PROPOSED
PAINT CONTAINMENT SYSTEM
(PROJECT SPECIFICATION ITEM #900.645)

FOR THE

REPAINTING OF
CASTLETON STATE HIGHWAY BRIDGE OVER U.S. ROUTE 4
AND U.S. ROUTE 4 BRIDGES OVER CLARENDON-PITTSFIELD RAILROAD
CASTLETON/WEST RUTLAND, VERMONT

MARCH 2, 2015
REV. APRIL 2, 2015

STATE OF VERMONT
DAVID E. ECKMAN
NO. 8211
CIVIL
LICENSED
PROFESSIONAL ENGINEER

4/2/15

PREPARED BY:

ECKMAN Engineering, LLC

PO Box 3035
Portsmouth, New Hampshire 03802

PREPARED FOR:

Modern Protective Coatings, Inc.
61 Robinson Road
Hudson, New Hampshire 03051

ECKMAN Engineering, LLC

March 2, 2015
April 2, 2015

Scott Roystan
Modern Protective Coatings, Inc.
159 Robinson Road
Hudson, New Hampshire 03051

Re: Proposed Paint Containment System
(Project Specification Item # 900.645)
For Repainting Castleton State Highway Bridge Over U.S. Route 4
And U.S. Route 4 Bridges Over Clarendon-Pittsfield Railroad
Castleton/West Rutland, Vermont

Dear Scott:

Attached, please find plans, specifications, and calculations for the containment system proposed by Modern Protective Coatings, Inc. to complete the above referenced project.

If you have any questions or require additional information please feel free to contact me.

Yours truly,

David Eckman

David E. Eckman, P.E.
Principal Engineer

TABLE OF CONTENTS

PAINT CONTAINMENT SYSTEM
SPECIFICATION ITEM #900.645
SUBMITTED FOR APPROVAL

By: *MODERN PROTECTIVE COATINGS, INC.*

Address: *61 Robinson Road*

Hudson, New Hampshire 03051

I hereby certify that I have carefully examined the attached submittal and have determined and verified all field conditions, construction criteria, materials, catalog numbers and similar data, coordinated the material contractors. To the best of my knowledge and belief, the attached submittal is in full compliance with the contract requirements and specifications.

SIGNATURE: Authorized Person/MPCI Date

Work Platform and Beam Hanger Design and Analysis Executive Summary

The Work Platform and Beam Hanger were analyzed independently since their capacities vary due to different variables. The existing bridge beam flange width controls the capacity of the individual platform hangers. The spacing of the existing bridge beams controls the capacity of the work platform with respect to bending, shear and deflection.

The beam hanger analysis looked at each structural component of the hanger. The horizontal member (with brackets that attach to the existing bridge beam) was identified as the critical member when existing beam flanges are greater than 12.5 inches. The tubular section is limited due to the positive bending moment. When you have a 12 inch ± wide flange the bolt that holds the waler bracket becomes the control due to shear failure.

The Work Platform Analysis looked at the performance of each structural member in the system. The OSHA required safety factor of 4.0 was applied to all structural components of the work platform and platform hanger analysis.

1.0 – CONTAINMENT NARRATIVE

Modern Protective Coatings, Inc
Containment Plan- SSPC Class 1A Containment

Project Name:	**Castleton-West Rutland**
Project Number:	**Vermont Agency of Transportation Project # BF BPNT (15)**
Bridge Location:	**Castleton Br. 2 Over U.S. Route 4 and U.S. Route 4 Over Clarendon-Pittsfield Railroad Castleton/West Rutland, Vermont**

Containment description for bridges on or over U.S. Route 4:

1. This plan addresses the containment of all debris related to the cleaning and painting of three bridges on or over US Route 4. These bridges will receive total removal of existing coatings by abrasive blasting in accordance with Section 900.645 of the Special Provisions. They will receive a 3 coat Zinc/Epoxy/Urethane system.

2. The containment will comply with SSPC Class 1A requirements. There are two containment types to be used on this bridge (engineered lumber platform and rapid deployment platform). These containments will use a combination of rigid and flexible materials. The tarp materials are air-impermeable. Joints are fully sealed using spruce strapping to sandwich the tarps together and we will use re-sealable entries. We will use mechanical ventilation to achieve negative pressure within the containment enclosure, and the exhaust will be filtered. This is in accordance with SSPC Guide 6, *Containment Criteria for Removal of Paint Containing Lead and Other Toxic Metals,* for SSPC-Class 1A containments.

3. Bulkheads, between the beams will be constructed, using 2x4 lumber, wedged between the beam flanges. Additional 2x4 lumber will extend from one upright to the other, attached with 3" screws, on both the top and bottom and Monarflex brand reinforced plastic sheeting will be stapled to the 2x4's. Rubber will be used to seal the bulkheads and provide some protection from the abrasive blasting. Side tarps are tied to the railing above, every 4 ', using 1/4" nylon rope. Tarps are attached at the bottom with spruce strapping, attached to the platform using 1 5/8" screws.

3. The bridges are proposed to be contained using a rapid deployment system and an engineered lumber work platform completed phases.

   A. The Castleton bridge will be completed using both rapid deployment and the engineered lumber work platform. Spans 2 and 3 will be completed using the platform at each end with the middle portion being rapid deployment. Spans 1 and 4 will be fully work platform.

   B. The West Rutland bridges will be completed using only the engineered lumber work platform as there is not access to do rapid deployment. The contractor intends to install the platform under each span but will only be working in a small area of each span at any given time.

5. Ground tarps will be placed beneath the lumber work platforms to collect any debris that may escape the primary containment system.

6. All equipment will be located in the lane closures shown in the traffic control plans. There will be no additional equipment load on top of this bridge.

7. Recyclable steel grit will be used as the blast media for this project.

8. The containment will be ventilated using an ARS 45 Dust Collector. The ventilation will occur at the floor level of the containment platform (using three 20" ducts). Input air vents will be located at the opposite end of the containment, from the dust collector to create "cross draft" and to facilitate air-flow.

