natural Stone wall with contoured crown panels.



Surface treatment detail of Natural Stone wall.

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Field Installation Manual

For

MSE *Plus*™

Retaining Walls

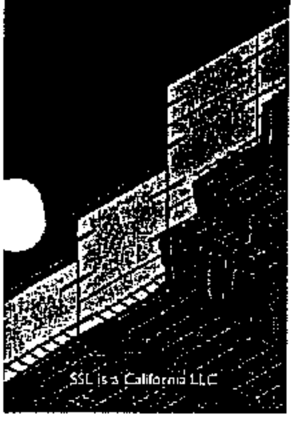


Table of Contents

INTRODUCTION

MSE PLUS™ walls are simple and economical earth retaining structures with an aesthetically pleasing appearance.

The system consists of precast concrete facing panels, soil reinforcing mesh attached to the panels, and backfill material.

The theory of SSL *MSE PLUS™* involves the transfer of stresses from the soil to the reinforcing mesh through bearing. Bearing pressure is developed on the projected area of the cross bars and is in turn transferred to the longitudinal bars, thus placing them in tension and enabling the soil mass to withstand loads in the direction of the reinforcement.

This manual is designed as an aid for the erection of *MSE PLUS™* walls. Its contents should be thoroughly reviewed by those given the responsibility of wall erection before the delivery of materials.

The contents of this manual are only general guidelines and do not relieve the contractor of the responsibility to adhere to the contract drawings and specifications.

SECTION I

SSL *MSE PLUS™* WALL SYSTEM components that make up the MSE PLUS™ Wall System are as follows:

Concrete Leveling Pad - Cast-in-place leveling pads for *MSE PLUS™* walls are 2,500 psi unreinforced concrete, 6 inches deep and 12 inches wide. This will serve as a flat and level starting surface for the facing panels. The allowable elevation tolerances are +/- 1/4 inch. Improperly placed leveling pads will decrease production rates and can result in subsequent panel misalignment.

Precast Facing Panels - There are three standard types of facing panels used in the *MSE PLUS™* Wall System. Additionally, panels of other configurations may be used depending on the geometry of each wall. These special panels may be precast or field ... depending on specific requirements of the project.

Preformed Bearing Pad - This ¾ inch pad is used between all horizontal joints, and provides a bearing surface between panels. A minimum of two pads per joint is required.

Filter Fabric / Foam Strips - Filter fabric is generally used on all joints on the fill side of the precast facing panels. This prevents backfill fines from seeping through the joints while allowing hydrostatic relief. Adhesive is supplied to hold the fabric against the panels until backfill is placed. In some cases open cell polyester foam may be required in addition to or substituted for the filter fabric. The foam is placed in the joints between facing panels.

Soil Reinforcing Mesh - The mesh is shop fabricated from W11, W15, W20 and W24 steel wire. The longitudinal wires are spaced at 8 inches on center, and the cross wires are spaced from 6 to 30 inches on center, depending on wall and design conditions. Each mesh element may have 3, 4, 5 or 6 longitudinal wires. The length of the mesh varies with the height of the wall and wall loading conditions.

Backfill Material - The backfill shall conform to SSL *MSE PLUS™* Specifications or specifications given in the Contract Special Provisions.

Coping - In most cases a reinforced concrete coping is placed at the top of the *MSE PLUS™* Walls. It provides an attractive finished appearance and aids in the placement of traffic barrier, sound walls, fences and signs when required. The coping may be either precast or cast in-place. In the event coping is not installed, slope top panels are available to provide a neat and finished appearance for the wall.

PROPER STORAGE AND HANDLING - The panels ould be stacked one on one, separated by non-staining dunnage, with no more than five panels per stack. The dunnage should be placed in the vertical direction of the erected panels or perpendicular to the connecting pin void. Care should be taken not to damage the edges or face of the panels during unloading, storage or setting. The panels may be unloaded in stacks by using nylon slings as shown in Figure 1.

During the erection phase, the panels will be lifted and set by use of the 2 lifting devices located in the top of each panel shown in Figure 2. When lifting panels from the stack, place dunnage blocks opposite the lifting eye to prevent damage when rotating panels from horizontal to vertical shown in Figure 3.

Sheets of mesh will arrive at the jobsite in bundles. Care should be taken not to bend or damage the mesh, mesh coating or connecting loops during unloading, storage and handling.

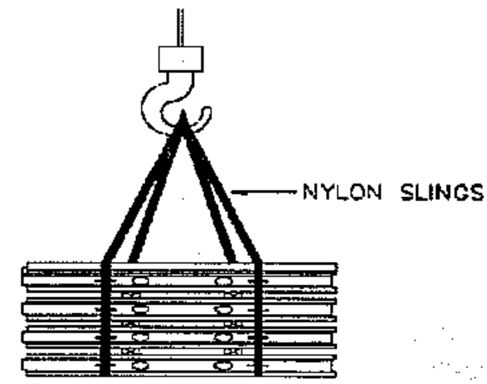


Figure 1

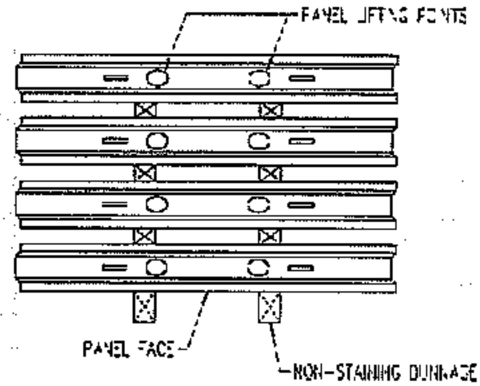
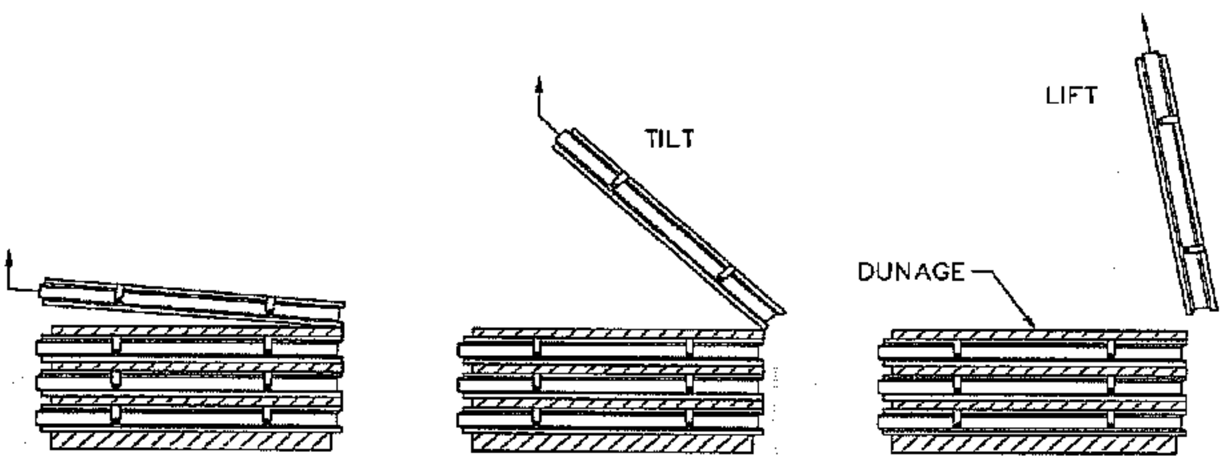


Figure 2



igure 3

SECTION II

TOOLS, EQUIPMENT AND MATERIALS - Because of the simple erection procedures of the *MSE PLUS™* System, a nominal amount of tools are required. We suggest that the contractor have on hand the following tools, equipment and materials:

- Nylon slings for unloading
- Shovels
- Wrecking bars
- 4-foot level
- 2-foot level
- Adjustable wrenches
- Claw hammers
- Sledge hammer
- Broom
- Chalk line
- Wooden wedges
- 2 x 4 stock lumber
- Clamps (wood or metal) minimum opening 7 inches Bolt cutters
- Caulking Gun (when filter fabric/ adhesive is used)

Equipment:

- Small crane or boom truck
- Small bulldozer for spreading backfill material
- Large, smooth drum, vibratory roller
- Small, walk-behind flat or vibratory compactor for compaction within 3 ft. of panels.

SSL will supply the following:

- MSE wall components
- Panel lifting eyes
- Technical Assistance
- Shop Drawings

SEQUENCE OF ERECTION

1. **Site Preparation** - The area where the *MSE PLUS™* wall is to be placed should be graded level, to a width equal to the length of the reinforcing mesh plus 6 inches, or to contract specifications. Any unsuitable materials should be removed and replaced with select backfill and compacted according to the contract specifications.

2. **Construction of the Concrete Leveling Pad** - Construct the leveling pads along the lines and grades shown on the contract drawings. Cure the concrete at least 12 hours prior to the setting of the facing panels as shown in Figure 4 below.

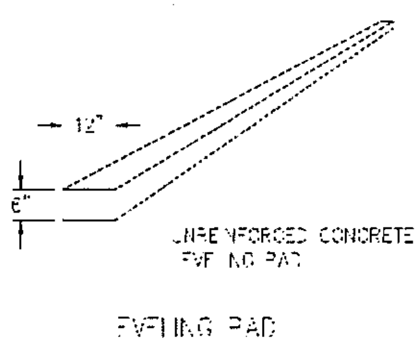


Figure 4

3. **Erection of the Base Line of Panels** - It must be emphasized that care should be exercised in the alignment and leveling of the first course or base line of panels. This will insure the aesthetics of the wall and also increase production of the erection of subsequent courses.

a) The first step in the erection of the base line is to establish the starting point. If a working point is shown on the drawings, or if the wall matches an existing structure, this would be the starting point. If neither of these are the case, then begin the erection on the footing with the lowest elevation.

b) The second step is to establish a face of wall line. This line should be snapped on the concrete leveling pad with a chalk line. The method for establishing reference points for this will be left to the discretion of the contractor.

c) Third, place the beginning half panel as shown in Figure 5. with the outside face flush with the face of wall line. The panel is then leveled with a 2-foot level and battered to the fill side approximately 5/8 inch in 5 feet. This batter of 5/8 inch batter is to compensate for backfill loading and will vary with the nature of the backfill material. The actual amount of batter can be determined only by trial and error.

d) The second panel is then placed as shown in Figure 5. The third panel is then set. Check the inclined joint spacing between panels and adjust to between 5/8 and 3/4 inch. Level and check the height between the panels.

e) Adjust the panels with wedges or spacers to achieve 3/8 inch + / - from point of full panel to top face of partial panel.

f) Check batter and level of these panels before proceeding. Continue panel erection.

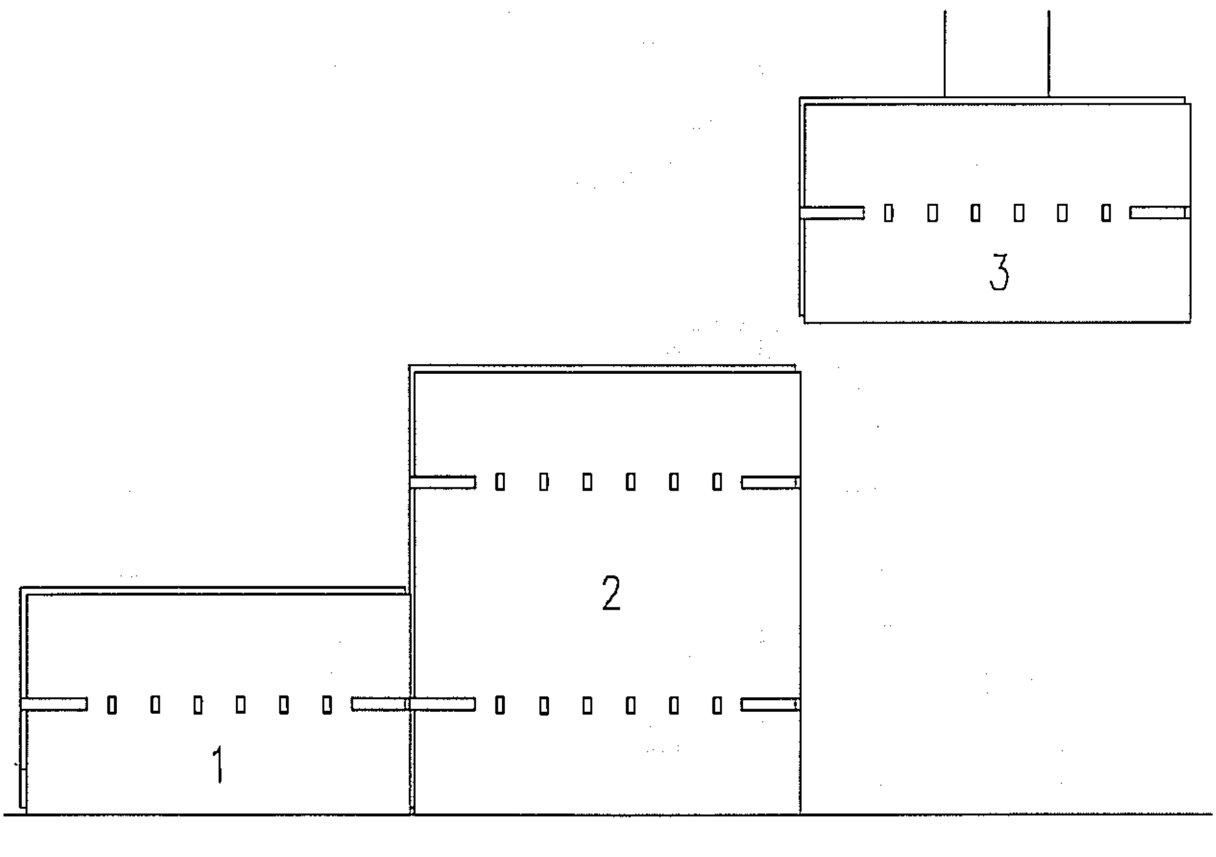


Figure 5

g) After the base line has been set, brace all of the full panels with 2 x 4 kickers on the face side. The batter should be checked before nailing. Clamp the smaller panels to the larger panels. The base course must be clamped and braced to maintain alignment and batter. No bracing will be required on subsequent courses. See details in Figure 6

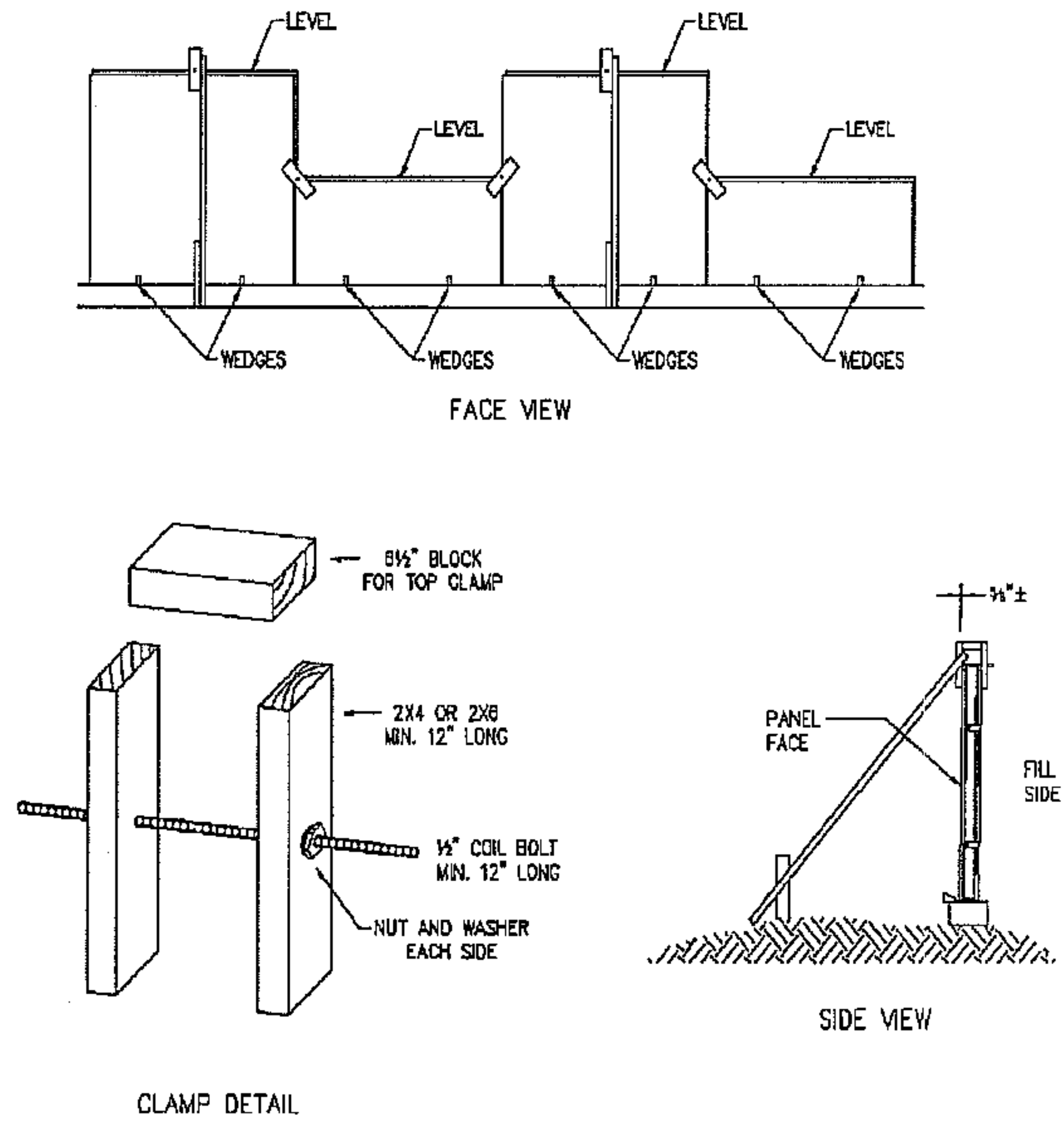


Figure 6

h) Glue the filter cloth to the back face of the panels over the joints. Using no more than a ¼ inch adhesive bead to hold the filter fabric to the panel while backfill is being placed. (Fig. 7). If foam is required, push the foam strips into the panel joints from the back face.

i) Place approved backfill to the level of the first row of loop connectors. (Fig. 8). Do not place the first lift of backfill directly against the panels. Compact the backfill to within 3 feet of the back face of the wall with the use of the smooth drum, vibratory roller.

j) Attach mesh to panels with the pin connectors provided. Align the loop on the mesh into the loop pockets in the panel. Insert the pin connector rod through the pin window and into loops the 3 loop pockets. Repeat this step for the other 3 loop pockets.

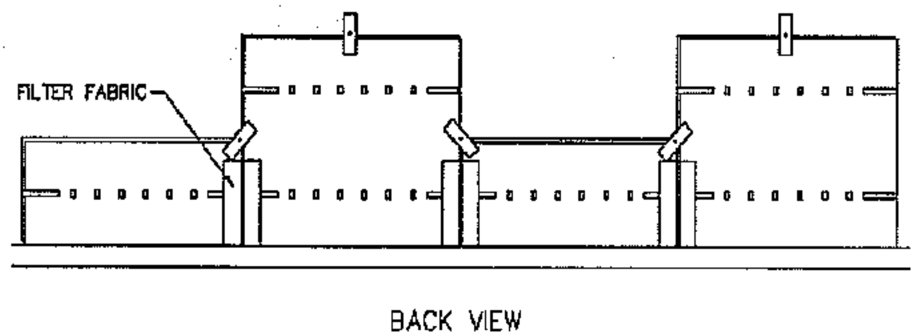


Figure 7

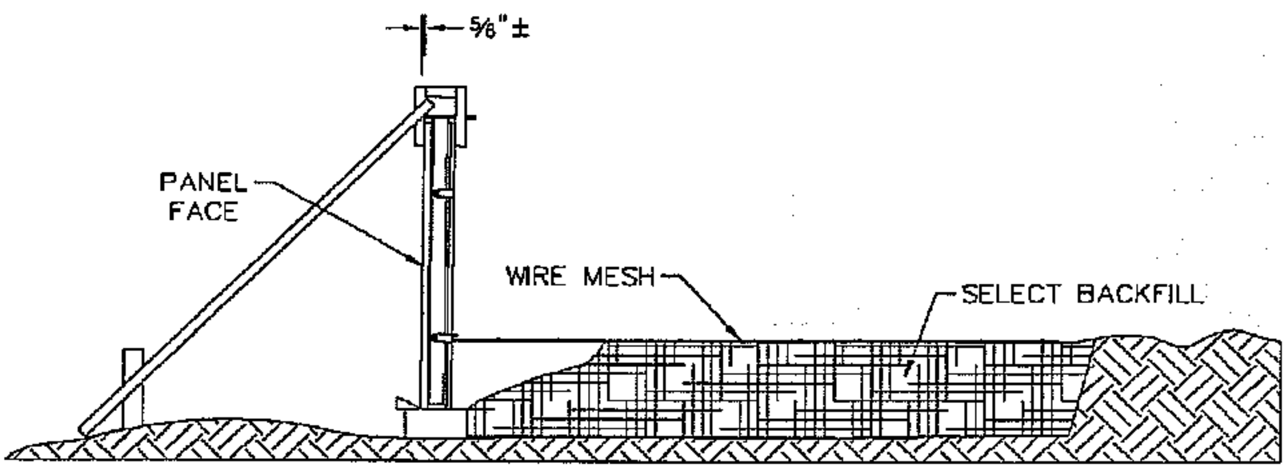


Figure 8

k) The next lifts of backfill are then placed (the thickness determined by specifications). Fill and compact up to the top of the smaller panel as shown in Figure 9. Backfill within 3 ft. of the panels is compacted using a lightweight walk behind tamper or roller. Compaction tests should not be taken within 3 ft. of the panels.

4. **Erection of Subsequent Courses –**

a) Place the 3/4-inch preformed bearing pads on top of the smaller panels and then place the second row of panels. (Figure 10).

b) If care was taken on the base line, little if any leveling should be required. The batter may be set by using. wedges between the clamp and panel or in the horizontal panel joint (Figure 11).

c) Place filter cloth on back face of panels.

d) Place the backfill up to the next level of mesh, install the mesh as above, and repeat this sequence for the remaining wall height. Fill may be sloped downward toward the panels within 2 ft. of the back face if necessary to prevent excessive outward movement when compacting the backfill.

e) Install end and top panels as required.

f) Continue the above procedures until all facing panels are installed.

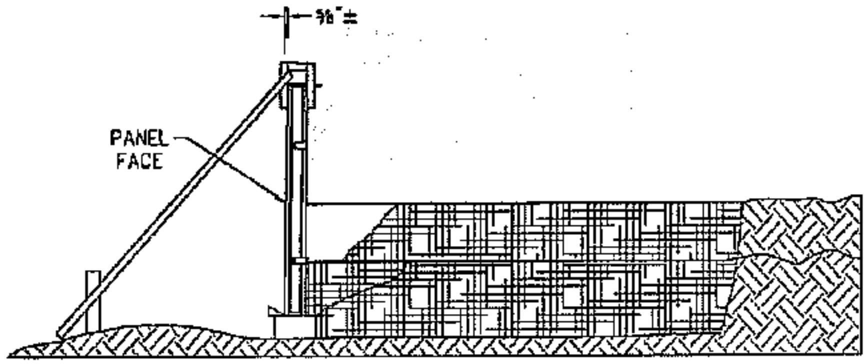


Figure 9

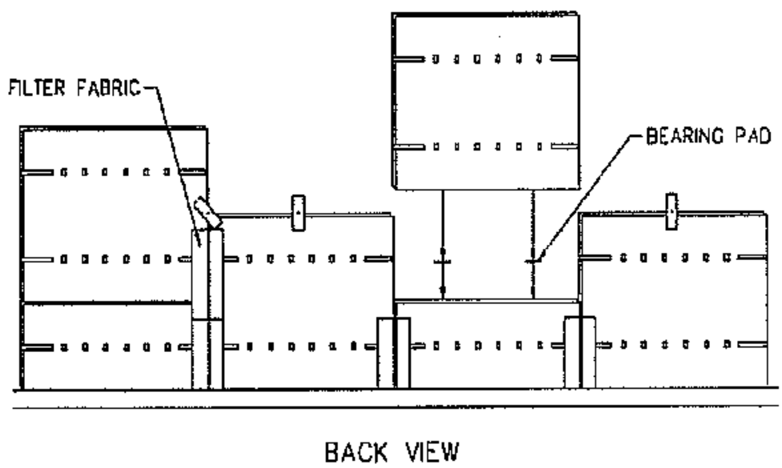


Figure 10

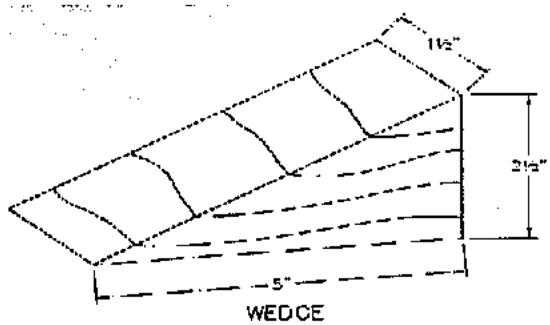


Figure 11

Install Coping -

a) Cast-in-place coping see Figure 12.

b) Precast coping Figure 13.

Summary of Construction Sequence –

1. Prepare the site for wall construction.
2. Install the concrete leveling pad.
3. Install the bottom course of MSE precast panels.
4. Place filter cloth.
5. Place the first lifts of backfill and compact.
6. Install mesh and connect to precast panels.
7. Place next lifts of backfill and compact.
8. Place next course of panels.
9. Repeat steps 4 through 8.
10. Install top panels.
11. Place coping if required.

When using wedges in the horizontal panel joints to set the precast panel facing batter, at least two but no more than three layers of wedges shall remain in place.

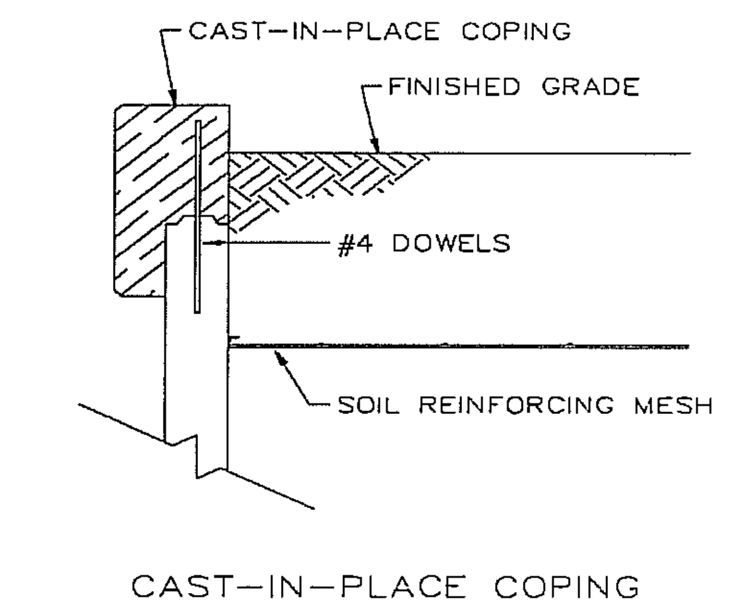


Figure 12

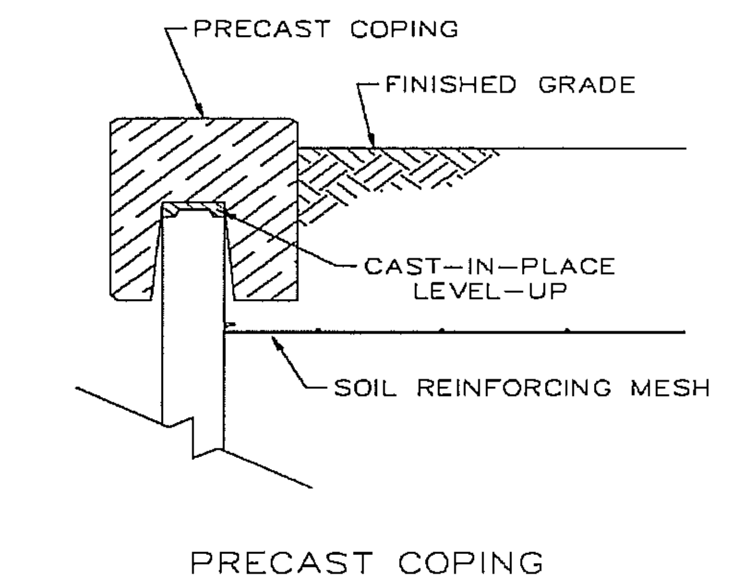


Figure 13

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Quality Control Manual

For

MSE *Plus*™

Retaining Walls

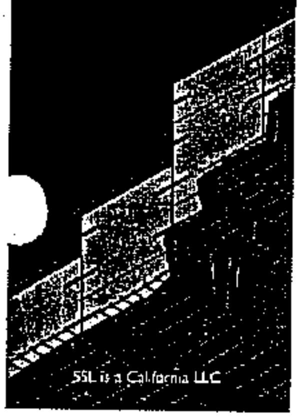

Table of Contents

INTRODUCTION

This manual has been prepared as a guide for building MSE *Plus*™ structures. Its contents should be thoroughly reviewed by the Contractor and the superintendent responsible for construction prior to the delivery of MSE *Plus*™ materials to the job site.

SSL will provide on-site assistance to help the Contractor implement correct construction procedures. Compliance with the guidelines herein does not relieve the Contractor of the responsibility to adhere to Contract Plans and Specifications.

A. Purpose

This document is intended to provide the Owner, Contractor, Engineer and the inspection staff, those who are responsible for overall quality control and inspection during construction, with the criteria necessary to monitor the erection of MSE Plus structures for compliance with the Plans, Specifications, and Contract Documents.

B. Responsibilities

It is the responsibility of the Contractor to provide completed construction in strict accordance with the Plans, Specifications, and Contract Documents. To assist the Contractor , SSL provides recommended erection procedures in the document "Installation Manual for MSE *Plus*™ Retaining Walls."

It should be verified that the Contractor's personnel on site are in possession of and are familiar with the recommendations of "Installation Manual for MSE *Plus*™ Retaining Walls."

Technical Advisors from SSL may assist the Contractor with material scheduling and coordination, together with advice in the recommended construction procedures applicable to MSE *Plus*™ structures. Technical Advisors are available on site both during initial construction and on a periodic basis as required thereafter.

·hnical Advisors are not on site on a full time basis, and are not provided with the intent of replacing the .signated quality control of the Owners inspection staff. Only the Owners Engineer can enforce the requirements of the Plans, Specifications, and Contract Documents.

C. Plans, Specifications, Layout

1. The Contractor should verify, prior to commencing any site work, that the latest issue, approved for construction, Plans, Specifications, and Contract Documents, are being used to build the Work.
2. The Contractor should also confirm that the Work is being constructed in the proper location by verifying line, grade, offset, or other location criteria.

D. Foundation

1. Evaluation and approval of foundation suitability is the responsibility of the Owners Engineer.

2. The foundation area for the Work shall be graded level for a width exceeding the length of the welded wire mesh by a minimum of 12 inches, or as otherwise shown on the Plans.

3. The foundation area shall be proof-rolled to a density suitable for the bearing pressure shown on the Plans, as directed by the Engineer.

4. Any foundation soils found to be unsuitable by the Engineer shall be removed and replaced with material approved by the Engineer. The material shall then be compacted as directed by the Engineer, to a density suitable for the bearing pressure as shown on the Plans.

5. In the event of over-excavation of the sub-grade, the Engineer must approve replacement material. The Engineer must also approve gradation, compaction and placement.

   Foundation evaluation and control are critical; the behavior and performance of the wall is largely dependent on the foundation upon which the MSE *Plus*™ volume is placed.

E. Leveling Pad

1. An unreinforced, smooth finish, concrete leveling pad shall be placed at each foundation elevation. This pad should have nominal dimensions of 6" thickness by 1'-0" width, and shall be cast using minimum 2,500 PSI 28-day compressive strength concrete. The pad shall cure a minimum of 12 hours before panels are set.

2. The leveling pad shall be cast to the design elevations as shown on the Plans. The allowable elevation tolerances are +0.01' (1/8"), and - 0.02'(1/8"), at design elevation.

   An improperly placed leveling pad can result in subsequent panel misalignment, and decrease wall construction productivity.

F. Materials

Panels

Panels should be free from any surface defects that may occur in transportation, unloading, or on-site storage, such as:

(a) cracked or broken corners

(b) permanent stains on exposed face

(c) cracks in panel surface.

Repairs to panels must be accomplished to the satisfaction of the Engineer.

2. Welded wire mesh, connector pins, joint materials

   Welded wire mesh and connector pins, filter fabric, adhesive, bearing pads, and other special items that may be required, are properly package to minimize damage in unloading and handling.

   These materials should be thoroughly inspected upon arrival at the job site, damaged materials set aside, and SSL notified immediately. All materials must be handled and stored in such a manner as to prevent damage, or theft. Polyurethane foam and filter fabric must be stored on site in such a manner as to be protected from sunlight.

3. Both partial and drop shipments may be made to the job site by SSL or their suppliers.

4. Certificates of compliance with project specifications for all materials are furnished by SSL. However, it is the contractor responsibility to verify that all materials received on site are in accordance with shipping documents and project requirements. Any discrepancies should be reported immediately to SSL.

The Contractor should continuously monitor the materials available to ensure that adequate quantities are available to prevent a construction delay.

Wall Erection

1. First Course - Panels

(a) The first course of panels should be set directly on the concrete leveling pad. Horizontal joint filler materials, are not permitted between the first course of panels and the leveling pad, unless specifically shown on the Plans, or authorized in writing by SSL. Shims may be used to shim between the leveling pad and first course of panels. Wood shims are not permitted between the first course of panels and the leveling pad. Temporary hardwood wedges may be used between the first course of panels and the leveling pad to set batter in the panels, if they are then removed during subsequent construction.

(b) All first courses, panels in excess of 3'- 0" in height, must be securely braced. Bracing may be removed only after all braced panels have been completely backfilled.

(c) Panel shoulder clamps must be tightened to hold the unit in position, and prevent individual panel movement.

(d) While setting and battering first course panels, horizontal alignment should be checked visually or with a string line.

(e) Panels must be installed exactly as shown on the Plans.

It is of utmost importance that the panel types, and mesh number in the panel coincide with the requirement shown on the Plans.

2. Select Granular Backfill Material

) The select granular backfill material to be used for the MSE *Plus*™ volume must conform strictly to the requirements of the Specifications. Material not conforming to the Specifications shall not be used for select granular backfill.

(b) Prior to placing the select granular backfill, the Contractor shall certify to the Engineer that the select granular backfill meets the requirements stated in the Specifications for MSE *Plus*™ structures.

(c) The gradation of the select granular backfill should be tested periodically during construction to assure compliance with the Specifications. This gradation testing should be performed, at least once for, every 2,000 cubic yards of material placed, and/or whenever the appearance or behavior of the material noticeably changes. Immediate gradation and moisture testing is required if either excessive panel movement or backfill pumping occurs during construction.

(d) The uniform loose thickness placement of each lift of Select Granular Backfill material, before compaction, must not exceed 10 inches.

(e) The placement moisture content of the select granular backfill material must be less than or equal to the optimum moisture content.

3. Compaction

(a) With the exception of the 3 ft zone directly behind the facing panels, large, smooth drum, vibratory rollers should be used to accomplish the required compaction of the select granular backfill material. Sheepsfoot rollers are not to be used for compaction of select granular backfill.

(b) Within the 3 ft zone, small, single or double drum, walk-behind-vibratory rollers, or walk-behind vibrating plate compactors must be used. Compaction tests for quality control should not be taken within 3 feet of the back face of the wall.

(c) When fine, uniform sands, which contain in excess of 60 percent passing a No. 40 sieve are used for select granular backfill, they must be compacted with a smooth drum, static roller. Do not use vibratory compaction equipment when compacting fine uniform sands.

(d) Select granular backfill material shall be compacted to 95% of maximum density, per AASHTO T-99 methods C or D.

In assessing the quality of compacted backfill for approval, the placement moisture content requirements shall be given a consideration equal to the compaction density requirements.

The minimum frequency of compaction testing shall be one test per lift of select granular backfill material placed. The location of testing to be determined by the Engineer.

(e) It is recommended that a suitable type device be used to perform the compaction testing on the Select Granular Backfill, when applicable.

4. Grading

(a) At the end of each day's work, the backfill must be graded or sloped away from the back of the panels to divert run-off from the wall area. Failure to properly grade the backfill may result in excessive water in the Select Granular Backfill and subsequent movement of the panels beyond alignment tolerances.

5. Welded wire mesh

(a) Welded wire mesh must be installed in strict compliance with the density and length requirements shown on the Plans.

(b) Welded wire mesh should be placed perpendicular to the back of the facing panel.

(c) In specific, limited situations, it may be necessary to skew the mesh sheet from its design location perpendicular to the facing panel, in either the horizontal or vertical plane.

Unless otherwise detailed on the plans, the design of the MSE *Plus*™ structure is based on the welded wire mesh being installed perpendicular to the back of the facing panel, with the proper density and length of mesh being attached to each panel. The effect of skewing any mesh must be reviewed by SSL. The placement of any welded wire mesh in a skewed manner must be authorized in writing by SSL prior to placement in the field.

6. Joint Materials

(a) Horizontal bearing pads must be installed in strict accordance with the Plans.

(b) Other joint materials.

1. When required, filter fabric, must be installed with an adhesive.

7. Second, and Subsequent Panel Courses

(a) Throughout construction, panels should only be set at grade. Placing a panel on top of one that has not been completely backfilled is prohibited.

(b) Construction/Erection procedures for panel installation, backfill placement and compaction, reinforcing mesh installation, and placement of horizontal/vertical joint materials, are the same, (with the exception of bracing), for the second and subsequent panel courses, as for the first course. No panel bracing is required for second or subsequent courses.

(1) In addition, on the second and subsequent panel courses, wedges should be checked after the erection of each panel course, and they should be securely seated at all times until removed.

(2) Panel batter should be checked after backfilling and necessary adjustments made to insure they are plumb. At least two, but no more than three rows of panel wedges should remain in place at any time during construction. After completion of construction all panel wedges must be removed.

(c) Quality control requirements for select granular backfill, including density and placement moisture content, are the same for the second and subsequent courses as for the first course, unless otherwise indicated in the specifications.

H. Erection Tolerances

(a) Walls are to be constructed to acceptable lines and grades shown in the Contract Plans. Variations to intended lines and grades are acceptable provided the wall aesthetics are not affected.

Troubleshooting

Plus structures are to be erected in strict compliance with the structural and aesthetic requirements of the Plans, Specifications, and Contract Documents. The desired results can be achieved through the use of quality materials, correct construction procedures, and proper inspection. However, considering the nature of construction work, there may be occasions when dimensional tolerances and/or aesthetic limits are exceeded. Corrective measures must be taken immediately to control the structure within acceptable limits.

Presented below are several examples of these condition cause relationships.

CONDITION	CAUSE
1. Distortion in wall: (a) Differential settlement or low spot in wall. (b) Overall wall leaning. (c) Panel contact, resulting in spalling/chipping.	1. Foundation (sub-grade) material too weak or wet for proper bearing. If fill material, poor quality or not properly compacted.
2. First course difficult to set and/or maintain level.	2. Leveling pad not within tolerance.
3. Wall leaning out.	3. (a) Panel not battered sufficiently. (b) Large backfill placing and/or compaction equipment working within 3 ft zone of back of wall. (c) Backfill material placed wet of optimum moisture content. (d) Backfill contains excessive fine materials (beyond the Specifications for percent of materials passing a No. 200 sieve). (e) Backfill material pushed against back of wall before being compacted on mesh. (f) Excessive or vibratory compaction on uniform fine sand (more than 60 percent passing a No. 40 sieve). Backfill material dumped close to free end of Welded wire mesh, then spread towards back of wall causing bulge in mesh and pushing panel out. (g) Shoulder wedges not seated securely. (h) Shoulder clamps not tight. (i) Excessive compactive effort. (j) Excessive lift thickness.
4. Wall leaning in.	4. (a) Excessive batter set in panels for select granular backfill material being used. (b) Inadequate backfill compaction. (c) Foundation settlements.
5. Wall out of horizontal alignment tolerance, or bulging.	5. (a) See causes 3c, 3d, and 3e. (b) Backfill saturated (heavy rain or improper grading of backfill after each day's operations.
6. (a) Panels do not fit properly in their intended locations. (b)Subsequent panels are spalling or chipping.	6. (a) Panels are not level. (b) Differential settlement (see Condition 1a). (c) Leveling pad incorrect.

Glossary of Terms

Agency	The person(s), firm, or corporation acting as Agent for the Owner.
Contract Documents	The Owner-Contractor Agreement, the conditions of the Contract (general, supplementary, and other conditions), the drawings, Specifications and all addenda issued prior to execution of the Contract, all modifications thereto, and any other items specifically stipulated as being included in the Contract Documents.
Contractor	The individual, firm or corporation undertaking the execution of the Work under the terms of the Contract, and acting directly through its Agents or employees.
Engineer	The person(s) designated by the Owner, as having authoritative charge over certain specific engineering operations and duties.
Inspector	The authorized representative assigned to make a detailed inspection of any or all portions of the Work or materials thereof in the Owner's behalf.
C s	The Owner of a project. The agency, person, firm or corporation with which a Contract has been made for the payment of the Work performed under that Contract.
Plans	The official approved Plans, profiles typical cross sections, working drawings and supplemental drawings, or exact reproductions thereof, which show the location, character, dimensions and details of the Work to be performed.
Specifications	A description, for contract purposes, of the materials and workmanship required in a structure(s), as also shown on the related working drawings. The written material containing the standard provisions and special provisions, as may be necessary, pertaining to the quantities and qualities of materials to be furnished under the Contract.
Technical Advisor	Representative of The SSL who advises the Contractor regarding correct installation procedures in the construction of MSE Plus structures.
Work	The entire scope of the Work to be performed at the site of the construction project including labor, materials, equipment, transportation and such other facilities as are necessary to fulfill all obligations under the Contract.

Appendix E

Project Name	Contract No.	Owner	State	Contractor	Wall Information No	Area
Winchester Estates PH 1	-	CC Myers	CA	Lapco Construction	3	4,633
100% Complete		$ 283,000		Laurie Pecoraro	5	11,103
				916-544-8274	6	11,120
					11	1,688
						28,543
Arden Garden	PN:TA87	City of Sacramento	CA	Lapco Construction	1	5,950
100% Complete		$ 136,838		Laurie Pecoraro	3	6,650
				916-544-8274		**12,600**
Route 15/30	08-204304	Caltrans	CA	E. L. Yeager Construction	152	11,208
		$ 441,035		Doug Adland	153	11,208
				909-684-5360	160	16,791
					161	16,791
					N AB1	2,624
					S AB3	2,975
						61,597
Route 5 at Orangewood	12-059254	Caltrans	CA	Ortiz Construction	1164	15,286
		$ 642,193		Norm Day	1165	19,743
				714-753-1414	1178	16,567
					1179	12,184
					AB3	1,088
						64,868
Route 5 at Fullerton	12-035724	Caltrans	CA	Ortiz Construction	1100	10,680
		$ 105,732		Norm Day		**10,680**
				714-753-1414		
Yosemite 140 Reconstruction	YOSE 16(1)	FHWA/Forest Service	CA	Kiewit Pacific Company	Seg'mt A	50,000
25 % Complete		$ 518,500		Phil Martin	Seg'mt B	20,000
				510-686-3030	Seg'mt C	15,000
						85,000
I-25 at Founder Parkway	STU 0252-294	Colorado DOT	CO	SEMA Construction	AB1	717
100% Complete		$ 19,628		Tom Jackson	AB3	938
				303-649-9265		**1,655**
Route 168 near Fresno	06-342264	Caltrans	CA	Morrison - Knudsen	Shaw	29,534
		$ 271,026		Tony Ferruccio	Avenue	**29,534**
				909-425-4200		
Agua Fria-I-10 to Encanto		ADOT	AZ	Sundt Corporation	Wall 3	9,650
		$ 248,640			Wall 7	1,068
					Wall 8	5,418
					Wall 9	5,861
						21,997
Agua Fria-Encanto to Camelback		ADOT	AZ	Ames Construction	4	**17,580**
		$156,772				

Project Name	Contract No.	Owner	State	Contractor	Wall Information No	Area
Walnut Ave Overcrossing	12-013334	Caltrans $191,675	CA	Lapco Construction	1	19,740
Blue Oaks Interchange		City of Rocklin $53,228	CA	Lapco Construction	1	3,802
Universal Station		Metro Trans. Authority $223,038	CA	EL Yeager Construction	9	27,233
Fairview Ave	05-371604	Caltrans $50,564	CA	Burke Construction	2	5,438
Imperial Ave/36th Imp.	11-048074	Caltrans $132,371	CA	Archer Western	2	10,484
MSE Embankment	12AO511	Caltrans $18,722	CA	Gansek Construction	1	1,204
Overland Drive Overcrossing		City of Temecula $172,721	CA	CC Myers	4	18,715
Terminal 18		City of Seattle $251,842	WA	Raven Development	2	28,782
CBT Access Road		Vandenberg AFB $92,588	CA	Granite Construction	2	9,974
Flowery Trail Road		Chewelah $133,555	WA	KRC Constuction	2	9,683
Imperial Grade Separation	07-119464	Wilmington Ave $35,840	CA	Ortiz Construction	1	7,000

ACORD. CERTIFICATE OF LIABILITY INSURANCE

CSR PS CONC-01

DATE (MM/DD/YY) 12/02/98

PRODUCER

Lovsted Company
424 3rd Avenue West
Seattle WA 98119

Tom North
Phone No. 206-285-7735 Fax No. 206-285-3461

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW.

INSURED

SSL, LLC

COMPANIES AFFORDING COVERAGE

COMPANY	
A	National Surety Corporation
B	Fireman's Fund Insurance Co.
C	
D	

COVERAGES

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED, NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

CO LTR	TYPE OF INSURANCE	POLICY NUMBER	POLICY EFFECTIVE DATE (MM/DD/YY)	POLICY EXPIRATION DATE (MM/DD/YY)	LIMITS	
	GENERAL LIABILITY				GENERAL AGGREGATE	$ 2,000,000
A	X COMMERCIAL GENERAL LIABILITY	DDX80705335	07/01/98	07/01/99	PRODUCTS - COMP/OP AGG	$ 2,000,000
	CLAIMS MADE X OCCUR				PERSONAL & ADV INJURY	$ 1,000,000
	X OWNER'S & CONTRACTOR'S PROT				EACH OCCURRENCE	$ 1,000,000
					FIRE DAMAGE (Any one fire)	$ 1,000,000
					MED EXP (Any one person)	$ 10,000
	AUTOMOBILE LIABILITY					
A	X ANY AUTO	DXX80705335	07/01/98	07/01/99	COMBINED SINGLE LIMIT	$ 1,000,000
	ALL OWNED AUTOS				BODILY INJURY (Per person)	$
	SCHEDULED AUTOS					
	X HIRED AUTOS				BODILY INJURY (Per accident)	$
	X NON-OWNED AUTOS					
					PROPERTY DAMAGE	$
	GARAGE LIABILITY				AUTO ONLY - EA ACCIDENT	$
	ANY AUTO				OTHER THAN AUTO ONLY:	
					EACH ACCIDENT	$
					AGGREGATE	$
	EXCESS LIABILITY				EACH OCCURRENCE	$ 10,000,000
A	X UMBRELLA FORM	XYZ00083421495	07/01/98	07/01/99	AGGREGATE	$ 10,000,000
	OTHER THAN UMBRELLA FORM				RETENTION	$ -0-
	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY				X WC STATUTORY LIMITS / OTHER	
					EL EACH ACCIDENT	$ 1,000,000
B	THE PROPRIETOR/ PARTNERS/EXECUTIVE OFFICERS ARE: INCL / EXCL	DWP80776132	07/01/98	07/01/99	EL DISEASE - POLICY LIMIT	$ 1,000,000
		CA WORKERS COMP			EL DISEASE - EA EMPLOYEE	$ 1,000,000
	OTHER					

DESCRIPTION OF OPERATIONS/LOCATIONS/VEHICLES/SPECIAL ITEMS

EVIDENCE OF LIABILITY INSURANCE

CERTIFICATE HOLDER

TOWHOMI

TO WHOM IT MAY CONCERN

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, THE ISSUING COMPANY WILL ENDEAVOR TO MAIL 45 DAYS WRITTEN NOTICE TO THE CERTIFICATE HOLDER NAMED TO THE LEFT, BUT FAILURE TO MAIL SUCH NOTICE SHALL IMPOSE NO OBLIGATION OR LIABILITY OF ANY KIND UPON THE COMPANY, ITS AGENTS OR REPRESENTATIVES.