9. We will utilize impermeable containment tarps. These will consist of Sherwin Williams HangTuf CN-1 FR Coated airbag nylon tarps and Monarflex Super T-Plus Flamesafe reinforced scaffold sheeting.

10. The containment enclosure will be monitored by the quality control inspector, Joe Kenney (NACE level 2 # 31416). IF visible emissions are noted abrasive blasting will be halted and the leak will be addressed. Any visible debris resulting from the containment breach will be vacuumed up with a HEPA vacuum.

11. Tarp data sheets are attached, along with a stamped containment design and platform calculations.

APPENDICES

APPENDIX "A"

Paint Containment Plans

REPAINTING OF THE
EAST HUBBARDTON RD. BRIDGE OVER U.S. ROUTE 4
U.S ROUTE 4 E.B. & W.B. BRIDGES OVER CASTLETON RIVER
CASTLETON & WEST RUTLAND, VERMONT

PROPOSED
PAINT CONTAINMENT SYSTEM
FEBRUARY 24, 2015

Owner: VERMONT AGENCY OF TRANSPORATION
One National Life Drive
Montpelier, Vermont 05633

Contractor: MODERN PROTECTIVE COATINGS, INC.
61 Robinson Road
Hudson, New Hampshire 03051

Prepared By: ECKMAN ENGINEERING, LLC
1950 Lafayette Rd. Suite 301, PO Box 3035
Portsmouth, New Hampshire 03802

COVER SHEET

No.	Description	Appd	Date

REVISIONS

DATE: FEBRUARY 24, 2015
SCALE: AS SHOWN
DESIGNED BY: GDG
DRAWN BY: SRP
APPROVED BY: DEE
PROJECT NO: 15–106
FILE NO: 15–106_PC

REPAINTING OF THE
EAST HUBBARDTON RD BRIDGE OVER U.S ROUTE 4
U.S ROUTE 4 E.B & W.B BRIDGES OVER CASTLETON RIVER
CASTLETON & WEST RUTLAND, VERMONT

OWNER:
Vermont Agency of Transportation
One National Life Drive
Montpelier, Vermont 05633

APPLICANT:
MODERN PROTECTIVE COATINGS
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Hudson, New Hampshire 03051

ECKMAN Engineering, LLC
1950 Lafayette Rd. Suite 301, PO Box 3035
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GENERAL NOTES

1. THESE DRAWINGS DEPICT THE PROPOSED CONTAINMENT SYSTEMS FOR THE EAST HUBBARDTON RD BRIDGE AND ROUTE U.S 4 E.B & W.B BRIDGES PROJECT IN CASTLETON & WEST RUTLAND, VT, AS CONTRACTED TO MODERN PROTECTIVE COATINGS, INC.

2. THE LEAD PROGRAM AND SAFETY PLAN AS ESTABLISHED BY MODERN PROTECTIVE COATINGS, INC. AND PROVIDED TO THE VERMONT AGENCY OF TRANSPORTATION, IN COMBINATION WITH THE PROJECT SPECIFICATIONS SHALL DICTATE AND CONTROL ALL HEALTH AND SAFETY ISSUES RELATED TO HANDLING AND DISPOSAL OF HAZARDOUS MATERIALS AND PROCESSES ASSOCIATED WITH PAINT REMOVAL AND PAINTING.

3. ALL REMOVAL OF PAINT COATINGS CONTAINING LEAD AND OTHER TOXIC METALS IS TO BE DESIGNED IN FULL ACCORDANCE WITH SSPC (SOCIETY FOR PROTECTIVE COATINGS, FORMERLY STEEL STRUCTURES PAINTING COUNCIL) CONTAINMENT CRITERIA SPECIFICATIONS.

CONTAINMENT CRITERIA FOR ABRASIVE BLAST CLEANING REMOVAL METHOD

CRITERIA CATEGORY	REQUIREMENT	PROVIDED IN DESIGN
SSPC CONTAINMENT CLASS	1A	CRITERIA FOLLOWED
CONTAINMENT MATERIAL (FLEXIBILITY)	RIGID OR FLEXIBLE	FLEXIBLE SYSTEM
CONTAINMENT MATERIAL (PERMEABILITY)	IMPENETRABLE	10-MIL HDPE
SUPPORT STRUCTURE	RIGID OR FLEXIBLE	RIGID FRAME
MATERIAL JOINTS	FULLY SEALED	FULLY SEALED
CONTAINMENT ENTRYWAY	AIRLOCK OR RESEALABLE	BOTH UTILIZED
VENTILATION SYSTEM REQUIRED	MECHANICAL	MAKE-UP AIR INLETS (1) 45,000 CFM VACUUM DUST COLLECTOR SYSTEM
NEGATIVE PRESSURE REQUIRED	REQUIRED	PROVIDED CONTAINMENT
EXHAUST FILTRATION REQUIRED	REQUIRED	ARS DC45 COLLECTOR

4. THE CLASS 1A CONTAINMENT SYSTEM WILL MAINTAIN A MINIMUM CROSS-DRAFT AIR VELOCITY OF 100 FT/MIN AND 50 FT/MIN DOWNDRAFT AND THE OSHA VENTILATION STANDARDS. THE MAXIMUM CROSS SECTIONAL AREA FOR AIRFLOW WITHIN THE ENCLOSURE IS 224 SQUARE FEET.

5. THE CONTAINMENT SYSTEMS UTILIZED DURING THIS PROJECT ARE REQUIRED TO LIMIT THE WORKER EXPOSURE TO LEAD CONCENTRATIONS LESS THAN 50 MICROGRAMS PER CUBIC METER OVER AN 8-HOUR PERIOD. THIS PERMISSIBLE EXPOSURE LIMIT (PEL) WILL BE ACHIEVED THROUGH APPROPRIATE ENGINEERING CONTROLS AND WORK PRACTICES. IN THE EVENT THAT PEL CANNOT BE REASONABLY ACHIEVED THROUGH ENGINEERING CONTROL AND WORK PRACTICES, APPROPRIATE RESPIRATORY PROTECTION WILL BE UTILIZED AS A SUPPLEMENTARY MEASURE IN ORDER TO MEET THE PEL. (MODERN PROTECTIVE COATINGS PROPOSES A RESPIRATORY-AIR HELMET AND CAPE METHOD)

6. IN THE EVENT OF A FAILURE OF A CONTAINMENT SYSTEM, AS DETERMINED BY THE RESIDENT ENGINEER, ALL BLAST CLEANING OPERATIONS SHALL BE IMMEDIATELY SUSPENDED. THE CAUSE OF THE FAILURE WILL BE DETERMINED AND REPAIRED TO THE SATISFACTION OF THE RESIDENT ENGINEER PRIOR TO RESUMING THE ABRASIVE BLASTING OPERATIONS.