AUTHORIZED REPRESENTATIVE

Tom North

Tom North

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Lovsted Company

Insurance

FAX (206) 285-3461

424 3rd AVENUE WEST
SEATTLE, WA 98119
(206) 285-7735

December 2, 1998

SSL, L.L.C.
Attn. Steve Ruel
4740 Scotts Valley Dr. Ste #E
Scotts Valley, CA 95066

Re: Professional Liability

Dear Steve,

We will be able to provide you with a Professional Liability policy for your design work on either a Project-by-Project basis, or on an Annual policy basis.

Please feel free to give us a call if you have any further questions.

Best Regards,

Tom

Thomas M. North
Lovsted Company

TMN/pns

Appendix B

5’ x 6’ STANDARD PANELS

	Area	Diameter
16	Galvanize Life Coating	
12	Corrosion Rate Carbon Steel (in microns)	
75	Design Life	

cross-sectional area after corrosion

Wire	Area sqin	Diameter in	Diameter microns	Diameter after microns	Diameter after in	% effective	Area after sqin					6	7	8
W5	0.05	0.252	6408.757	4992.757	0.1966	0.6069	0.0303	2	3	4	5	0.1821	0.2124	0.2428
W8	0.08	0.319	8106.507	6690.507	0.2634	0.6812	0.0545	0.1090	0.1635	0.2180	0.2725	0.3270	0.3815	0.4359
W11	0.11	0.374	9505.722	8089.722	0.3185	0.7243	0.0797	0.1593	0.2390	0.3187	0.3983	0.4780	0.5577	0.6374
W15	0.15	0.437	11100.292	9684.292	0.3813	0.7611	0.1142	0.2283	0.3425	0.4567	0.5709	0.6850	0.7992	0.9134
W20	0.20	0.505	12817.513	11401.513	0.4489	0.7913	0.1583	0.3165	0.4748	0.6330	0.7913	0.9495	1.1078	1.2660
W24	0.24	0.553	14040.882	12624.882	0.4970	0.8085	0.1940	0.3881	0.5821	0.7761	0.9702	1.1642	1.3582	1.5523
W30	0.30	0.618	15698.184	14282.184	0.5623	0.8277	0.2483							

The maximum load applied to the panel is equivalent with the maximum load applied/allowable for each soil reinforcement wire/connection point. WWM soil reinforcement wires used are W11, W20, and W24.

The maximum allowable tension/point load applied for each wire/connection point on panel is applied.

For W11 wire = 0.0797 in2 x 75 ksi x 0.65(RF) = 3.885 KIPS per point.
For W20 wire = 0.1583 in2 x 75 ksi x 0.65(RF) = 7.717 KIPS per point.
For W24 wire = 0.1940 in2 x 75 ksi x 0.65(RF) = 9.458 KIPS per point.

Panels using all 3W11, 4W11, 5W11, 6W11, 4W20, 5W20, 6W20, 5W24, 6W24 barmats are evaluated for maximum bending moment and shear. The bending moment and shear are used for reinforced concrete flexural analyses.

Slab on grade model is used for the analyses with the spring constant determined as follow:

SPRING CONSTANT

Modulus of Sub-Grade Reaction and Spring Constant Check
From Principles of Foundation Engineering; Braja M. Das 8th Edition:

Table 8.2 Typical Subgrade Reaction Values, $k_{0.3}(k_1)$

Soil type	$k_{0.3}(k_1)$ MN/m³	$k_{0.3}(k_1)$ lb/in.³
Dry or moist sand:		
Loose	8–25	30–90
Medium	25–125	90–450
Dense	125–375	450–1350
Saturated sand:		
Loose	10–15	35–55
Medium	35–40	125–145
Dense	130–150	475–550
Clay:		
Stiff	10–25	40–90
Very stiff	25–50	90–185
Hard	>50	>185

$K_{0.3}$ (k_1) = 1350 lb/in^3 (is selected)
(dense Sand, value is conservative considering no reinforcement is included)

Adjust to panel 5' x 10' (1.5m x 3m)

Foundations on Sandy Soils

For foundations on sandy soils,

$$k = k_{0.3}\left(\frac{B+0.3}{2B}\right)^2 \quad (8.45)$$

where $k_{0.3}$ and k = coefficients of subgrade reaction of foundations measuring 0.3 m × 0.3 m and B(m) × B(m), respectively (unit is kN/m³).

In English units, Eq. (8.45) may be expressed as

$$k = k_1\left(\frac{B+1}{2B}\right)^2 \quad (8.46)$$

where k_1 and k = coefficients of subgrade reaction of foundations measuring 1 ft × 1 ft and B(ft) × B(ft), respectively (unit is lb/in³).

$$k_{1.5} = k_{0.3} \cdot \left(\frac{B+0.3}{2B}\right)^2$$

$$k_{1.5} = 1350\ x \left(\frac{1.5+0.3}{2\ x\ 1.5}\right)^2$$

$k_{1.5}$ = 486 lb/in^3

$$k_{1.5x3.0} = k_{1.5} \cdot \left(\frac{1+\frac{1.5}{3.0}}{1.5}\right)^2$$

$k_{1.5x3.0}$ = 486 lb/in^3

$k_{1.5x3.0}$ = 839.755 kip/ft^3

From Foundation Analysis And Design; Joseph E. Bowles, RE., S.E. 5th Edition:

10-5 MODULUS OF SUBGRADE REACTION k_s FOR MATS AND PLATES

All three discrete element methods given in this chapter for mats/plates use the modulus of subgrade reaction k_s to support the plate. The modulus k_s is used to compute node springs based on the contributing plan area of an element to any node as in Fig. 10-5. From the figure we see the following:

Node	Contributing area
1 (corner)	$\frac{1}{4}$ of rectangle *abde*
2 (side)	$\frac{1}{4}$ of *abde* + $\frac{1}{4}$ of *bcef*
3 (interior)	$\frac{1}{4}$ of each rectangle framing to a common node (as node 3)

For a triangle one should arbitrarily use one-third of the triangle area to any corner node. For these area contributions the fraction of k_s node resistance from any element is

$$K_i = k_s, \text{ kN/m}^3, \times \text{Area}, \text{ m}^2 = \text{units of kN/m (or kips/ft in Fps)}$$

Since this computation gives units of a "spring" it is common to call the effect a *node spring*.

In this form the springs are independent of each other, the system of springs supporting the plate is termed a "Winkler" foundation, and the springs are uncoupled. Uncoupling means that the deflection of any spring is not influenced by adjacent springs.

Spring Constant

Note Spacing: 1ft x 1ft

Tributary Area: 1' x 1' = 1SF

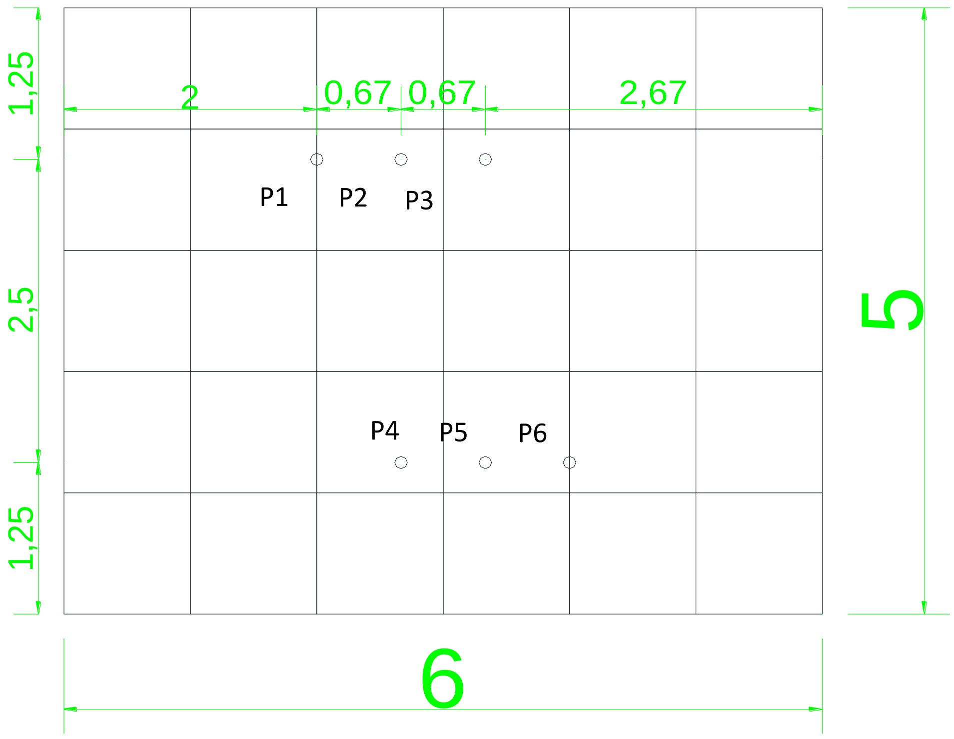
Ka = k x a

Ka = 839.755 kip/ft (Input to Staad Pro)

MAXIMUM BENDING MOMENT AND SHEAR

Typical Panel Type (mesh 3W11), Panel Thickness 6", 5'x6'

Point load Input Force in panel for Staad Pro input



Location	Coordinated From Center Panel 1'x1'	
	X	Y
P1	0.5	0.25
P2	0.1667	0.25
P3	-0.1667	0.25
P4	0.1667	-0.25
P5	-0.1667	-0.25
P6	0.5	-0.25

Load to panel based on Bar Mat Capacity per Bar Mat Point

Bar Mat Used:

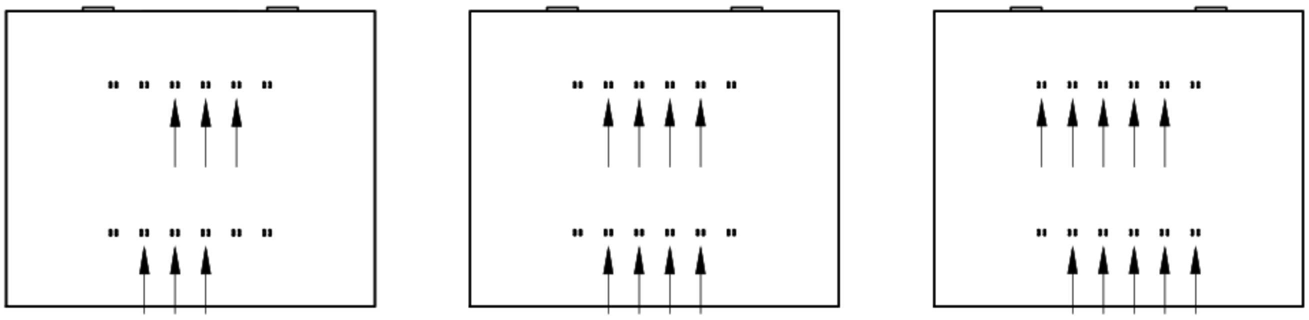
W11 - 75 Years

A = 0.0797 in^2

Fy = 75 ksi

P = 0.65 x A x Fy

= 3.885 Kips (per wire point)



ATTACHMENT BY No. WIRES

(STANDARD PANELS ONLY)

Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
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Job Title	Ref Panel Check		
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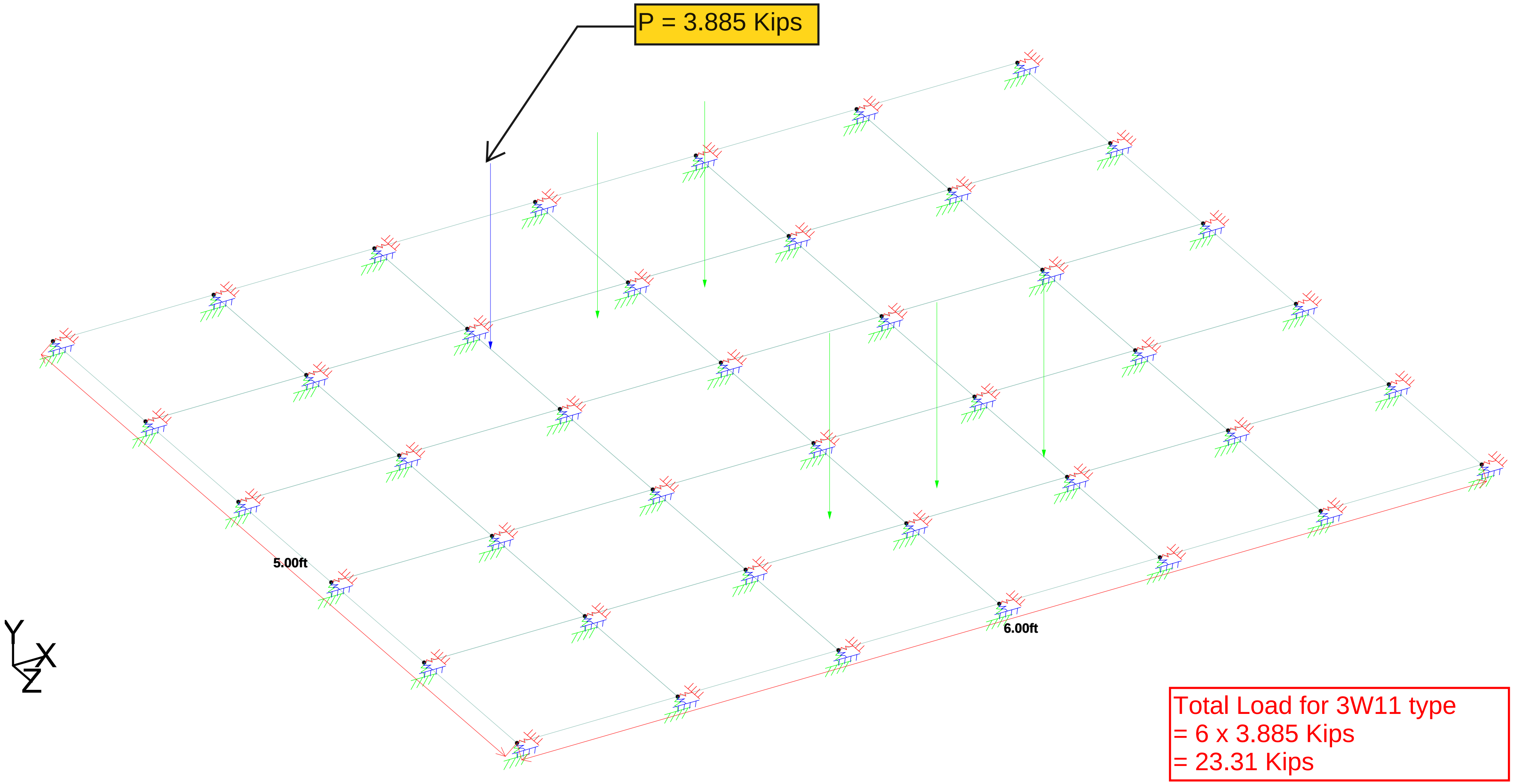
Client SSL	File Panel Check - 5x6 type A	Date/Time 06-Mar-2021 17:19	



Software licensed to Optimal Engineering Support

Job No	Sheet No	Rev
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Part

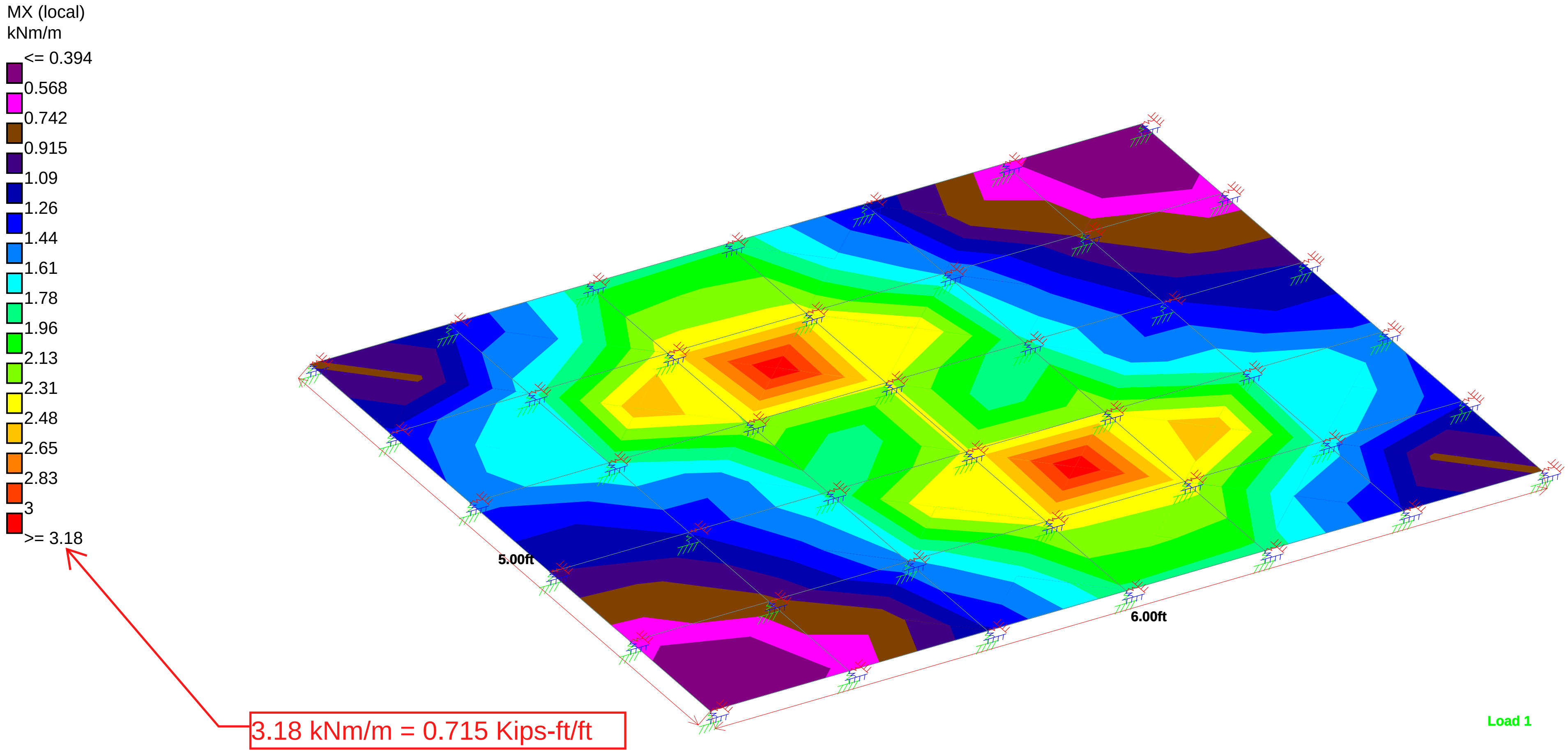
Ref Panel Check

By CH Date 04-Mar-21 Chd

Job Title

Client SSL

File Panel Check - 5x6 type A Date/Time 06-Mar-2021 17:19



Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
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Job Title	Ref Panel Check		
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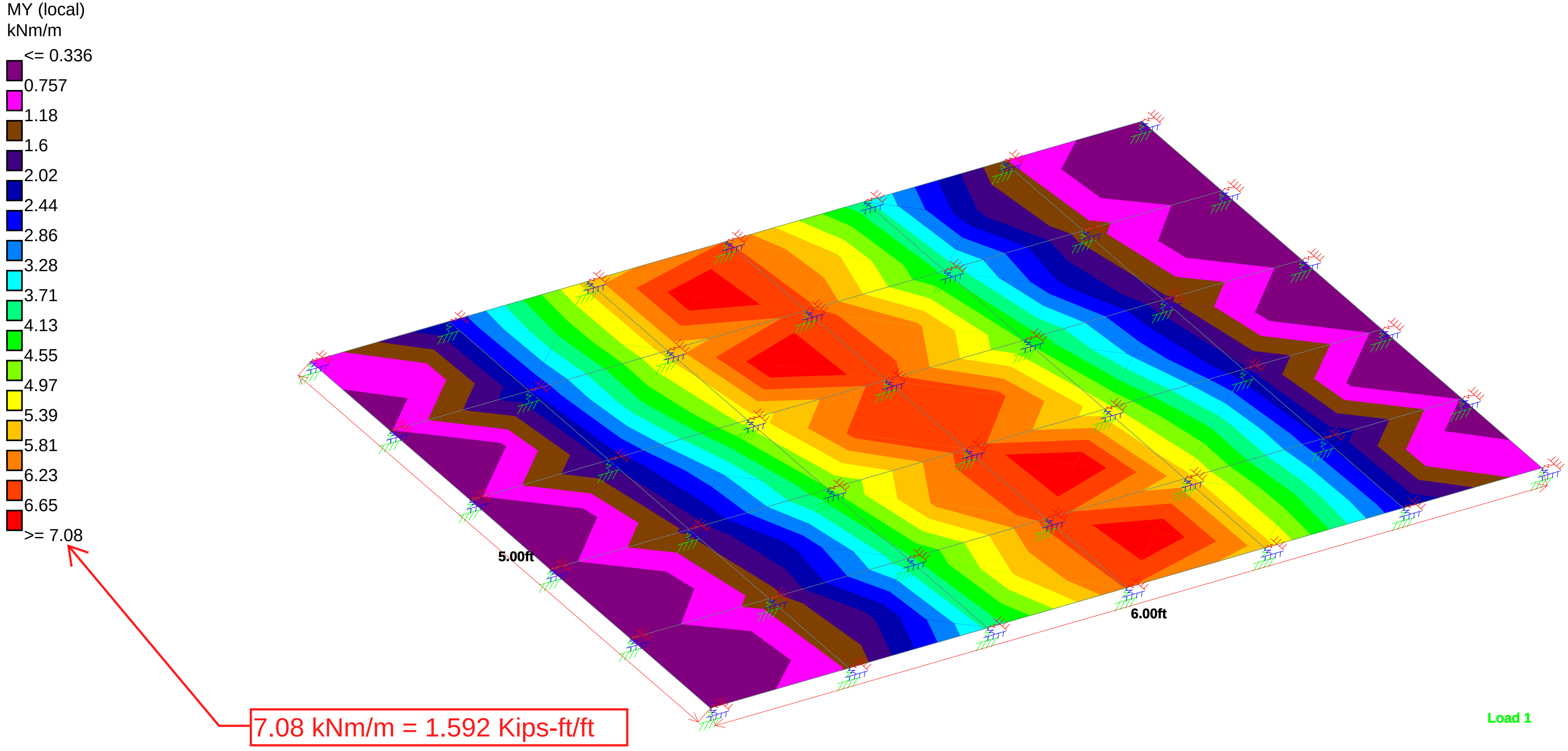
Client SSL	File Panel Check - 5x6 type A	Date/Time 06-Mar-2021 17:19	



Software licensed to Optimal Engineering Support

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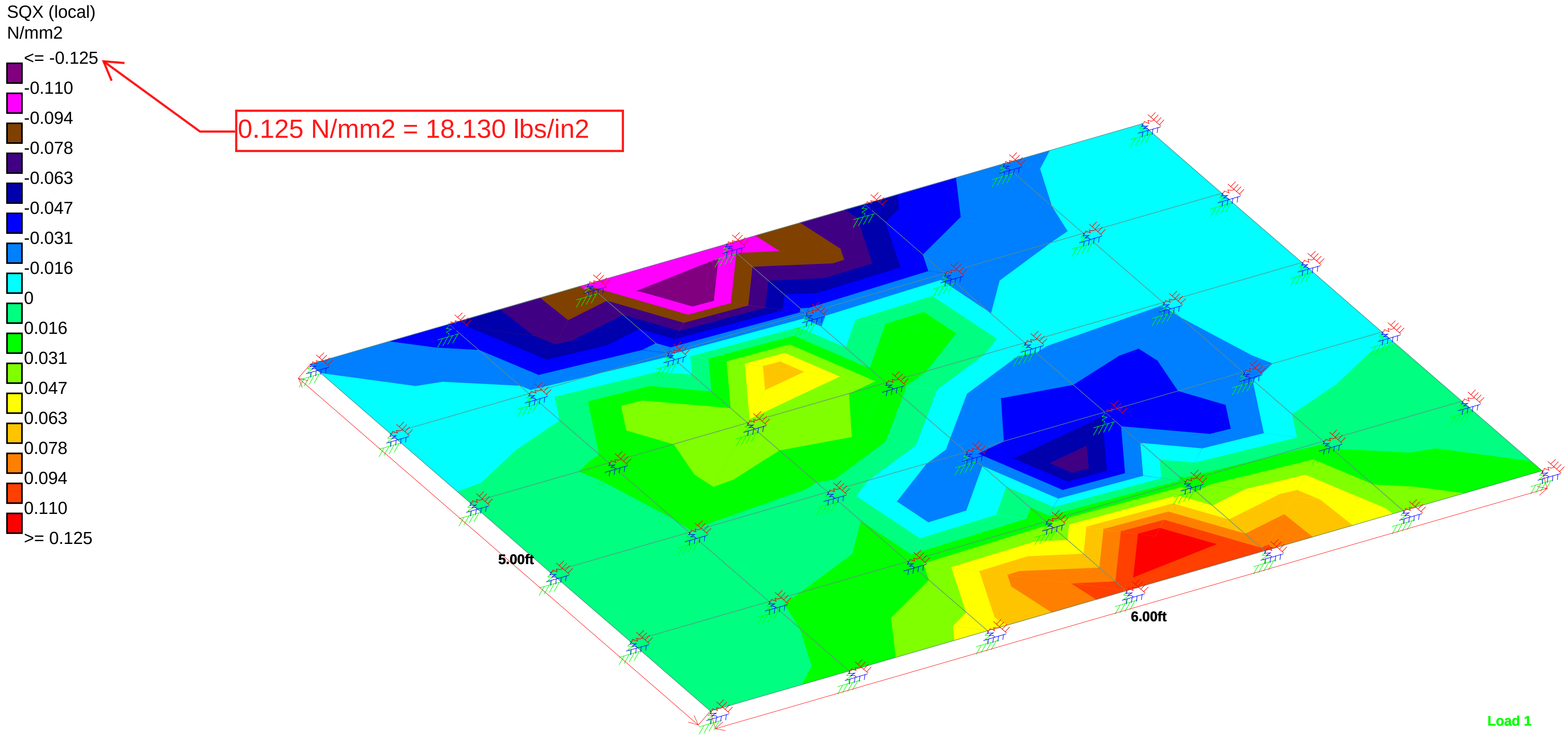

Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
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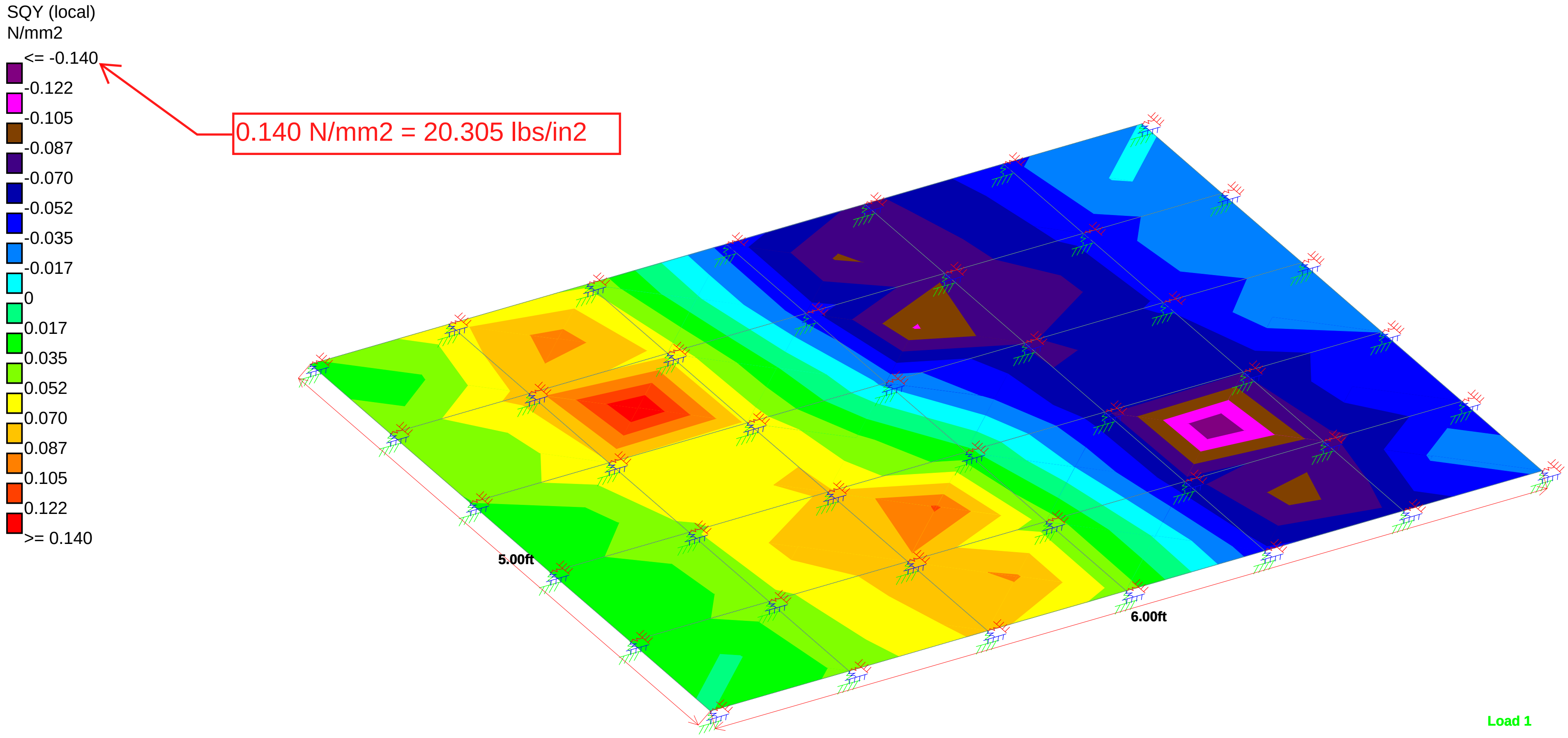

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*          Research Engineers,  Intl.                 *
*          Date=    MAR  6, 2021                      *
*          Time=    17:20:17                          *
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     3. ENGINEER DATE 04-MAR-21
     4. JOB CLIENT SSL
     5. ENGINEER NAME CH
     6. JOB REF PANEL CHECK
     7. END JOB INFORMATION
     8. INPUT WIDTH 79
     9. UNIT FEET KIP
    10. JOINT COORDINATES
    11. 1 0 0 0; 2 1 0 0; 3 2 0 0; 4 3 0 0; 5 4 0 0; 6 5 0 0; 7 6 0 0; 10 0 0 -1.
    12. 11 1 0 -1; 12 2 0 -1; 13 3 0 -1; 14 4 0 -1; 15 5 0 -1; 16 6 0 -1; 19 0 0 -2
    13. 20 1 0 -2; 21 2 0 -2; 22 3 0 -2; 23 4 0 -2; 24 5 0 -2; 25 6 0 -2; 28 0 0 -3
    14. 29 1 0 -3; 30 2 0 -3; 31 3 0 -3; 32 4 0 -3; 33 5 0 -3; 34 6 0 -3; 45 0 0 -4
    15. 46 1 0 -4; 47 2 0 -4; 48 3 0 -4; 49 4 0 -4; 50 5 0 -4; 51 6 0 -4; 56 0 0 -5
    16. 57 1 0 -5; 58 2 0 -5; 59 3 0 -5; 60 4 0 -5; 61 5 0 -5; 62 6 0 -5
    17. ELEMENT INCIDENCES SHELL
    18. 1 1 10 11 2; 2 10 19 20 11; 3 19 28 29 20; 4 2 11 12 3; 5 11 20 21 12
    19. 6 20 29 30 21; 7 3 12 13 4; 8 12 21 22 13; 9 21 30 31 22; 10 4 13 14 5
    20. 11 13 22 23 14; 12 22 31 32 23; 13 5 14 15 6; 14 14 23 24 15; 15 23 32 33 24
    21. 16 6 15 16 7; 17 15 24 25 16; 18 24 33 34 25; 31 28 45 46 29; 32 29 46 47 30
    22. 33 30 47 48 31; 34 31 48 49 32; 35 32 49 50 33; 36 33 50 51 34; 41 45 56 57 46
    23. 42 46 57 58 47; 43 47 58 59 48; 44 48 59 60 49; 45 49 60 61 50; 46 50 61 62 51
    24. ELEMENT PROPERTY
    25. 1 TO 18 31 TO 36 41 TO 46 THICKNESS 0.5
    26. DEFINE MATERIAL START
    27. ISOTROPIC CONCRETE
    28. E 614304
    29. POISSON 0.17
    30. DENSITY 0.15
    31. ALPHA 1E-005
    32. DAMP 0.05
    33. END DEFINE MATERIAL
    34. CONSTANTS
    35. MATERIAL CONCRETE ALL
    36. SUPPORTS
    37. 1 TO 7 10 TO 16 19 TO 25 28 TO 34 45 TO 51 56 TO 61 -
    38. 62 FIXED BUT KFX 839.76 KFY 839.76 KFZ 839.76 KMX 1 KMY 1 KMZ 1
    39. LOAD 1 LOADTYPE PUSH  TITLE WIRE STRENGTH
    40. ELEMENT LOAD
```

4266 ksi = 614304 KSF

839.76 KIP/FT, see spring constant selection/calcs


```
    41. 32 PR GY -3.885 0.25 0.5
    42. 33 PR GY -3.885 0.25 0.1667
    43. 34 PR GY -3.885 0.25 -0.1667
    44. 8 PR GY -3.885 -0.25 0.1667
    45. 11 PR GY -3.885 -0.25 -0.1667
    46. 11 PR GY -3.885 -0.25 0.5
    47. PERFORM ANALYSIS
```

P R O B L E M   S T A T I S T I C S

```
NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =    42/    30/    42

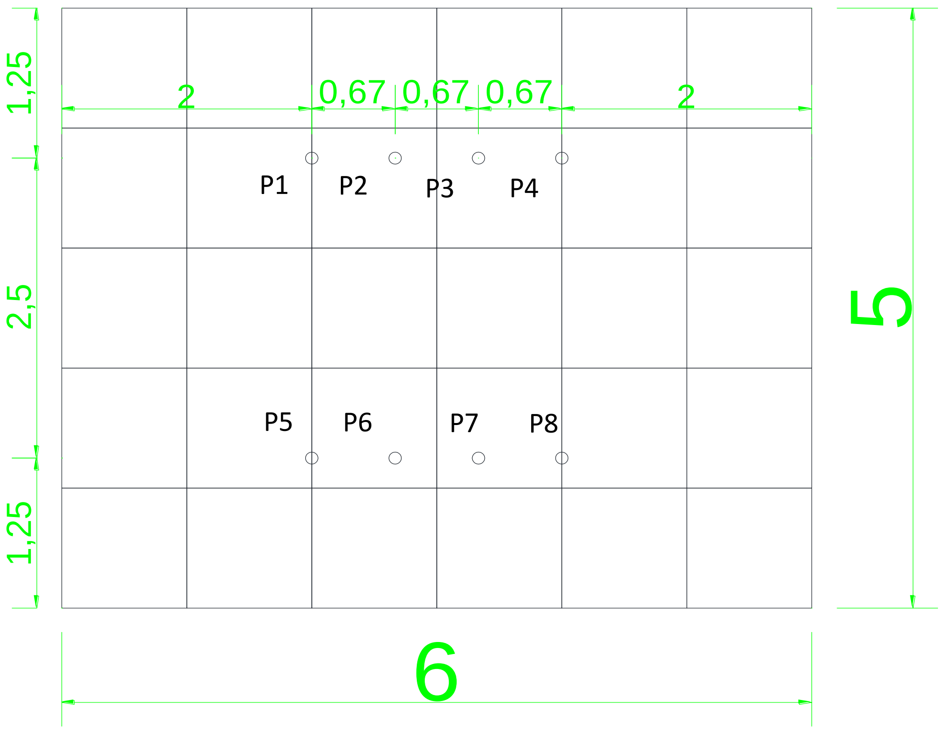
      SOLVER USED IS THE OUT-OF-CORE BASIC SOLVER

ORIGINAL/FINAL BAND-WIDTH=     8/     8/     54 DOF
TOTAL PRIMARY LOAD CASES =     1, TOTAL DEGREES OF FREEDOM =    252
SIZE OF STIFFNESS MATRIX =       14 DOUBLE  KILO-WORDS
REQRD/AVAIL. DISK SPACE  =     12.3/ 263443.7 MB
```