7. IN THE EVENT THAT THE LEVEL OF LIGHTING WITHIN THE ENCLOSURE DROPS BELOW THE MINIMUM ALLOWABLE LEVEL OF 10 FOOT-CANDLES (30 FOOT-CANDLES DURING INSPECTION). AN AUXILIARY LIGHTING SYSTEM WILL BE FURNISHED TO MEET THE MINIMUM LIGHTING REQUIREMENTS.

CONTAINMENT ENCLOSURE SHEETING (LDPE)

1. ALL CONTAINMENTS SHALL BE CONSTRUCTED OF HIGH-STRENGTH, LIGHT TRANSMISSIVE, FIRE RESISTANT REINFORCED LDPE WITH A RIGID SUPPORT STRUCTURE MADE FROM MANUFACTURED SCAFFOLDING AND A PRE-ENGINEERED WORK PLATFORM AS REQ'D.

2. ALL SEAMS BETWEEN LDPE SECTIONS AND/OR LDPES AND THE TEMPORARY SUPPORT STRUCTURE SHALL BE IMPERVIOUS TO THE EMISSION OF DUST AND DEBRIS. ALL SEAMS BETWEEN LDPE SHALL INCLUDE A 1'-0" (MINIMUM) OVERLAP AND A CONTINUOUS SEAL. ACCEPTABLE SEALING MEASURES INCLUDE TAPE, CAULK, VELCRO, CLAMPS, STRAPPING, OR OTHER SIMILAR MATERIALS CAPABLE OF FORMING A CONTINUOUS IMPENETRABLE SEAL.

3. THE LDPE TO BE UTILIZED FOR THE ENCLOSURE SHALL CONSIST OF THE IMPERMEABLE T-PLUS SCAFFOLD SHEETING.

T-PLUS SCAFFOLD SHEETING SPECIFICATIONS

MANUFACTURER	MONARFLEX, INC.
TENSILE STRENGTH	10 KN/M
COMPOSITION	LDPE REINF. W/ 1500 DENIER POLYESTER YARN
ROLL SIZE	7'-4" x 138'-0"
ROLL WEIGHT	67 POUNDS
THICKNESS	10 MIL
SCRIM	1500 DENIER
COLOR	CLEAR
USABLE TEMPERATURE	-40 to +140 degrees (F)
LIGHT TRANSMITTING	90%
UV RESISTANCE	MAXIMUM UV RESISTANCE

4. IF THE WIND VELOCITY CAUSES THE LDPE ENCLOSURE TO BILLOW AND/OR EMIT DUST AND DEBRIS, ALL BLASTING OPERATIONS WILL BE SUSPENDED AND THE EMITTED DEBRIS WILL BE COLLECTED USING VACUUMS. UNDER SEVERE CONDITIONS, THE LDPE ENCLOSURE WILL BE CLEANED WITH VACUUMS PRIOR TO DISASSEMBLING AND/OR MOVING THE ENCLOSURE.

5. WORKERS SHALL ENTER AND EXIT THE CONTAINMENT THROUGH A RE-SEALABLE ENTRYWAY LOCATED AT ONE CORNER OF THE CONTAINMENT. ACCEPTABLE SEALING METHODS INCLUDE THE USE OF ZIPPERS, VELCRO, CLAMPS, OR SIMILAR FASTENERS.

VENTILATION SYSTEM

1. CROSS-DRAFT (HORIZONTAL) VENTILATION WILL BE UTILIZED FOR THE ABRASIVE BLASTING OPERATIONS ON THE BRIDGE.

2. ONE MOBILE FABRIC FILTER DUST COLLECTION SYSTEM, INCLUDING FLEXIBLE EXHAUST DUCTS AND MAKE-UP AIR INLETS, WILL BE UTILIZED TO PROVIDE NEGATIVE AIR PRESSURE WITHIN THE CONTAINMENTS. THE DUST COLLECTION SYSTEM IS DESIGNED IN CONJUNCTION WITH THE ENCLOSURES TO MEET THE AIRFLOW VELOCITY REQUIREMENTS.

3. DESIGN INFORMATION FOR THE MOBILE FABRIC FILTER DUST COLLECTOR TO BE UTILIZED DURING THIS CONTRACT IS AS FOLLOWS:

GENERAL EXHAUST VENTILATION (MECHANICAL TYPE)

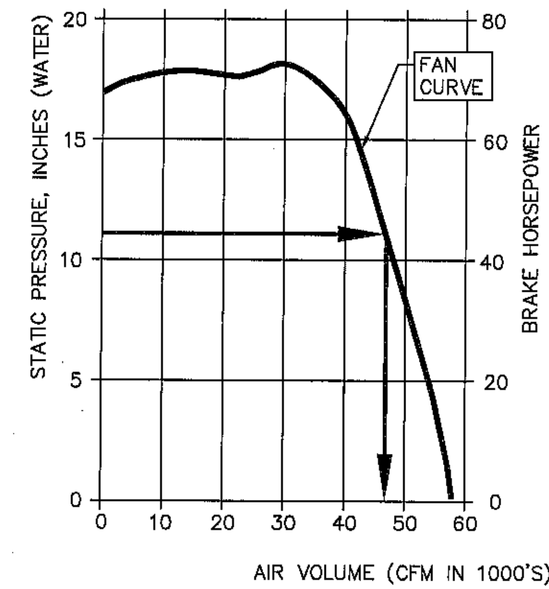
MANUFACTURER	ADVANCED RECYCLING SYSTEMS, INC.
MODEL NO.	MODEL 45
TOTAL EXHAUST VOLUME	45,000 CFM ~ 13" W.G.
FILTERING EFFICIENCY	99.9% @ 0.5 MICRONS
TYPE OF FILTER ELEMENTS	CARTRIDGE
CARTRIDGE	VERTICAL
NO. OF CARTRIDGES	84
TOTAL FILTER AREA	12,600 SF
AIR-TO-CLOTH RATIO	3.5 TO 1
DUCT CONNECTIONS	(4) 20 " DIA.
FAN TYPE	CLASS IV NON-OVERLOADING TYPE "C" SPARK RESISTANT
ENGINE TYPE	165 H.P. DIESEL
WASTE HANDLING	SCREW CONVEYOR TO 55 GAL. DRUM