```
    48. FINISH
```

Typical Panel Type (mesh 4W11), Panel Thickness 6", 5'x6'

Point load Input Force in panel for Staad Pro input



Location	Coordinated From Center Panel 1'x1'	
	X	Y
P1	0.5	0.25
P2	0.1667	0.25
P3	-0.1667	0.25
P4	0.5	0.25
P5	0.5	-0.25
P6	0.1667	-0.25
P7	-0.1667	-0.25
P8	0.5	-0.25

Load to panel based on Bar Mat Capacity per Bar Mat Point

Bar Mat Used:

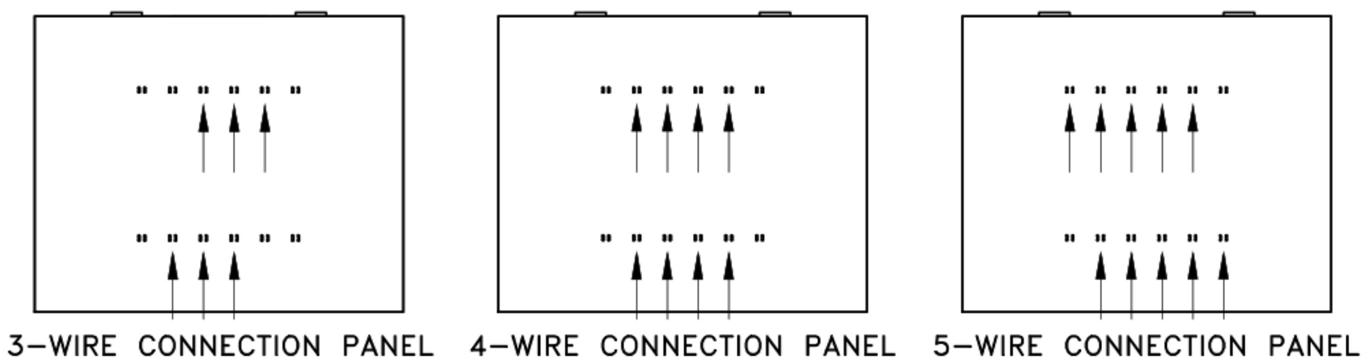
W11 - 75 Years

A = 0.0797 in^2

Fy = 75 ksi

P = 0.65 x A x Fy

= 3.885 Kips (per wire point)

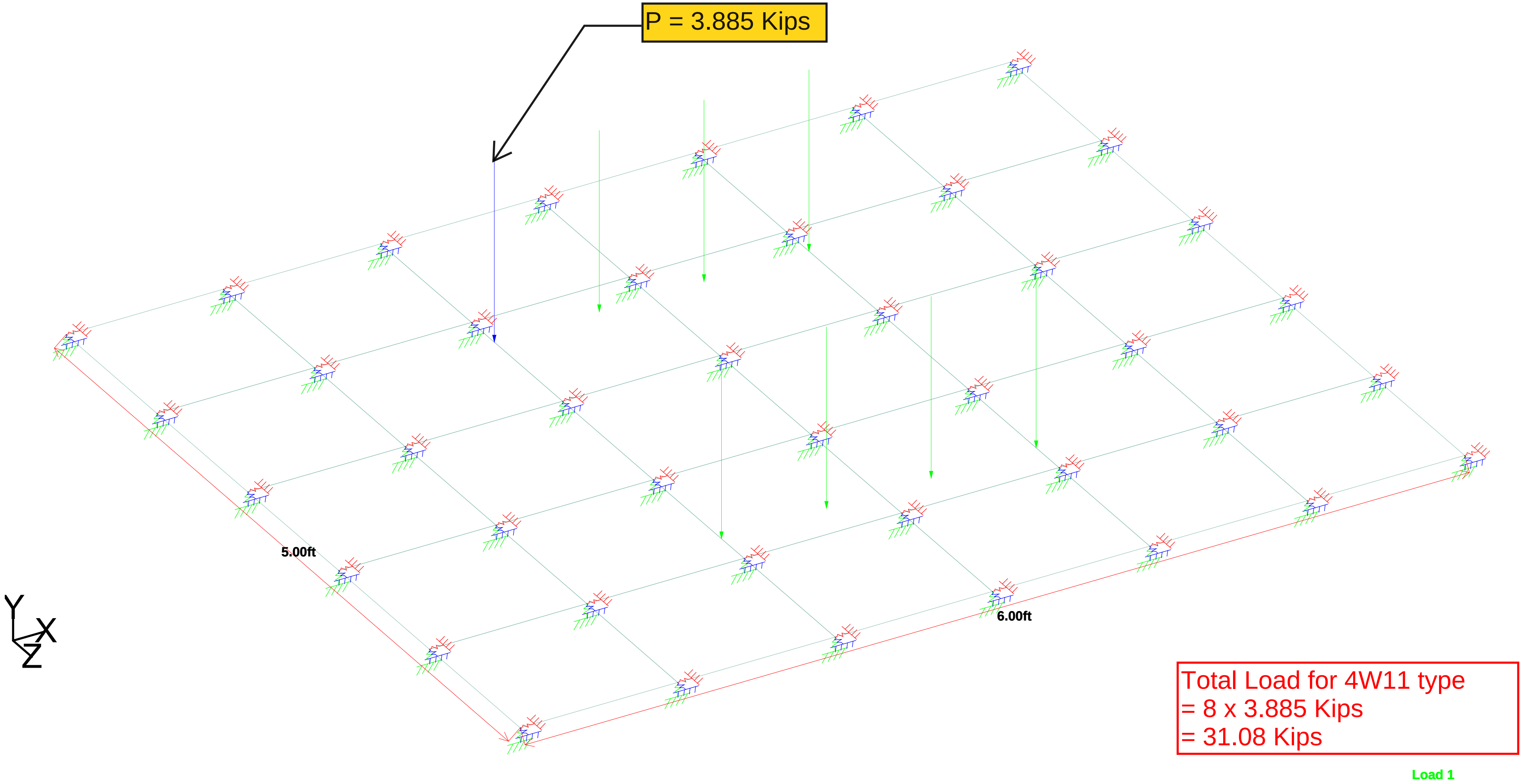


ATTACHMENT BY No. WIRES

(STANDARD PANELS ONLY)

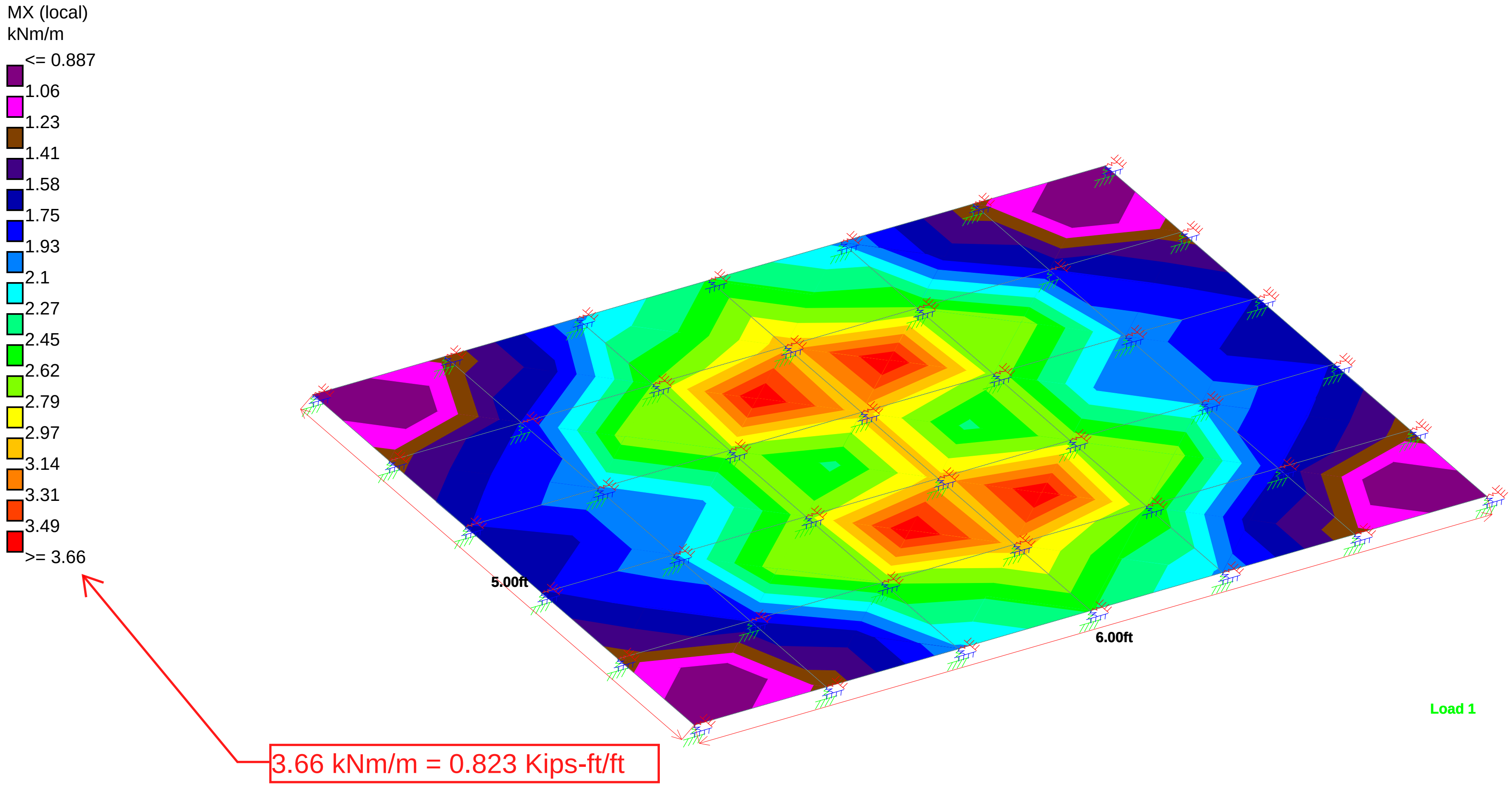
Software licensed to Optimal Engineering Support

Job No	Sheet No 1	Rev	
Part			
Job Title	Ref Panel Check		
	By CH	Date 04-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 06-Mar-2021 18:25	



Software licensed to Optimal Engineering Support

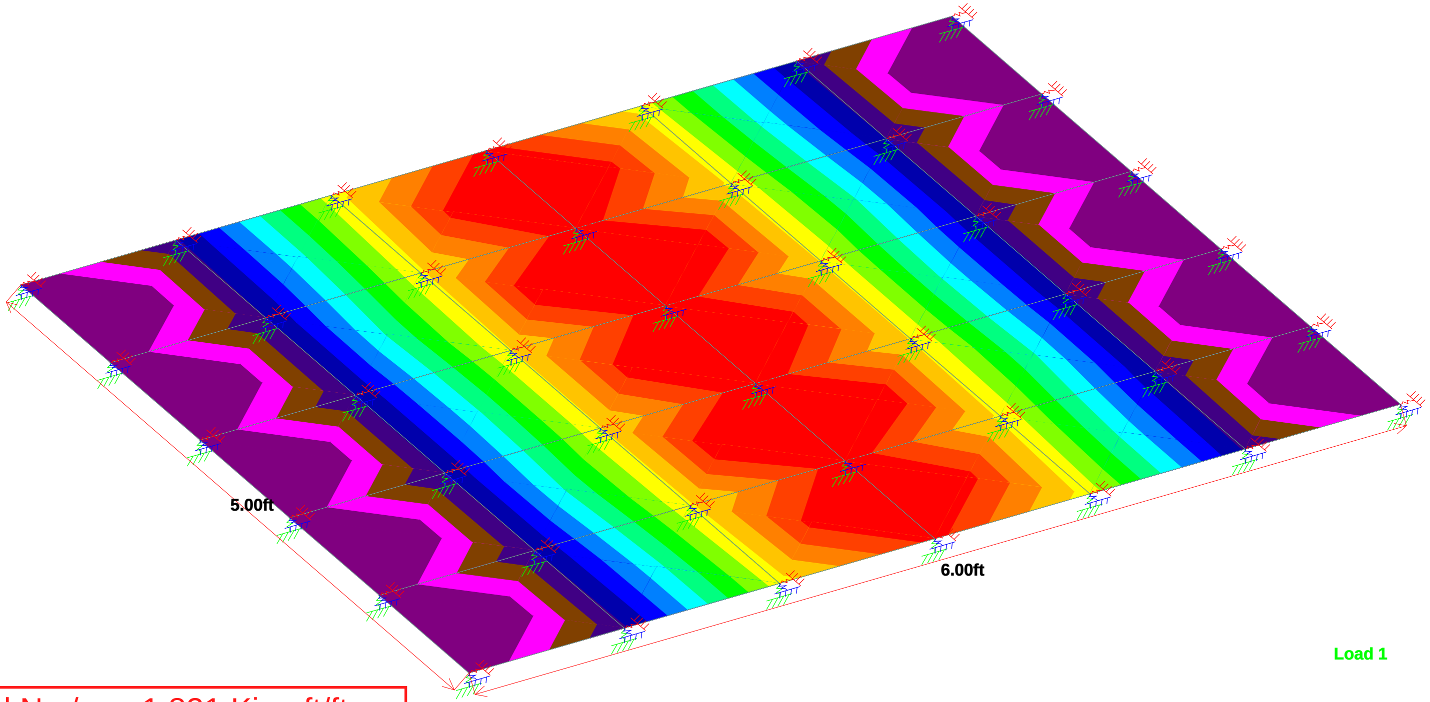
	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 04-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 06-Mar-2021 18:25	



Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 04-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 06-Mar-2021 18:25	

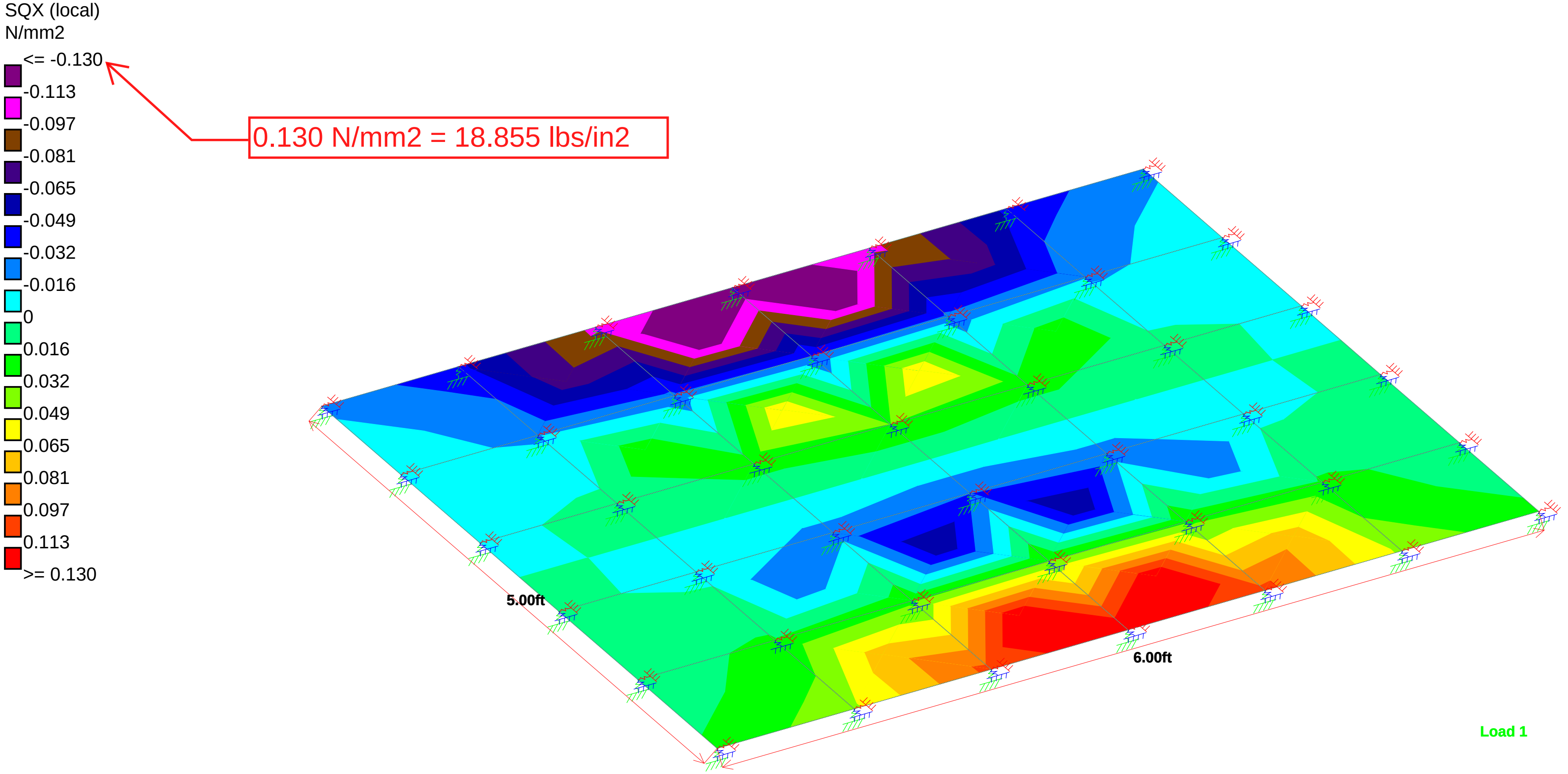
MY (local)
kNm/m

<= 0.788
1.24
1.7
2.16
2.62
3.07
3.53
3.99
4.44
4.9
5.36
5.81
6.27
6.73
7.18
7.64
>= 8.1

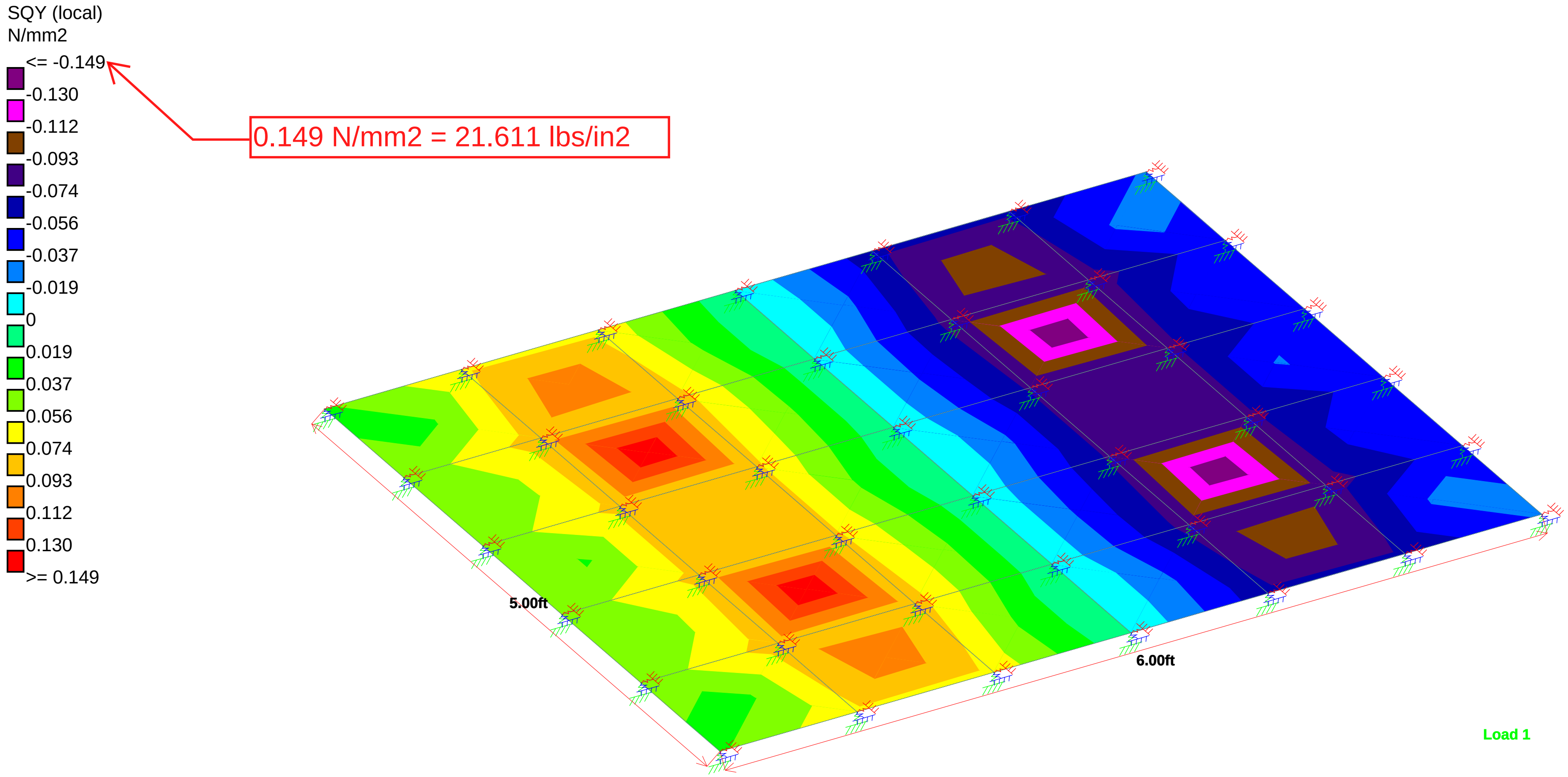


8.1 kNm/m = 1.821 Kips-ft/ft

Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 04-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 06-Mar-2021 18:25	



Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 04-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 06-Mar-2021 18:25	



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*                                                  *
*          STAAD.Pro                               *
*          Version  2007    Build 04               *
*          Proprietary Program of                  *
*          Research Engineers,  Intl.              *
*          Date=    MAR  6, 2021                   *
*          Time=    18:25: 0                       *
*                                                  *
*      USER ID: Optimal Engineering Support        *
****************************************************
```

```
     1. STAAD SPACE
INPUT FILE: Panel Check - 5x6 type A (4W11).STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 04-MAR-21
     4. JOB CLIENT SSL
     5. ENGINEER NAME CH
     6. JOB REF PANEL CHECK
     7. END JOB INFORMATION
     8. INPUT WIDTH 79
     9. UNIT FEET KIP
    10. JOINT COORDINATES
    11. 1 0 0 0; 2 1 0 0; 3 2 0 0; 4 3 0 0; 5 4 0 0; 6 5 0 0; 7 6 0 0; 10 0 0 -1.
    12. 11 1 0 -1; 12 2 0 -1; 13 3 0 -1; 14 4 0 -1; 15 5 0 -1; 16 6 0 -1; 19 0 0 -2
    13. 20 1 0 -2; 21 2 0 -2; 22 3 0 -2; 23 4 0 -2; 24 5 0 -2; 25 6 0 -2; 28 0 0 -3
    14. 29 1 0 -3; 30 2 0 -3; 31 3 0 -3; 32 4 0 -3; 33 5 0 -3; 34 6 0 -3; 45 0 0 -4
    15. 46 1 0 -4; 47 2 0 -4; 48 3 0 -4; 49 4 0 -4; 50 5 0 -4; 51 6 0 -4; 56 0 0 -5
    16. 57 1 0 -5; 58 2 0 -5; 59 3 0 -5; 60 4 0 -5; 61 5 0 -5; 62 6 0 -5
    17. ELEMENT INCIDENCES SHELL
    18. 1 1 10 11 2; 2 10 19 20 11; 3 19 28 29 20; 4 2 11 12 3; 5 11 20 21 12
    19. 6 20 29 30 21; 7 3 12 13 4; 8 12 21 22 13; 9 21 30 31 22; 10 4 13 14 5
    20. 11 13 22 23 14; 12 22 31 32 23; 13 5 14 15 6; 14 14 23 24 15; 15 23 32 33 24
    21. 16 6 15 16 7; 17 15 24 25 16; 18 24 33 34 25; 31 28 45 46 29; 32 29 46 47 30
    22. 33 30 47 48 31; 34 31 48 49 32; 35 32 49 50 33; 36 33 50 51 34; 41 45 56 57 46
    23. 42 46 57 58 47; 43 47 58 59 48; 44 48 59 60 49; 45 49 60 61 50; 46 50 61 62 51
    24. ELEMENT PROPERTY
    25. 1 TO 18 31 TO 36 41 TO 46 THICKNESS 0.5
    26. DEFINE MATERIAL START
    27. ISOTROPIC CONCRETE
    28. E 614304
    29. POISSON 0.17
    30. DENSITY 0.15
    31. ALPHA 1E-005
    32. DAMP 0.05
    33. END DEFINE MATERIAL
    34. CONSTANTS
    35. MATERIAL CONCRETE ALL
    36. SUPPORTS
    37. 1 TO 7 10 TO 16 19 TO 25 28 TO 34 45 TO 51 56 TO 61 -
    38. 62 FIXED BUT KFX 839.76 KFY 839.76 KFZ 839.76 KMX 1 KMY 1 KMZ 1
    39. LOAD 1 LOADTYPE PUSH TITLE WIRE STRENGTH
    40. ELEMENT LOAD
```

4266 ksi = 614304 KSF

839.76 KIP/FT, see spring constant selection/calcs


```
    41. 32 PR GY -3.885 0.25 0.5
    42. 33 PR GY -3.885 0.25 0.1667
    43. 34 PR GY -3.885 0.25 -0.1667
    44. 34 PR GY -3.885 0.25 0.5
    45. 5 PR GY -3.885 -0.25 0.5
    46. 8 PR GY -3.885 -0.25 0.1667
    47. 11 PR GY -3.885 -0.25 -0.1667
    48. 11 PR GY -3.885 -0.25 0.5
    49. PERFORM ANALYSIS
```

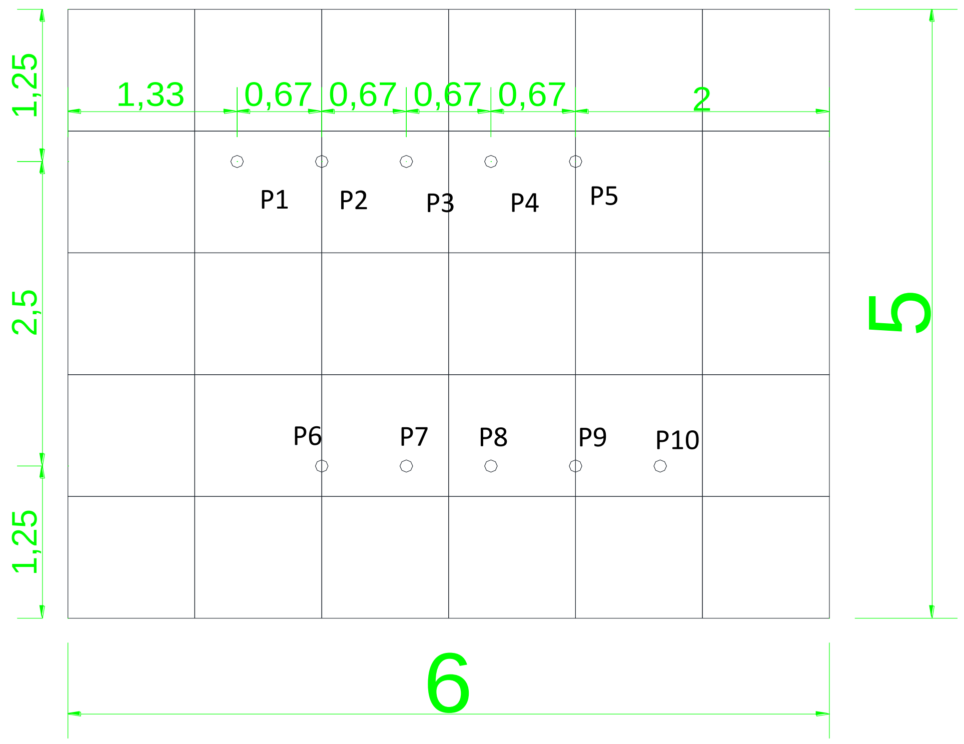
P R O B L E M   S T A T I S T I C S

```
NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =    42/    30/    42

      SOLVER USED IS THE OUT-OF-CORE BASIC SOLVER

ORIGINAL/FINAL BAND-WIDTH=     8/     8/     54 DOF
TOTAL PRIMARY LOAD CASES =     1, TOTAL DEGREES OF FREEDOM =    252
SIZE OF STIFFNESS MATRIX =       14 DOUBLE  KILO-WORDS
REQRD/AVAIL. DISK SPACE  =     12.3/ 263441.7 MB
```

```
    50. FINISH
```

Typical Panel Type (mesh 5W11), Panel Thickness 6", 5'x6'

Point load Input Force in panel for Staad Pro input



Location	Coordinated From Center Panel 1'x1'	
	X	Y
P1	-0.1667	0.25
P2	0.5	0.25
P3	0.1667	0.25
P4	-0.1667	0.25
P5	0.5	0.25
P6	0.5	-0.25
P7	0.1667	-0.25
P8	-0.1667	-0.25
P9	0.5	-0.25
P10	0.1667	-0.25

Load to panel based on Bar Mat Capacity per Bar Mat Point

Bar Mat Used:

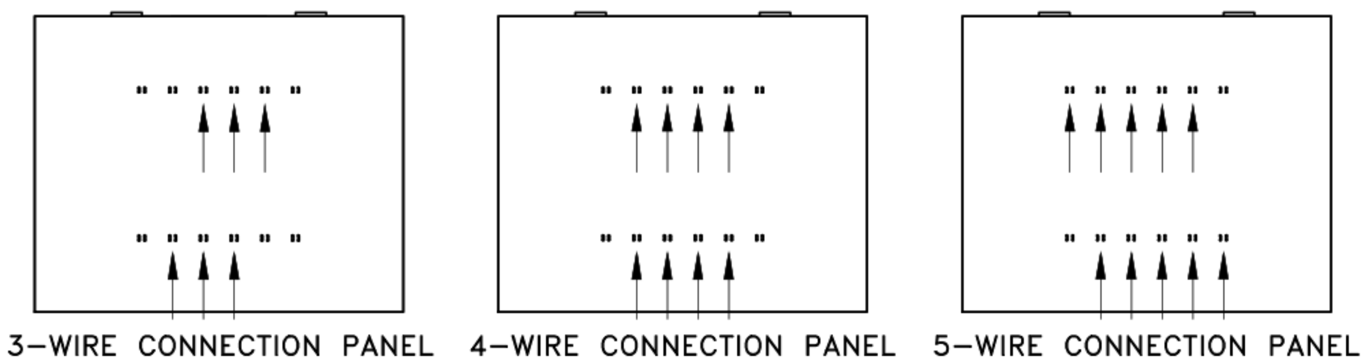
W11 - 75 Years

A = 0.0797 in^2

Fy = 75 ksi

P = 0.65 x A x Fy

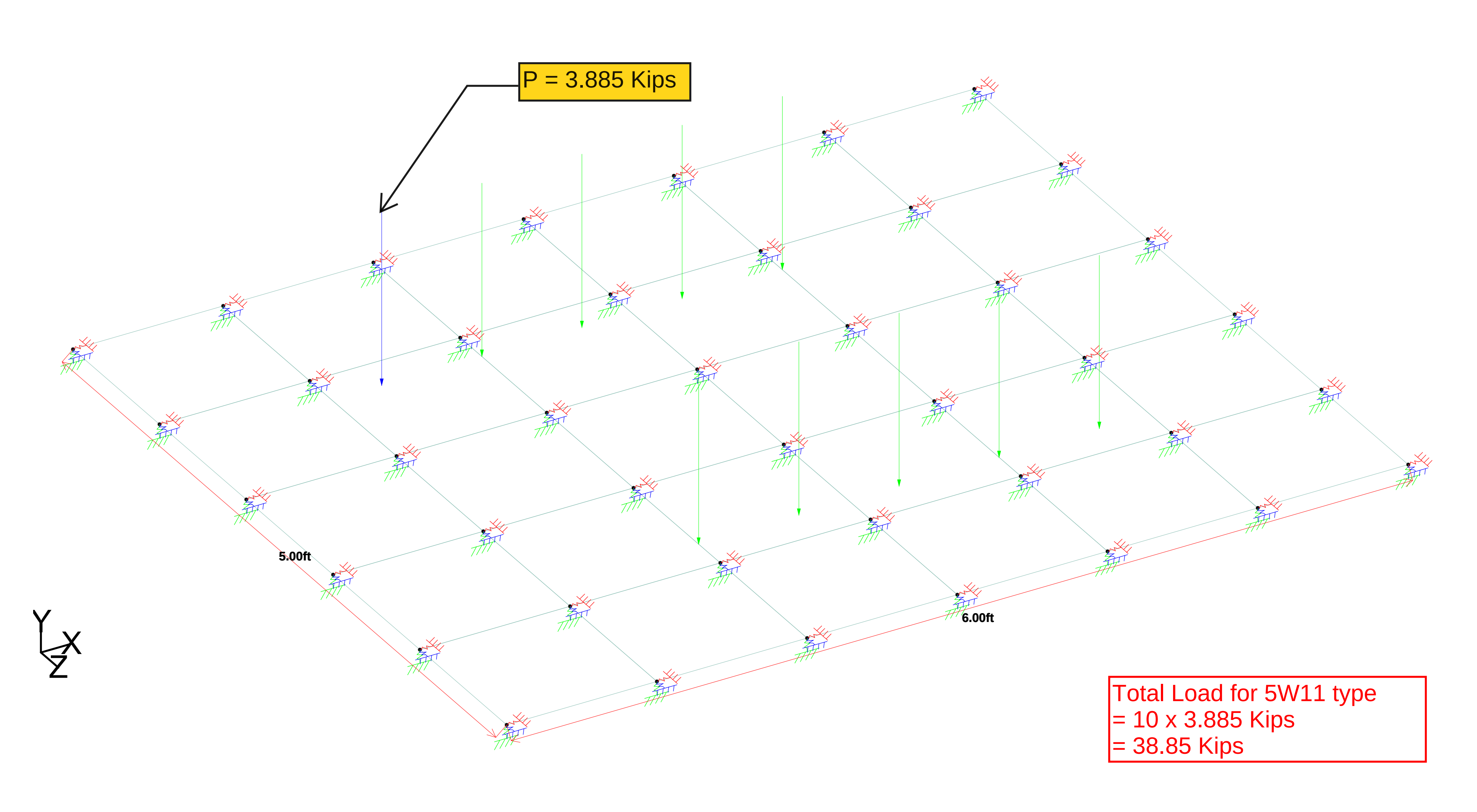
= 3.885 Kips (per wire point)



ATTACHMENT BY No. WIRES

(STANDARD PANELS ONLY)

Software licensed to Optimal Engineering Support	Job No	Sheet No **1**	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 04-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 06-Mar-2021 21:36	

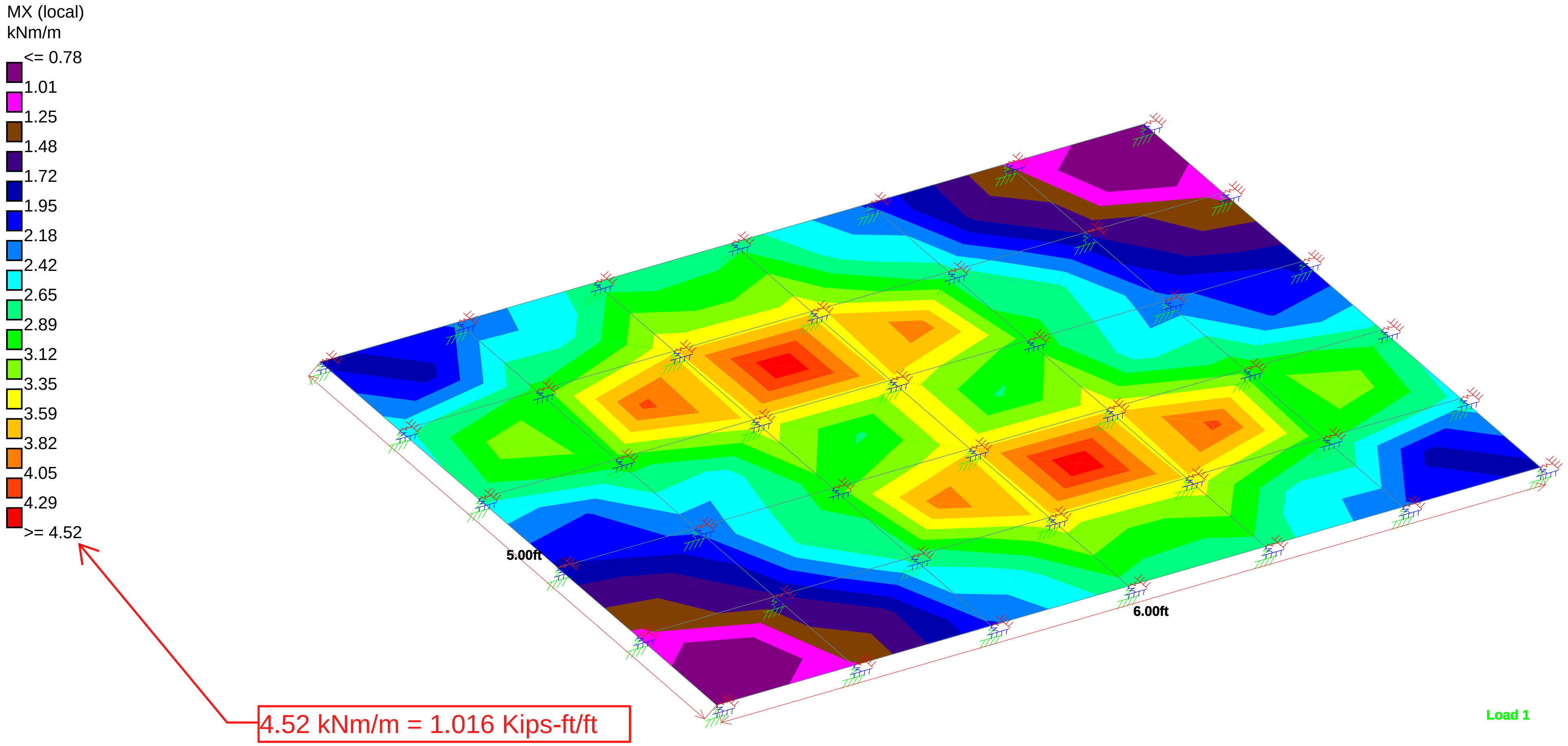


Software licensed to Optimal Engineering Support

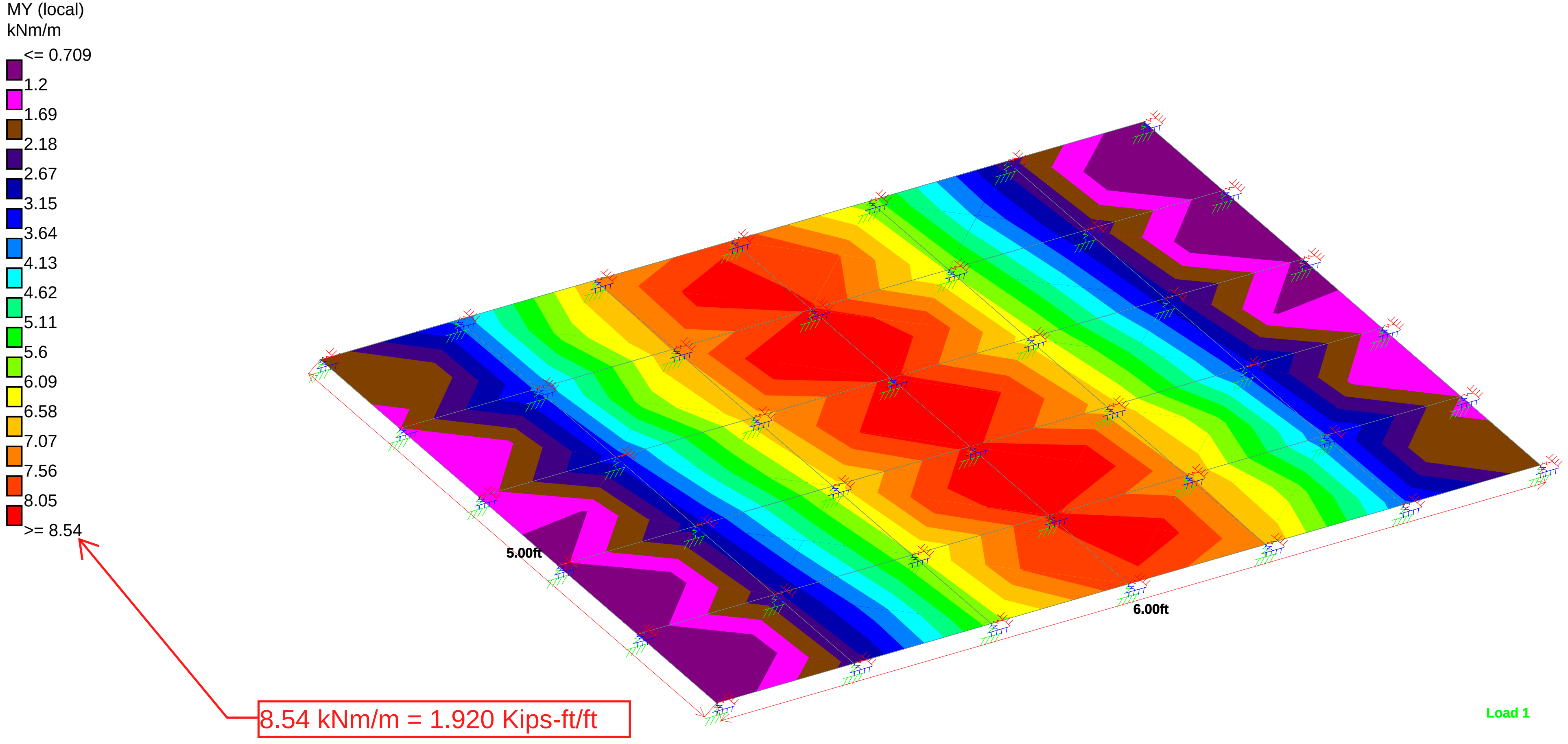
Job No	Sheet No 1		Rev
Part			
Ref Panel Check			
By CH	Date 04-Mar-21	Chd	
File Panel Check - 5x6 type A	Date/Time 06-Mar-2021 21:36		

Job Title

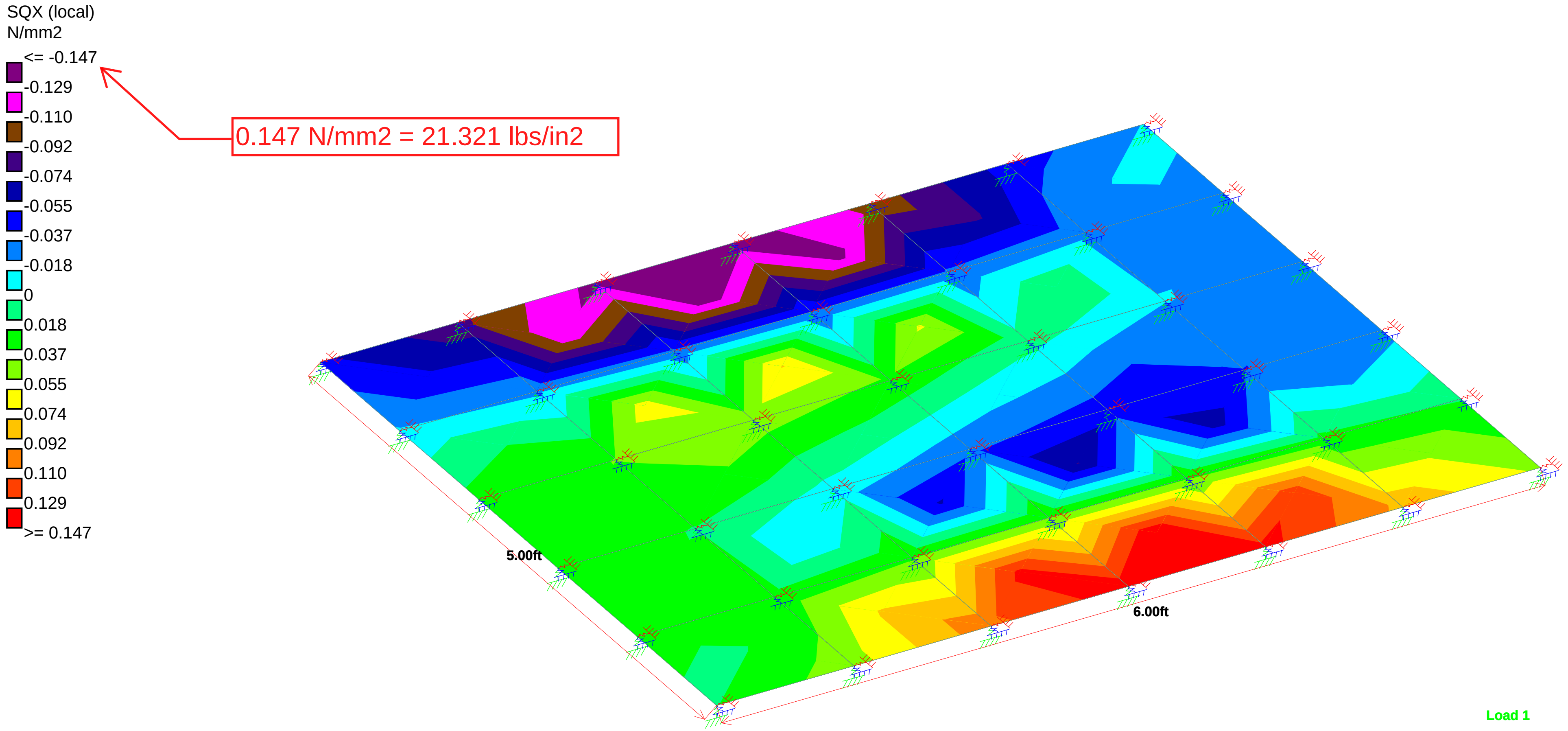
Client SSL



Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 04-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 06-Mar-2021 21:36	

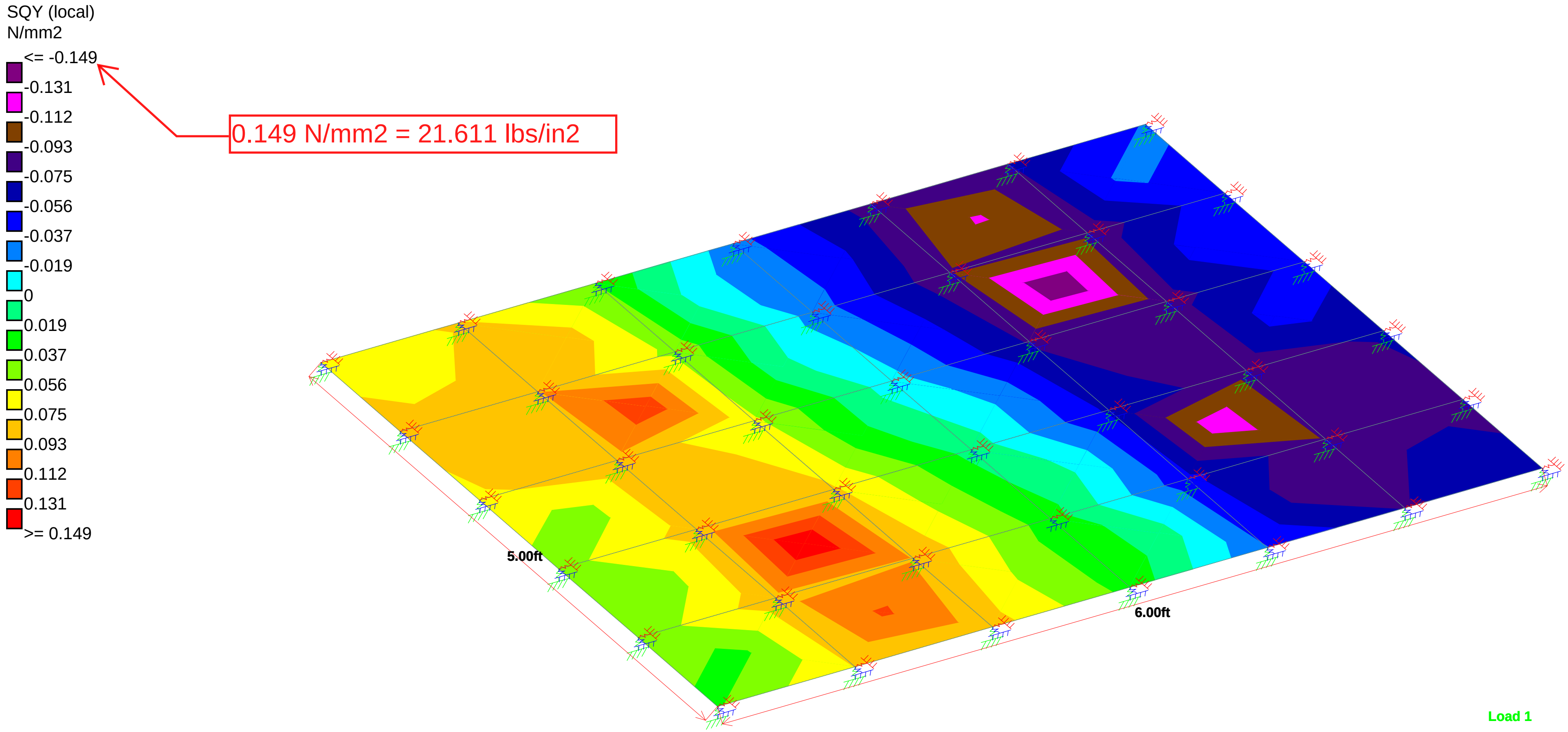


Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 04-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 06-Mar-2021 21:36	



Software licensed to Optimal Engineering Support

Job No	Sheet No 1	Rev	
Part			
Job Title	Ref Panel Check		
	By CH	Date 04-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 06-Mar-2021 21:36	



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*           STAAD.Pro                              *
*           Version  2007    Build 04              *
*           Proprietary Program of                 *
*           Research Engineers,  Intl.             *
*           Date=    MAR  6, 2021                  *
*           Time=    21:36:18                      *
*                                                  *
*      USER ID: Optimal Engineering Support        *
****************************************************
```

```
     1. STAAD SPACE
INPUT FILE: Panel Check - 5x6 type A (5W11).STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 04-MAR-21
     4. JOB CLIENT SSL
     5. ENGINEER NAME CH
     6. JOB REF PANEL CHECK
     7. END JOB INFORMATION
     8. INPUT WIDTH 79
     9. UNIT FEET KIP
    10. JOINT COORDINATES
    11. 1 0 0 0; 2 1 0 0; 3 2 0 0; 4 3 0 0; 5 4 0 0; 6 5 0 0; 7 6 0 0; 10 0 0 -1.
    12. 11 1 0 -1; 12 2 0 -1; 13 3 0 -1; 14 4 0 -1; 15 5 0 -1; 16 6 0 -1; 19 0 0 -2
    13. 20 1 0 -2; 21 2 0 -2; 22 3 0 -2; 23 4 0 -2; 24 5 0 -2; 25 6 0 -2; 28 0 0 -3
    14. 29 1 0 -3; 30 2 0 -3; 31 3 0 -3; 32 4 0 -3; 33 5 0 -3; 34 6 0 -3; 45 0 0 -4
    15. 46 1 0 -4; 47 2 0 -4; 48 3 0 -4; 49 4 0 -4; 50 5 0 -4; 51 6 0 -4; 56 0 0 -5
    16. 57 1 0 -5; 58 2 0 -5; 59 3 0 -5; 60 4 0 -5; 61 5 0 -5; 62 6 0 -5
    17. ELEMENT INCIDENCES SHELL
    18. 1 1 10 11 2; 2 10 19 20 11; 3 19 28 29 20; 4 2 11 12 3; 5 11 20 21 12
    19. 6 20 29 30 21; 7 3 12 13 4; 8 12 21 22 13; 9 21 30 31 22; 10 4 13 14 5
    20. 11 13 22 23 14; 12 22 31 32 23; 13 5 14 15 6; 14 14 23 24 15; 15 23 32 33 24
    21. 16 6 15 16 7; 17 15 24 25 16; 18 24 33 34 25; 31 28 45 46 29; 32 29 46 47 30
    22. 33 30 47 48 31; 34 31 48 49 32; 35 32 49 50 33; 36 33 50 51 34; 41 45 56 57 46
    23. 42 46 57 58 47; 43 47 58 59 48; 44 48 59 60 49; 45 49 60 61 50; 46 50 61 62 51
    24. ELEMENT PROPERTY
    25. 1 TO 18 31 TO 36 41 TO 46 THICKNESS 0.5
    26. DEFINE MATERIAL START
    27. ISOTROPIC CONCRETE
    28. E 614304
    29. POISSON 0.17
    30. DENSITY 0.15
    31. ALPHA 1E-005
    32. DAMP 0.05
    33. END DEFINE MATERIAL
    34. CONSTANTS
    35. MATERIAL CONCRETE ALL
    36. SUPPORTS
    37. 1 TO 7 10 TO 16 19 TO 25 28 TO 34 45 TO 51 56 TO 61 -
    38. 62 FIXED BUT KFX 839.76 KFY 839.76 KFZ 839.76 KMX 1 KMY 1 KMZ 1
    39. LOAD 1 LOADTYPE PUSH  TITLE WIRE STRENGTH
    40. ELEMENT LOAD
```

4266 ksi = 614304 KSF

839.76 KIP/FT, see spring constant selection/calcs


```
    41. 32 PR GY -3.885 0.25 -0.1667
    42. 32 PR GY -3.885 0.25 0.5
    43. 33 PR GY -3.885 0.25 0.1667
    44. 34 PR GY -3.885 0.25 -0.1667
    45. 34 PR GY -3.885 0.25 0.5
    46. 5 PR GY -3.885 -0.25 0.5
    47. 8 PR GY -3.885 -0.25 0.1667
    48. 11 PR GY -3.885 -0.25 -0.1667
    49. 11 PR GY -3.885 -0.25 0.5
    50. 14 PR GY -3.885 -0.25 0.1667
    51. PERFORM ANALYSIS
```

P R O B L E M   S T A T I S T I C S

```
NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =     42/    30/    42

      SOLVER USED IS THE OUT-OF-CORE BASIC SOLVER

ORIGINAL/FINAL BAND-WIDTH=     8/     8/     54 DOF
TOTAL PRIMARY LOAD CASES =     1, TOTAL DEGREES OF FREEDOM =     252
SIZE OF STIFFNESS MATRIX =       14 DOUBLE  KILO-WORDS
REQRD/AVAIL. DISK SPACE  =     12.3/ 263438.8 MB
```

```
    52. FINISH
```

Typical Panel Type (mesh 6W11), Panel Thickness 6", 5'x6'

Point load Input Force in panel for Staad Pro input

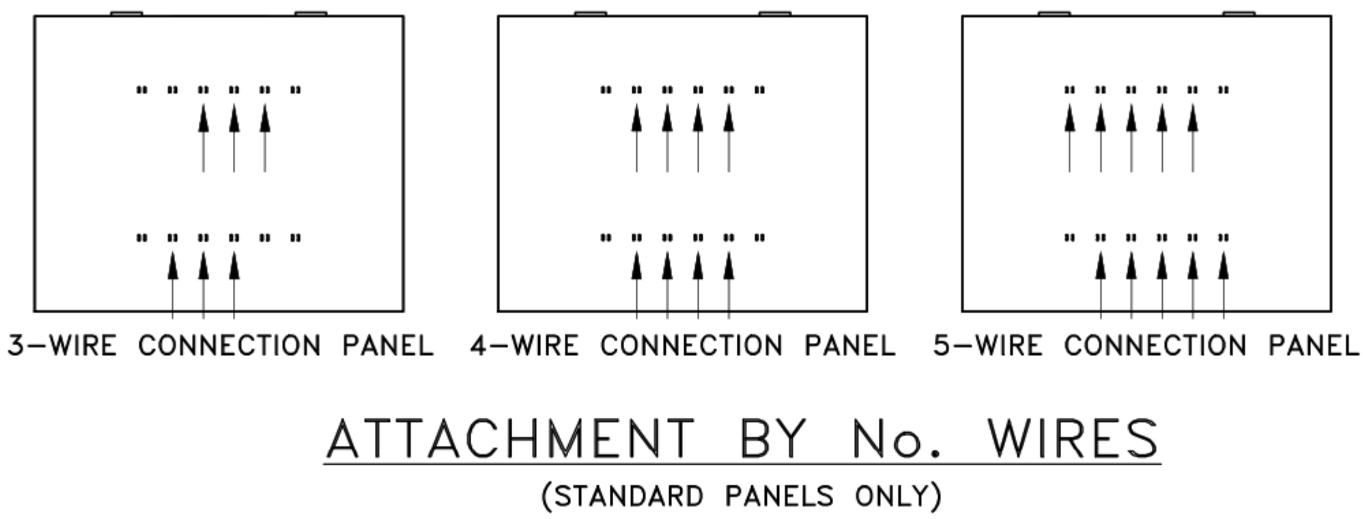
Location	Coordinated From Center Panel 1'x1'	
	X	Y
P1	-0.1667	0.25
P2	0.5	0.25
P3	0.1667	0.25
P4	-0.1667	0.25
P5	0.5	0.25
P6	0.1667	0.25
P7	-0.1667	-0.25
P8	0.5	-0.25
P9	0.1667	-0.25
P10	-0.1667	-0.25
P11	0.5	-0.25
P12	0.1667	-0.25

Load to panel based on Bar Mat Capacity per Bar Mat Point

Bar Mat Used:
W11 - 75 Years

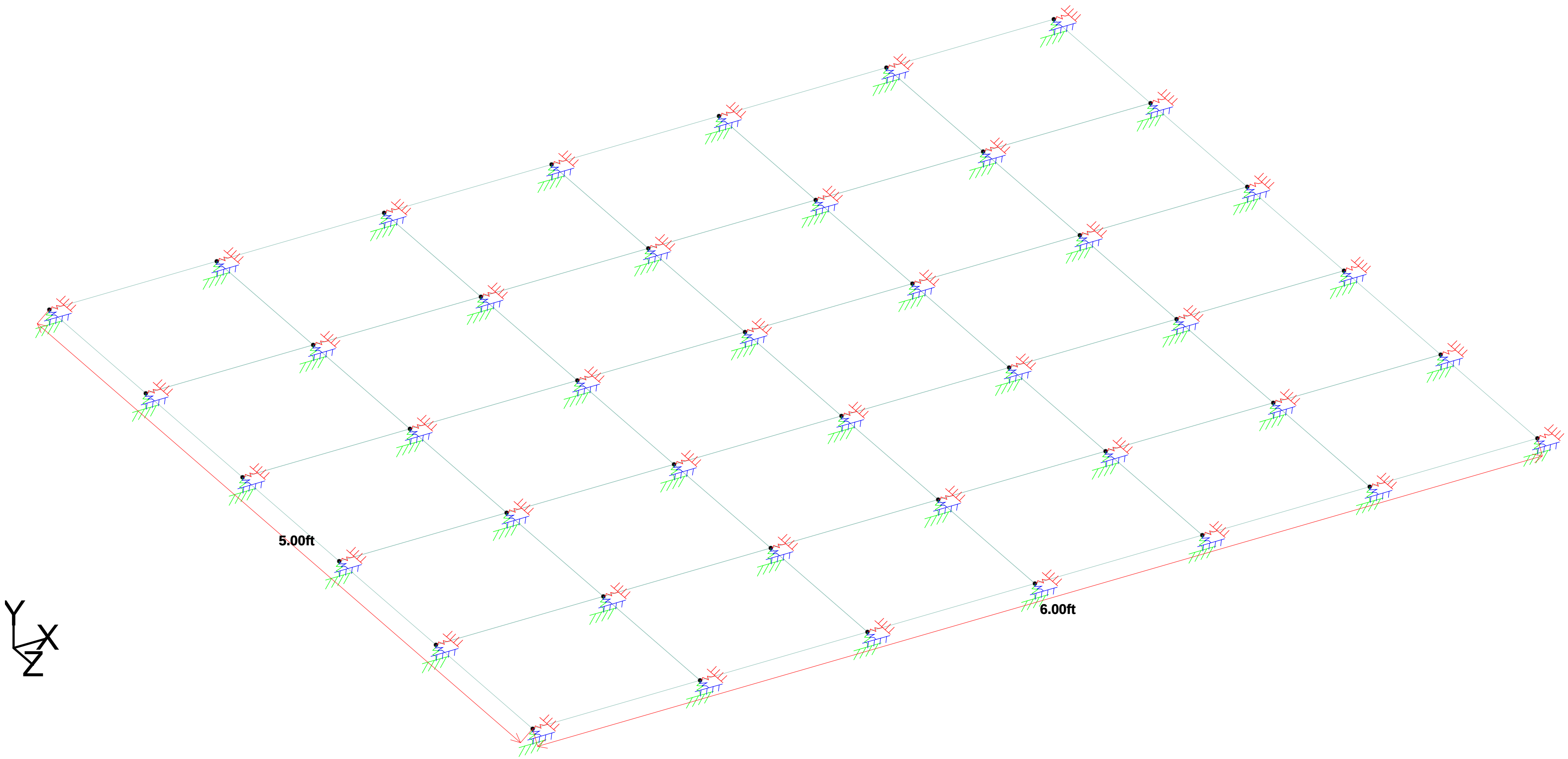
A = 0.0797 in^2
Fy = 75 ksi

P = 0.65 x A x Fy
= 3.885 Kips (per wire point)

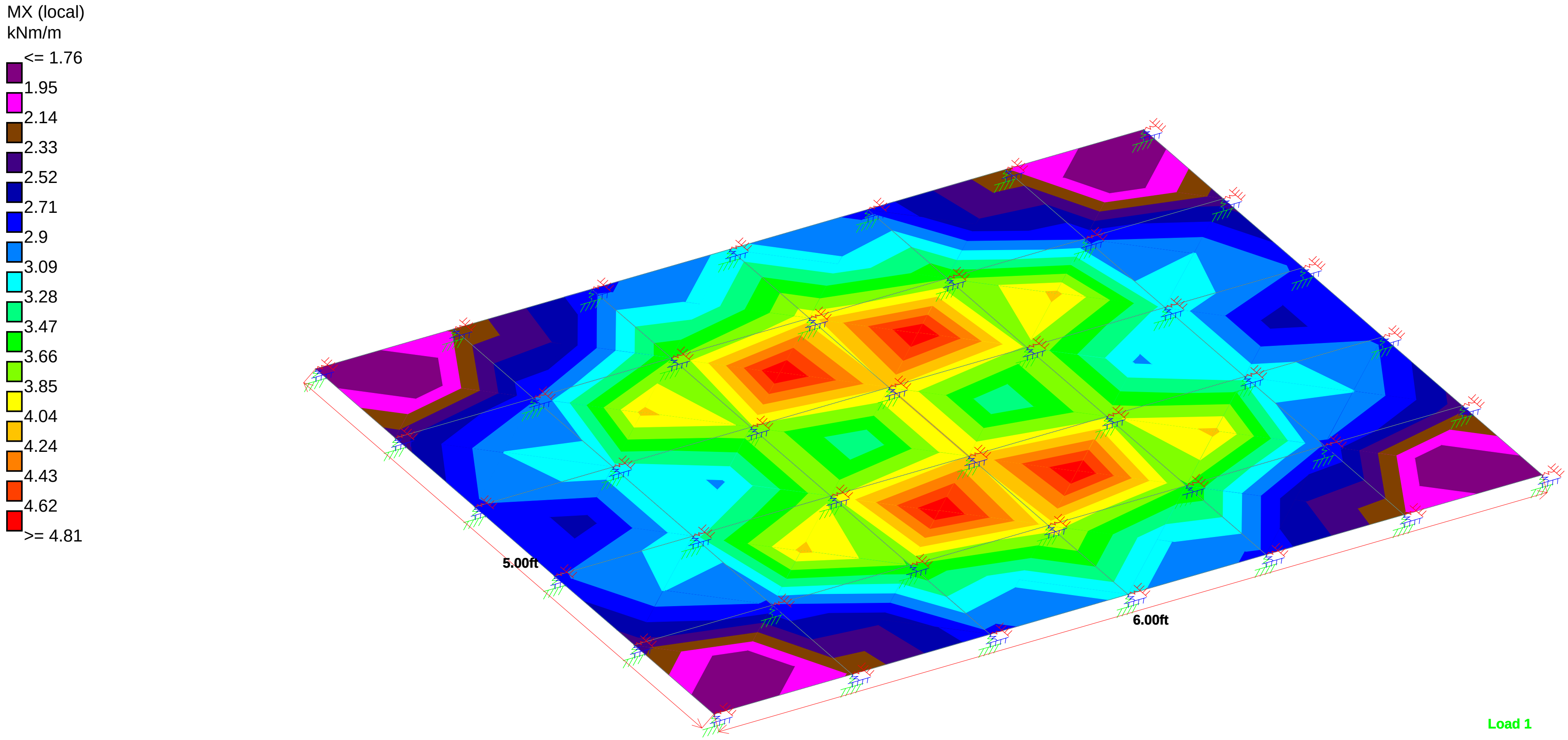


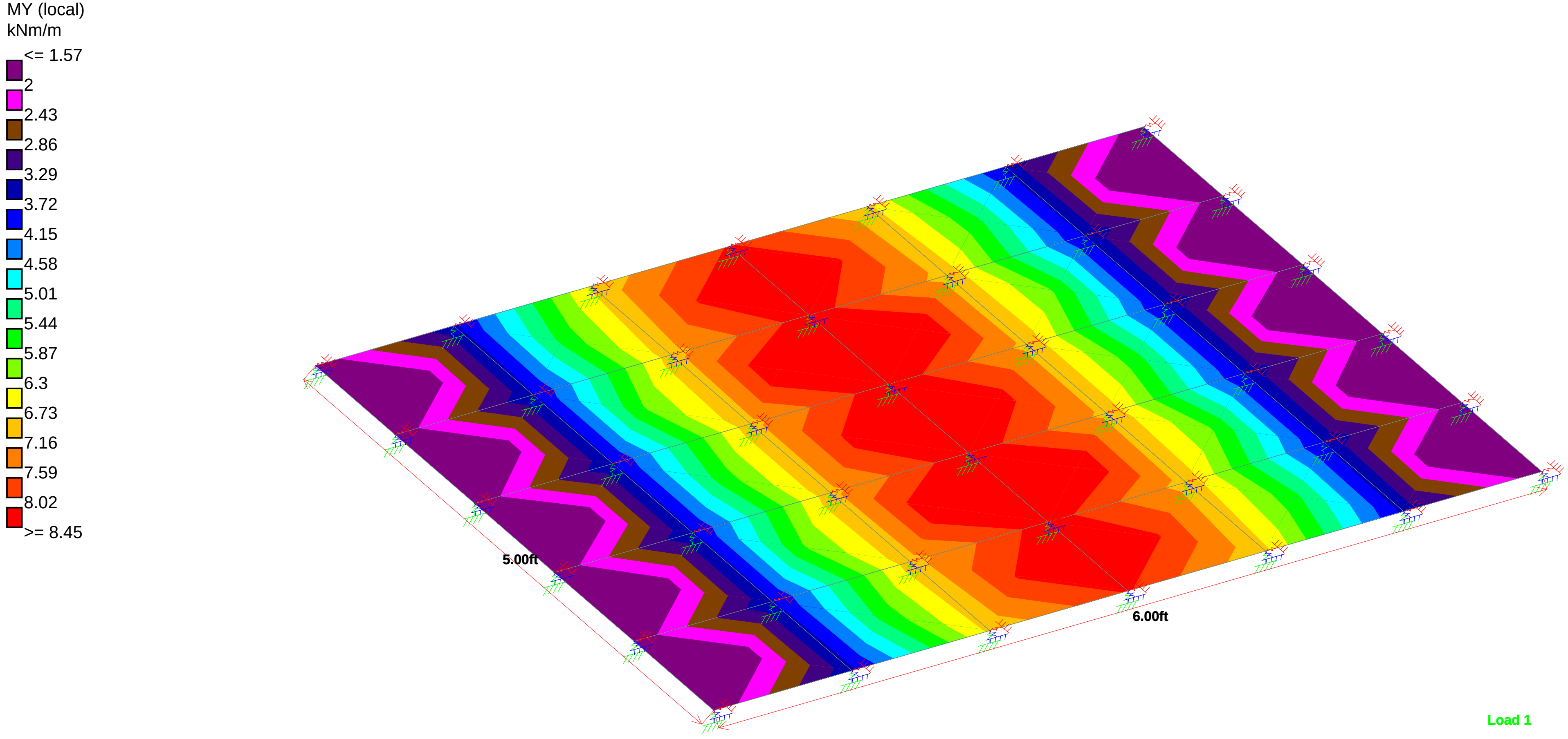
Software licensed to Optimal Engineering Support

	Job No	Sheet No **1**	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 04-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 06-Mar-2021 22:30	



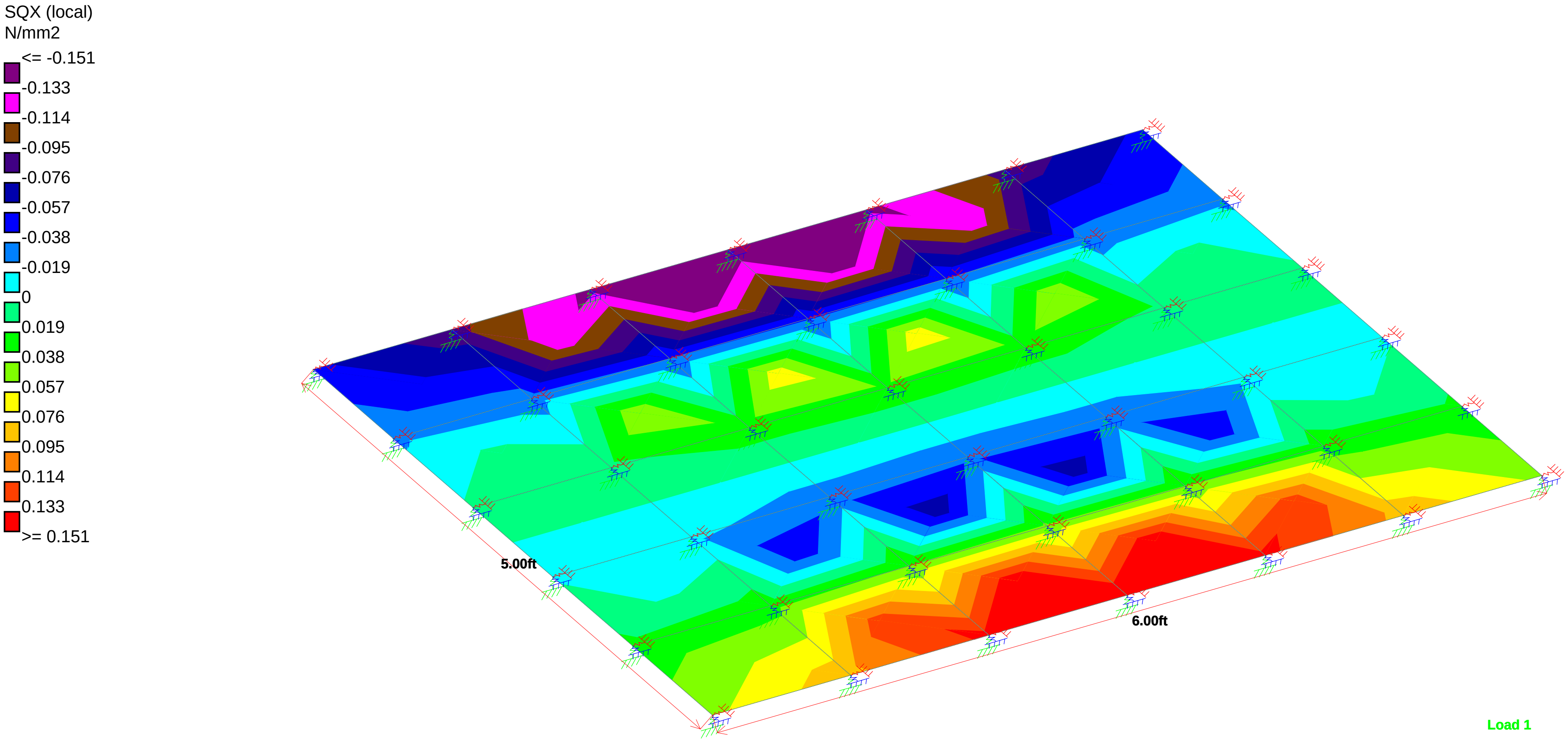
Software licensed to Optimal Engineering Support	Job No	Sheet No **1**		Rev
	Part			
Job Title	Ref Panel Check			
	By CH	Date 04-Mar-21		Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 06-Mar-2021 22:30		



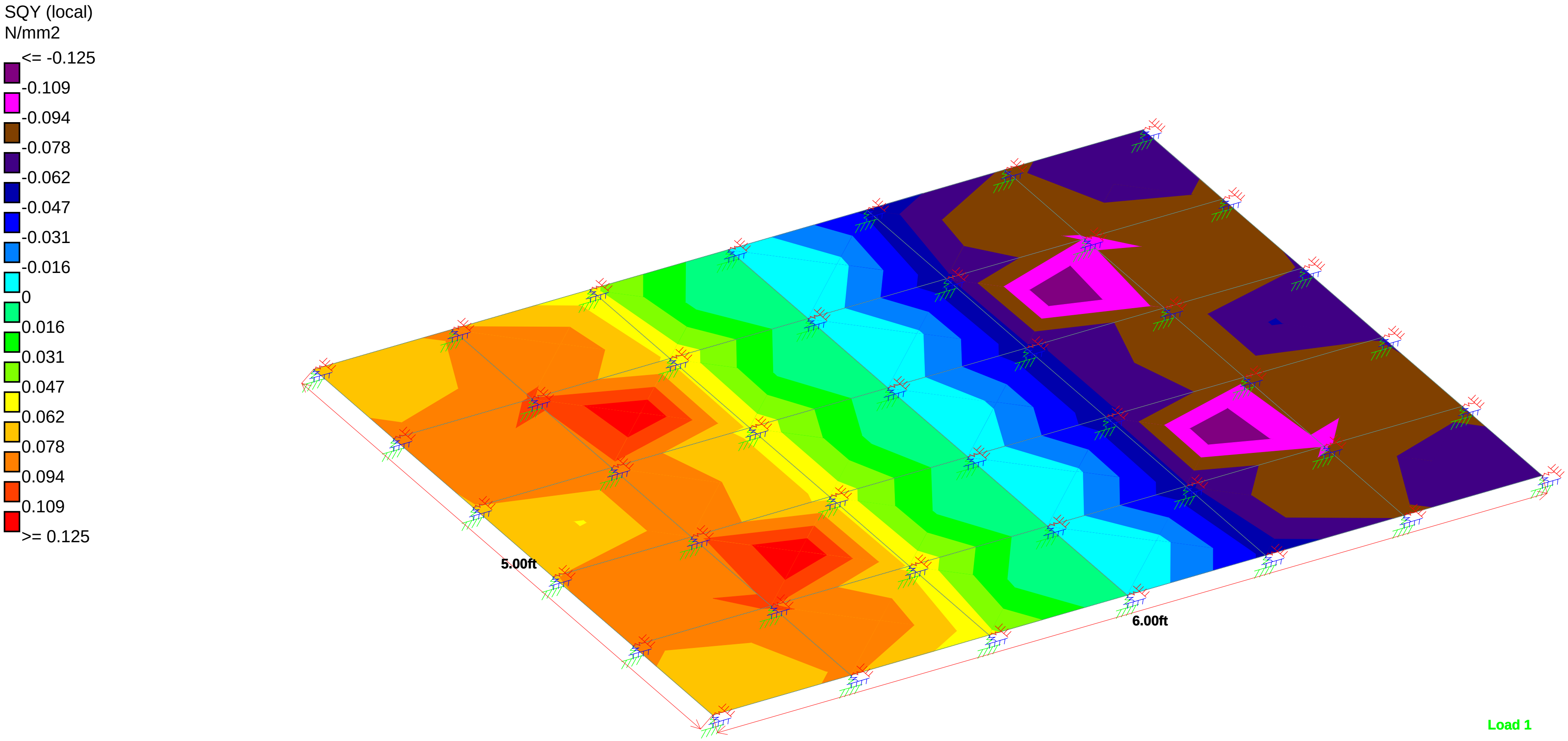


MY (local)
kNm/m
<= 1.57
2
2.43
2.86
3.29
3.72
4.15
4.58
5.01
5.44
5.87
6.3
6.73
7.16
7.59
8.02
>= 8.45
5.00ft
6.00ft
Load 1

Software licensed to Optimal Engineering Support	Job No	Sheet No **1**	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 04-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 06-Mar-2021 22:30	



Software licensed to Optimal Engineering Support	Job No	Sheet No **1**		Rev
	Part			
Job Title	Ref Panel Check			
	By CH	Date 04-Mar-21		Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 06-Mar-2021 22:30		

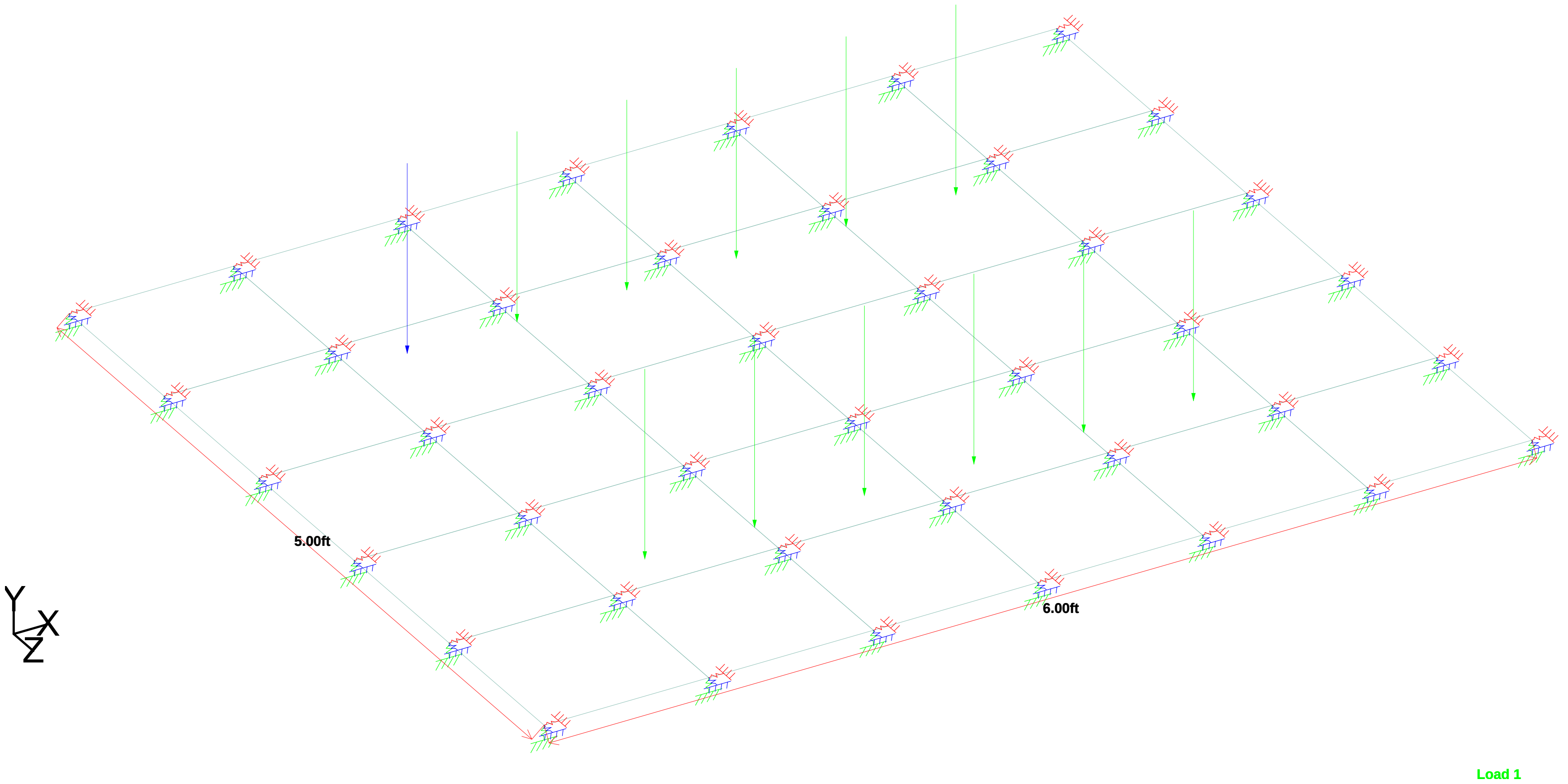


Software licensed to Optimal Engineering Support

Job No	Sheet No	Rev
	1	
Part		
Ref Panel Check		
By CH	Date 04-Mar-21	Chd
File Panel Check - 5x6 type A	Date/Time 06-Mar-2021 22:30	

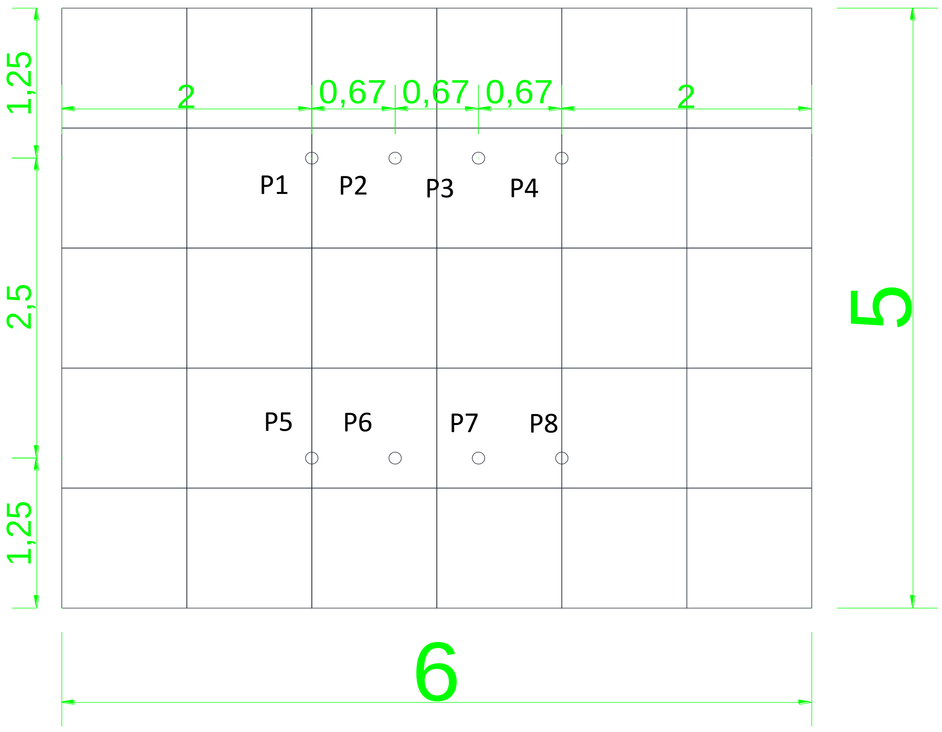
Job Title

Client SSL



Typical Panel Type (mesh 4W20), Panel Thickness 6", 5'x6'

Point load Input Force in panel for Staad Pro input



Location	Coordinated From Center Panel 1'x1'	
	X	Y
P1	0.5	0.25
P2	0.1667	0.25
P3	-0.1667	0.25
P4	0.5	0.25
P5	0.5	-0.25
P6	0.1667	-0.25
P7	-0.1667	-0.25
P8	0.5	-0.25

Load to panel based on Bar Mat Capacity per Bar Mat Point

Bar Mat Used:

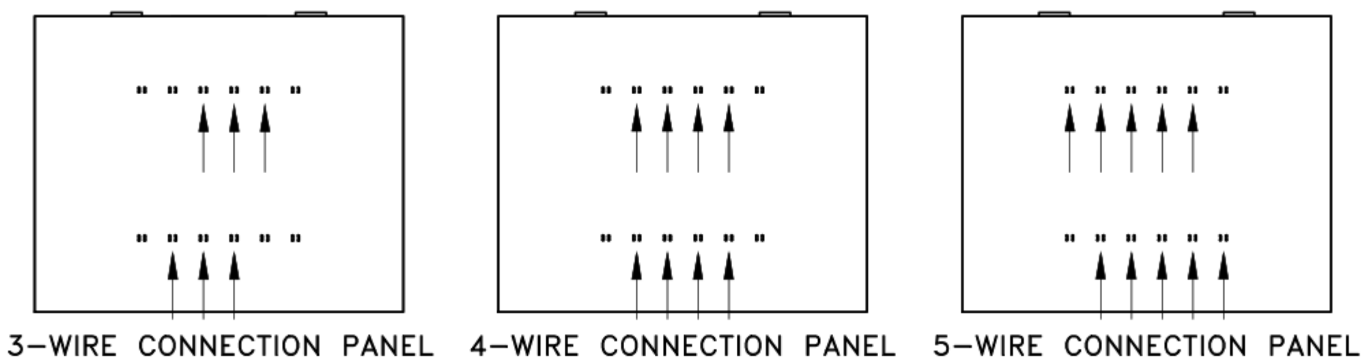
W20 - 75 Years

A = 0.1583 in^2

Fy = 75 ksi

P = 0.65 x A x Fy

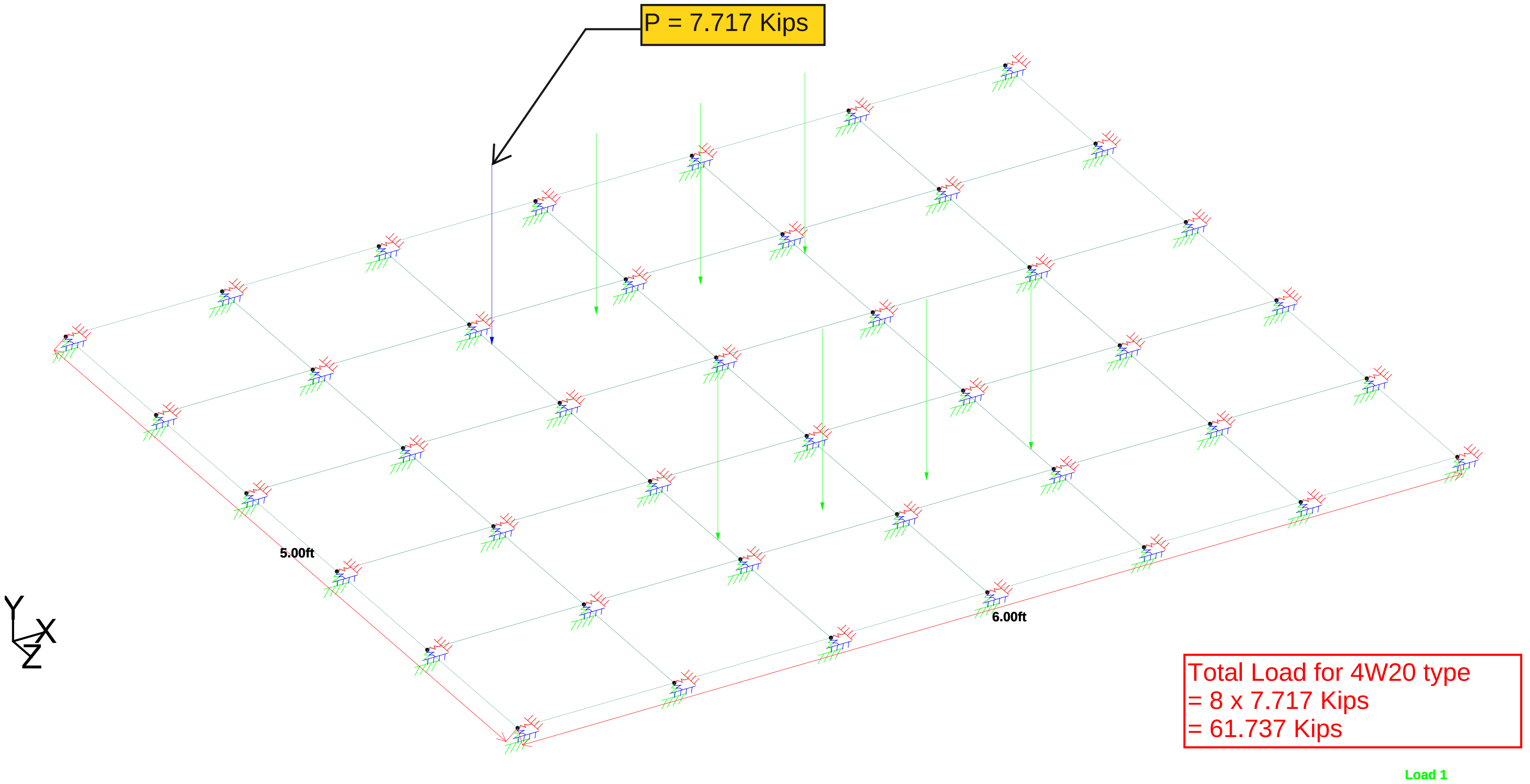
= 7.717 Kips (per wire point)



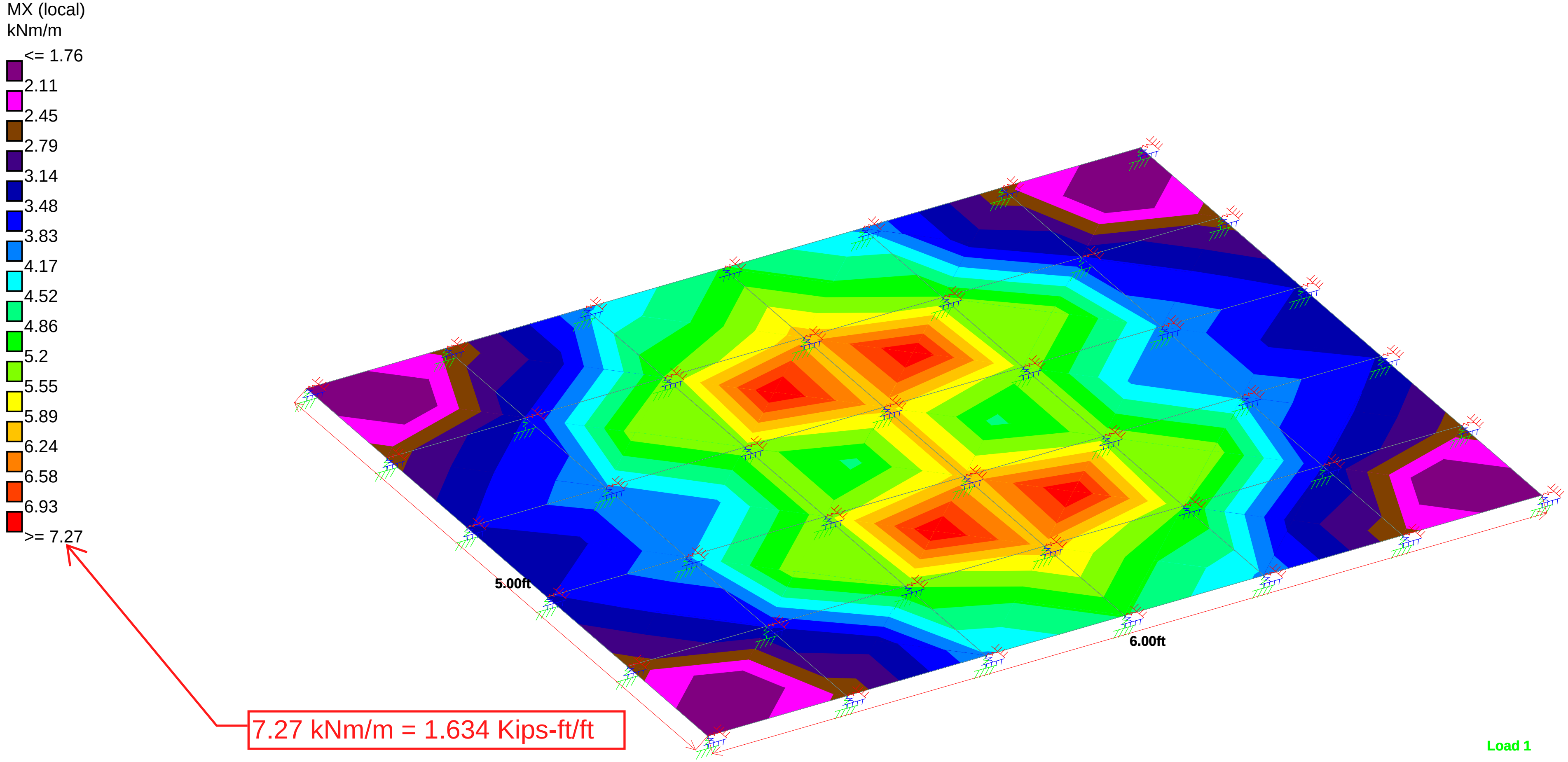
ATTACHMENT BY No. WIRES

(STANDARD PANELS ONLY)

Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 07-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 07-Mar-2021 21:15	



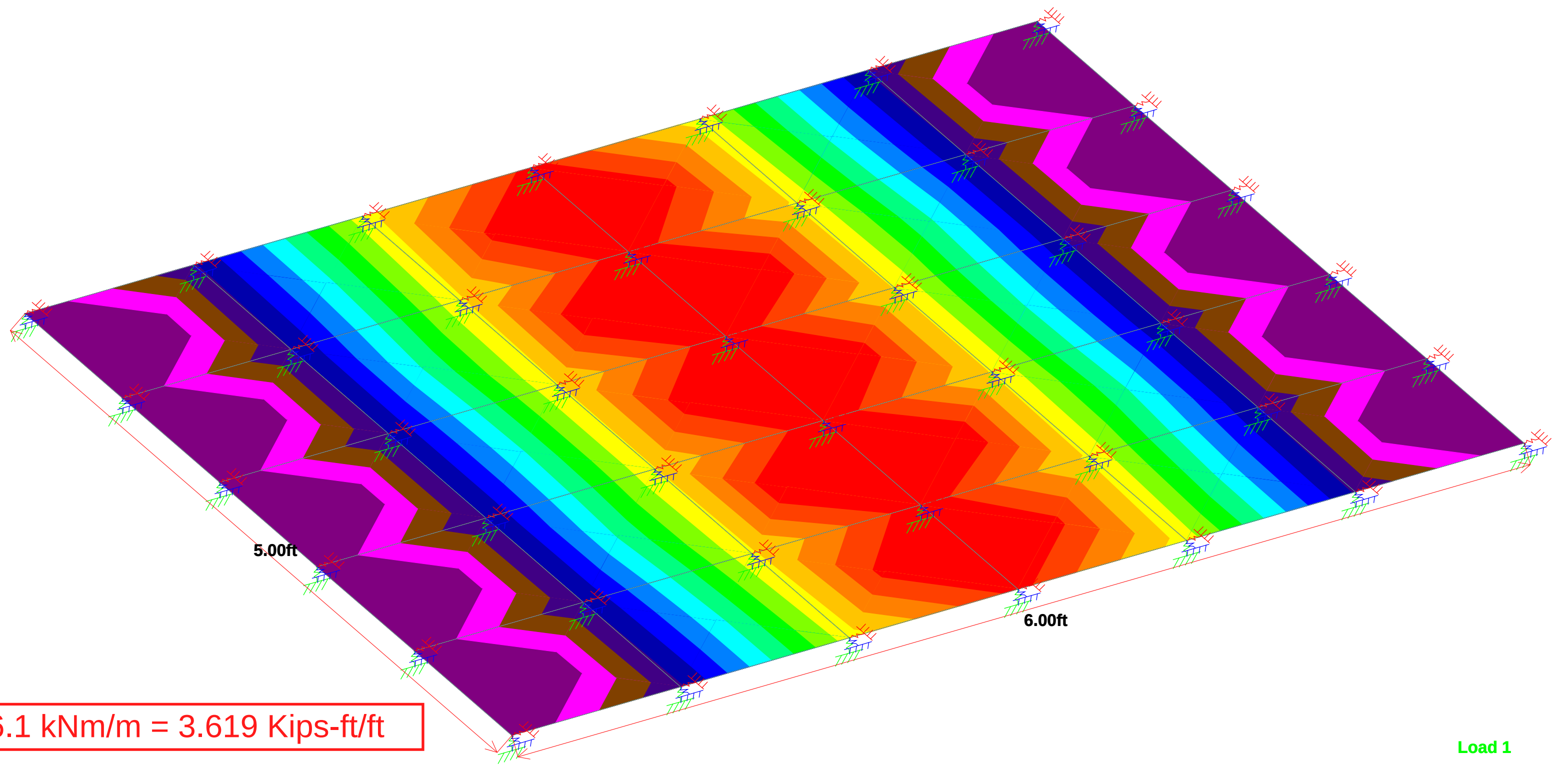
Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 07-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 07-Mar-2021 21:15	



Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 07-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 07-Mar-2021 21:15	

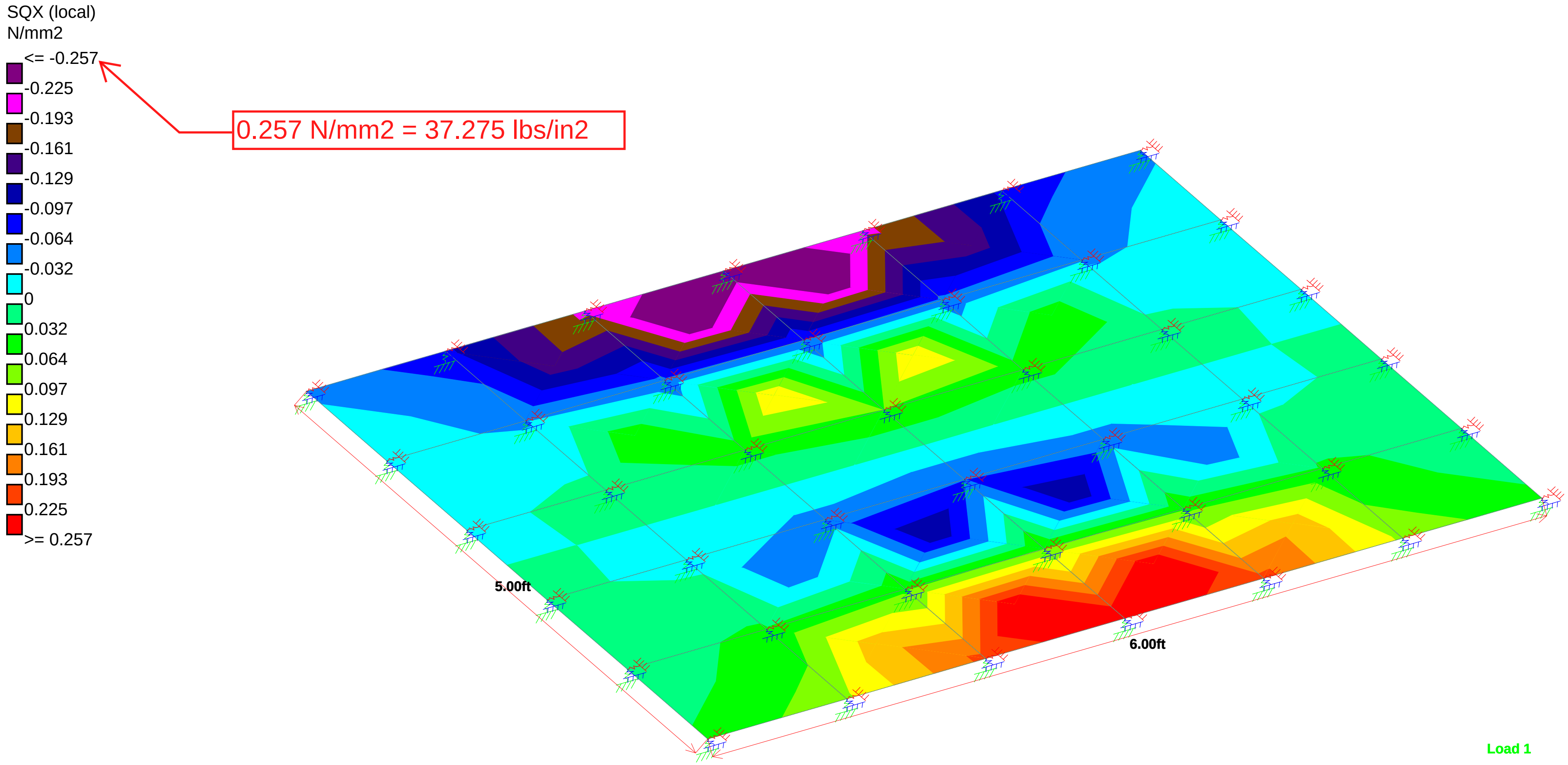
MY (local)
kNm/m

<= 1.57
2.47
3.38
4.29
5.2
6.1
7.01
7.92
8.83
9.73
10.6
11.5
12.5
13.4
14.3
15.2
>= 16.1

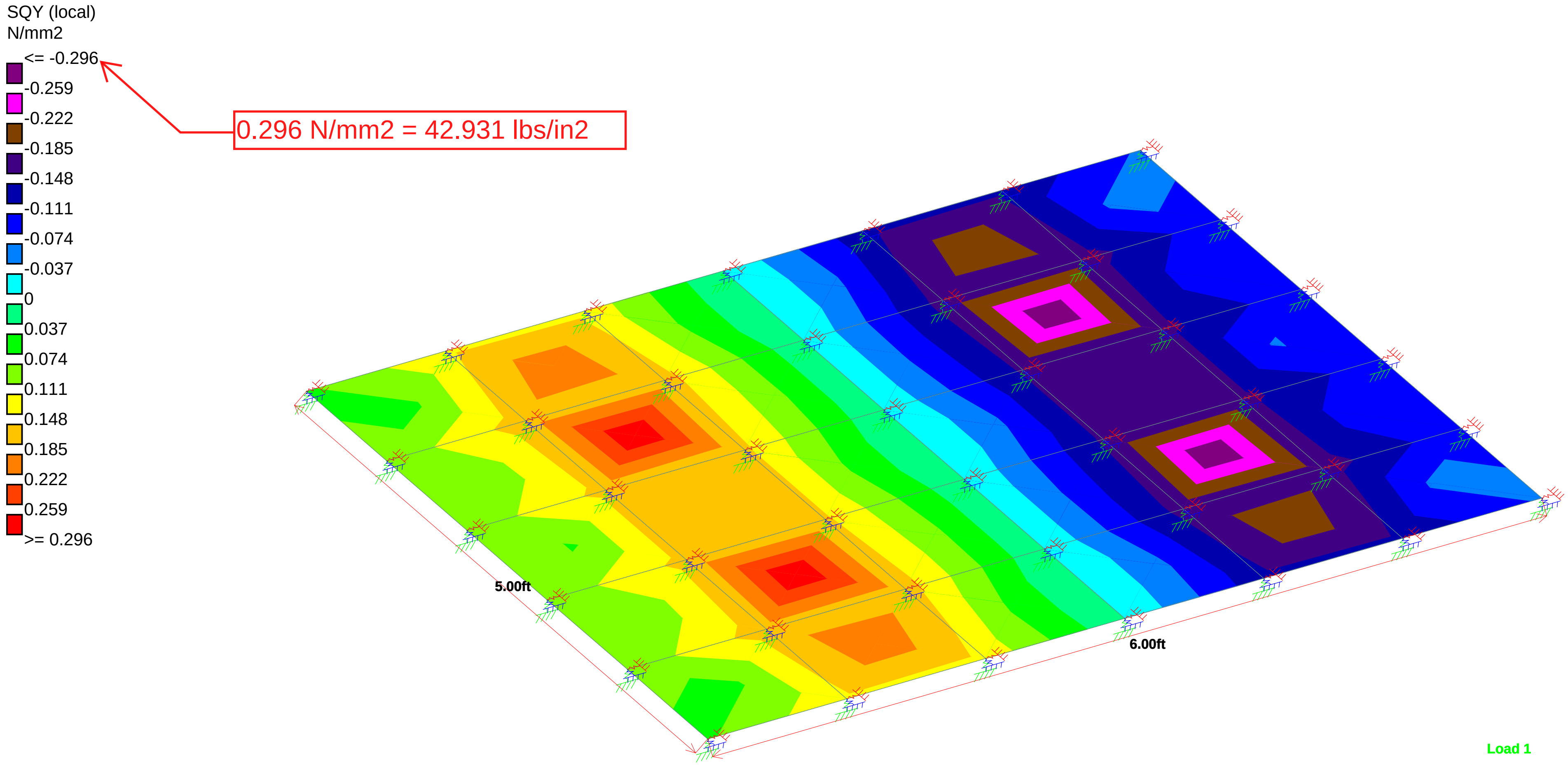


16.1 kNm/m = 3.619 Kips-ft/ft

Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 07-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 07-Mar-2021 21:15	



Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 07-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 07-Mar-2021 21:15	



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*           STAAD.Pro                              *
*           Version  2007    Build 04              *
*           Proprietary Program of                 *
*           Research Engineers,  Intl.             *
*           Date=    MAR  7, 2021                  *
*           Time=    21:19:52                      *
*                                                  *
*      USER ID: Optimal Engineering Support        *
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     1. STAAD SPACE
INPUT FILE: Panel Check - 5x6 type A (4W20).STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 07-MAR-21
     4. JOB CLIENT SSL
     5. ENGINEER NAME CH
     6. JOB REF PANEL CHECK
     7. END JOB INFORMATION
     8. INPUT WIDTH 79
     9. UNIT FEET KIP
    10. JOINT COORDINATES
    11. 1 0 0 0; 2 1 0 0; 3 2 0 0; 4 3 0 0; 5 4 0 0; 6 5 0 0; 7 6 0 0; 10 0 0 -1.
    12. 11 1 0 -1; 12 2 0 -1; 13 3 0 -1; 14 4 0 -1; 15 5 0 -1; 16 6 0 -1; 19 0 0 -2
    13. 20 1 0 -2; 21 2 0 -2; 22 3 0 -2; 23 4 0 -2; 24 5 0 -2; 25 6 0 -2; 28 0 0 -3
    14. 29 1 0 -3; 30 2 0 -3; 31 3 0 -3; 32 4 0 -3; 33 5 0 -3; 34 6 0 -3; 45 0 0 -4
    15. 46 1 0 -4; 47 2 0 -4; 48 3 0 -4; 49 4 0 -4; 50 5 0 -4; 51 6 0 -4; 56 0 0 -5
    16. 57 1 0 -5; 58 2 0 -5; 59 3 0 -5; 60 4 0 -5; 61 5 0 -5; 62 6 0 -5
    17. ELEMENT INCIDENCES SHELL
    18. 1 1 10 11 2; 2 10 19 20 11; 3 19 28 29 20; 4 2 11 12 3; 5 11 20 21 12
    19. 6 20 29 30 21; 7 3 12 13 4; 8 12 21 22 13; 9 21 30 31 22; 10 4 13 14 5
    20. 11 13 22 23 14; 12 22 31 32 23; 13 5 14 15 6; 14 14 23 24 15; 15 23 32 33 24
    21. 16 6 15 16 7; 17 15 24 25 16; 18 24 33 34 25; 31 28 45 46 29; 32 29 46 47 30
    22. 33 30 47 48 31; 34 31 48 49 32; 35 32 49 50 33; 36 33 50 51 34; 41 45 56 57 46
    23. 42 46 57 58 47; 43 47 58 59 48; 44 48 59 60 49; 45 49 60 61 50; 46 50 61 62 51
    24. ELEMENT PROPERTY
    25. 1 TO 18 31 TO 36 41 TO 46 THICKNESS 0.5
    26. DEFINE MATERIAL START
    27. ISOTROPIC CONCRETE
    28. E 614304
    29. POISSON 0.17
    30. DENSITY 0.15
    31. ALPHA 1E-005
    32. DAMP 0.05
    33. END DEFINE MATERIAL
    34. CONSTANTS
    35. MATERIAL CONCRETE ALL
    36. SUPPORTS
    37. 1 TO 7 10 TO 16 19 TO 25 28 TO 34 45 TO 51 56 TO 61 -
    38. 62 FIXED BUT KFX 839.76 KFY 839.76 KFZ 839.76 KMX 1 KMY 1 KMZ 1
    39. LOAD 1 LOADTYPE PUSH  TITLE WIRE STRENGTH
    40. ELEMENT LOAD
```