4. AIR WILL BE EXHAUSTED FROM THE ENCLOSURE VIA TWO 20" DIAMETER FLEXIBLE EXHAUST DUCTS TO PROVIDE A UNIFORM AIR FLOW DISTRIBUTION THROUGHOUT THE WORKING AREA. EACH 20" EXHAUST DUCT IS DESIGNED TO PROVIDE A MINIMUM TRANSPORT VELOCITY OF 1.529 FT./MIN (3.558 FT./MIN. TOTAL FOR 2 DUCTS).

5. TWO PASSIVE INTAKE LOUVERS WILL BE PROVIDED WITHIN THE ENCLOSURE TO PROVIDE A UNIFORM AIRFLOW DISTRIBUTION THROUGH THE ENTIRE ENCLOSURE. THE PASSIVE INLET OPENINGS WILL BE CONSTRUCTED OF A REINFORCED LDPE FLAP WEIGHTED WITH LUMBER STRAPPING. FABRIC FILTER MEDIA SHALL BE UTILIZED UNLESS OTHERWISE NOTED.

VENTILATION SYSTEM CALCULATIONS

1. THE FOLLOWING FAN CURVE WAS PROVIDED BY ADVANCED RECYCLING SYSTEMS, INC. FOR THE MODEL 45 COLLECTOR. THE FAN CURVE REPRESENTS THE ANTICIPATED CFM FOR VARIOUS STATIC PRESSURES WITH THE DUST COLLECTOR AT FULL THROTTLE. ALL POINTS UNDER THE CURVE ARE THEREFORE POSSIBLE WITHIN THE DESIGN PARAMETERS SHOWN.



2. THE FOLLOWING CALCULATIONS ESTIMATE THE SYSTEM STATIC PRESSURE. PRIOR TO UTILIZATION OF THE CONTAINMENT STRUCTURE AIR VELOCITIES SHALL BE FIELD MEASURED AND THE CONTAINMENT SYSTEM INSPECTED FOR AIR LEAKS THAT PREVENT PROPER PERFORMANCE OF THE SYSTEM.

3.75-INCHES WG.	150-LF OF 20" DIAMETER DUCT (2.50"/100FT)
3.45-INCHES WG.	LOSS THROUGH DUCT ELBOWS (3~EQUIV. 46 FT/ELBOW)
0.64-INCHES WG.	LOSS THROUGH CONTAINMENT: (0.49 x 1.31(VPducts))
2.00-INCHES WG.	LOSS THROUGH DUST COLLECTOR
0.25-INCHES WG.	LOSS THROUGH OUTLET DAMPER
1.00-INCHES WG.	SUCTION LIFT OF AIR AND DUST (10 FT@0.1LB/CF)

11.09-INCHES WG. (TOTAL)

DUST COLLECTOR AIR VOLUME = 35,250 CFM

HORIZONTAL CROSS VELOCITY = 117 FT/MIN >= 100 FT/MIN OKAY

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	REVISIONS		

DATE: FEBRUARY 24, 2015
SCALE: AS SHOWN
DESIGNED BY: GDG
DRAWN BY: SRP
APPROVED BY: DEE
PROJECT NO: 15-106
FILE NO: 15-106_PC

REPAINTING OF THE EAST HUBBARDTON RD BRIDGE OVER U.S ROUTE 4 U.S ROUTE 4 E.B & W.B BRIDGES OVER CASTLETON RIVER CASTLETON & WEST RUTLAND, VERMONT

OWNER:
Vermont Agency of Transportation
One National Life Drive
Montpelier, Vermont 05633

APPLICANT:
MODERN PROTECTIVE COATINGS
61 Robinson Road
Hudson, New Hampshire 03051