4266 ksi = 614304 KSF

839.76 KIP/FT, see spring constant selection/calcs


```
    41. 32 PR GY -7.717 0.25 0.5
    42. 33 PR GY -7.717 0.25 0.1667
    43. 34 PR GY -7.717 0.25 -0.1667
    44. 34 PR GY -7.717 0.25 0.5
    45. 5 PR GY -7.717 -0.25 0.5
    46. 8 PR GY -7.717 -0.25 0.1667
    47. 11 PR GY -7.717 -0.25 -0.1667
    48. 11 PR GY -7.717 -0.25 0.5
    49. PERFORM ANALYSIS
```

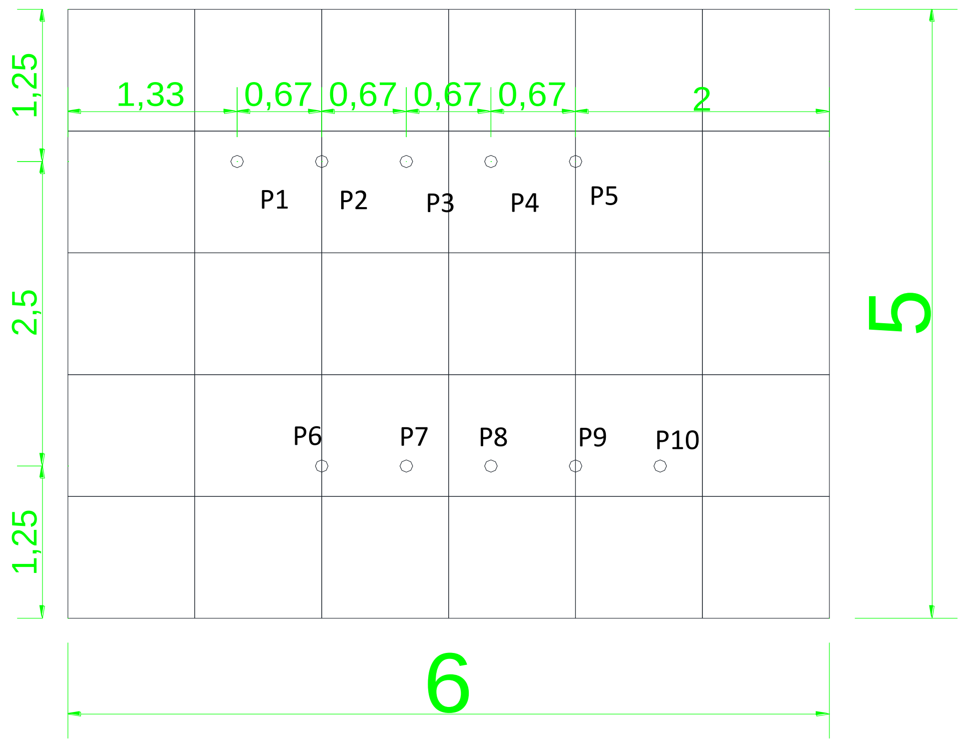
P R O B L E M   S T A T I S T I C S

```
 NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =    42/    30/    42

       SOLVER USED IS THE OUT-OF-CORE BASIC SOLVER

 ORIGINAL/FINAL BAND-WIDTH=     8/     8/     54 DOF
 TOTAL PRIMARY LOAD CASES =     1, TOTAL DEGREES OF FREEDOM =    252
 SIZE OF STIFFNESS MATRIX =       14 DOUBLE  KILO-WORDS
 REQRD/AVAIL. DISK SPACE  =     12.3/ 263423.7 MB
```

```
    50. FINISH
```

Typical Panel Type (mesh 5W20), Panel Thickness 6", 5'x6'

Point load Input Force in panel for Staad Pro input



Location	Coordinated From Center Panel 1'x1'	
	X	Y
P1	-0.1667	0.25
P2	0.5	0.25
P3	0.1667	0.25
P4	-0.1667	0.25
P5	0.5	0.25
P6	0.5	-0.25
P7	0.1667	-0.25
P8	-0.1667	-0.25
P9	0.5	-0.25
P10	0.1667	-0.25

Load to panel based on Bar Mat Capacity per Bar Mat Point

Bar Mat Used:

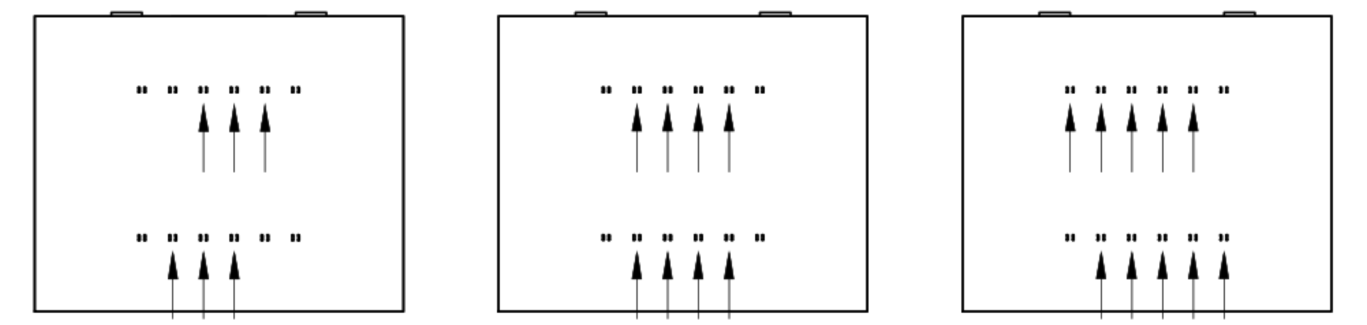
W20 - 75 Years

A = 0.1583 in^2

Fy = 75 ksi

P = 0.65 x A x Fy

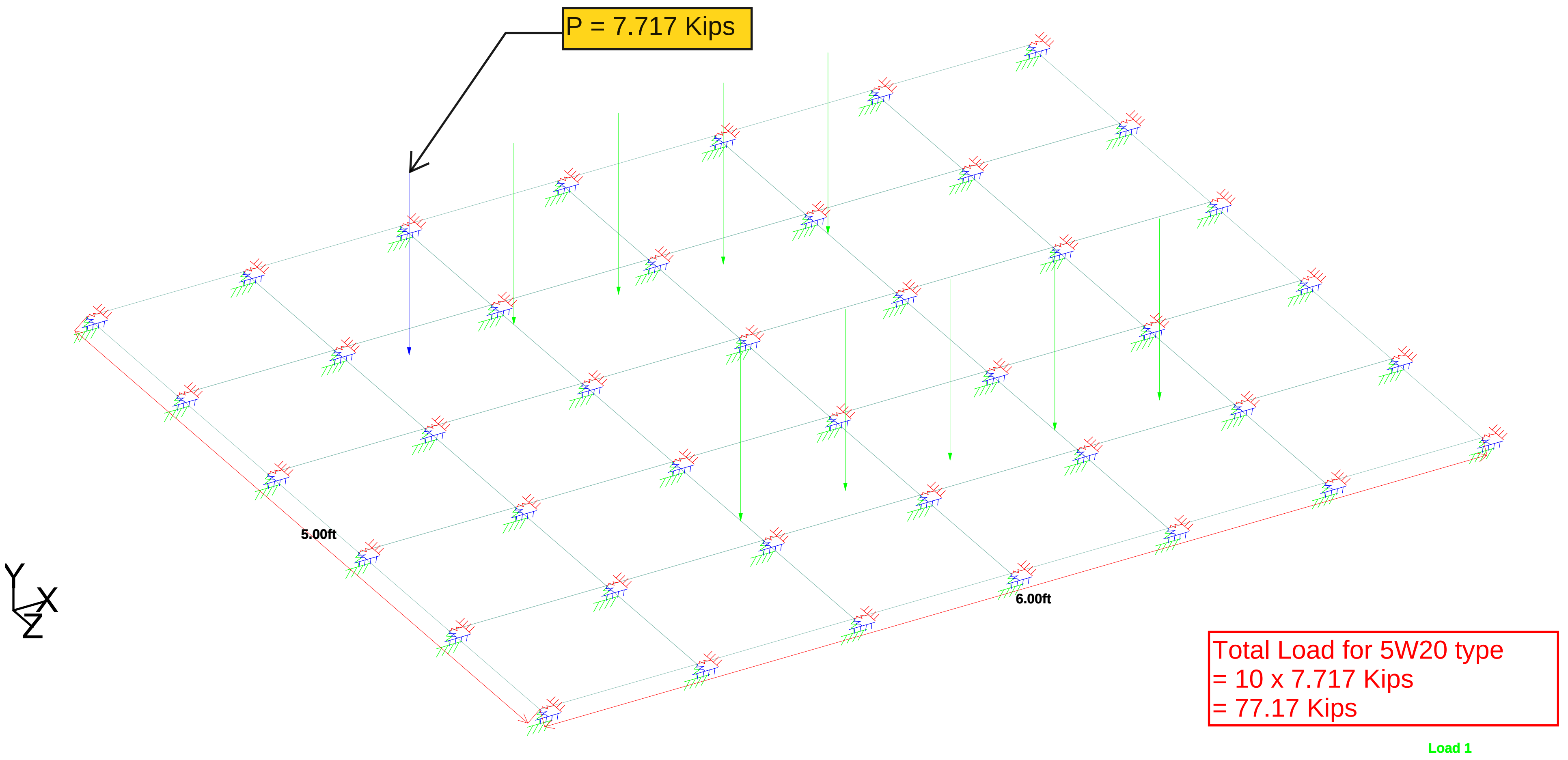
= 7.717 Kips (per wire point)



ATTACHMENT BY No. WIRES

(STANDARD PANELS ONLY)

Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 07-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 07-Mar-2021 22:57	



Software licensed to Optimal Engineering Support

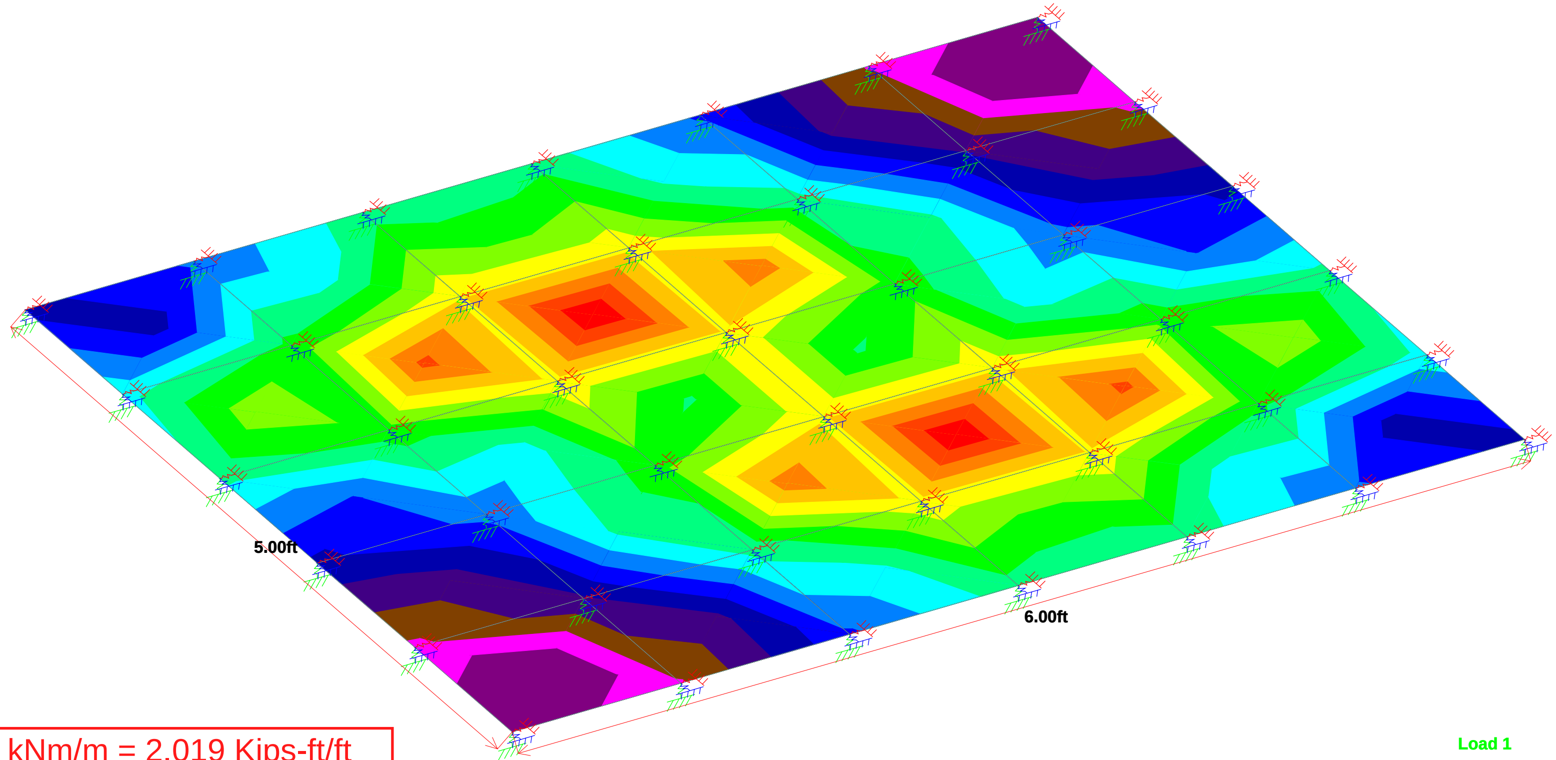
Job No	Sheet No 1	Rev
Part		
Ref Panel Check		
By CH	Date 07-Mar-21	Chd
File Panel Check - 5x6 type A	Date/Time 07-Mar-2021 22:57	

Job Title

Client SSL

MX (local)
kNm/m

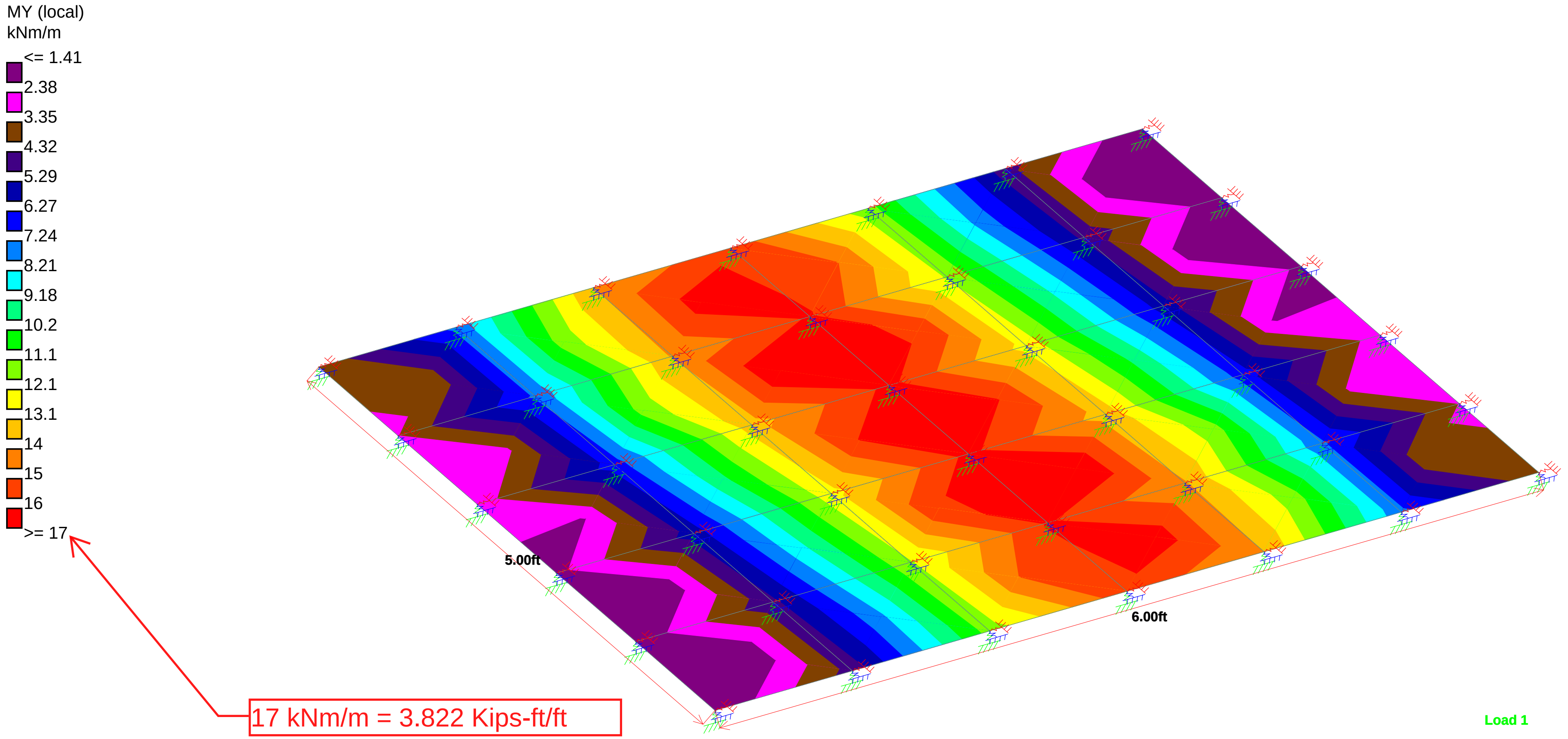
- <= 1.55
- 2.01
- 2.48
- 2.94
- 3.41
- 3.87
- 4.34
- 4.8
- 5.27
- 5.73
- 6.2
- 6.66
- 7.12
- 7.59
- 8.05
- 8.52
- >= 8.98



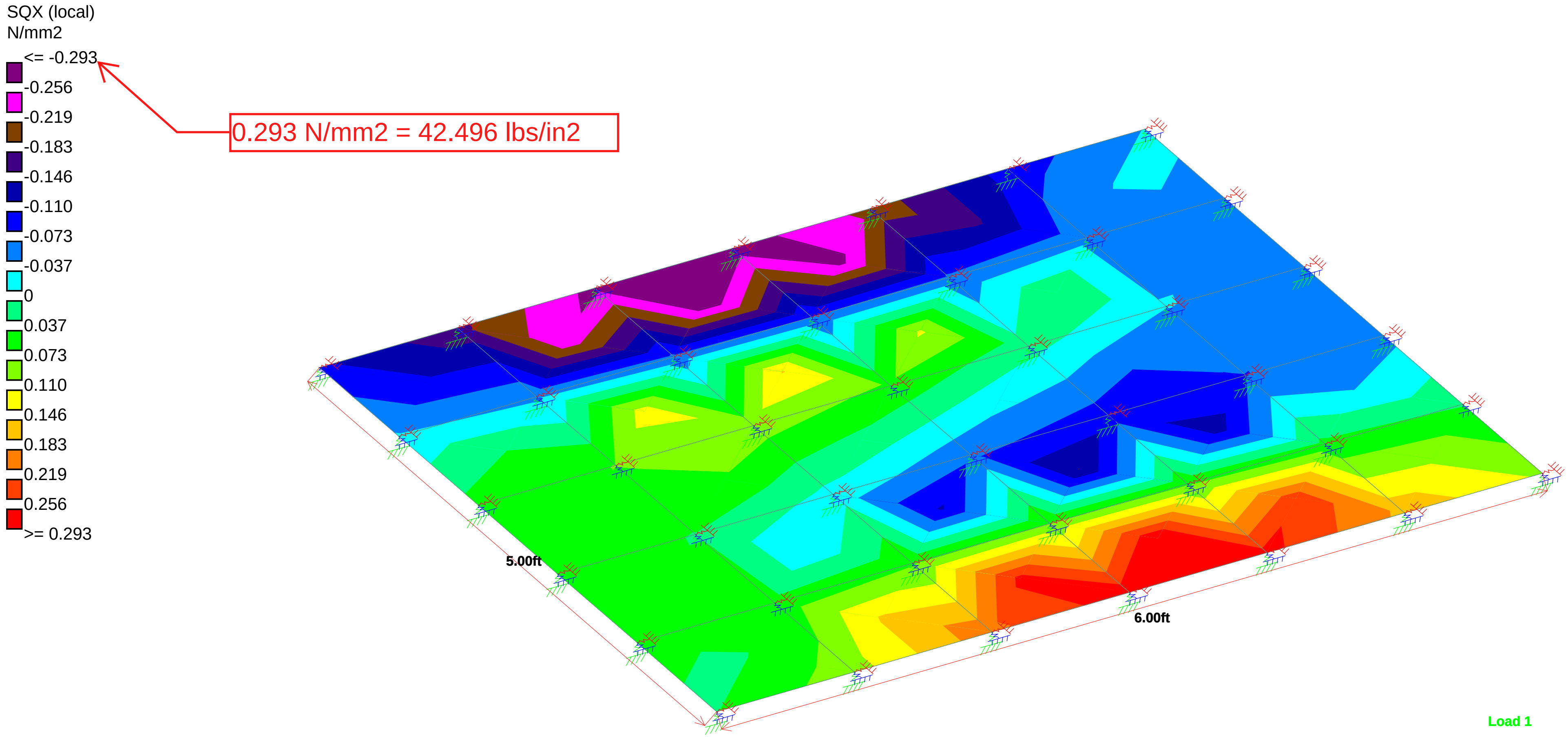
8.98 kNm/m = 2.019 Kips-ft/ft

Software licensed to Optimal Engineering Support

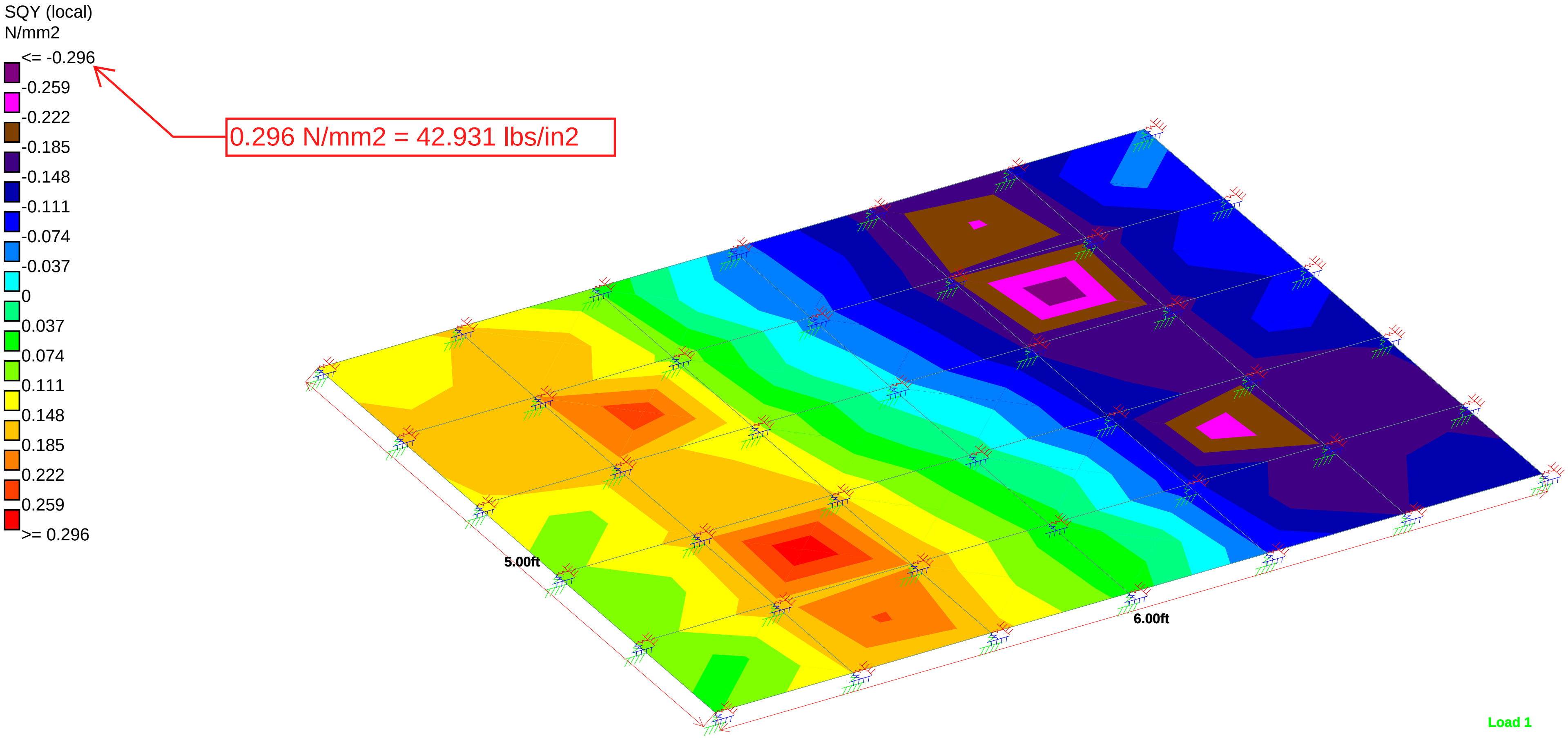
Job Title		Job No	Sheet No 1		Rev
		Part			
		Ref Panel Check			
		By CH	Date 07-Mar-21		Chd
Client	SSL	File Panel Check - 5x6 type A	Date/Time 07-Mar-2021 22:57		



Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 07-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 07-Mar-2021 22:57	



Software licensed to Optimal Engineering Support	Job No	Sheet No 1		Rev
	Part			
Job Title	Ref Panel Check			
	By CH	Date 07-Mar-21		Chd
Client SSL	File Panel Check - 5x6 type A		Date/Time 07-Mar-2021 22:57	



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     *           Version  2007    Build 04              *
     *           Proprietary Program of                 *
     *           Research Engineers,  Intl.             *
     *           Date=    MAR  7, 2021                  *
     *           Time=    22:58:19                      *
     *                                                  *
     *      USER ID: Optimal Engineering Support        *
     ****************************************************
```

```
     1. STAAD SPACE
INPUT FILE: Panel Check - 5x6 type A (5W20).STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 07-MAR-21
     4. JOB CLIENT SSL
     5. ENGINEER NAME CH
     6. JOB REF PANEL CHECK
     7. END JOB INFORMATION
     8. INPUT WIDTH 79
     9. UNIT FEET KIP
    10. JOINT COORDINATES
    11. 1 0 0 0; 2 1 0 0; 3 2 0 0; 4 3 0 0; 5 4 0 0; 6 5 0 0; 7 6 0 0; 10 0 0 -1.
    12. 11 1 0 -1; 12 2 0 -1; 13 3 0 -1; 14 4 0 -1; 15 5 0 -1; 16 6 0 -1; 19 0 0 -2
    13. 20 1 0 -2; 21 2 0 -2; 22 3 0 -2; 23 4 0 -2; 24 5 0 -2; 25 6 0 -2; 28 0 0 -3
    14. 29 1 0 -3; 30 2 0 -3; 31 3 0 -3; 32 4 0 -3; 33 5 0 -3; 34 6 0 -3; 45 0 0 -4
    15. 46 1 0 -4; 47 2 0 -4; 48 3 0 -4; 49 4 0 -4; 50 5 0 -4; 51 6 0 -4; 56 0 0 -5
    16. 57 1 0 -5; 58 2 0 -5; 59 3 0 -5; 60 4 0 -5; 61 5 0 -5; 62 6 0 -5
    17. ELEMENT INCIDENCES SHELL
    18. 1 1 10 11 2; 2 10 19 20 11; 3 19 28 29 20; 4 2 11 12 3; 5 11 20 21 12
    19. 6 20 29 30 21; 7 3 12 13 4; 8 12 21 22 13; 9 21 30 31 22; 10 4 13 14 5
    20. 11 13 22 23 14; 12 22 31 32 23; 13 5 14 15 6; 14 14 23 24 15; 15 23 32 33 24
    21. 16 6 15 16 7; 17 15 24 25 16; 18 24 33 34 25; 31 28 45 46 29; 32 29 46 47 30
    22. 33 30 47 48 31; 34 31 48 49 32; 35 32 49 50 33; 36 33 50 51 34; 41 45 56 57 46
    23. 42 46 57 58 47; 43 47 58 59 48; 44 48 59 60 49; 45 49 60 61 50; 46 50 61 62 51
    24. ELEMENT PROPERTY
    25. 1 TO 18 31 TO 36 41 TO 46 THICKNESS 0.5
    26. DEFINE MATERIAL START
    27. ISOTROPIC CONCRETE
    28. E 614304
    29. POISSON 0.17
    30. DENSITY 0.15
    31. ALPHA 1E-005
    32. DAMP 0.05
    33. END DEFINE MATERIAL
    34. CONSTANTS
    35. MATERIAL CONCRETE ALL
    36. SUPPORTS
    37. 1 TO 7 10 TO 16 19 TO 25 28 TO 34 45 TO 51 56 TO 61 -
    38. 62 FIXED BUT KFX 839.76 KFY 839.76 KFZ 839.76 KMX 1 KMY 1 KMZ 1
    39. LOAD 1 LOADTYPE PUSH  TITLE WIRE STRENGTH
    40. ELEMENT LOAD
```

4266 ksi = 614304 KSF

839.76 KIP/FT, see spring constant selection/calcs


```
    41. 32 PR GY -7.717 0.25 -0.1667
    42. 32 PR GY -7.717 0.25 0.5
    43. 33 PR GY -7.717 0.25 0.1667
    44. 34 PR GY -7.717 0.25 -0.1667
    45. 34 PR GY -7.717 0.25 0.5
    46. 5 PR GY -7.717 -0.25 0.5
    47. 8 PR GY -7.717 -0.25 0.1667
    48. 11 PR GY -7.717 -0.25 -0.1667
    49. 11 PR GY -7.717 -0.25 0.5
    50. 14 PR GY -7.717 -0.25 0.1667
    51. PERFORM ANALYSIS
```

```
        P R O B L E M   S T A T I S T I C S
        -----------------------------------

 NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =     42/    30/    42

       SOLVER USED IS THE OUT-OF-CORE BASIC SOLVER

 ORIGINAL/FINAL BAND-WIDTH=     8/      8/      54 DOF
 TOTAL PRIMARY LOAD CASES =     1, TOTAL DEGREES OF FREEDOM =     252
 SIZE OF STIFFNESS MATRIX =        14 DOUBLE  KILO-WORDS
 REQRD/AVAIL. DISK SPACE  =     12.3/ 263422.0 MB
```

```
    52. FINISH
```

Typical Panel Type (mesh 6W20), Panel Thickness 6", 5'x6'

Point load Input Force in panel for Staad Pro input

Location	Coordinated From Center Panel 1'x1'	
	X	Y
P1	-0.1667	0.25
P2	0.5	0.25
P3	0.1667	0.25
P4	-0.1667	0.25
P5	0.5	0.25
P6	0.1667	0.25
P7	-0.1667	-0.25
P8	0.5	-0.25
P9	0.1667	-0.25
P10	-0.1667	-0.25
P11	0.5	-0.25
P12	0.1667	-0.25

Load to panel based on Bar Mat Capacity per Bar Mat Point

Bar Mat Used:

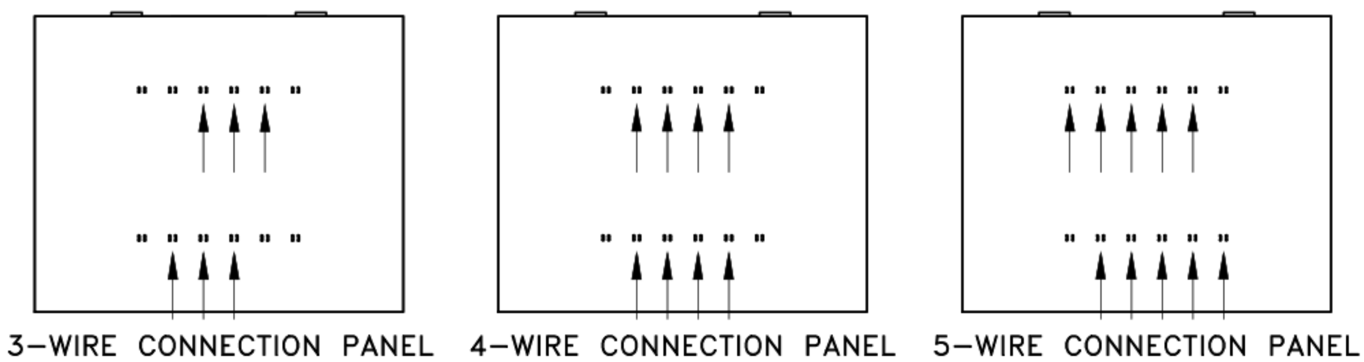
W20 - 75 Years

A = 0.1583 in^2

Fy = 75 ksi

P = 0.65 x A x Fy

= 7.717 Kips (per wire point)



ATTACHMENT BY No. WIRES

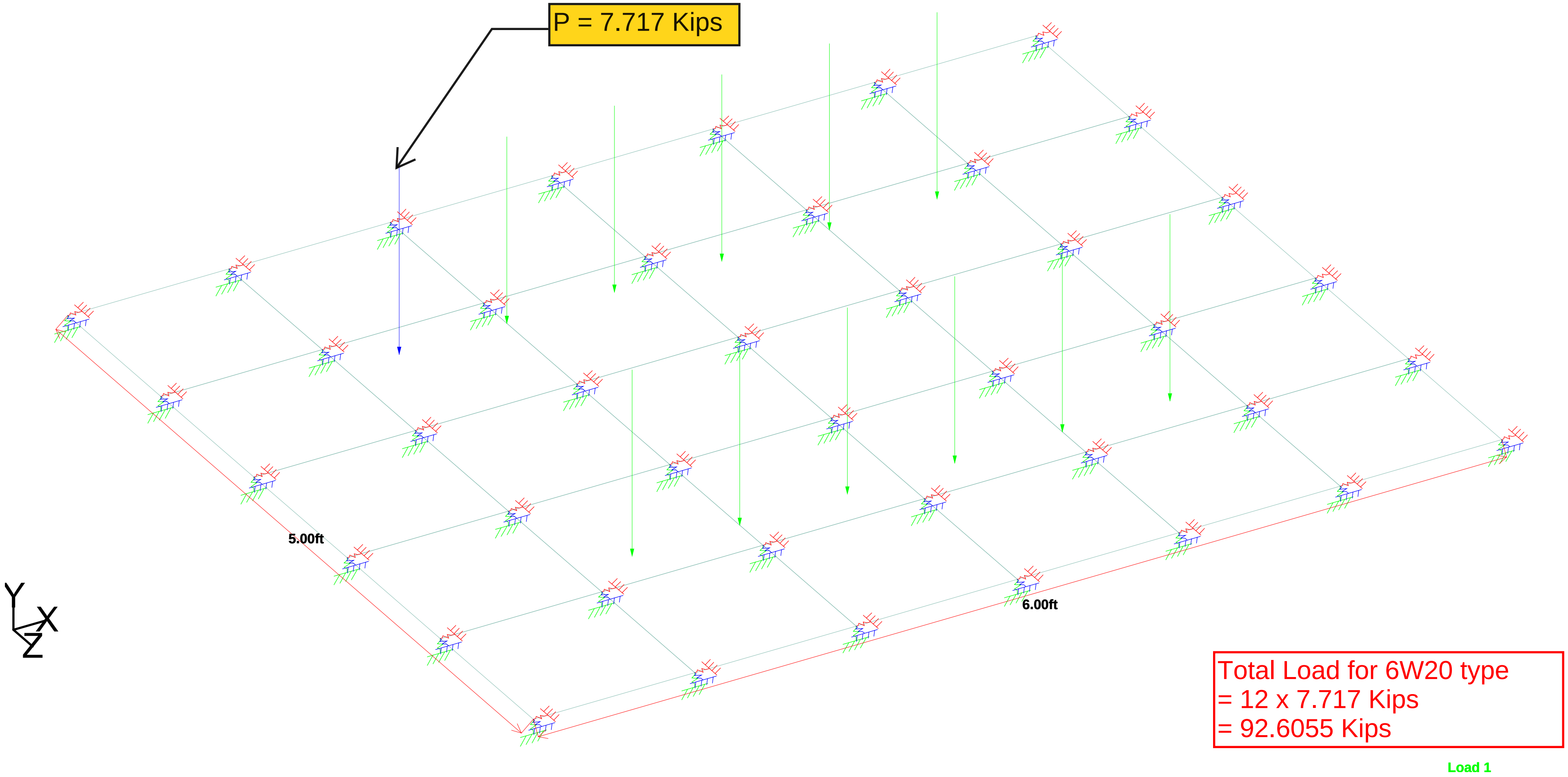
(STANDARD PANELS ONLY)

Software licensed to Optimal Engineering Support

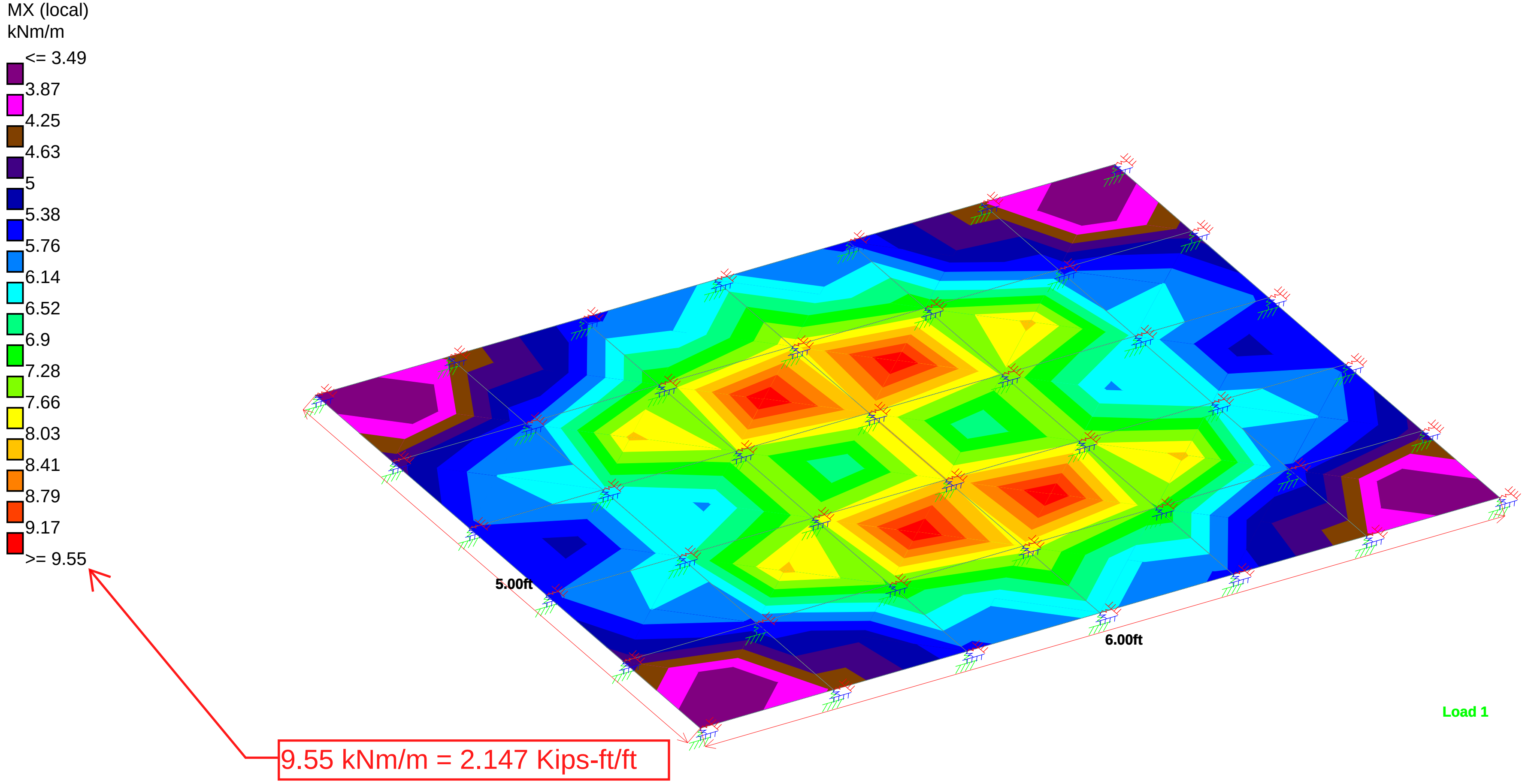
Job No	Sheet No 1		Rev
Part			
Ref Panel Check			
By CH	Date 07-Mar-21		Chd
File Panel Check - 5x6 type A		Date/Time 07-Mar-2021 23:34	

Job Title

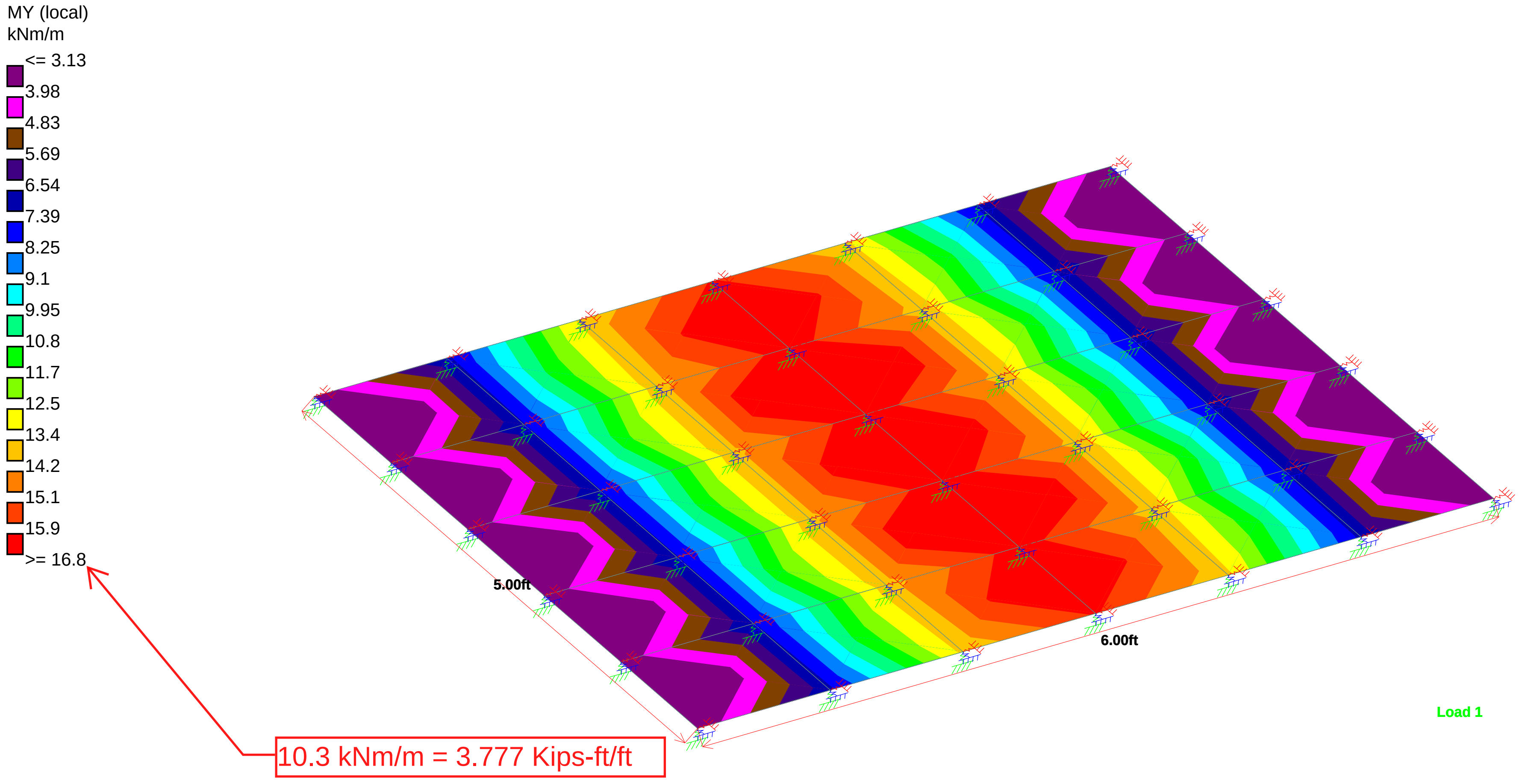
Client SSL



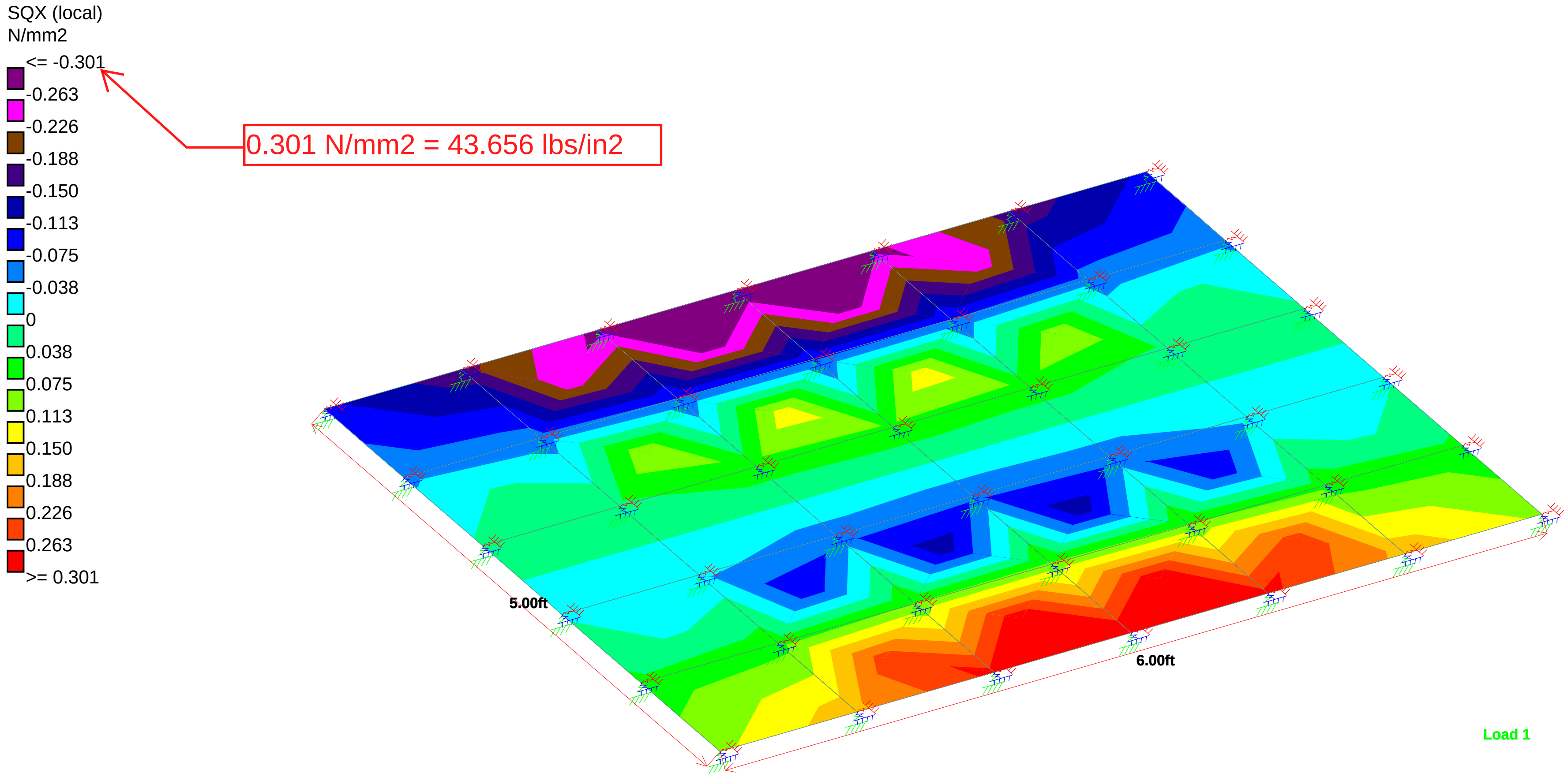
Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 07-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 07-Mar-2021 23:34	



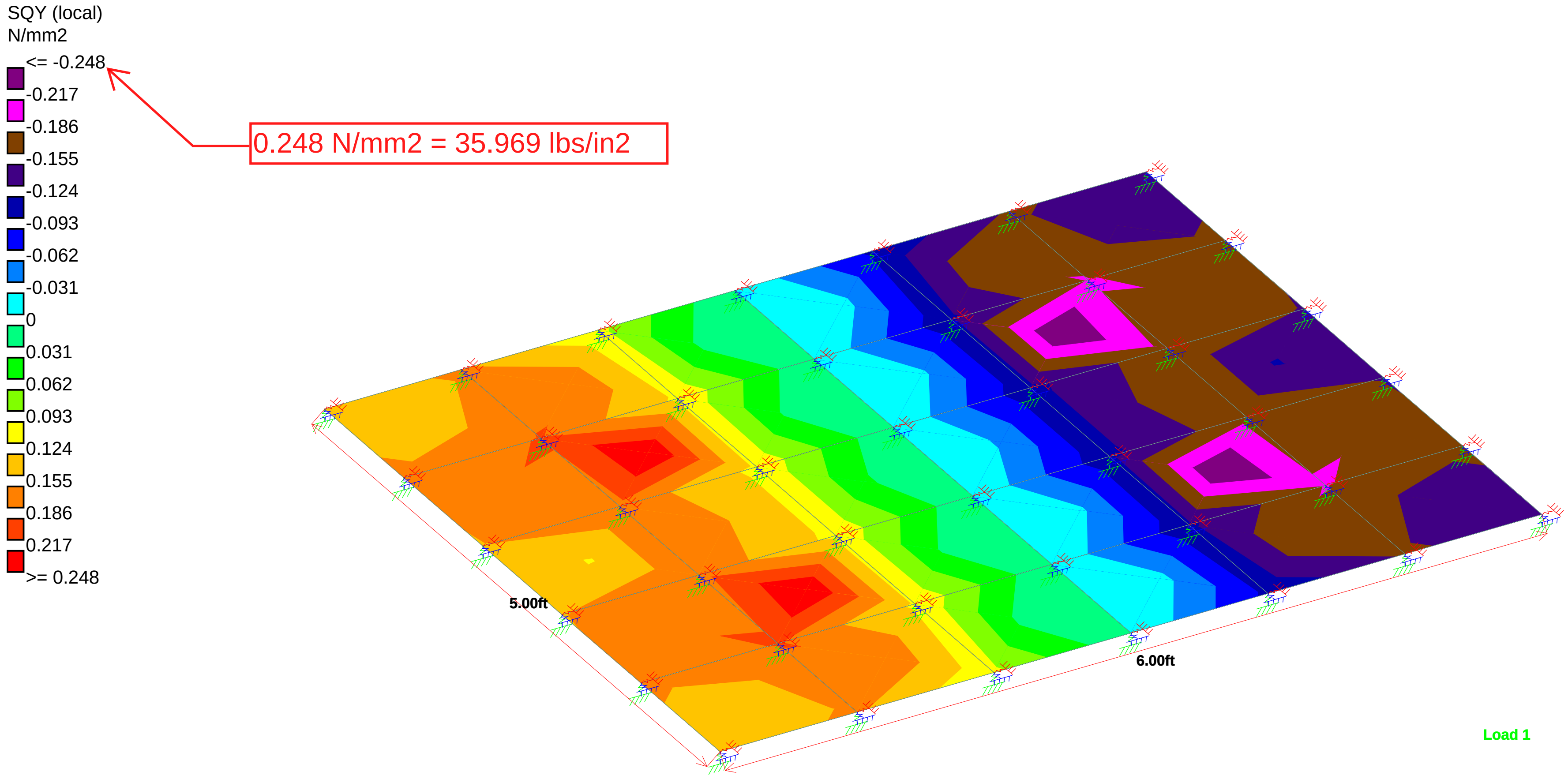
Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 07-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 07-Mar-2021 23:34	



Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
	Part		
Job Title	Ref Panel Check		
	By CH	Date 07-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 07-Mar-2021 23:34	



Software licensed to Optimal Engineering Support	Job No	Sheet No **1**		Rev
	Part			
Job Title	Ref Panel Check			
	By CH	Date 07-Mar-21	Chd	
Client SSL	File Panel Check - 5x6 type A	Date/Time 07-Mar-2021 23:34		



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     *           STAAD.Pro                              *
     *           Version  2007    Build 04              *
     *           Proprietary Program of                 *
     *           Research Engineers,  Intl.             *
     *           Date=    MAR  7, 2021                  *
     *           Time=    23:34:31                      *
     *                                                  *
     *      USER ID: Optimal Engineering Support        *
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     1. STAAD SPACE
INPUT FILE: Panel Check - 5x6 type A (6W20).STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 07-MAR-21
     4. JOB CLIENT SSL
     5. ENGINEER NAME CH
     6. JOB REF PANEL CHECK
     7. END JOB INFORMATION
     8. INPUT WIDTH 79
     9. UNIT FEET KIP
    10. JOINT COORDINATES
    11. 1 0 0 0; 2 1 0 0; 3 2 0 0; 4 3 0 0; 5 4 0 0; 6 5 0 0; 7 6 0 0; 10 0 0 -1.
    12. 11 1 0 -1; 12 2 0 -1; 13 3 0 -1; 14 4 0 -1; 15 5 0 -1; 16 6 0 -1; 19 0 0 -2
    13. 20 1 0 -2; 21 2 0 -2; 22 3 0 -2; 23 4 0 -2; 24 5 0 -2; 25 6 0 -2; 28 0 0 -3
    14. 29 1 0 -3; 30 2 0 -3; 31 3 0 -3; 32 4 0 -3; 33 5 0 -3; 34 6 0 -3; 45 0 0 -4
    15. 46 1 0 -4; 47 2 0 -4; 48 3 0 -4; 49 4 0 -4; 50 5 0 -4; 51 6 0 -4; 56 0 0 -5
    16. 57 1 0 -5; 58 2 0 -5; 59 3 0 -5; 60 4 0 -5; 61 5 0 -5; 62 6 0 -5
    17. ELEMENT INCIDENCES SHELL
    18. 1 1 10 11 2; 2 10 19 20 11; 3 19 28 29 20; 4 2 11 12 3; 5 11 20 21 12
    19. 6 20 29 30 21; 7 3 12 13 4; 8 12 21 22 13; 9 21 30 31 22; 10 4 13 14 5
    20. 11 13 22 23 14; 12 22 31 32 23; 13 5 14 15 6; 14 14 23 24 15; 15 23 32 33 24
    21. 16 6 15 16 7; 17 15 24 25 16; 18 24 33 34 25; 31 28 45 46 29; 32 29 46 47 30
    22. 33 30 47 48 31; 34 31 48 49 32; 35 32 49 50 33; 36 33 50 51 34; 41 45 56 57 46
    23. 42 46 57 58 47; 43 47 58 59 48; 44 48 59 60 49; 45 49 60 61 50; 46 50 61 62 51
    24. ELEMENT PROPERTY
    25. 1 TO 18 31 TO 36 41 TO 46 THICKNESS 0.5
    26. DEFINE MATERIAL START
    27. ISOTROPIC CONCRETE
    28. E 614304
    29. POISSON 0.17
    30. DENSITY 0.15
    31. ALPHA 1E-005
    32. DAMP 0.05
    33. END DEFINE MATERIAL
    34. CONSTANTS
    35. MATERIAL CONCRETE ALL
    36. SUPPORTS
    37. 1 TO 7 10 TO 16 19 TO 25 28 TO 34 45 TO 51 56 TO 61 -
    38. 62 FIXED BUT KFX 839.76 KFY 839.76 KFZ 839.76 KMX 1 KMY 1 KMZ 1
    39. LOAD 1 LOADTYPE PUSH  TITLE WIRE STRENGTH
    40. ELEMENT LOAD
```

4266 ksi = 614304 KSF

839.76 KIP/FT, see spring constant selection/calcs

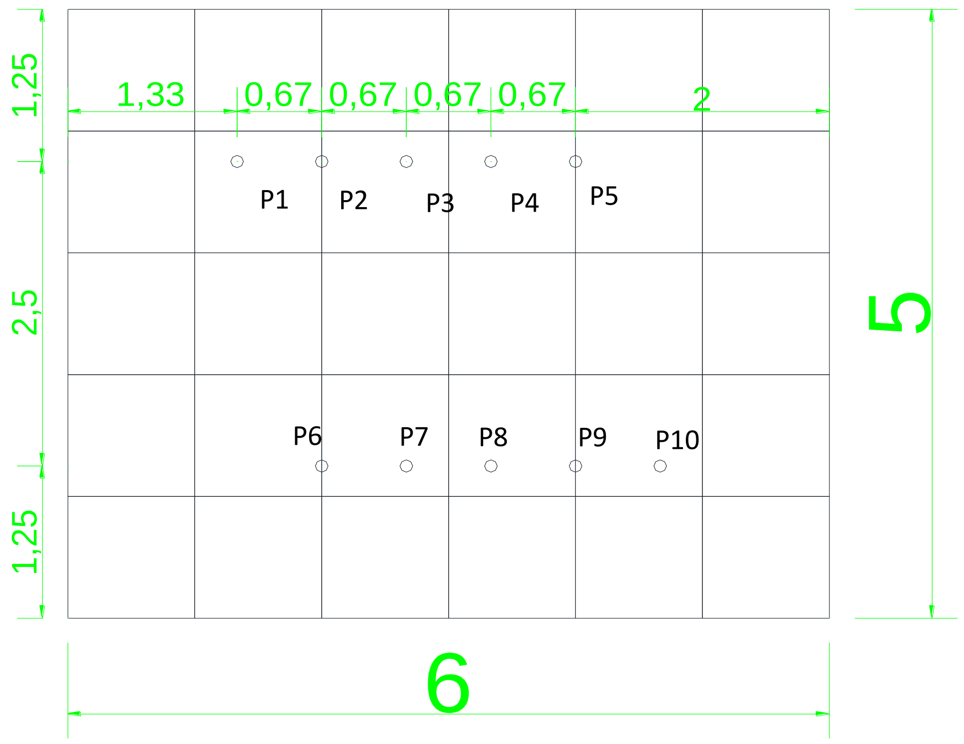

```
    41. 32 PR GY -7.717 0.25 -0.1667
    42. 32 PR GY -7.717 0.25 0.5
    43. 33 PR GY -7.717 0.25 0.1667
    44. 34 PR GY -7.717 0.25 -0.1667
    45. 34 PR GY -7.717 0.25 0.5
    46. 35 PR GY -7.717 0.25 0.1667
    47. 5 PR GY -7.717 -0.25 -0.1667
    48. 5 PR GY -7.717 -0.25 0.5
    49. 8 PR GY -7.717 -0.25 0.1667
    50. 11 PR GY -7.717 -0.25 -0.1667
    51. 11 PR GY -7.717 -0.25 0.5
    52. 14 PR GY -7.717 -0.25 0.1667
    53. PERFORM ANALYSIS
```

```
         P R O B L E M   S T A T I S T I C S
         -----------------------------------

 NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =     42/    30/    42

       SOLVER USED IS THE OUT-OF-CORE BASIC SOLVER

 ORIGINAL/FINAL BAND-WIDTH=     8/     8/     54 DOF
 TOTAL PRIMARY LOAD CASES =     1, TOTAL DEGREES OF FREEDOM =     252
 SIZE OF STIFFNESS MATRIX =       14 DOUBLE  KILO-WORDS
 REQRD/AVAIL. DISK SPACE  =     12.3/ 263420.3 MB
```

```
    54. FINISH
```

Typical Panel Type (mesh 5W24), Panel Thickness 6", 5'x6'

Point load Input Force in panel for Staad Pro input



Location	Coordinated From Center Panel 1'x1'	
	X	Y
P1	-0.1667	0.25
P2	0.5	0.25
P3	0.1667	0.25
P4	-0.1667	0.25
P5	0.5	0.25
P6	0.5	-0.25
P7	0.1667	-0.25
P8	-0.1667	-0.25
P9	0.5	-0.25
P10	0.1667	-0.25

Load to panel based on Bar Mat Capacity per Bar Mat Point

Bar Mat Used:

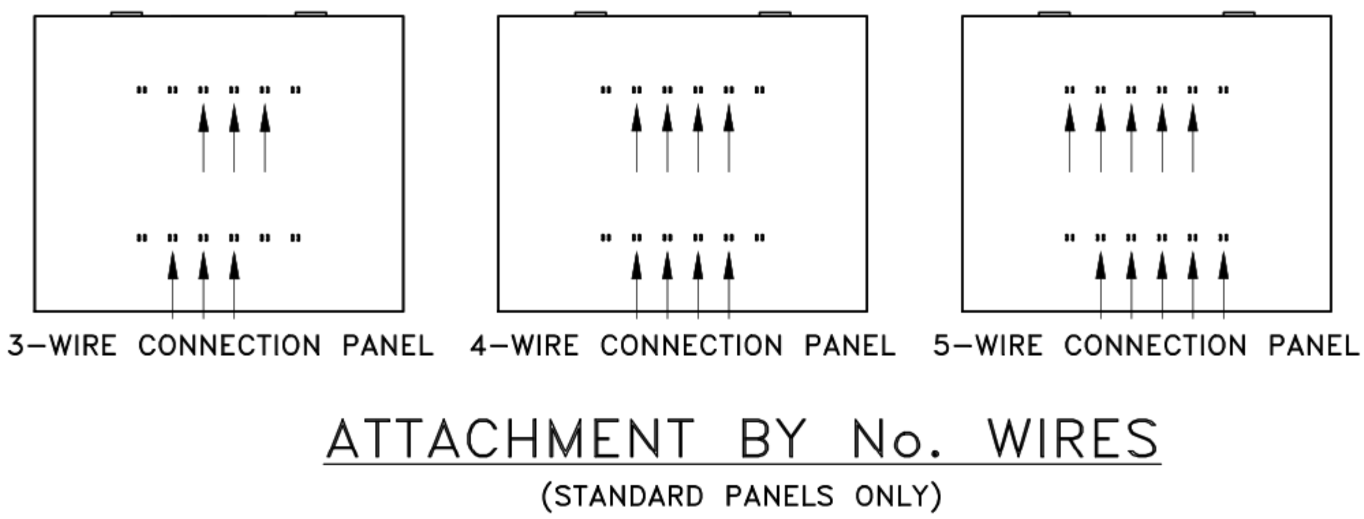
W24 - 75 Years

$A = 0.194\ in^2$

$Fy = 75$ ksi

$P = 0.65 \times A \times Fy$

$= 9.458$ Kips (per wire point)



Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
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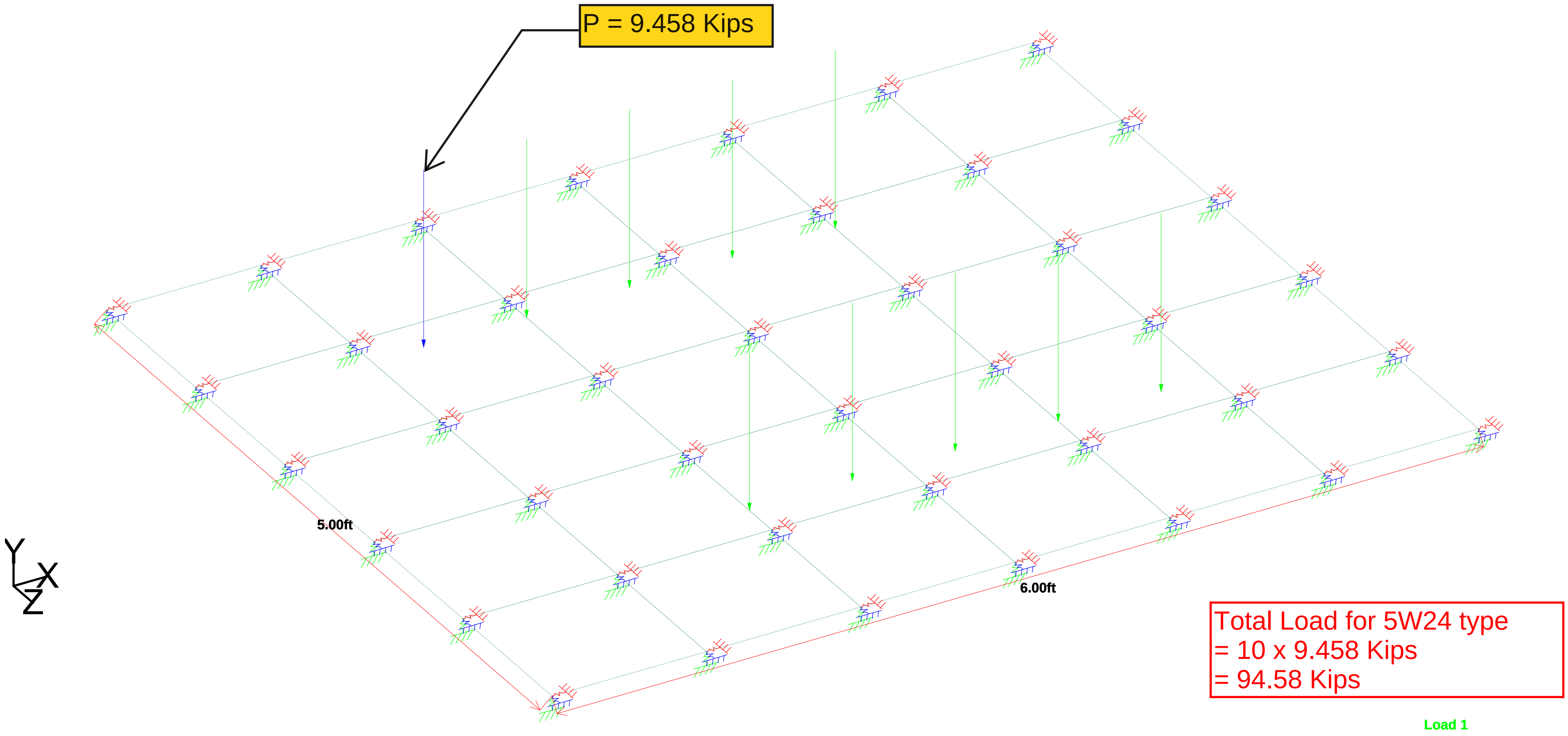
Job Title	Ref Panel Check		
	By CH	Date 07-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 08-Mar-2021 00:08	



Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
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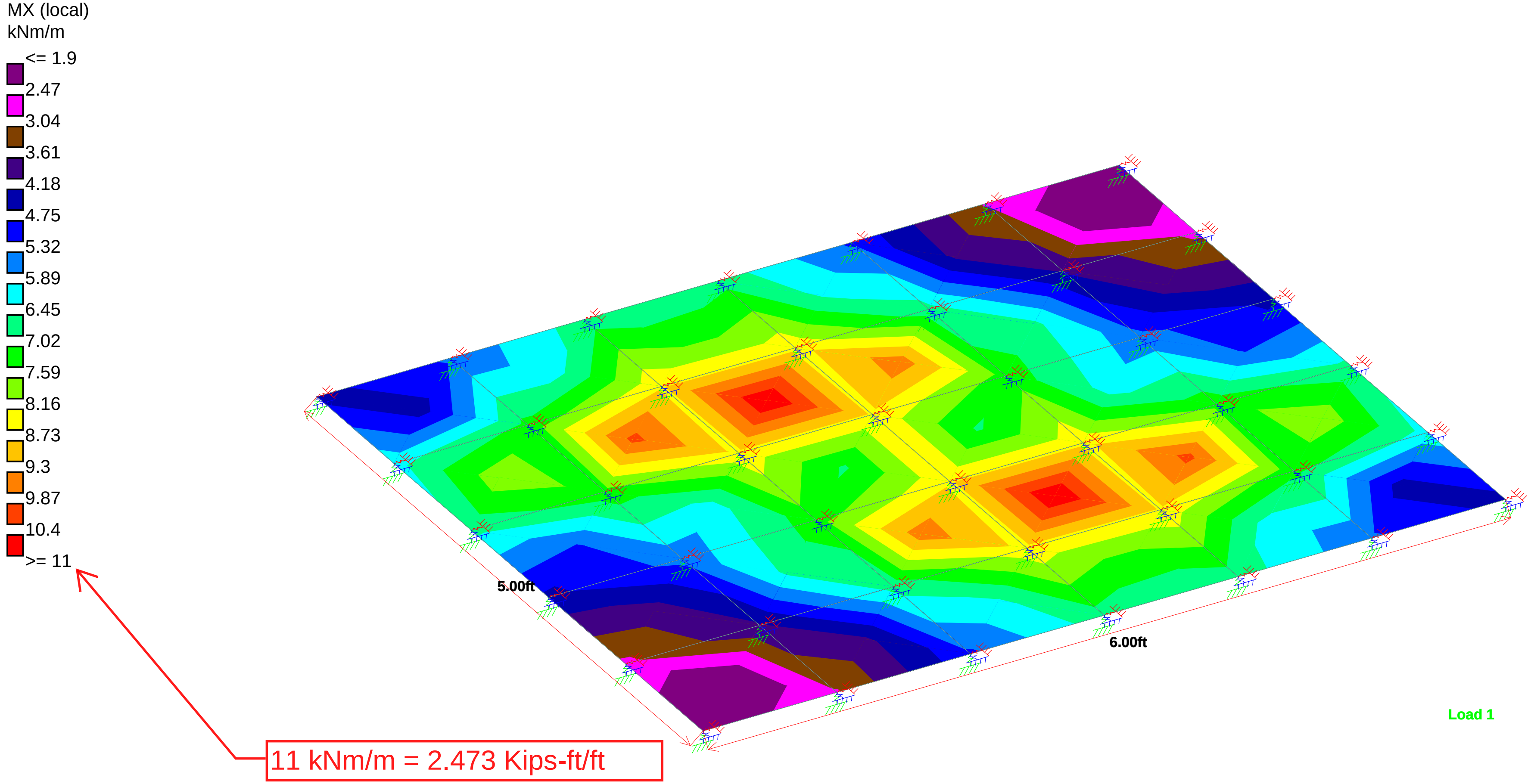

Software licensed to Optimal Engineering Support	Job No	Sheet No **1**	Rev
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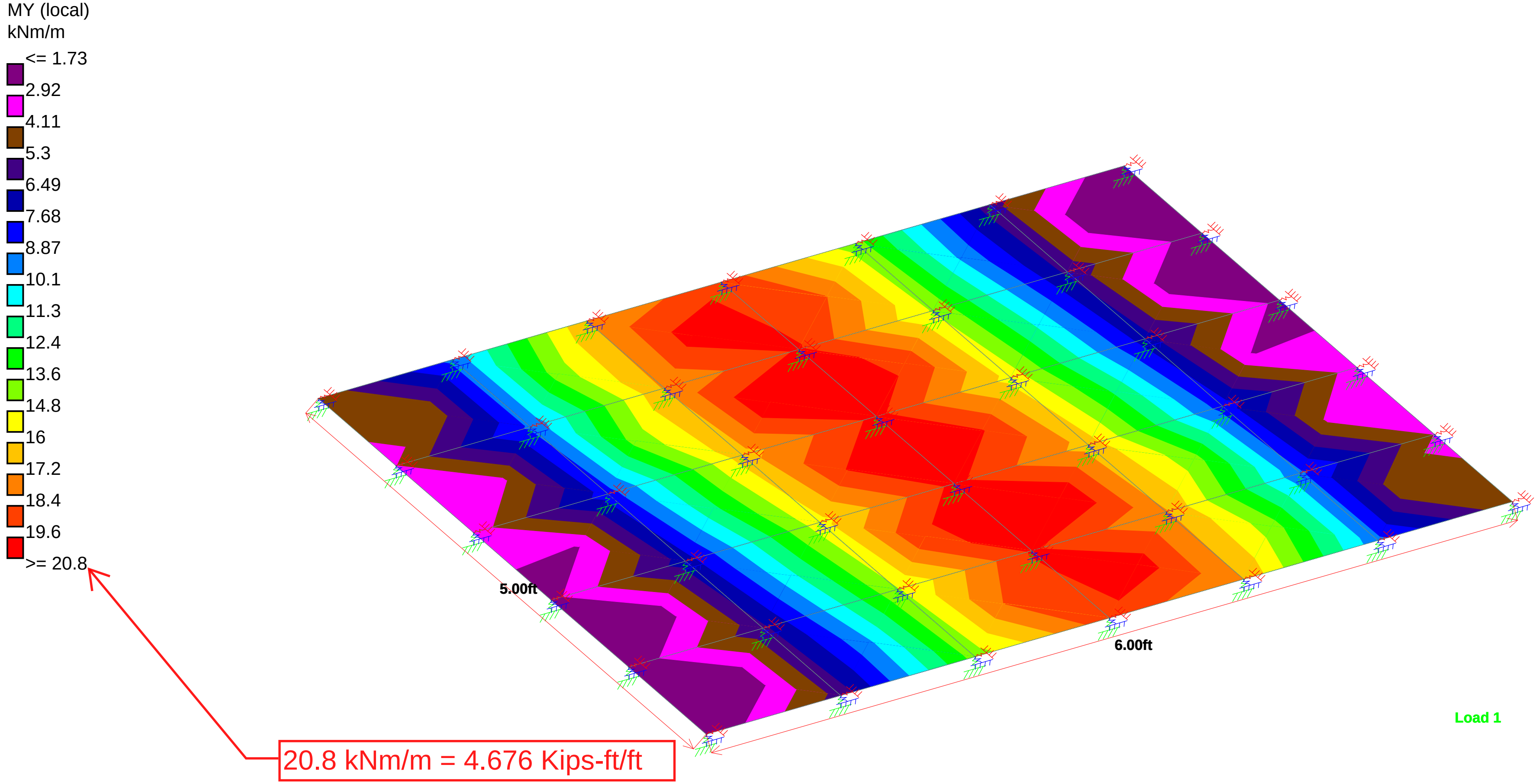
	By CH	Date 07-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 08-Mar-2021 00:08	



Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
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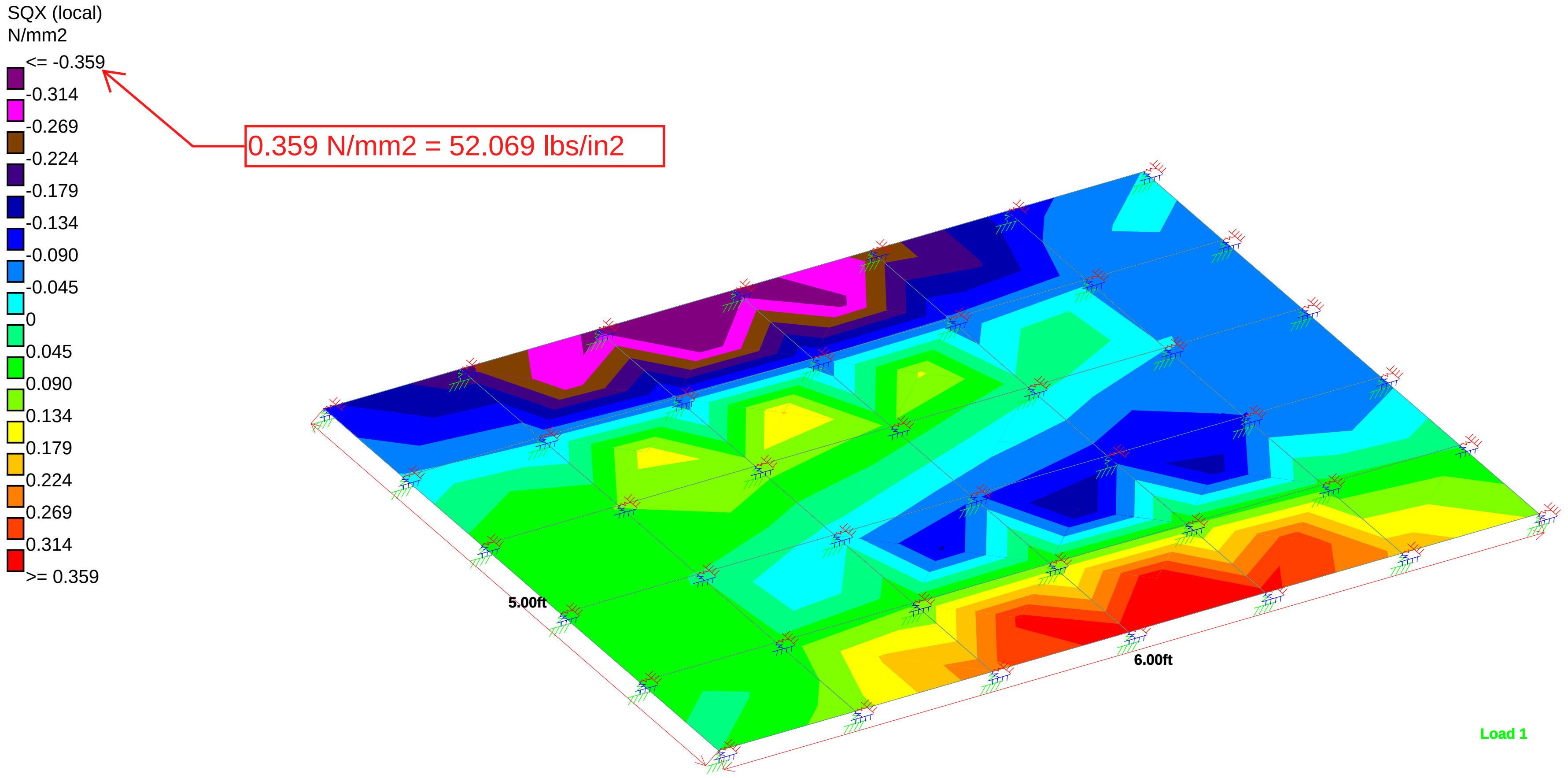
Job Title	Ref Panel Check		
	By CH	Date 07-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 08-Mar-2021 00:08	



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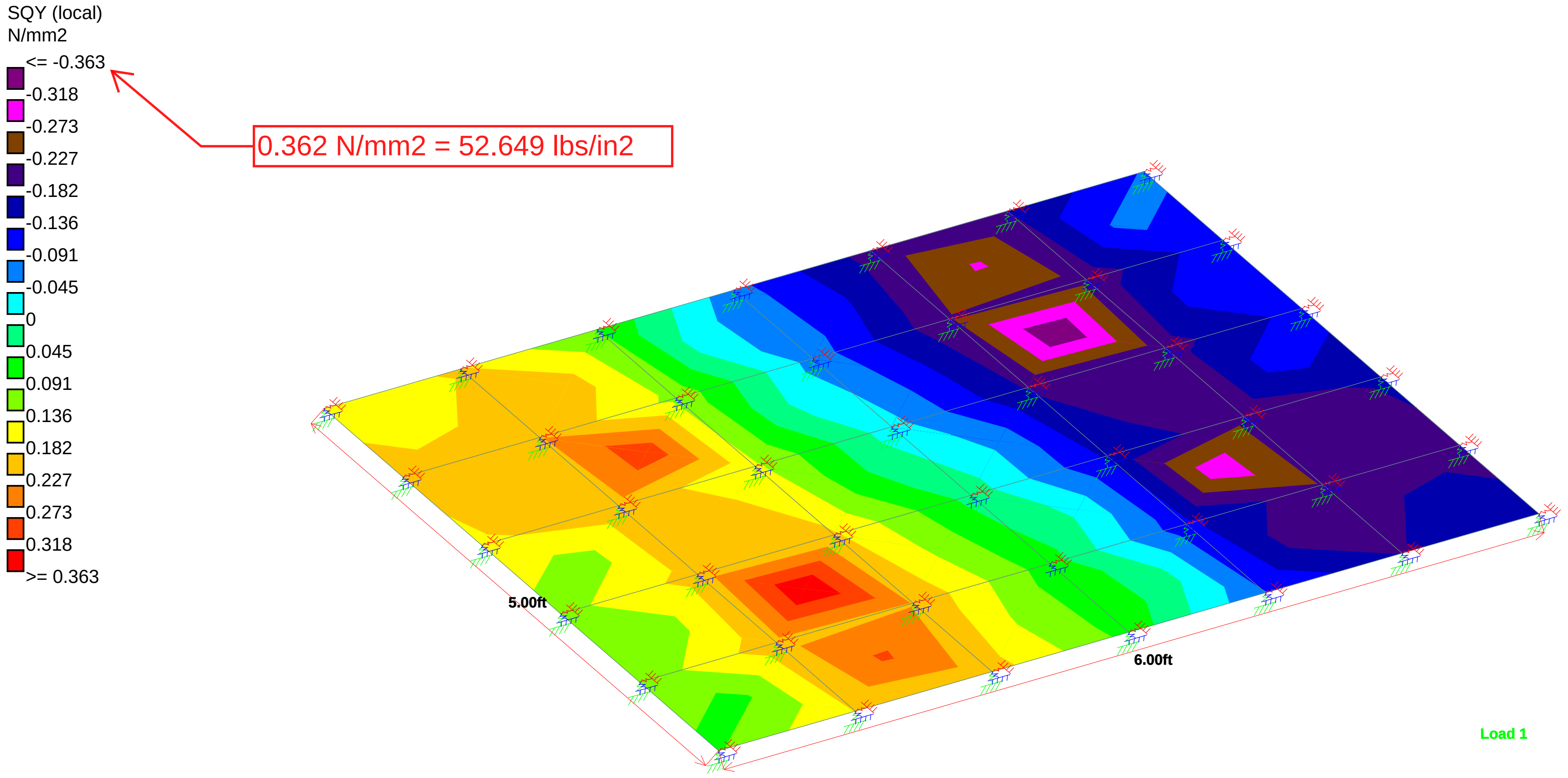
	By CH	Date 07-Mar-21		Chd
Client SSL	File Panel Check - 5x6 type A		Date/Time 08-Mar-2021 00:08	



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*           Research Engineers,  Intl.             *
*           Date=    MAR  8, 2021                  *
*           Time=     0:11: 4                      *
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     3. ENGINEER DATE 07-MAR-21
     4. JOB CLIENT SSL
     5. ENGINEER NAME CH
     6. JOB REF PANEL CHECK
     7. END JOB INFORMATION
     8. INPUT WIDTH 79
     9. UNIT FEET KIP
    10. JOINT COORDINATES
    11. 1 0 0 0; 2 1 0 0; 3 2 0 0; 4 3 0 0; 5 4 0 0; 6 5 0 0; 7 6 0 0; 10 0 0 -1.
    12. 11 1 0 -1; 12 2 0 -1; 13 3 0 -1; 14 4 0 -1; 15 5 0 -1; 16 6 0 -1; 19 0 0 -2
    13. 20 1 0 -2; 21 2 0 -2; 22 3 0 -2; 23 4 0 -2; 24 5 0 -2; 25 6 0 -2; 28 0 0 -3
    14. 29 1 0 -3; 30 2 0 -3; 31 3 0 -3; 32 4 0 -3; 33 5 0 -3; 34 6 0 -3; 45 0 0 -4
    15. 46 1 0 -4; 47 2 0 -4; 48 3 0 -4; 49 4 0 -4; 50 5 0 -4; 51 6 0 -4; 56 0 0 -5
    16. 57 1 0 -5; 58 2 0 -5; 59 3 0 -5; 60 4 0 -5; 61 5 0 -5; 62 6 0 -5
    17. ELEMENT INCIDENCES SHELL
    18. 1 1 10 11 2; 2 10 19 20 11; 3 19 28 29 20; 4 2 11 12 3; 5 11 20 21 12
    19. 6 20 29 30 21; 7 3 12 13 4; 8 12 21 22 13; 9 21 30 31 22; 10 4 13 14 5
    20. 11 13 22 23 14; 12 22 31 32 23; 13 5 14 15 6; 14 14 23 24 15; 15 23 32 33 24
    21. 16 6 15 16 7; 17 15 24 25 16; 18 24 33 34 25; 31 28 45 46 29; 32 29 46 47 30
    22. 33 30 47 48 31; 34 31 48 49 32; 35 32 49 50 33; 36 33 50 51 34; 41 45 56 57 46
    23. 42 46 57 58 47; 43 47 58 59 48; 44 48 59 60 49; 45 49 60 61 50; 46 50 61 62 51
    24. ELEMENT PROPERTY
    25. 1 TO 18 31 TO 36 41 TO 46 THICKNESS 0.5
    26. DEFINE MATERIAL START
    27. ISOTROPIC CONCRETE
    28. E 614304
    29. POISSON 0.17
    30. DENSITY 0.15
    31. ALPHA 1E-005
    32. DAMP 0.05
    33. END DEFINE MATERIAL
    34. CONSTANTS
    35. MATERIAL CONCRETE ALL
    36. SUPPORTS
    37. 1 TO 7 10 TO 16 19 TO 25 28 TO 34 45 TO 51 56 TO 61 -
    38. 62 FIXED BUT KFX 839.76 KFY 839.76 KFZ 839.76 KMX 1 KMY 1 KMZ 1
    39. LOAD 1 LOADTYPE PUSH   TITLE WIRE STRENGTH
    40. ELEMENT LOAD
```

4266 ksi = 614304 KSF

839.76 KIP/FT, see spring constant selection/calcs


```
    41. 32 PR GY -9.458 0.25 -0.1667
    42. 32 PR GY -9.458 0.25 0.5
    43. 33 PR GY -9.458 0.25 0.1667
    44. 34 PR GY -9.458 0.25 -0.1667
    45. 34 PR GY -9.458 0.25 0.5
    46. 5 PR GY -9.458 -0.25 0.5
    47. 8 PR GY -9.458 -0.25 0.1667
    48. 11 PR GY -9.458 -0.25 -0.1667
    49. 11 PR GY -9.458 -0.25 0.5
    50. 14 PR GY -9.458 -0.25 0.1667
    51. PERFORM ANALYSIS


        P R O B L E M   S T A T I S T I C S
        -----------------------------------

 NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =     42/    30/    42

       SOLVER USED IS THE OUT-OF-CORE BASIC SOLVER

 ORIGINAL/FINAL BAND-WIDTH=     8/     8/     54 DOF
 TOTAL PRIMARY LOAD CASES =     1, TOTAL DEGREES OF FREEDOM =     252
 SIZE OF STIFFNESS MATRIX =       14 DOUBLE  KILO-WORDS
 REQRD/AVAIL. DISK SPACE  =     12.3/ 263418.5 MB