ECKMAN Engineering, LLC
1950 Lafayette Rd. Suite 301, PO Box 3035
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Phone: (603) 433-1354
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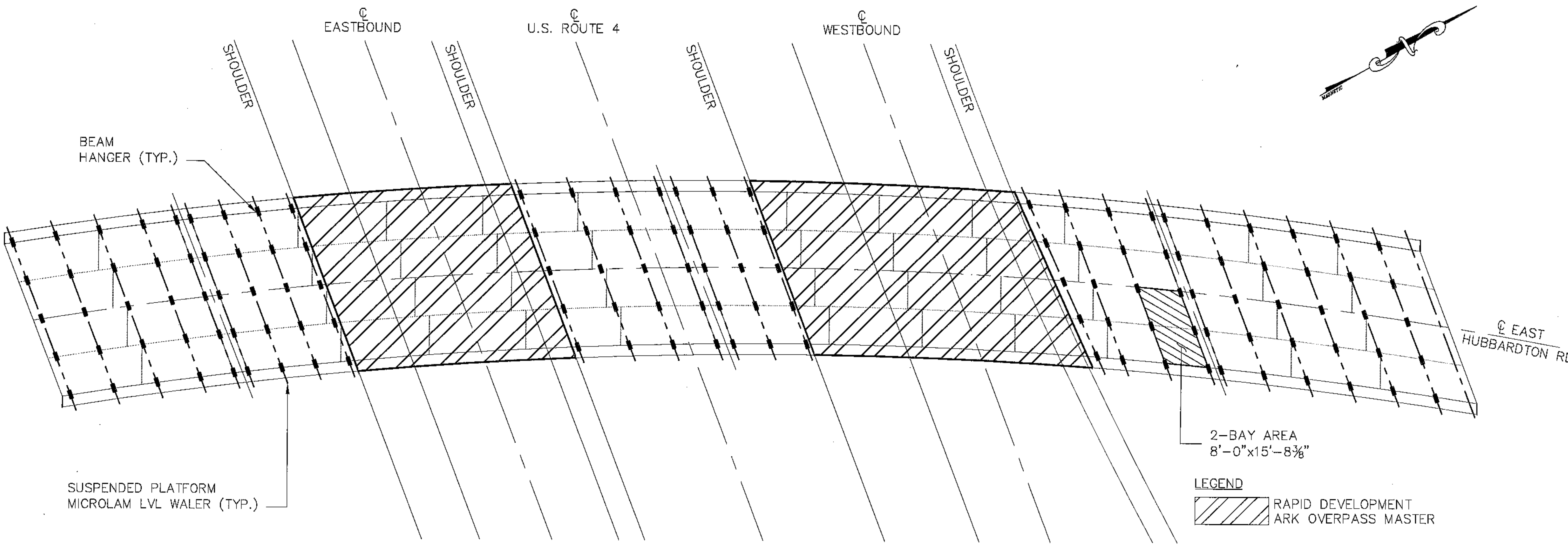
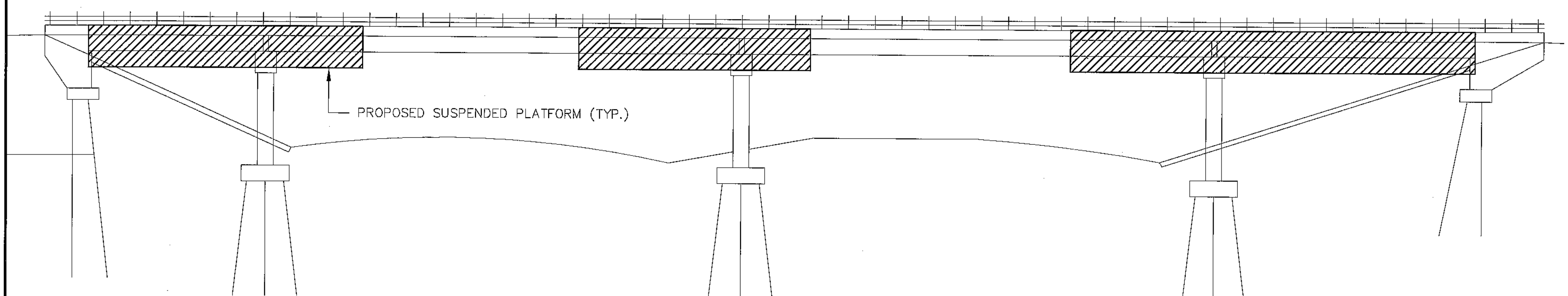
CONTAINMENT SPECIFICATIONS

PC-2



CONTAINMENT PLAN

SCALE: 1" = 20'



ELEVATION

SCALE: 1" = 20'

CASTLETON CONTAINMENT PLAN & ELEVATION

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OWNER:
Vermont Agency of Transportation
One National Life Drive
Montpelier, Vermont 05633

APPLICANT:
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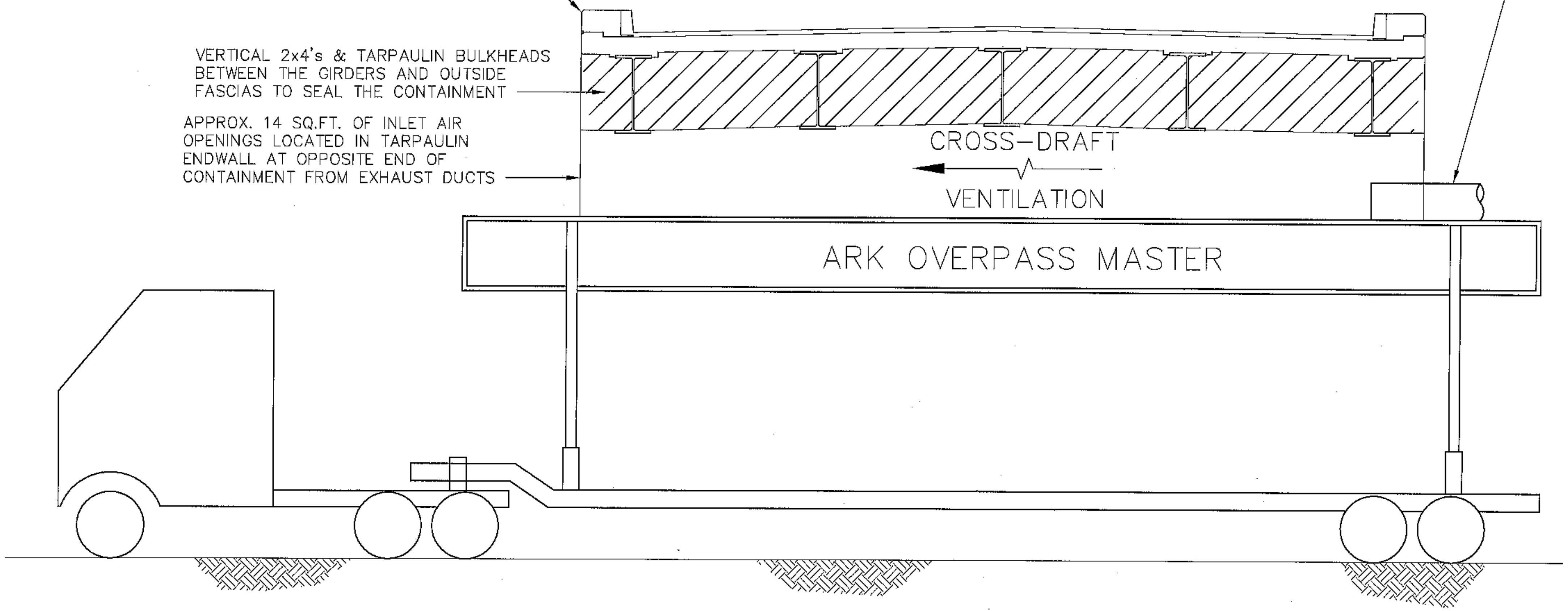
PC-3



RAPID DEPLOYMENT SECTION

SCALE: 3/16" = 1'-0"

Containment Design Schedule			
	DESIGN PARAMETERS	SUSPENDED PLATFORM	PLATFORM TRAILER
Dimensions, feet	Length, L	49.0	VARIES
	Width, W	32.5	14.0
	Height, H	8.5 AVG	8.0
	Area, A = W x H	277 sq.ft.	112 sq.ft.
Ventilation	System	Cross-Draft	
	Volume 'Q' (cfm)	35,250	12,375
	V = Q/A (ft/min)	**127**	**110**
Inlets	Min. Area 'A' (sq.ft.)	36	14
	V = Q/A (ft/min)	979	883
No. of Exhaust Ducts		3	1

NOTES:

1. MODERN PROTECTIVE COATINGS WILL PERFORM ABRASIVE BLAST PAINT REMOVAL AND PAINTING OPERATIONS ON THE EAST HUBBARDTON ROAD BRIDGE, IN CASTLETON, VT. A SSPC-GUIDE 6 CLASS 1A CONTAINMENT SYSTEMS WILL BE IMPLEMENTED FOR ALL ABRASIVE BLAST REMOVAL OPERATIONS PERFORMED UNDER THIS CONTRACT, AS DEPICTED ON THESE DRAWINGS.

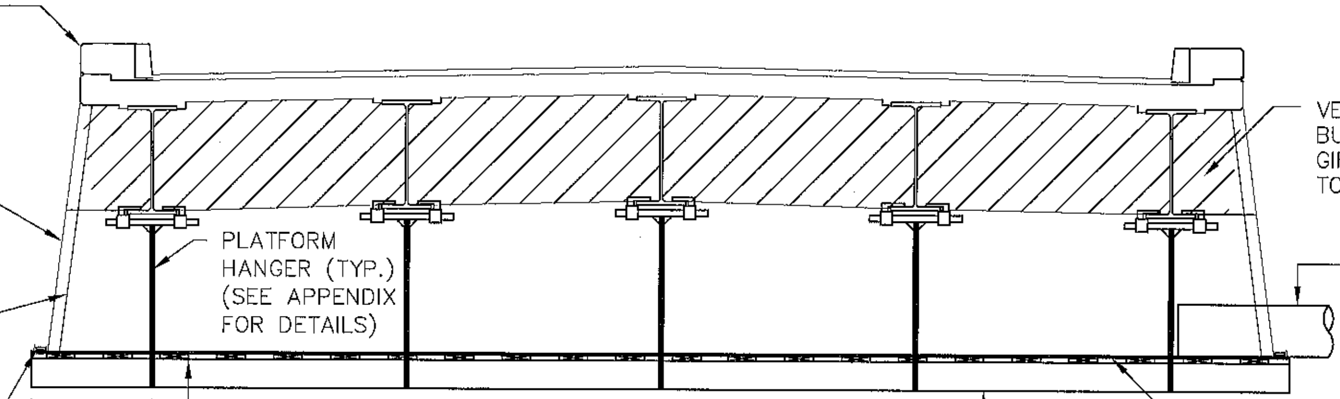
2. DETAILS, MATERIALS OF CONSTRUCTION, AND SPECIFICATIONS ASSOCIATED WITH THE PROPOSED CONTAINMENT SYSTEM AND VENTILATION EQUIPMENT ARE PROVIDED WITHIN THE REPORT PACKAGE ENTITLED: "REPAINTING OF THE EAST HUBBARDTON ROAD BRIDGE OVER U.S ROUTE 4 AND THE U.S ROUTE 4 BRIDGES OVER CASTLETON RIVER, CASTLETON AND WEST RUTLAND, VT, DATED FEBRUARY 24, 2015.

3. THE VERTICAL IMPERMEABLE SHEETING WALL SHALL BE SEALED TO THE DECK BY WRAPPING THE SHEETING AROUND LUMBER OR FUR STRAPPING AND FASTENING TO THE BRIDGE DECK IN ORDER TO PREVENT EMISSIONS. THE ENTIRE PROPOSED CONTAINMENT SYSTEM WILL BE TESTED PRIOR TO USE TO INSURE PROPER SEAL OF THE IMPERMEABLE SHEETING BEFORE ANY ABRASIVE BLAST REMOVAL PROCESSES BEGIN.

4. A CROSS-DRAFT VENTILATION SYSTEM SHALL BE UTILIZED IN ALL CONTAINMENTS USED ON THE BRIDGE. THE RESULTING HORIZONTAL AIR FLOW VELOCITY THROUGH THE ENCLOSURE SHALL BE 100 FT./MIN.

5. THE VERTICAL SHEETING WALLS ARE DESIGNED TO HANDLE A MAXIMUM WIND LOAD OF 40 MPH. IN THE EVENT THE WIND LOAD EXCEEDS 40 MPH OR GUSTS OF 40 MPH ARE EXPECTED, THE IMPERMEABLE ENCLOSURE SHALL BE IMMEDIATELY DISSASSEMBLED, OR PARTIALLY DISASSEMBLED AS DIRECTED BY THE ENGINEER.

6. ADDITIONAL TARPS WILL BE LAID OUT ON THE GROUND BENEATH CONTAINMENT PLATFORMS TO CAPTURE ANYTHING THAT MIGHT ACCIDENTALLY ESCAPE PRIMARY CONTAINMENT.