    52. FINISH
```

Typical Panel Type (mesh 6W20), Panel Thickness 6", 5'x6'

Point load Input Force in panel for Staad Pro input

Location	Coordinated From Center Panel 1'x1'	
	X	Y
P1	-0.1667	0.25
P2	0.5	0.25
P3	0.1667	0.25
P4	-0.1667	0.25
P5	0.5	0.25
P6	0.1667	0.25
P7	-0.1667	-0.25
P8	0.5	-0.25
P9	0.1667	-0.25
P10	-0.1667	-0.25
P11	0.5	-0.25
P12	0.1667	-0.25

Load to panel based on Bar Mat Capacity per Bar Mat Point

Bar Mat Used:

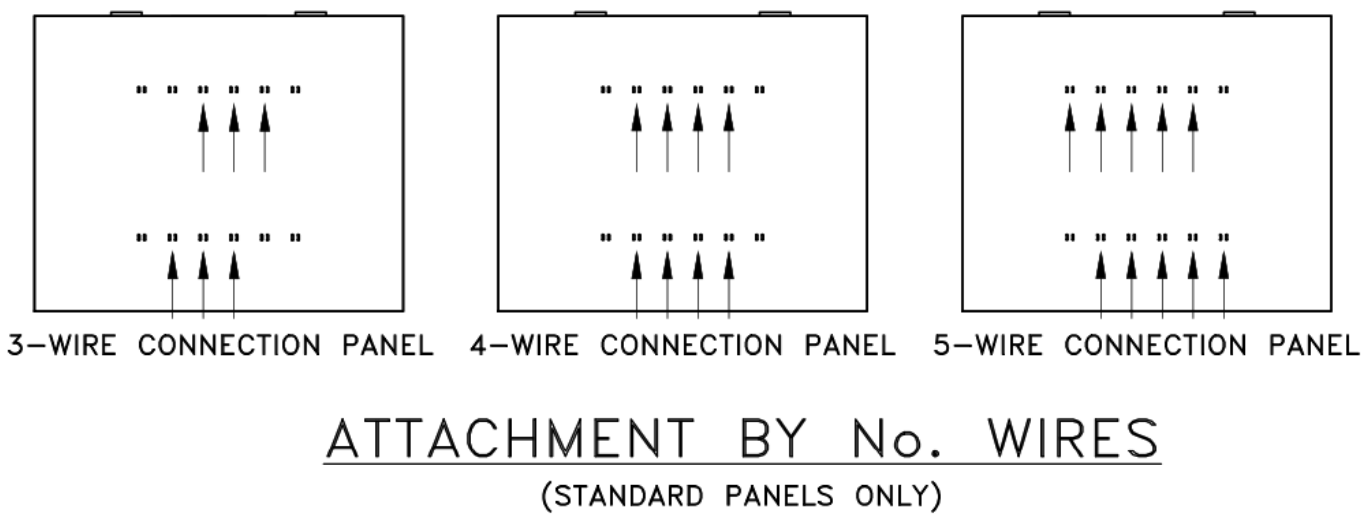
W24 - 75 Years

A = 0.194 in^2

Fy = 75 ksi

P = 0.65 x A x Fy

= 9.458 Kips (per wire point)



Software licensed to Optimal Engineering Support

Job No	Sheet No 1		Rev
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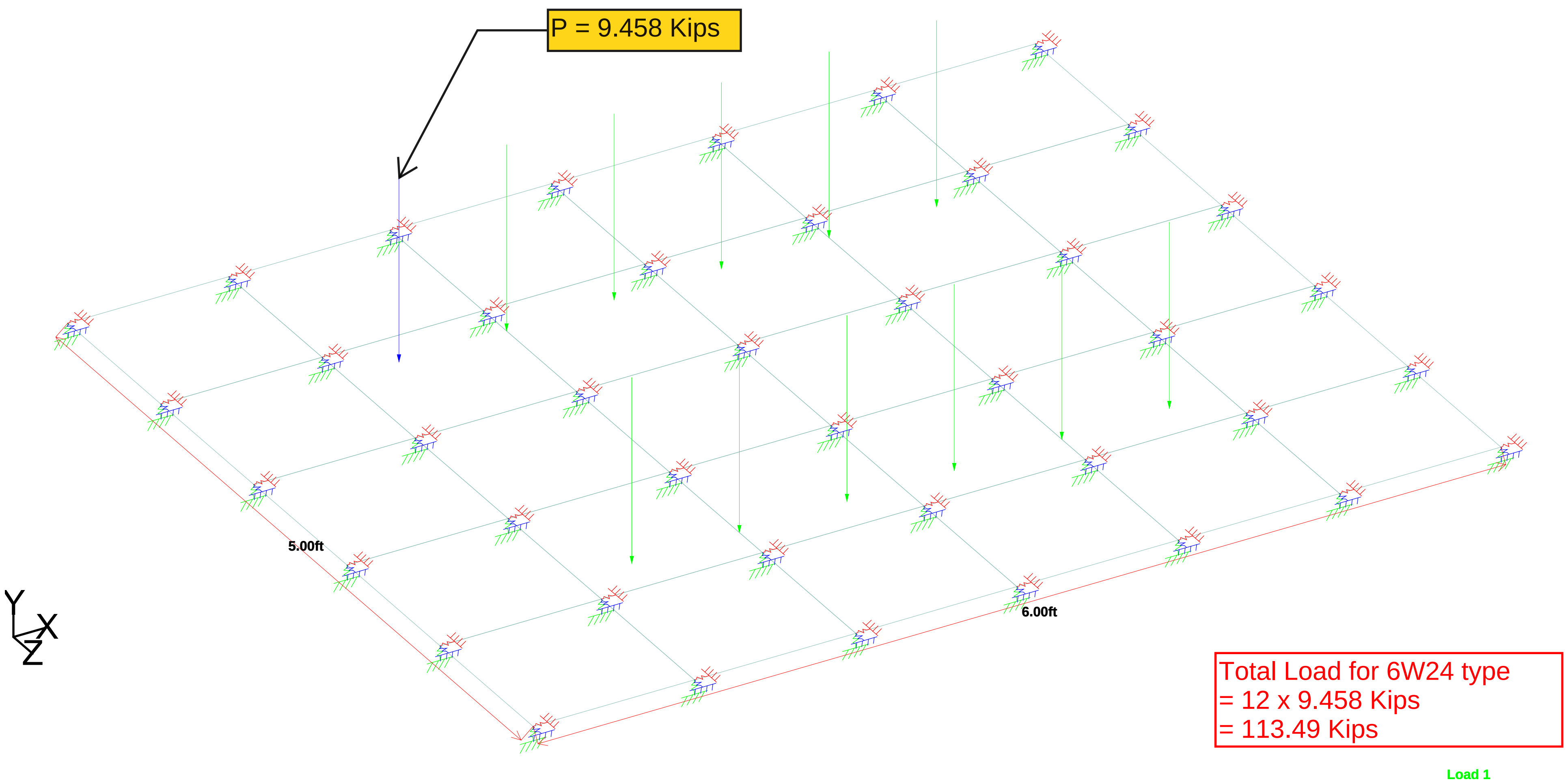
	By CH	Date 07-Mar-21	Chd
Client SSL	File Panel Check - 5x6 type A	Date/Time 08-Mar-2021 01:09	



Software licensed to Optimal Engineering Support

Job No	Sheet No 1		Rev
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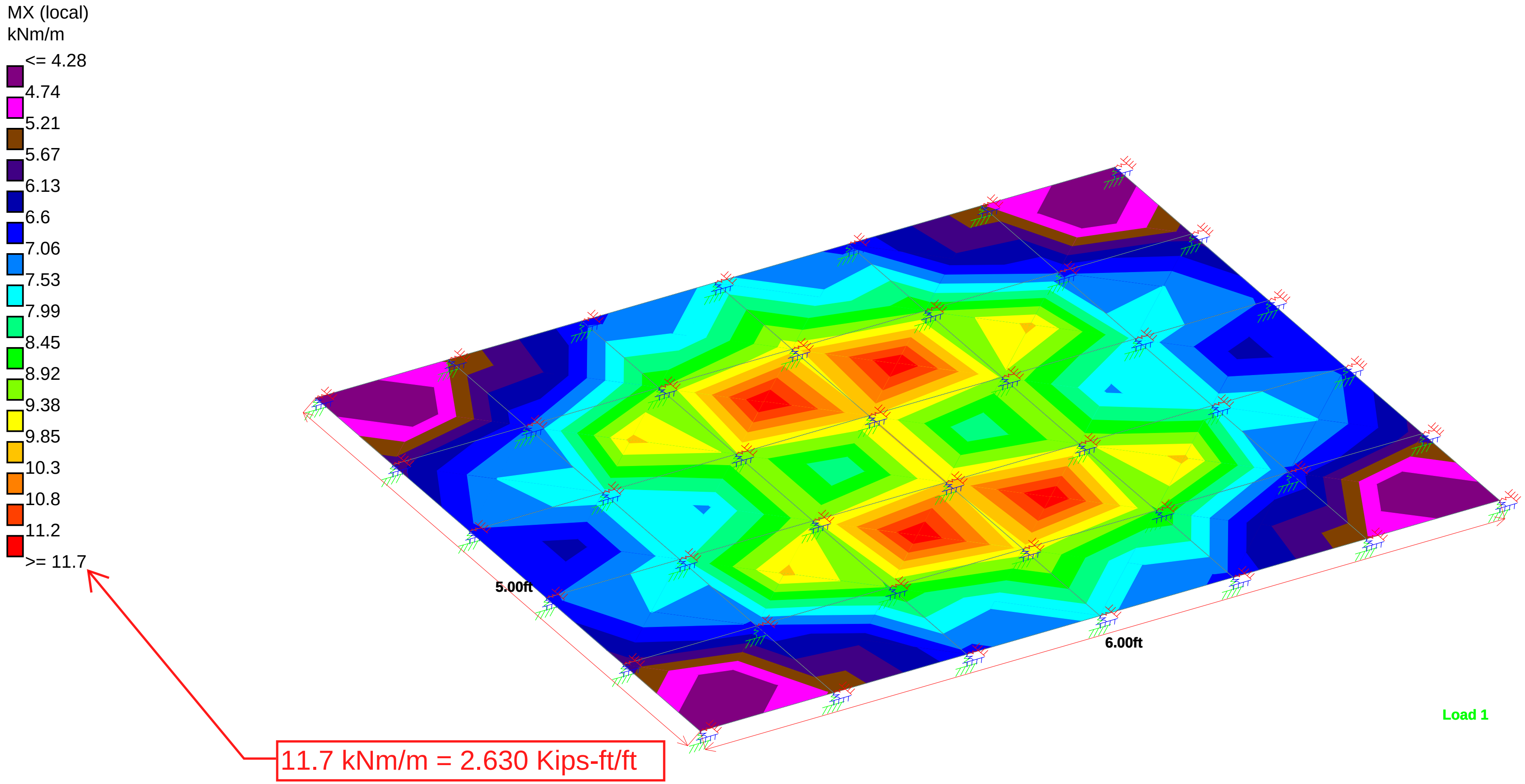
By CH	Date 07-Mar-21	Chd	
File Panel Check - 5x6 type A	Date/Time 08-Mar-2021 01:09		

Job Title

Client SSL



Software licensed to Optimal Engineering Support

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	Part		
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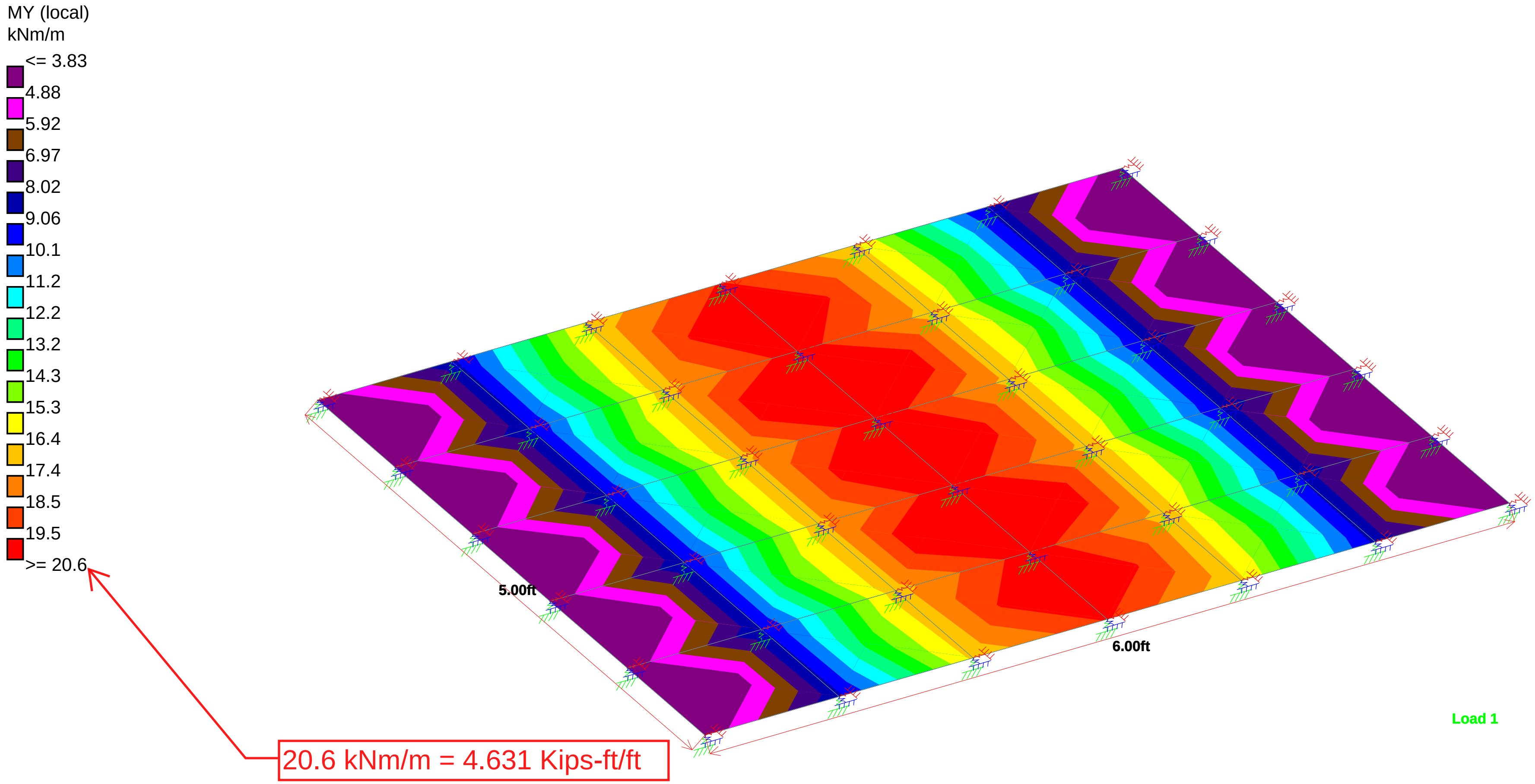
Client SSL	File Panel Check - 5x6 type A	Date/Time 08-Mar-2021 01:09	



Software licensed to Optimal Engineering Support

Job No	Sheet No 1	Rev	
Part			
Job Title	Ref Panel Check		
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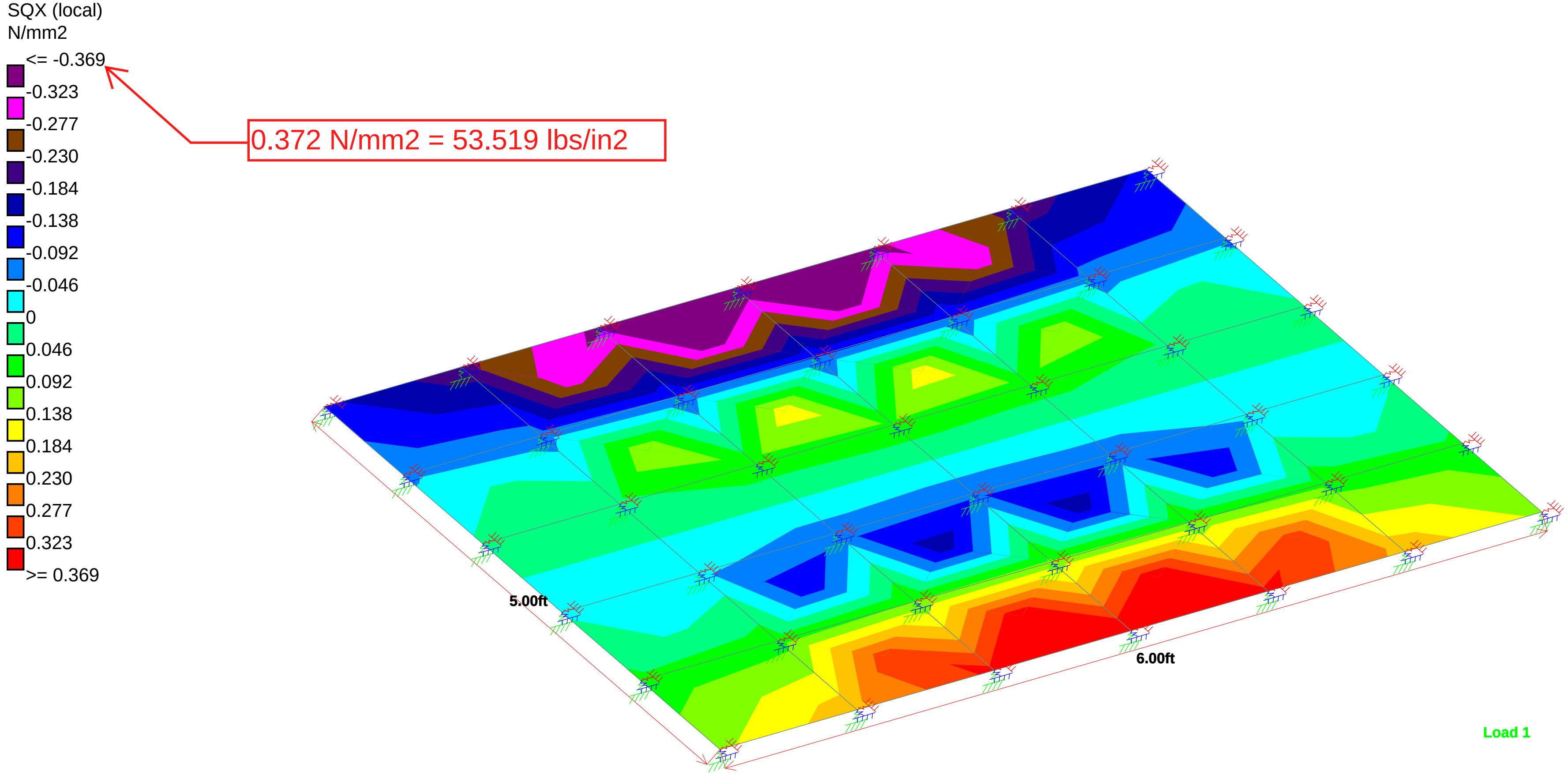
Client SSL	File Panel Check - 5x6 type A	Date/Time 08-Mar-2021 01:09	



Software licensed to Optimal Engineering Support	Job No	Sheet No 1	Rev
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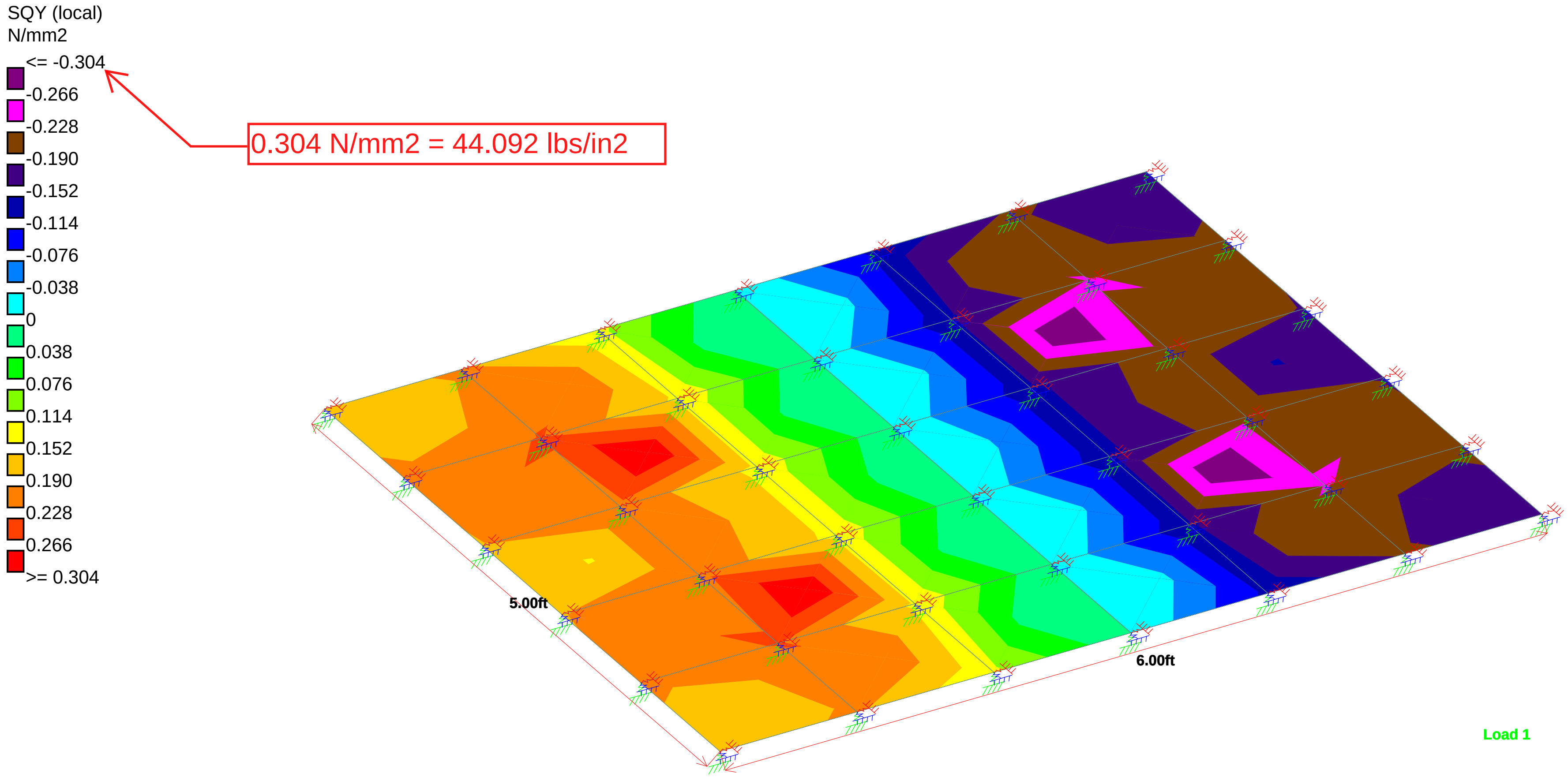
Client SSL	File Panel Check - 5x6 type A	Date/Time 08-Mar-2021 01:09	



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*          Proprietary Program of                     *
*          Research Engineers,  Intl.                 *
*          Date=    MAR  8, 2021                      *
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*      USER ID: Optimal Engineering Support           *
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INPUT FILE: Panel Check - 5x6 type A (6W24).STD
     2. START JOB INFORMATION
     3. ENGINEER DATE 07-MAR-21
     4. JOB CLIENT SSL
     5. ENGINEER NAME CH
     6. JOB REF PANEL CHECK
     7. END JOB INFORMATION
     8. INPUT WIDTH 79
     9. UNIT FEET KIP
    10. JOINT COORDINATES
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    13. 20 1 0 -2; 21 2 0 -2; 22 3 0 -2; 23 4 0 -2; 24 5 0 -2; 25 6 0 -2; 28 0 0 -3
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    16. 57 1 0 -5; 58 2 0 -5; 59 3 0 -5; 60 4 0 -5; 61 5 0 -5; 62 6 0 -5
    17. ELEMENT INCIDENCES SHELL
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    21. 16 6 15 16 7; 17 15 24 25 16; 18 24 33 34 25; 31 28 45 46 29; 32 29 46 47 30
    22. 33 30 47 48 31; 34 31 48 49 32; 35 32 49 50 33; 36 33 50 51 34; 41 45 56 57 46
    23. 42 46 57 58 47; 43 47 58 59 48; 44 48 59 60 49; 45 49 60 61 50; 46 50 61 62 51
    24. ELEMENT PROPERTY
    25. 1 TO 18 31 TO 36 41 TO 46 THICKNESS 0.5
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    27. ISOTROPIC CONCRETE
    28. E 614304
    29. POISSON 0.17
    30. DENSITY 0.15
    31. ALPHA 1E-005
    32. DAMP 0.05
    33. END DEFINE MATERIAL
    34. CONSTANTS
    35. MATERIAL CONCRETE ALL
    36. SUPPORTS
    37. 1 TO 7 10 TO 16 19 TO 25 28 TO 34 45 TO 51 56 TO 61 -
    38. 62 FIXED BUT KFX 839.76 KFY 839.76 KFZ 839.76 KMX 1 KMY 1 KMZ 1
    39. LOAD 1 LOADTYPE PUSH TITLE WIRE STRENGTH
    40. ELEMENT LOAD
```

4266 ksi = 614304 KSF

839.76 KIP/FT, see spring constant selection/calcs


```
41. 32 PR GY -9.458 0.25 -0.1667
42. 32 PR GY -9.458 0.25 0.5
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48. 5 PR GY -9.458 -0.25 0.5
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50. 11 PR GY -9.458 -0.25 -0.1667
51. 11 PR GY -9.458 -0.25 0.5
52. 14 PR GY -9.458 -0.25 0.1667
53. PERFORM ANALYSIS
```

P R O B L E M   S T A T I S T I C S

```
 NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =     42/    30/    42

       SOLVER USED IS THE OUT-OF-CORE BASIC SOLVER

 ORIGINAL/FINAL BAND-WIDTH=      8/      8/      54 DOF
 TOTAL PRIMARY LOAD CASES =     1, TOTAL DEGREES OF FREEDOM =    252
 SIZE OF STIFFNESS MATRIX =       14 DOUBLE  KILO-WORDS
 REQRD/AVAIL. DISK SPACE  =     12.3/ 263416.8 MB
```

```
54. FINISH
```

Summary Result From Staad Pro Analysis Output

Standard Panel Size	Barmat Type	Panel Type	Horz Rebar	Vert Rebar	Staad Pro Output				Data for AASHTO LRFD Design Check			
					Mx (kNm/m)	My (kNm/m)	SQx (N/mm^2)	SQy (N/mm^2)	Mx (Kips-ft/ft)	My (Kips-ft/ft)	SQx (lbs/in^2)	SQy (lbs/in^2)
5'x6'	3W11	A	4 #4	4 #4	3.180	7.080	0.125	0.140	0.715	1.592	18.130	20.305
	4W11				3.660	8.100	0.130	0.149	0.823	1.821	18.855	21.611
	5W11				4.520	**8.540**	0.147	**0.149**	1.016	**1.920**	21.321	**21.611**
	6W11				**4.810**	8.450	**0.151**	0.125	**1.081**	1.900	**21.901**	18.130
	4W20	X	6 #4	5 #4	7.270	16.100	0.257	0.296	1.634	3.619	37.275	42.931
	5W20				8.980	**17.000**	0.293	**0.296**	2.019	**3.822**	42.496	**42.931**
	6W20				**9.550**	16.800	**0.301**	0.248	**2.147**	3.777	**43.656**	35.969
	5W24	Y	7 #4	7 #4	11.000	**20.800**	0.359	**0.363**	2.473	**4.676**	52.069	**52.649**
	6W24				**11.700**	20.600	**0.369**	0.304	**2.630**	4.631	**53.519**	44.092

* Maximum bending moment and shear for each standard panel size shown in **red bold** font

5’ x 6’ STANDARD

A PANEL

Typical Panel Type A, Panel Thickness 6", 5'x6', Horizontal Rebar

Panel Strength Design

Design of panel reinforcement per
AASHTO LRFD Bridge Design Specification 5.7.3 (typical rectangular beam design)

The following design method can be used for normal weight concrete with specified compressive strength up to 15.0 ksi.
This Design are to present the information about the acceptable panel reinforcement sizes and spacing.

Panel Thickness	t_{panel}	=	6	in	
Finishing Thickness		=	1	in	
Additional Load from Finishes		=	0.0125	Kip/ft^2	
Concrete Cover	C_{panel}	=	1.5	in	
Vertical Bar Size #4					Logitudinal Bar Size #4
Rebar Diameter	d_b	=	0.5	in	d_{bh} = 0 in
Rebar Area	A_b	=	0.196	in^2	$A_b = {}^1/_4 \pi d_b{}^2$
Rebar spacing	s	=	15	in	
Width of the design section	b	=	12	in	
Effective depth of section	d_s	=	4.25	in	$d_s = t_{panel} - C_{panel} - d_{bh} - {}^1/_2 d_b$
Effective depth of section for Negative Moment	$d_{s(M^-)}$	=	1.75	in	$d_{s(M^-)} = t_{panel} - d_s$
Correction factor for source aggregate	K_1	=	1	in	AASHTO 5.4.2.4
Concrete Density	W_c	=	0.15	kcf	
Concrete Strength	f'_c	=	4.00	ksi	(Concrete Class A compressive strength)
Reinforcement Strength	f_y	=	60	ksi	(Minimum yield strength of grade 60 steel)
Modulus Elasticity of concrete	Ec	=	4266	ksi	$E_c = 120000 k_1 W_c{}^2 f'_c{}^{0.33}$
Modulus Elasticity of reinforcement	Es	=	29000	ksi	
Modular Ratio	n	=	6.798		$n = Es/Ec$
Area of Steel per Design Strip	A_s	=	0.157	in^2	$A_s = b(\frac{A_b}{s})$

$+M_u$	=	1.92	kip-ft	$+M_{u\_service}$	=	1.42	kip-ft	(FK = 1.35)
$-M_u$	=	0.00	kip-ft	$-M_{u\_service}$	=	0.00	kip-ft	(FK = 1.35)

Resistance factor for tension-controlled section φ_{STR} = 0.90 AASHTO 5.5.4.2

Positive Moment Capacity

Depth of equivalent stress block $a = \frac{A_s f_y}{0.85 f'_c b}$ = 0.231 in

Factored flexural resistance $+\varphi M_n = \varphi A_s f_y \left(d_s - \frac{a}{2}\right)$ = 2.923 kip-ft

Check $+\varphi M_n > +M_u$ 2.923 > 1.92 **OK**

Negative Moment Capacity

Depth of equivalent stress block $a = \frac{A_s f_y}{0.85 f'_c b}$ = 0.231 in

Factored flexural resistance $-\varphi M_n = \varphi A_s f_y \left(d_{s(M^-)} - \frac{a}{2}\right)$ = 1.155 kip-ft

Check $-\varphi M_n > -M_u$ 1.155 > 0.00 **OK**

Minimum Reinforcement AASHTO 5.7.3.3.2

Unless otherwise specified, the amount of prestressed and non-prestressed tensile reinforcement shall be adequate to develop a factored flexural resistance, Mr = φMn, at least equal to the lesser of:

1.33 times the positive factored ultimate moment

Cracking moment

$$M_{cr} = \gamma_3 \left[(\gamma_1 f_r + \gamma_2 \gamma_{cpe}) S_c - M_{dnc} \left(\frac{S_c}{S_{nc}} - 1 \right) \right]$$ AASHTO 5.7.3.3.2-1

When simplified by removing all values applicable to prestressed and non composite section, this equation becomes the following:

$$M_{cr} = \gamma_3 \gamma_1 f_r S_c$$

where:

flexural cracking variability factor		γ_1	=	1.60		(non-segmental brg)
ratio of specified min. yield strength to ultimate tensile strength		γ_3	=	0.67		(A615 steel)
concrete density modification factor		λ	=	1.00		AASHTO 5.4.2.8
modulus of rapture	$f_r = 0.24\lambda\sqrt{f_c'}$	f_r	=	0.48	ksi	AASHTO 5.4.2.6
section modulus of design section	$S_c = \frac{b\,h^2}{6} = \frac{bt_{panel}{}^2}{6}$	S_c	=	72.00	in^3	
Cracking moment	$M_{cr} = \gamma_3 \gamma_1 f_r S_c$	M_{cr}	=	3.09	kip-ft	

check positive moment reinforcement:

1.33 x factored ultimate moment		=	2.55	kip-ft
Cracking moment		=	3.09	kip-ft
min from (1.33 x factored +M_u and M_{cr})		=	2.55	kip-ft
Check: $+\varphi M_n > \min(+M_u, M_{cr})$	2.923	>	2.55	**OK**

check negative moment reinforcement:

1.33 x factored ultimate moment		=	0.00	kip-ft
Cracking moment		=	3.09	kip-ft
min from (1.33 x factored -M_u and M_{cr})		=	0.00	kip-ft
Check: $-\varphi M_n > \min(-M_u, M_{cr})$	1.155	>	0.00	**OK**

Typical Panel Type A, Panel Thickness 6", 5'x6', Horizontal Rebar

Shear on Panel

Panel Thickness	t_{panel}	=	6	in	
Concrete Cover	C_{panel}	=	1.5	in	
Concrete Strength	f'_c	=	4.0	ksi	(Concrete Class A compressive strength)
Reinforcement Strength	f_y	=	60	ksi	(Minimum yield strength of grade 60 steel)
Bar Size #4					
Rebar Diameter	d_b	=	0.500	in	
Rebar Area	A_b	=	0.196	in^2	$A_b = {}^1/_4 \pi {d_b}^2$
Rebar spacing	s	=	15	in	
Width of the design section	b	=	12	in	
Area of Steel per Design Strip	A_s	=	0.157	in^2	$A_s = b(\frac{A_b}{s})$
$c = \frac{A_s \, . f_s}{\alpha_1 . f_c{}' . \beta_1 \, . b}$	c	=	0.272	in	
$d_v = t_{panel} - \frac{c}{2} - C_{panel} - \frac{d_b}{2}$	d_v	=	4.114	in	

AASHTO 5.7.3.3

Vn shall be the lesser of:

(1) $V_n = V_c + V_s$

$V_c = 0.0316 \, . \beta \, . \alpha \, . \sqrt{f_c{}'} \, . \, b_v \, . d_v$	Vc	=	6.240	Kips
$V_s = \frac{A_v \, . f_y \, . d_v \, . (\cot\theta + \cot\alpha) \, . \sin\alpha}{s}$	Vs	=	3.231	Kips
	(1) Vn	=	9.472	Kips
(2) $V_n = 0.25 \, . f_c'. b_v \, . d_v$	(2) Vn	=	49.369	Kips

From (1) and (2) Vn should be: Vn = 9.472 Kips

ϕ . Vn = 0.9 . Vn
= 8.524 Kips

Shear Force:

From Staad Pro Result Vmax = 0.149 N/mm^2
= 21.61 lbs/in^2

Shear Section Area = b x tpanel
= 12 x 6

Vmax = 1555.97 lbs
= 1.556 Kips **OK, Vmax less than Vn**

Typical Panel Type A, Panel Thickness 6", 5'x6', Vertical Rebar

Panel Strength Design

Design of panel reinforcement per

AASHTO LRFD Bridge Design Specification 5.7.3 (typical rectangular beam design)

The following design method can be used for normal weight concrete with specified compressive strength up to 15.0 ksi.

This Design are to present the information about the acceptable panel reinforcement sizes and spacing.

Panel Thickness	t_{panel}	=	6	in	
Finishing Thickness		=	1	in	
Additional Load from Finishes		=	0.0125	Kip/ft^2	
Concrete Cover	C_{panel}	=	1.5	in	
Vertical Bar Size #4					Logitudinal Bar Size #4
Rebar Diameter	d_b	=	0.5	in	d_{bh} = 0.5 in
Rebar Area	A_b	=	0.196	in^2	$A_b = {}^1/_4 \pi d_b{}^2$
Rebar spacing	s	=	18	in	
Width of the design section	b	=	12	in	
Effective depth of section	d_s	=	3.75	in	$d_s = t_{panel} - C_{panel} - d_{bh} - {}^1/_2 d_b$
Effective depth of section for Negative Moment	$d_{s(M^-)}$	=	2.25	in	$d_{s(M^-)} = t_{panel} - d_s$
Correction factor for source aggregate	K_1	=	1	in	AASHTO 5.4.2.4
Concrete Density	W_c	=	0.15	kcf	
Concrete Strength	f'_c	=	4.00	ksi	(Concrete Class A compressive strength)
Reinforcement Strength	f_y	=	60	ksi	(Minimum yield strength of grade 60 steel)
Modulus Elasticity of concrete	Ec	=	4266	ksi	$E_c = 120000 k_1 W_c{}^2 f'_c{}^{0.33}$
Modulus Elasticity of reinforcement	Es	=	29000	ksi	
Modular Ratio	n	=	6.798		$n = Es/Ec$
Area of Steel per Design Strip	A_s	=	0.131	in^2	$A_s = b(\frac{A_b}{s})$

$+M_u$	=	1.08	kip-ft	$+M_{u\_service}$	=	0.80	kip-ft	(FK = 1.35)
$-M_u$	=	0.00	kip-ft	$-M_{u\_service}$	=	0.00	kip-ft	(FK = 1.35)

Resistance factor for tension-controlled section φ_{STR} = 0.90 AASHTO 5.5.4.2

Positive Moment Capacity

Depth of equivalent stress block $a = \frac{A_s f_y}{0.85 f'_c b}$ = 0.192 in

Factored flexural resistance $+\varphi M_n = \varphi A_s f_y \left(d_s - \frac{a}{2}\right)$ = 2.152 kip-ft

Check $+\varphi M_n > +M_u$ 2.152 > 1.08 **OK**

Negative Moment Capacity

Depth of equivalent stress block $a = \frac{A_s f_y}{0.85 f'_c b}$ = 0.192 in

Factored flexural resistance $-\varphi M_n = \varphi A_s f_y \left(d_{s(M^-)} - \frac{a}{2}\right)$ = 1.269 kip-ft

Check $-\varphi M_n > -M_u$ 1.269 > 0.00 **OK**

Minimum Reinforcement AASHTO 5.7.3.3.2

Unless otherwise specified, the amount of prestressed and non-prestressed tensile reinforcement shall be adequate to develop a factored flexural resistance, Mr = φMn, at least equal to the lesser of:

1.33 times the positive factored ultimate moment

Cracking moment

$$M_{cr} = \gamma_3 \left[(\gamma_1 f_r + \gamma_2 \gamma_{cpe}) S_c - M_{dnc}\left(\frac{S_c}{S_{nc}} - 1\right)\right]$$ AASHTO 5.7.3.3.2-1

When simplified by removing all values applicable to prestressed and non composite section, this equation becomes the following:

$$M_{cr} = \gamma_3 \gamma_1 f_r S_c$$

where:

flexural cracking variability factor		γ_1	=	1.60		(non-segmental brg)
ratio of specified min. yield strength to ultimate tensile strength		γ_3	=	0.67		(A615 steel)
concrete density modification factor		λ	=	1.00		AASHTO 5.4.2.8
modulus of rapture	$f_r = 0.24\lambda\sqrt{f_c'}$	f_r	=	0.48	ksi	AASHTO 5.4.2.6
section modulus of design section	$S_c = \frac{b\,h^2}{6} = \frac{b t_{panel}^2}{6}$	S_c	=	72.00	in^3	
Cracking moment	$M_{cr} = \gamma_3 \gamma_1 f_r S_c$	M_{cr}	=	3.09	kip-ft	

check positive moment reinforcement:

1.33 x factored ultimate moment		=	1.44	kip-ft
Cracking moment		=	3.09	kip-ft
min from (1.33 x factored $+M_u$ and M_{cr})		=	1.44	kip-ft
Check: $+\varphi M_n > \min(+M_u, M_{cr})$	2.152	>	1.44	**OK**

check negative moment reinforcement:

1.33 x factored ultimate moment		=	0.00	kip-ft
Cracking moment		=	3.09	kip-ft
min from (1.33 x factored $-M_u$ and M_{cr})		=	0.00	kip-ft
Check: $-\varphi M_n > \min(-M_u, M_{cr})$	1.269	>	0.00	**OK**

Typical Panel Type A, Panel Thickness 6", 5'x6', Vertical Rebar

Shear on Panel

Panel Thickness	t_{panel}	=	6	in	
Concrete Cover	C_{panel}	=	2.5	in	
Concrete Strength	f'_c	=	4.0	ksi	(Concrete Class A compressive strength)
Reinforcement Strength	f_y	=	60	ksi	(Minimum yield strength of grade 60 steel)
Bar Size #4					
Rebar Diameter	d_b	=	0.500	in	
Rebar Area	A_b	=	0.196	in^2	$A_b = {}^1/_4 \pi d_b{}^2$
Rebar spacing	s	=	18	in	
Width of the design section	b	=	12	in	
Area of Steel per Design Strip	A_s	=	0.131	in^2	$A_s = b(\frac{A_b}{s})$
$c = \frac{A_s \,.\, f_s}{\alpha_1 . f_c{}' . \beta_1 \,.\, b}$	c	=	0.226	in	
$d_v = t_{panel} - \frac{c}{2} - C_{panel} - \frac{d_b}{2}$	d_v	=	3.137	in	

AASHTO 5.7.3.3

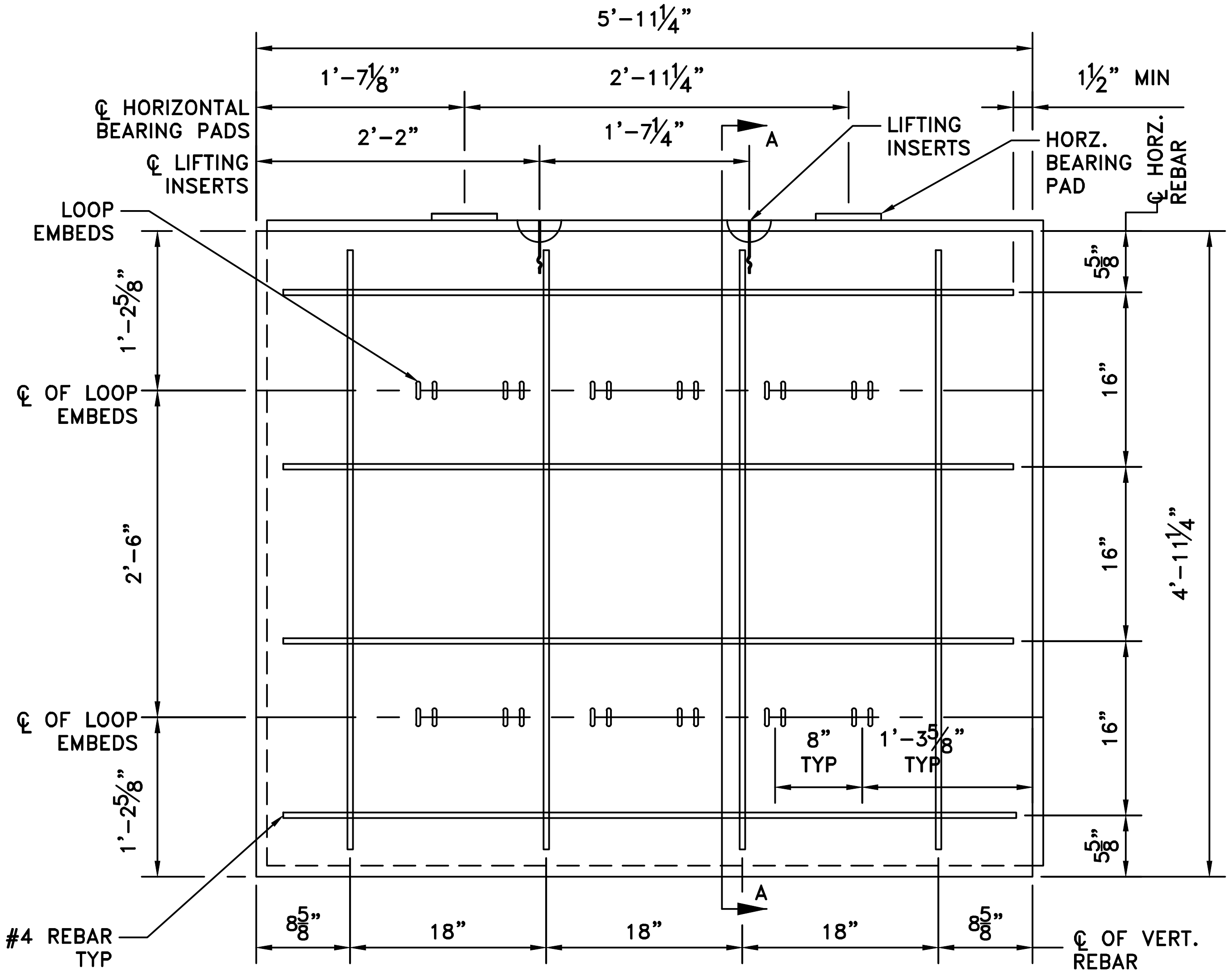
Vn shall be the lesser of:

(1) $V_n = V_c + V_s$

$V_c = 0.0316 \,.\, \beta \,.\, \alpha \,.\, \sqrt{f_c{}'} \,.\, b_v \,.\, d_v$	Vc	=	4.758	Kips
$V_s = \frac{A_v \,.\, f_y \,.\, d_v \,.\, (\cot\theta + \cot\alpha) \,.\, \sin\alpha}{s}$	Vs	=	2.053	Kips
	(1) Vn	=	6.811	Kips
(2) $V_n = 0.25 \,.\, f_c' . b_v \,.\, d_v$	(2) Vn	=	37.641	Kips
From (1) and (2) Vn should be:	Vn	=	6.811	Kips
	ϕ . Vn	=	0.9 . Vn	
		=	6.130	Kips

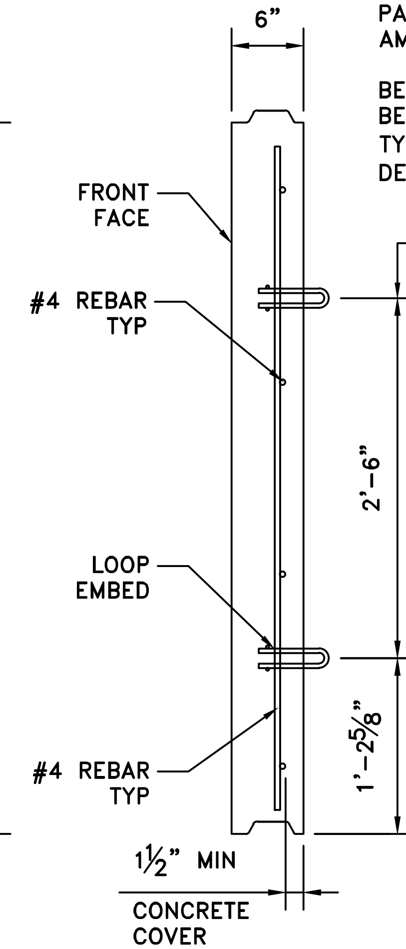
Shear Force:

From Staad Pro Result Vmax	=	0.151	N/mm^2		
	=	21.90	lbs/in^2		
Shear Section Area	=	b	x	tpanel	
	=	12	x	6	
Vmax	=	1576.85	lbs		
	=	1.577	Kips	**OK, Vmax less than Vn**	



TYPICAL PANEL

SHOWN FROM BACK FACE



SECTION A–A

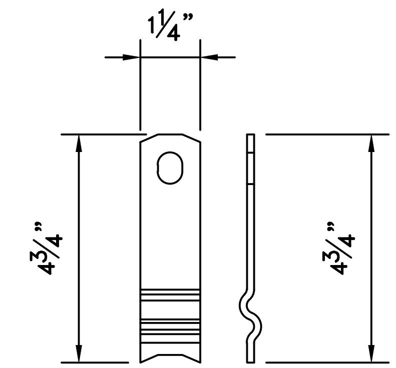
REBAR NOTE:
PANEL TYPES "A" & "Ai" REQUIRE THE SAME AMOUNT OF PANEL REINFORCEMENT.

BEARING PAD NOTE:
BEARING PAD PLACEMENT SHOWN IS FOR TYPICAL "A" PANEL ONLY, SEE STANDARD DETAILS: 5 OF 5 FOR "X" AND "Y" PANELS.

PANEL REINFORCEMENT TABLE

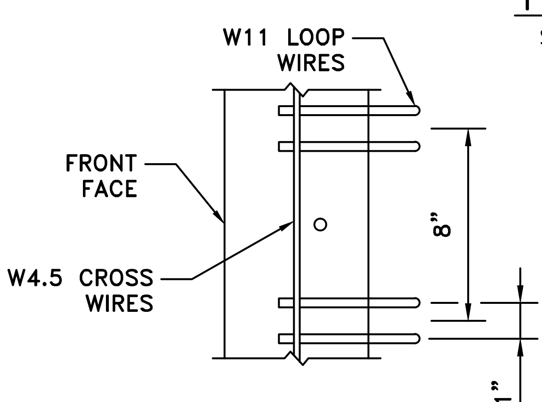
Panel Type	Vertical Bars Num / Size	Horz. Bars Num / Size
A	4 / #4	4 / #4
A2	4 / #4	2 / #4

18" MAX SPACING BETWEEN BARS

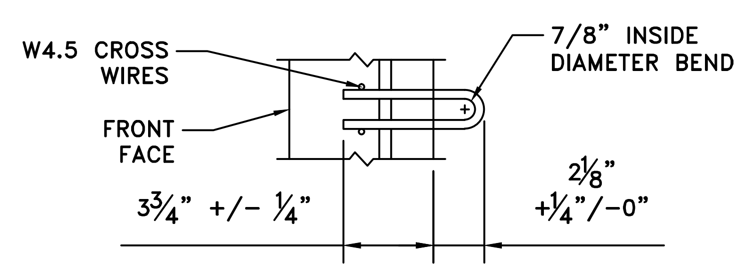


LIFTING INSERT DETAIL

NOTE:
"WAVY–TAIL" STYLE OF INSERT SHOWN. OTHER INSERTS OF EQUAL OR GREATER CAPACITY MAY BE USED IF APPROVED BY SSL.



PLAN VIEW



ELEVATION VIEW

LOOP EMBED DETAILS

PANEL TOLERANCES:

OVERALL DIMENSIONS:

- STANDARD PANEL
  ± ½" VERTICAL
  ± ½" HORIZONTAL
- TOP AND SPECIAL PANELS
  ± 1" VERTICAL
  ± ½" HORIZONTAL

CONNECTION DEVICE LOCATIONS:

- EMBEDS
  ± 1" VERTICAL
  ± 1" HORIZONTAL

PANEL SQUARENESS:

- 90° PANEL CORNERS
  ± 3⁄16" USING 2' SQUARE
  (MEASURE 3 PANEL CORNERS)

PANEL DIAGONAL:

- PANELS WITH 90° CORNERS
  ½" MAX. DIFFERENCE BETWEEN DIAGONALS

SURFACE FINISH:

- FINISH AT FRONT FACE
  ± ⅛" IN 5'

STANDARD TYPE "A" PANEL DETAILS

CERTIFIED ONLY WITH RESPECT TO INTERNAL STABILITY OF REINFORCED EARTH STRUCTURES

REGISTERED PROFESSIONAL ENGINEER
FRANSISCUS S. HARDIANTO
No. C60215
EXP. 06-30-22
CIVIL
STATE OF CALIFORNIA

FRANSISCUS S. HARDIANTO
03/09/21

SSL ™
INNOVATIVE CONSTRUCTION PRODUCTS
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CHECK BY: WM	03/09/21				
DESIGN BY: FSH	03/09/21				
CHECK BY: FSH	03/09/21				
PROJ. ENGR:	FSH	NO.	DATE	REVISION DESCRIPTION	BY

STANDARD DETAILS: 1 OF 5

STANDARD MSE WALL DETAILS

Scale: NTS
Job: --
Sheet: RW-01
Sheet 1 of 5

5’ x 6’ STANDARD

X PANEL

Typical Panel Type X, Panel Thickness 6", 5'x6', Horizontal Rebar

Panel Strength Design

Design of panel reinforcement per
AASHTO LRFD Bridge Design Specification 5.7.3 (typical rectangular beam design)

The following design method can be used for normal weight concrete with specified compressive strength up to 15.0 ksi.
This Design are to present the information about the acceptable panel reinforcement sizes and spacing.