PLATFORM SECTION

SCALE: 3/16" = 1'-0"

CASTLETON CONTAINMENT SECTIONS

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CASTLETON & WEST RUTLAND, VERMONT

OWNER: Vermont Agency of Transportation, One National Life Drive, Montpelier, Vermont 05633

APPLICANT: MODERN PROTECTIVE COATINGS, 61 Robinson Road, Hudson, New Hampshire 03051

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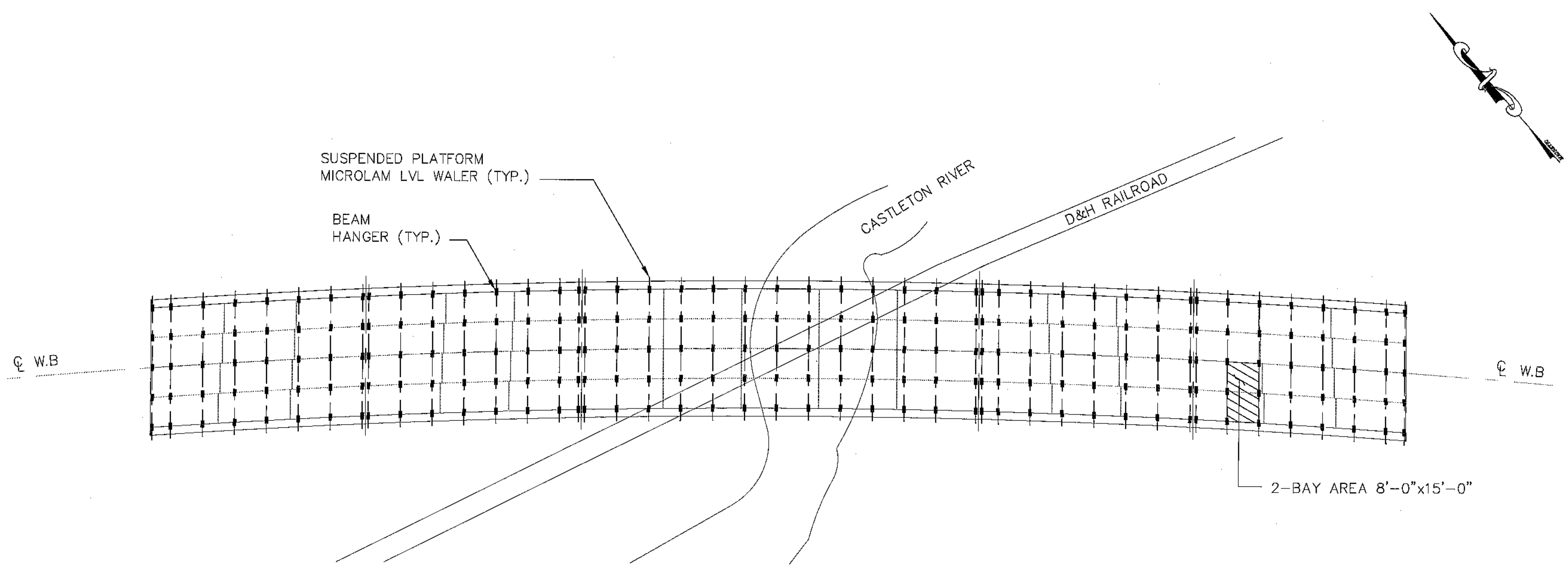
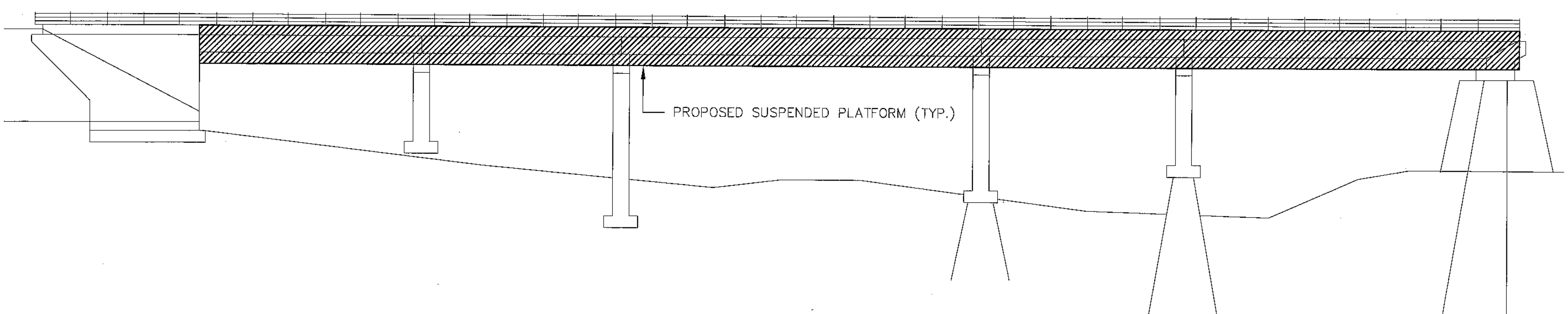
PC-4



CONTAINMENT PLAN

SCALE: 1" = 30'



ELEVATION

SCALE: 1" = 30'