Panel Thickness	t_{panel}	=	6	in	
Finishing Thickness		=	1	in	
Additional Load from Finishes		=	0.0125	Kip/ft^2	
Concrete Cover	C_{panel}	=	1.5	in	
Vertical Bar Size #4					Logitudinal Bar Size #4
Rebar Diameter	d_b	=	0.5	in	d_{bh} = 0 in
Rebar Area	A_b	=	0.196	in^2	$A_b = {}^1/_4 \pi d_b{}^2$
Rebar spacing	s	=	10	in	
Width of the design section	b	=	12	in	
Effective depth of section	d_s	=	4.25	in	$d_s = t_{panel} - C_{panel} - d_{bh} - {}^1/_2\, d_b$
Effective depth of section for Negative Moment	$d_{s(M^-)}$	=	1.75	in	$d_{s(M^-)} = t_{panel} - d_s$
Correction factor for source aggregate	K_1	=	1	in	AASHTO 5.4.2.4
Concrete Density	W_c	=	0.15	kcf	
Concrete Strength	f'_c	=	4.00	ksi	(Concrete Class A compressive strength)
Reinforcement Strength	f_y	=	60	ksi	(Minimum yield strength of grade 60 steel)
Modulus Elasticity of concrete	Ec	=	4266	ksi	$E_c = 120000 k_1 W_c{}^2 f'_c{}^{0.33}$
Modulus Elasticity of reinforcement	Es	=	29000	ksi	
Modular Ratio	n	=	6.798		$n = Es/Ec$
Area of Steel per Design Strip	A_s	=	0.236	in^2	$A_s = b(\frac{A_b}{s})$

$+M_u$	=	3.82	kip-ft	$+M_{u\_service}$	=	2.83	kip-ft	(FK = 1.35)
$-M_u$	=	0.00	kip-ft	$-M_{u\_service}$	=	0.00	kip-ft	(FK = 1.35)

Resistance factor for tension-controlled section φ_{STR} = 0.90 AASHTO 5.5.4.2

Positive Moment Capacity

Depth of equivalent stress block $a = \dfrac{A_s f_y}{0.85 f'_c b}$ = 0.346 in

Factored flexural resistance $+\varphi M_n = \varphi A_s f_y \left(d_s - \dfrac{a}{2}\right)$ = 4.323 kip-ft

Check $+\varphi M_n > +M_u$ 4.323 > 3.82 **OK**

Negative Moment Capacity

Depth of equivalent stress block $a = \dfrac{A_s f_y}{0.85 f'_c b}$ = 0.346 in

Factored flexural resistance $-\varphi M_n = \varphi A_s f_y \left(d_{s(M^-)} - \dfrac{a}{2}\right)$ = 1.672 kip-ft

Check $-\varphi M_n > -M_u$ 1.672 > 0.00 **OK**

Minimum Reinforcement AASHTO 5.7.3.3.2

Unless otherwise specified, the amount of prestressed and non-prestressed tensile reinforcement shall be adequate to develop a factored flexural resistance, Mr = φMn, at least equal to the lesser of:

1.33 times the positive factored ultimate moment

Cracking moment

$$M_{cr} = \gamma_3 \left[(\gamma_1 f_r + \gamma_2 \gamma_{cpe}) S_c - M_{dnc} \left(\frac{S_c}{S_{nc}} - 1 \right) \right]$$ AASHTO 5.7.3.3.2-1

When simplified by removing all values applicable to prestressed and non composite section, this equation becomes the following:

$$M_{cr} = \gamma_3 \gamma_1 f_r S_c$$

where:

flexural cracking variability factor		γ_1	=	1.60		(non-segmental brg)
ratio of specified min. yield strength to ultimate tensile strength		γ_3	=	0.67		(A615 steel)
concrete density modification factor		λ	=	1.00		AASHTO 5.4.2.8
modulus of rapture	$f_r = 0.24\lambda\sqrt{f_c'}$	f_r	=	0.48	ksi	AASHTO 5.4.2.6
section modulus of design section	$S_c = \frac{b\,h^2}{6} = \frac{bt_{panel}{}^2}{6}$	S_c	=	72.00	in^3	
Cracking moment	$M_{cr} = \gamma_3 \gamma_1 f_r S_c$	M_{cr}	=	3.09	kip-ft	

check positive moment reinforcement:

1.33 x factored ultimate moment	=	5.08	kip-ft
Cracking moment	=	3.09	kip-ft
min from (1.33 x factored $+M_u$ and M_{cr})	=	3.09	kip-ft

Check: $+\varphi M_n > \min(+M_u\,, M_{cr})$ 4.323 > 3.09 **OK**

check negative moment reinforcement:

1.33 x factored ultimate moment	=	0.00	kip-ft
Cracking moment	=	3.09	kip-ft
min from (1.33 x factored $-M_u$ and M_{cr})	=	0.00	kip-ft

Check: $-\varphi M_n > \min(-M_u\,, M_{cr})$ 1.672 > 0.00 **OK**

Typical Panel Type X, Panel Thickness 6", 5'x6', Horizontal Rebar

Shear on Panel

Panel Thickness	t_{panel}	=	6	in	
Concrete Cover	C_{panel}	=	1.5	in	
Concrete Strength	f'_c	=	4.0	ksi	(Concrete Class A compressive strength)
Reinforcement Strength	f_y	=	60	ksi	(Minimum yield strength of grade 60 steel)
Bar Size #4					
Rebar Diameter	d_b	=	0.500	in	
Rebar Area	A_b	=	0.196	in^2	$A_b = {}^1/_4 \pi {d_b}^2$
Rebar spacing	s	=	10	in	
Width of the design section	b	=	12	in	
Area of Steel per Design Strip	A_s	=	0.236	in^2	$A_s = b(\frac{A_b}{s})$
$c = \frac{A_s \cdot f_s}{\alpha_1 . f_c' . \beta_1 . b}$	c	=	0.408	in	
$d_v = t_{panel} - \frac{c}{2} - C_{panel} - \frac{d_b}{2}$	d_v	=	4.046	in	

AASHTO 5.7.3.3

Vn shall be the lesser of:

(1) $V_n = V_c + V_s$

$V_c = 0.0316 . \beta . \alpha . \sqrt{f_c'} . b_v . d_v$	Vc	=	6.137	Kips
$V_s = \frac{A_v . f_y . d_v . (\cot\theta + \cot\alpha) . \sin\alpha}{s}$	Vs	=	4.767	Kips
	(1) Vn	=	10.904	Kips
(2) $V_n = 0.25 . f_c' . b_v . d_v$	(2) Vn	=	48.554	Kips
From (1) and (2) Vn should be:	Vn	=	10.904	Kips
	ϕ . Vn	=	0.9 . Vn	
		=	9.814	Kips

Shear Force:

From Staad Pro Result Vmax	=	0.296	N/mm^2		
	=	42.93	lbs/in^2		
Shear Section Area	=	b	x	tpanel	
	=	12	x	6	
Vmax	=	3091.05	lbs		
	=	3.091	Kips	**OK, Vmax less than Vn**	

Typical Panel Type X, Panel Thickness 6", 5'x6', Vertical Rebar

Panel Strength Design

Design of panel reinforcement per
AASHTO LRFD Bridge Design Specification 5.7.3 (typical rectangular beam design)

The following design method can be used for normal weight concrete with specified compressive strength up to 15.0 ksi.
This Design are to present the information about the acceptable panel reinforcement sizes and spacing.

Panel Thickness	t_{panel}	=	6	in	
Finishing Thickness		=	1	in	
Additional Load from Finishes		=	0.0125	Kip/ft^2	
Concrete Cover	C_{panel}	=	1.5	in	
Vertical Bar Size #4					Logitudinal Bar Size #4
Rebar Diameter	d_b	=	0.5	in	d_{bh} = 0.5 in
Rebar Area	A_b	=	0.196	in^2	$A_b = {}^1/_4 \pi d_b{}^2$
Rebar spacing	s	=	12	in	
Width of the design section	b	=	12	in	
Effective depth of section	d_s	=	3.75	in	$d_s = t_{panel} - C_{panel} - d_{bh} - {}^1/_2 d_b$
Effective depth of section for Negative Moment	$d_{s(M^-)}$	=	2.25	in	$d_{s(M^-)} = t_{panel} - d_s$
Correction factor for source aggregate	K_1	=	1	in	AASHTO 5.4.2.4
Concrete Density	W_c	=	0.15	kcf	
Concrete Strength	f'_c	=	4.00	ksi	(Concrete Class A compressive strength)
Reinforcement Strength	f_y	=	60	ksi	(Minimum yield strength of grade 60 steel)
Modulus Elasticity of concrete	Ec	=	4266	ksi	$E_c = 120000 k_1 W_c{}^2 f'_c{}^{0.33}$
Modulus Elasticity of reinforcement	Es	=	29000	ksi	
Modular Ratio	n	=	6.798		$n = Es/Ec$
Area of Steel per Design Strip	A_s	=	0.196	in^2	$A_s = b(\frac{A_b}{s})$

$+M_u$	=	2.15	kip-ft	$+M_{u\_service}$	=	1.59	kip-ft	(FK = 1.35)
$-M_u$	=	0.00	kip-ft	$-M_{u\_service}$	=	0.00	kip-ft	(FK = 1.35)

Resistance factor for tension-controlled section φ_{STR} = 0.90 AASHTO 5.5.4.2

Positive Moment Capacity

Depth of equivalent stress block $a = \dfrac{A_s f_y}{0.85 f'_c b}$ = 0.289 in

Factored flexural resistance $+\varphi M_n = \varphi A_s f_y \left(d_s - \dfrac{a}{2}\right)$ = 3.186 kip-ft

Check $+\varphi M_n > +M_u$ 3.186 > 2.15 **OK**

Negative Moment Capacity

Depth of equivalent stress block $a = \dfrac{A_s f_y}{0.85 f'_c b}$ = 0.289 in

Factored flexural resistance $-\varphi M_n = \varphi A_s f_y \left(d_{s(M^-)} - \dfrac{a}{2}\right)$ = 1.860 kip-ft

Check $-\varphi M_n > -M_u$ 1.860 > 0.00 **OK**

Minimum Reinforcement AASHTO 5.7.3.3.2

Unless otherwise specified, the amount of prestressed and non-prestressed tensile reinforcement shall be adequate to develop a factored flexural resistance, Mr = φMn, at least equal to the lesser of:

1.33 times the positive factored ultimate moment

Cracking moment

$$M_{cr} = \gamma_3 \left[(\gamma_1 f_r + \gamma_2 \gamma_{cpe})S_c - M_{dnc}\left(\frac{S_c}{S_{nc}} - 1\right)\right]$$ AASHTO 5.7.3.3.2-1

When simplified by removing all values applicable to prestressed and non composite section, this equation becomes the following:

$$M_{cr} = \gamma_3 \gamma_1 f_r S_c$$

where:

flexural cracking variability factor		γ_1	=	1.60		(non-segmental brg)
ratio of specified min. yield strength to ultimate tensile strength		γ_3	=	0.67		(A615 steel)
concrete density modification factor		λ	=	1.00		AASHTO 5.4.2.8
modulus of rapture	$f_r = 0.24\lambda\sqrt{f_c'}$	f_r	=	0.48	ksi	AASHTO 5.4.2.6
section modulus of design section	$S_c = \frac{b\,h^2}{6} = \frac{bt_{panel}{}^2}{6}$	S_c	=	72.00	in^3	
Cracking moment	$M_{cr} = \gamma_3 \gamma_1 f_r S_c$	M_{cr}	=	3.09	kip-ft	

check positive moment reinforcement:

1.33 x factored ultimate moment	=	2.86	kip-ft
Cracking moment	=	3.09	kip-ft
min from (1.33 x factored +M_u and M_{cr})	=	2.86	kip-ft

Check: $+\varphi M_n > \min(+M_u, M_{cr})$ 3.186 > 2.86 **OK**

check negative moment reinforcement:

1.33 x factored ultimate moment	=	0.00	kip-ft
Cracking moment	=	3.09	kip-ft
min from (1.33 x factored -M_u and M_{cr})	=	0.00	kip-ft

Check: $-\varphi M_n > \min(-M_u, M_{cr})$ 1.860 > 0.00 **OK**

Typical Panel Type X, Panel Thickness 6", 5'x6', Vertical Rebar

Shear on Panel

Panel Thickness	t_{panel}	=	6	in	
Concrete Cover	C_{panel}	=	2.5	in	
Concrete Strength	f'_c	=	4.0	ksi	(Concrete Class A compressive strength)
Reinforcement Strength	f_y	=	60	ksi	(Minimum yield strength of grade 60 steel)
Bar Size #4					
Rebar Diameter	d_b	=	0.500	in	
Rebar Area	A_b	=	0.196	in^2	$A_b = {}^1/_4 \pi d_b{}^2$
Rebar spacing	s	=	12	in	
Width of the design section	b	=	12	in	
Area of Steel per Design Strip	A_s	=	0.196	in^2	$A_s = b(\frac{A_b}{s})$
$c = \frac{A_s \,.\, f_s}{\alpha_1 . f_c{}' . \beta_1 \,.\, b}$	c	=	0.340	in	
$d_v = t_{panel} - \frac{c}{2} - C_{panel} - \frac{d_b}{2}$	d_v	=	3.080	in	

AASHTO 5.7.3.3

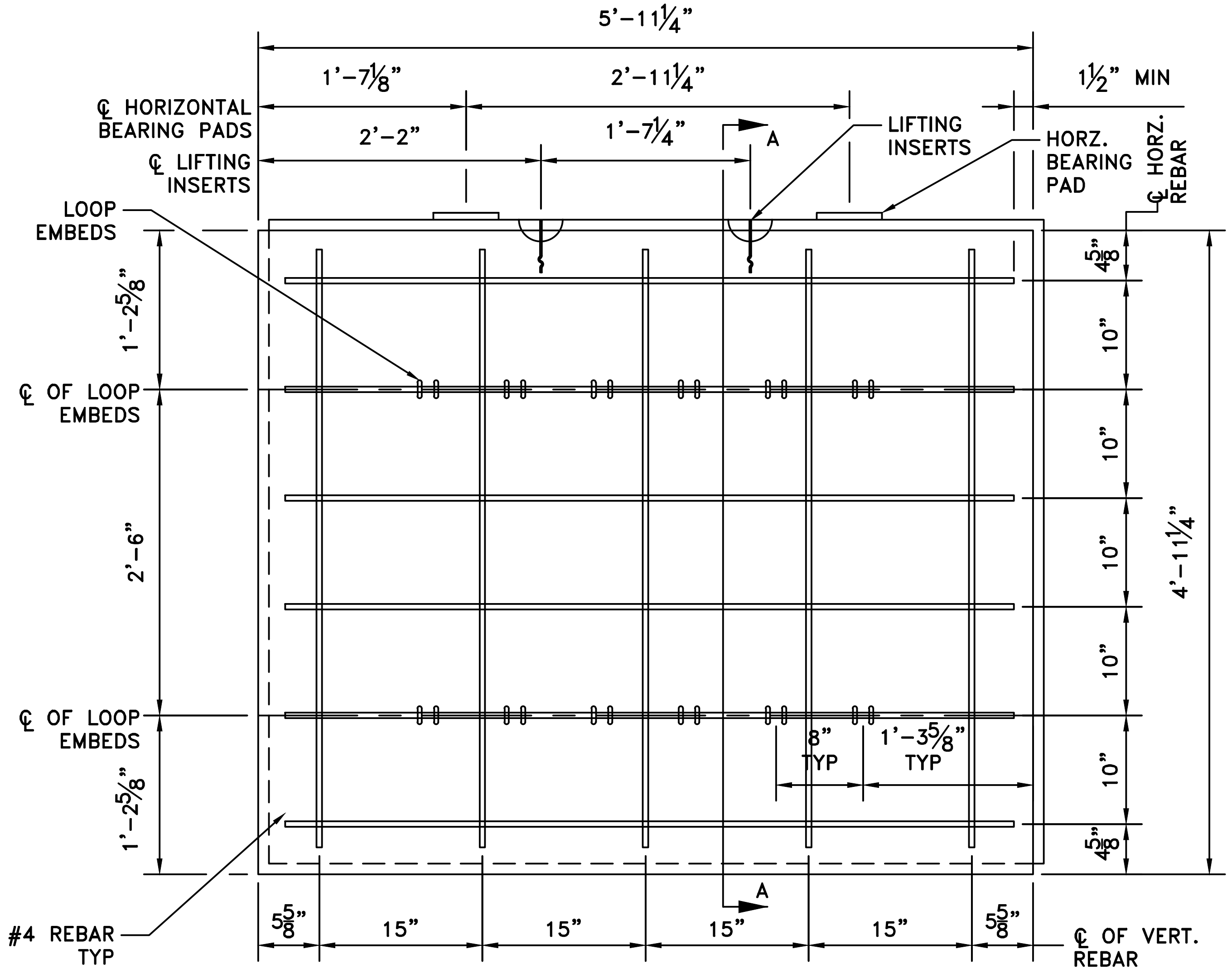
Vn shall be the lesser of:

(1) $V_n = V_c + V_s$

$V_c = 0.0316 \,.\, \beta \,.\, \alpha \,.\, \sqrt{f_c{}'} \,.\, b_v \,.\, d_v$	Vc	=	4.672	Kips
$V_s = \frac{A_v \,.\, f_y \,.\, d_v \,.\, (\cot\theta + \cot\alpha) \,.\, \sin\alpha}{s}$	Vs	=	3.024	Kips
	(1) Vn	=	7.696	Kips
(2) $V_n = 0.25 \,.\, f_c' . b_v \,.\, d_v$	(2) Vn	=	36.962	Kips
From (1) and (2) Vn should be:	Vn	=	7.696	Kips
	ϕ . Vn	=	0.9 . Vn	
		=	6.926	Kips

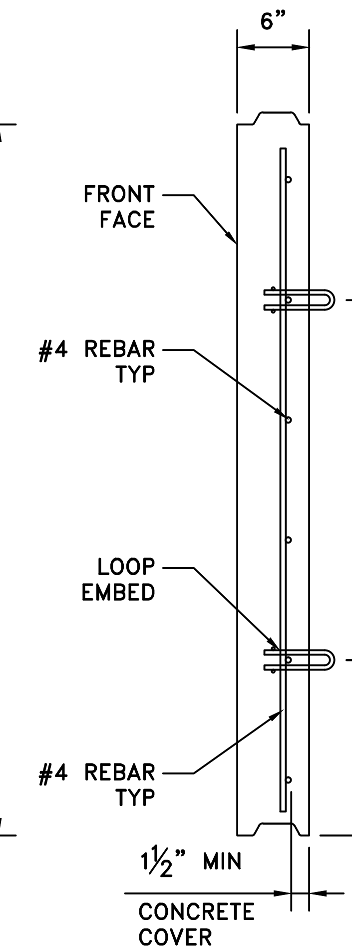
Shear Force:

From Staad Pro Result Vmax	=	0.301	N/mm^2		
	=	43.66	lbs/in^2		
Shear Section Area	=	b	x	tpanel	
	=	12	x	6	
Vmax	=	3143.26	lbs		
	=	3.143	Kips	**OK, Vmax less than Vn**	



TYPICAL PANEL

SHOWN FROM BACK FACE



SECTION A-A

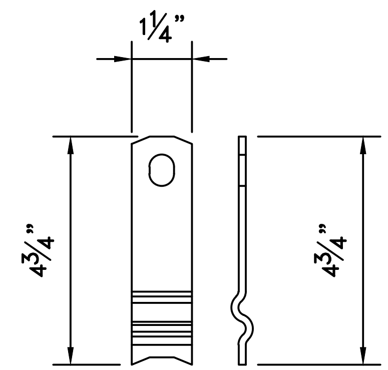
REBAR NOTE:
PANEL TYPES "X" & "XI" REQUIRE THE SAME AMOUNT OF PANEL REINFORCEMENT.

BEARING PAD NOTE:
BEARING PAD PLACEMENT SHOWN IS FOR TYPICAL "A" PANEL ONLY, SEE STANDARD DETAILS: 5 OF 5 FOR "X" AND "Y" PANELS.

PANEL REINFORCEMENT TABLE

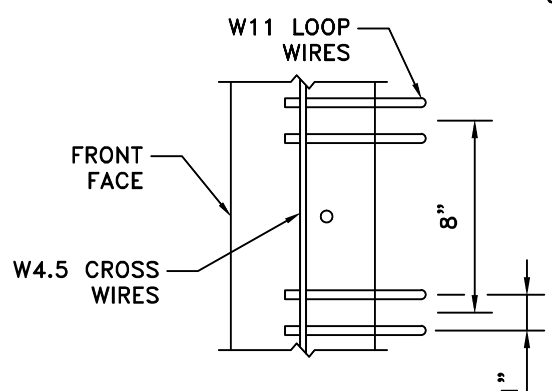
Panel Type	Vertical Bars Num / Size	Horz. Bars Num / Size
X	5 / #4	6 / #4
X2	5 / #4	3 / #4

18" MAX SPACING BETWEEN BARS

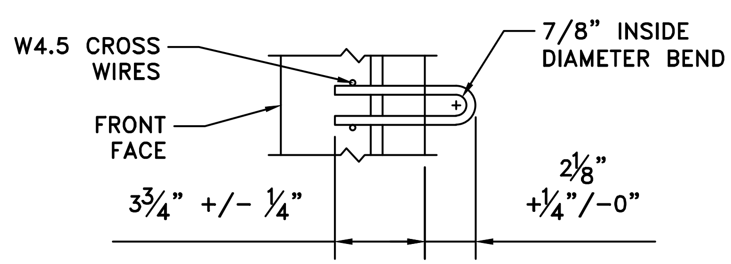


LIFTING INSERT DETAIL

NOTE:
"WAVY-TAIL" STYLE OF INSERT SHOWN. OTHER INSERTS OF EQUAL OR GREATER CAPACITY MAY BE USED IF APPROVED BY SSL.



PLAN VIEW



ELEVATION VIEW

LOOP EMBED DETAILS

PANEL TOLERANCES:

OVERALL DIMENSIONS:

- STANDARD PANEL
  ± ½" VERTICAL
  ± ½" HORIZONTAL
- TOP AND SPECIAL PANELS
  ± 1" VERTICAL
  ± ½" HORIZONTAL

CONNECTION DEVICE LOCATIONS:

- EMBEDS
  ± 1" VERTICAL
  ± 1" HORIZONTAL

PANEL SQUARENESS:

- 90° PANEL CORNERS
  ± 3⁄16" USING 2' SQUARE
  (MEASURE 3 PANEL CORNERS)

PANEL DIAGONAL:

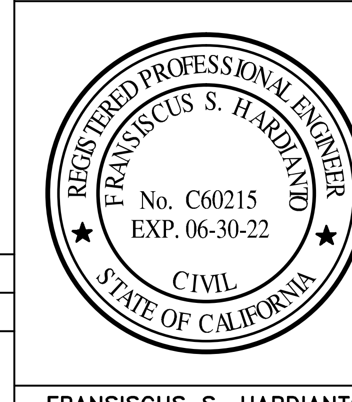
- PANELS WITH 90° CORNERS
  ½" MAX. DIFFERENCE BETWEEN DIAGONALS

SURFACE FINISH:

- FINISH AT FRONT FACE
  ± ⅛" IN 5'

STANDARD TYPE "X" PANEL DETAILS

CERTIFIED ONLY WITH RESPECT TO INTERNAL STABILITY OF REINFORCED EARTH STRUCTURES



INNOVATIVE CONSTRUCTION PRODUCTS
4740 SCOTTS VALLEY DRIVE, SUITE E
SCOTTS VALLEY, CA 95066
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DRAWN BY: WM	03/09/21				
CHECK BY: WM	03/09/21				
DESIGN BY: FSH	03/09/21				
CHECK BY: FSH	03/09/21				
PROJ. ENGR: FSH		NO.	DATE	REVISION DESCRIPTION	BY

STANDARD DETAILS: 2 OF 5

STANDARD MSE WALL DETAILS

Scale: NTS
Job: --
Sheet: RW-02
Sheet 2 of 5

FRANSISCUS S. HARDIANTO
03/09/21

5’ x 6’ STANDARD

Y PANEL

Typical Panel Type Y, Panel Thickness 6", 5'x6', Horizontal Rebar

Panel Strength Design

Design of panel reinforcement per
AASHTO LRFD Bridge Design Specification 5.7.3 (typical rectangular beam design)

The following design method can be used for normal weight concrete with specified compressive strength up to 15.0 ksi.
This Design are to present the information about the acceptable panel reinforcement sizes and spacing.

Panel Thickness	t_{panel}	=	6	in	
Finishing Thickness		=	1	in	
Additional Load from Finishes		=	0.0125	Kip/ft^2	
Concrete Cover	C_{panel}	=	1.5	in	
Vertical Bar Size #4					Logitudinal Bar Size #4
Rebar Diameter	d_b	=	0.5	in	d_{bh} = 0 in
Rebar Area	A_b	=	0.196	in^2	$A_b = {}^1/_4 \pi d_b{}^2$
Rebar spacing	s	=	8.57	in	
Width of the design section	b	=	12	in	
Effective depth of section	d_s	=	4.25	in	$d_s = t_{panel} - C_{panel} - d_{bh} - {}^1/_2\, d_b$
Effective depth of section for Negative Moment	$d_{s(M^-)}$	=	1.75	in	$d_{s(M^-)} = t_{panel} - d_s$
Correction factor for source aggregate	K_1	=	1	in	AASHTO 5.4.2.4
Concrete Density	W_c	=	0.15	kcf	
Concrete Strength	f'_c	=	4.00	ksi	(Concrete Class A compressive strength)
Reinforcement Strength	f_y	=	60	ksi	(Minimum yield strength of grade 60 steel)
Modulus Elasticity of concrete	Ec	=	4266	ksi	$E_c = 120000 k_1 W_c{}^2 f'_c{}^{0.33}$
Modulus Elasticity of reinforcement	Es	=	29000	ksi	
Modular Ratio	n	=	6.798		$n = Es/Ec$
Area of Steel per Design Strip	A_s	=	0.275	in^2	$A_s = b(\frac{A_b}{s})$

$+M_u$	=	4.68	kip-ft	$+M_{u\_service}$	=	3.46	kip-ft	(FK = 1.35)
$-M_u$	=	0.00	kip-ft	$-M_{u\_service}$	=	0.00	kip-ft	(FK = 1.35)

Resistance factor for tension-controlled section φ_{STR} = 0.90 AASHTO 5.5.4.2

Positive Moment Capacity

Depth of equivalent stress block $a = \frac{A_s f_y}{0.85 f'_c b}$ = 0.404 in

Factored flexural resistance $+\varphi M_n = \varphi A_s f_y \left(d_s - \frac{a}{2}\right)$ = 5.008 kip-ft

Check $+\varphi M_n > +M_u$ 5.008 > 4.68 **OK**

Negative Moment Capacity

Depth of equivalent stress block $a = \frac{A_s f_y}{0.85 f'_c b}$ = 0.404 in

Factored flexural resistance $-\varphi M_n = \varphi A_s f_y \left(d_{s(M^-)} - \frac{a}{2}\right)$ = 1.915 kip-ft

Check $-\varphi M_n > -M_u$ 1.915 > 0.00 **OK**

Minimum Reinforcement AASHTO 5.7.3.3.2

Unless otherwise specified, the amount of prestressed and non-prestressed tensile reinforcement shall be adequate to develop a factored flexural resistance, Mr = φMn, at least equal to the lesser of:

1.33 times the positive factored ultimate moment

Cracking moment

$$M_{cr} = \gamma_3 \left[(\gamma_1 f_r + \gamma_2 \gamma_{cpe}) S_c - M_{dnc} \left(\frac{S_c}{S_{nc}} - 1 \right) \right]$$ AASHTO 5.7.3.3.2-1

When simplified by removing all values applicable to prestressed and non composite section, this equation becomes the following:

$$M_{cr} = \gamma_3 \gamma_1 f_r S_c$$

where:

flexural cracking variability factor		γ_1	=	1.60		(non-segmental brg)
ratio of specified min. yield strength to ultimate tensile strength		γ_3	=	0.67		(A615 steel)
concrete density modification factor		λ	=	1.00		AASHTO 5.4.2.8
modulus of rapture	$f_r = 0.24\lambda\sqrt{f_c'}$	f_r	=	0.48	ksi	AASHTO 5.4.2.6
section modulus of design section	$S_c = \frac{b\,h^2}{6} = \frac{b t_{panel}{}^2}{6}$	S_c	=	72.00	in^3	
Cracking moment	$M_{cr} = \gamma_3 \gamma_1 f_r S_c$	M_{cr}	=	3.09	kip-ft	

check positive moment reinforcement:

1.33 x factored ultimate moment	=	6.22	kip-ft
Cracking moment	=	3.09	kip-ft
min from (1.33 x factored $+M_u$ and M_{cr})	=	3.09	kip-ft

Check: $+\varphi M_n > \min(+M_u, M_{cr})$ 5.008 > 3.09 **OK**

check negative moment reinforcement:

1.33 x factored ultimate moment	=	0.00	kip-ft
Cracking moment	=	3.09	kip-ft
min from (1.33 x factored $-M_u$ and M_{cr})	=	0.00	kip-ft

Check: $-\varphi M_n > \min(-M_u, M_{cr})$ 1.915 > 0.00 **OK**

Typical Panel Type Y, Panel Thickness 6", 5'x6', Horizontal Rebar

Shear on Panel

Panel Thickness	t_{panel}	=	6	in	
Concrete Cover	C_{panel}	=	1.5	in	
Concrete Strength	f'_c	=	4.0	ksi	(Concrete Class A compressive strength)
Reinforcement Strength	f_y	=	60	ksi	(Minimum yield strength of grade 60 steel)
Bar Size #4					
Rebar Diameter	d_b	=	0.500	in	
Rebar Area	A_b	=	0.196	in^2	$A_b = {}^1/_4 \pi d_b{}^2$
Rebar spacing	s	=	9	in	
Width of the design section	b	=	12	in	
Area of Steel per Design Strip	A_s	=	0.275	in^2	$A_s = b(\frac{A_b}{s})$
$c = \frac{A_s \cdot f_s}{\alpha_1 \cdot f_c{}' \cdot \beta_1 \cdot b}$	c	=	0.476	in	
$d_v = t_{panel} - \frac{c}{2} - C_{panel} - \frac{d_b}{2}$	d_v	=	4.012	in	

AASHTO 5.7.3.3

Vn shall be the lesser of:

(1) $V_n = V_c + V_s$

$V_c = 0.0316 \cdot \beta \cdot \alpha \cdot \sqrt{f_c{}'} \cdot b_v \cdot d_v$	Vc	=	6.086	Kips	
$V_s = \frac{A_v \cdot f_y \cdot d_v \cdot (\cot\theta + \cot\alpha) \cdot \sin\alpha}{s}$	Vs	=	5.515	Kips	
	(1) Vn	=	11.601	Kips	
(2) $V_n = 0.25 \cdot f_c' \cdot b_v \cdot d_v$	(2) Vn	=	48.146	Kips	
From (1) and (2) Vn should be:	Vn	=	11.601	Kips	
	ϕ . Vn	=	0.9 . Vn		
		=	10.441	Kips	

Shear Force:

From Staad Pro Result Vmax	=	0.363	N/mm^2		
	=	52.65	lbs/in^2		
Shear Section Area	=	b	x	tpanel	
	=	12	x	6	
Vmax	=	3790.71	lbs		
	=	3.791	Kips	**OK, Vmax less than Vn**	

Typical Panel Type Y, Panel Thickness 6", 5'x6', Vertical Rebar

Panel Strength Design

Design of panel reinforcement per
AASHTO LRFD Bridge Design Specification 5.7.3 (typical rectangular beam design)

The following design method can be used for normal weight concrete with specified compressive strength up to 15.0 ksi.
This Design are to present the information about the acceptable panel reinforcement sizes and spacing.

Panel Thickness	t_{panel}	=	6	in	
Finishing Thickness		=	1	in	
Additional Load from Finishes		=	0.0125	Kip/ft^2	
Concrete Cover	C_{panel}	=	1.5	in	
Vertical Bar Size #4					Logitudinal Bar Size #4
Rebar Diameter	d_b	=	0.5	in	d_{bh} = 0.5 in
Rebar Area	A_b	=	0.196	in^2	$A_b = {}^1/_4 \pi d_b{}^2$
Rebar spacing	s	=	10.28	in	
Width of the design section	b	=	12	in	
Effective depth of section	d_s	=	3.75	in	$d_s = t_{panel} - C_{panel} - d_{bh} - {}^1/_2\, d_b$
Effective depth of section for Negative Moment	$d_{s(M^-)}$	=	2.25	in	$d_{s(M^-)} = t_{panel} - d_s$
Correction factor for source aggregate	K_1	=	1	in	AASHTO 5.4.2.4
Concrete Density	W_c	=	0.15	kcf	
Concrete Strength	f'_c	=	4.00	ksi	(Concrete Class A compressive strength)
Reinforcement Strength	f_y	=	60	ksi	(Minimum yield strength of grade 60 steel)
Modulus Elasticity of concrete	Ec	=	4266	ksi	$E_c = 120000 k_1 W_c{}^2 f'_c{}^{0.33}$
Modulus Elasticity of reinforcement	Es	=	29000	ksi	
Modular Ratio	n	=	6.798		$n = Es/Ec$
Area of Steel per Design Strip	A_s	=	0.229	in^2	$A_s = b(\frac{A_b}{s})$

$+M_u$	=	2.63	kip-ft	$+M_{u\_service}$	=	1.95	kip-ft	(FK = 1.35)
$-M_u$	=	0.00	kip-ft	$-M_{u\_service}$	=	0.00	kip-ft	(FK = 1.35)

Resistance factor for tension-controlled section φ_{STR} = 0.90 AASHTO 5.5.4.2

Positive Moment Capacity

Depth of equivalent stress block $a = \frac{A_s f_y}{0.85 f'_c b}$ = 0.337 in

Factored flexural resistance $+\varphi M_n = \varphi A_s f_y \left(d_s - \frac{a}{2}\right)$ = 3.694 kip-ft

Check $+\varphi M_n > +M_u$ 3.694 > 2.63 **OK**

Negative Moment Capacity

Depth of equivalent stress block $a = \frac{A_s f_y}{0.85 f'_c b}$ = 0.337 in

Factored flexural resistance $-\varphi M_n = \varphi A_s f_y \left(d_{s(M^-)} - \frac{a}{2}\right)$ = 2.147 kip-ft

Check $-\varphi M_n > -M_u$ 2.147 > 0.00 **OK**

Minimum Reinforcement AASHTO 5.7.3.3.2

Unless otherwise specified, the amount of prestressed and non-prestressed tensile reinforcement shall be adequate to develop a factored flexural resistance, Mr = φMn, at least equal to the lesser of:

1.33 times the positive factored ultimate moment

Cracking moment

$$M_{cr} = \gamma_3 \left[(\gamma_1 f_r + \gamma_2 \gamma_{cpe}) S_c - M_{dnc} \left(\frac{S_c}{S_{nc}} - 1\right)\right]$$ AASHTO 5.7.3.3.2-1

When simplified by removing all values applicable to prestressed and non composite section, this equation becomes the following:

$$M_{cr} = \gamma_3 \gamma_1 f_r S_c$$

where:

flexural cracking variability factor		γ_1	=	1.60		(non-segmental brg)
ratio of specified min. yield strength to ultimate tensile strength		γ_3	=	0.67		(A615 steel)
concrete density modification factor		λ	=	1.00		AASHTO 5.4.2.8
modulus of rapture	$f_r = 0.24\lambda\sqrt{f_c'}$	f_r	=	0.48	ksi	AASHTO 5.4.2.6
section modulus of design section	$S_c = \frac{b\,h^2}{6} = \frac{bt_{panel}^2}{6}$	S_c	=	72.00	in^3	
Cracking moment	$M_{cr} = \gamma_3 \gamma_1 f_r S_c$	M_{cr}	=	3.09	kip-ft	

check positive moment reinforcement:

1.33 x factored ultimate moment		=	3.50	kip-ft
Cracking moment		=	3.09	kip-ft
min from (1.33 x factored $+M_u$ and M_{cr})		=	3.09	kip-ft
Check: $+\varphi M_n > \min(+M_u, M_{cr})$	3.694	>	3.09	**OK**

check negative moment reinforcement:

1.33 x factored ultimate moment		=	0.00	kip-ft
Cracking moment		=	3.09	kip-ft
min from (1.33 x factored $-M_u$ and M_{cr})		=	0.00	kip-ft
Check: $-\varphi M_n > \min(-M_u, M_{cr})$	2.147	>	0.00	**OK**

Typical Panel Type Y, Panel Thickness 6", 5'x6', Vertical Rebar

Shear on Panel

Panel Thickness	t_{panel}	=	6	in	
Concrete Cover	C_{panel}	=	2.5	in	
Concrete Strength	f'_c	=	4.0	ksi	(Concrete Class A compressive strength)
Reinforcement Strength	f_y	=	60	ksi	(Minimum yield strength of grade 60 steel)
Bar Size #4					
Rebar Diameter	d_b	=	0.500	in	
Rebar Area	A_b	=	0.196	in^2	$A_b = {}^1/_4 \pi d_b{}^2$
Rebar spacing	s	=	10	in	
Width of the design section	b	=	12	in	
Area of Steel per Design Strip	A_s	=	0.229	in^2	$A_s = b(\frac{A_b}{s})$
$c = \frac{A_s \, . f_s}{\alpha_1 . f_c{}' . \beta_1 \, . b}$	c	=	0.397	in	
$d_v = t_{panel} - \frac{c}{2} - C_{panel} - \frac{d_b}{2}$	d_v	=	3.052	in	

AASHTO 5.7.3.3

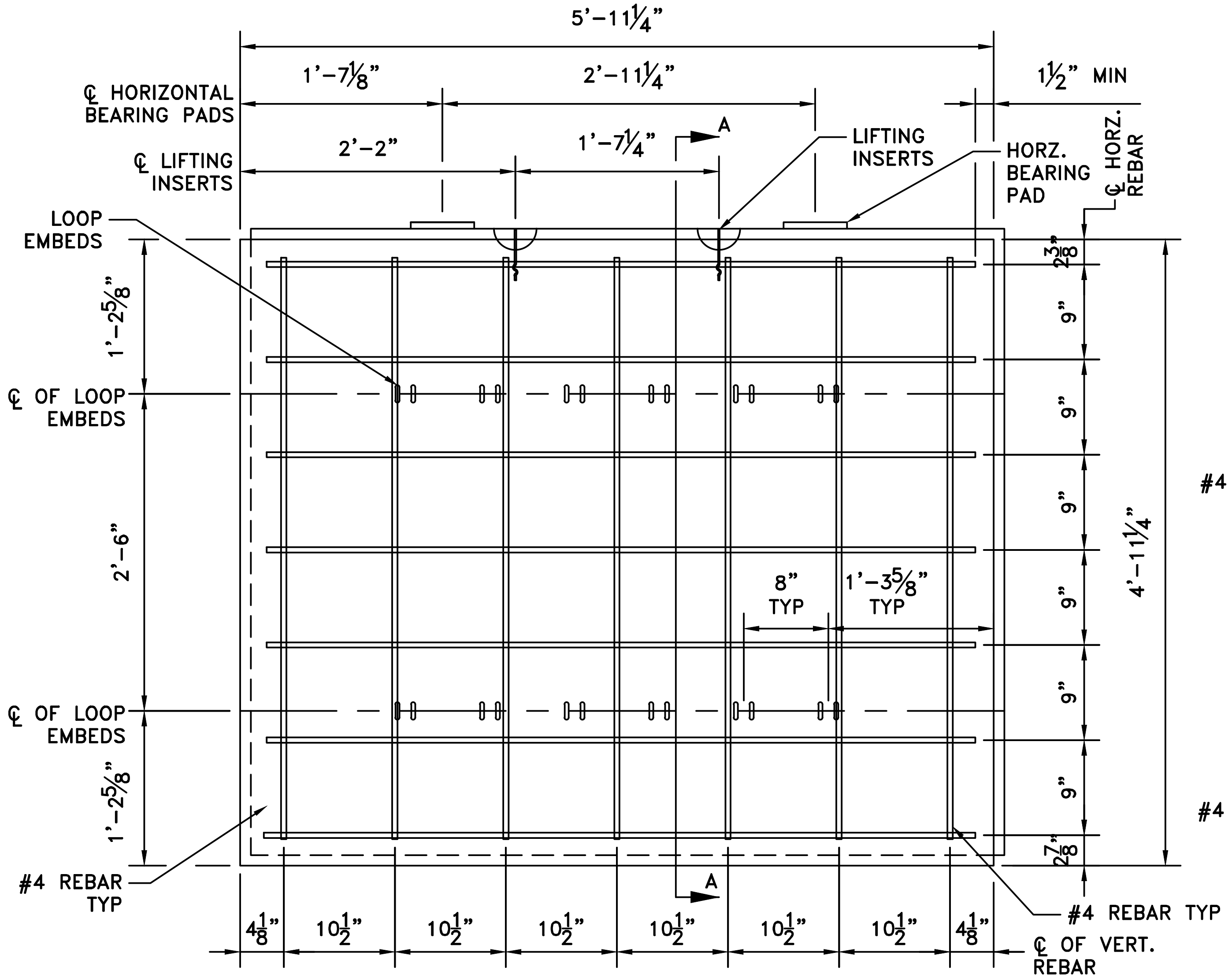
Vn shall be the lesser of:

(1) $V_n = V_c + V_s$

$V_c = 0.0316 \, . \beta \, . \alpha \, . \sqrt{f_c{}'} \, . \, b_v \, . d_v$	Vc	=	4.629	Kips
$V_s = \frac{A_v \, . f_y \, . d_v \, . (\cot\theta + \cot\alpha) \, . \sin\alpha}{s}$	Vs	=	3.497	Kips
	(1) Vn	=	8.126	Kips
(2) $V_n = 0.25 \, . f_c' . b_v \, . d_v$	(2) Vn	=	36.621	Kips
From (1) and (2) Vn should be:	Vn	=	8.126	Kips
	ϕ . Vn	=	0.9 . Vn	
		=	7.314	Kips

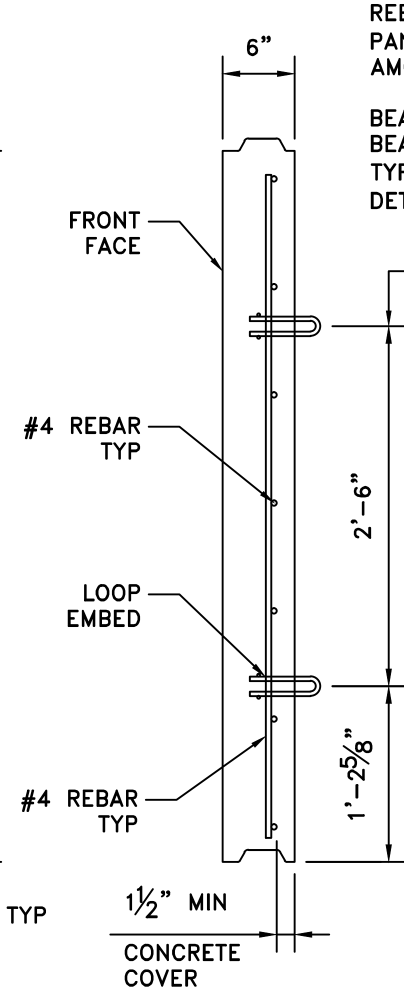
Shear Force:

From Staad Pro Result Vmax	=	0.369	N/mm^2		
	=	53.52	lbs/in^2		
Shear Section Area	=	b	x	tpanel	
	=	12	x	6	
Vmax	=	3853.37	lbs		
	=	3.853	Kips	**OK, Vmax less than Vn**	



TYPICAL PANEL

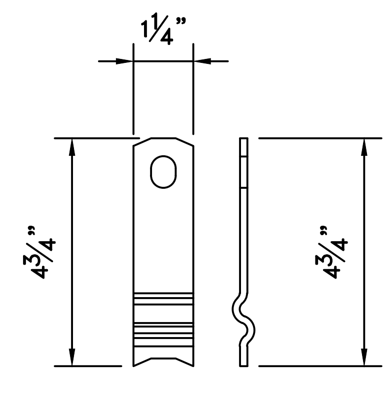
SHOWN FROM BACK FACE



SECTION A–A

REBAR NOTE:
PANEL TYPES "Y" & "Yi" REQUIRE THE SAME AMOUNT OF PANEL REINFORCEMENT.

BEARING PAD NOTE:
BEARING PAD PLACEMENT SHOWN IS FOR TYPICAL "A" PANEL ONLY, SEE STANDARD DETAILS: 5 OF 5 FOR "X" AND "Y" PANELS.



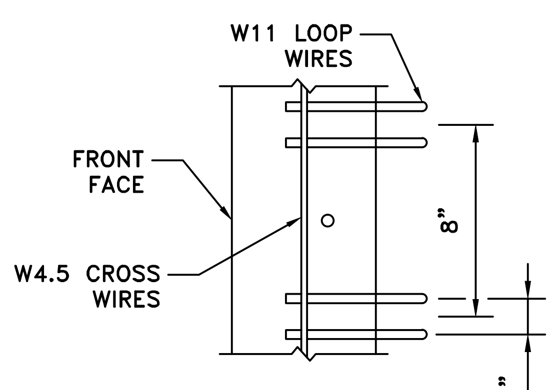
LIFTING INSERT DETAIL

NOTE:
"WAVY-TAIL" STYLE OF INSERT SHOWN. OTHER INSERTS OF EQUAL OR GREATER CAPACITY MAY BE USED IF APPROVED BY SSL.

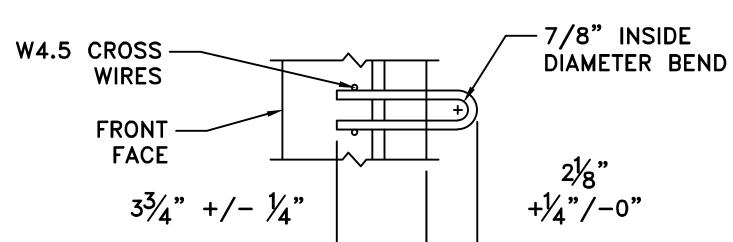
PANEL REINFORCEMENT TABLE

Panel Type	Vertical Bars Num / Size	Horz. Bars Num / Size
Y	7 / #4	7 / #4
Y2	7 / #4	4 / #4

18" MAX SPACING BETWEEN BARS



PLAN VIEW



ELEVATION VIEW

LOOP EMBED DETAILS

PANEL TOLERANCES:

OVERALL DIMENSIONS:

- STANDARD PANEL
  ± ½" VERTICAL
  ± ½" HORIZONTAL
- TOP AND SPECIAL PANELS
  ± 1" VERTICAL
  ± ½" HORIZONTAL

CONNECTION DEVICE LOCATIONS:

- EMBEDS
  ± 1" VERTICAL
  ± 1" HORIZONTAL

PANEL SQUARENESS:

- 90° PANEL CORNERS
  ± 3⁄16" USING 2' SQUARE
  (MEASURE 3 PANEL CORNERS)

PANEL DIAGONAL:

- PANELS WITH 90° CORNERS
  ½" MAX. DIFFERENCE BETWEEN DIAGONALS

SURFACE FINISH:

- FINISH AT FRONT FACE
  ± ⅛" IN 5'

STANDARD TYPE "Y" PANEL DETAILS

CERTIFIED ONLY WITH RESPECT TO INTERNAL STABILITY OF REINFORCED EARTH STRUCTURES

REGISTERED PROFESSIONAL ENGINEER
FRANSISCUS S. HARDIANTO
No. C60215
EXP. 06-30-22
CIVIL
STATE OF CALIFORNIA

FRANSISCUS S. HARDIANTO
03/09/21

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STANDARD DETAILS: 3 OF 5

STANDARD MSE WALL DETAILS

Scale: NTS
Job: --
Sheet: RW-03
Sheet 3 of 5