WEST RUTLAND W.B CONTAINMENT PLAN & ELEVATION

No.	Description	Appd	Date

REVISIONS

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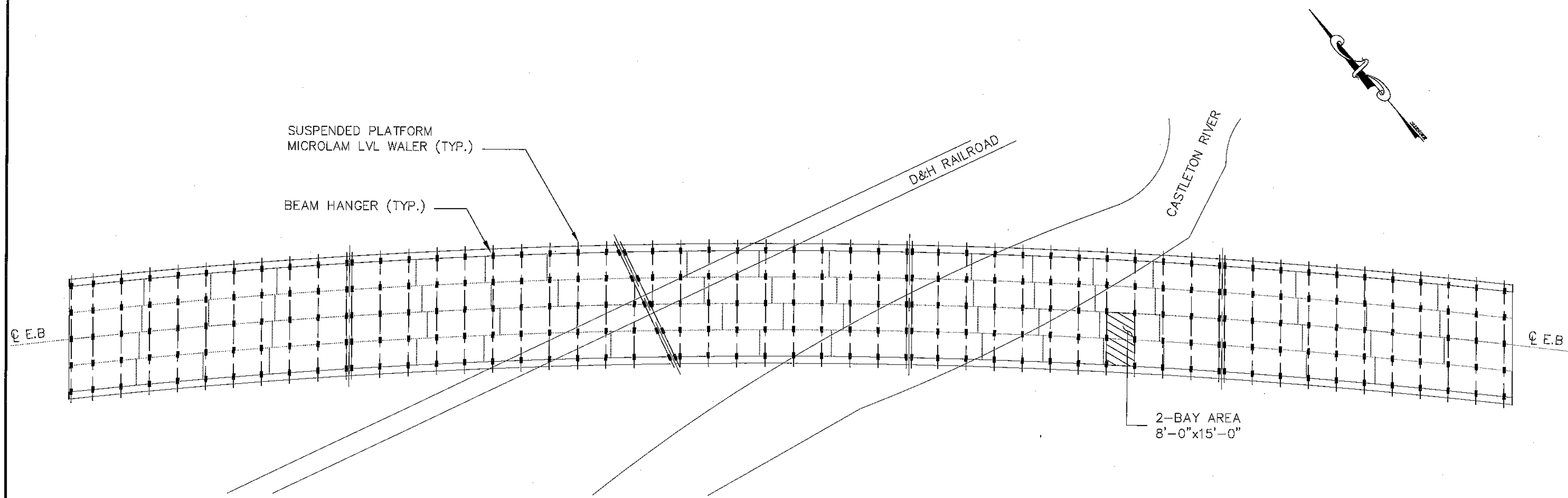
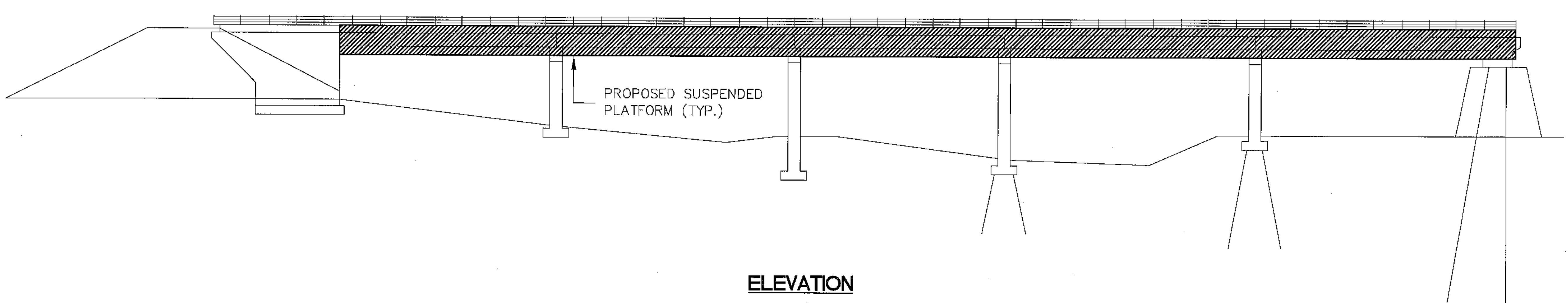
PC-5



CONTAINMENT PLAN

SCALE: 1" = 30'



ELEVATION

SCALE: 1" = 40'

WEST RUTLAND E.B CONTAINMENT PLAN & ELEVATION

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U.S ROUTE 4 E.B & W.B BRIDGES OVER CASTLETON RIVER
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Hudson, New Hampshire 03051

ECKMAN Engineering, LLC
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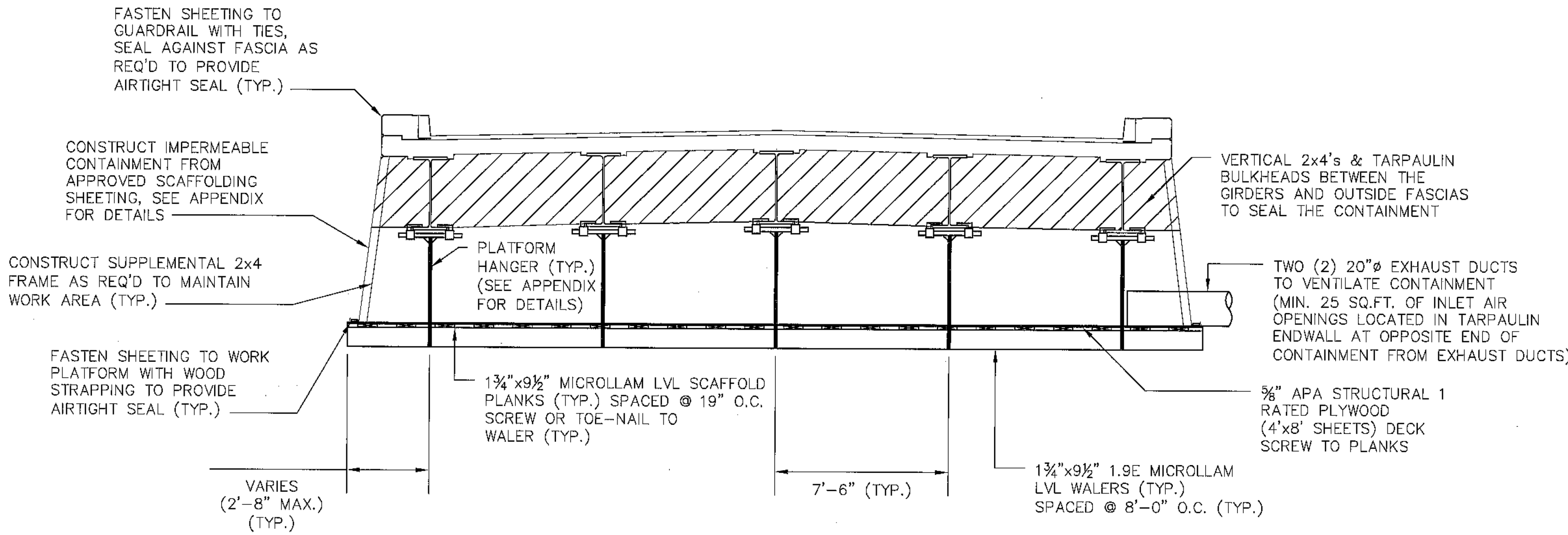
PC-6



PLATFORM SECTION

SCALE: 3/16" = 1'-0"

NOTES:

1. MODERN PROTECTIVE COATINGS WILL PERFORM ABRASIVE BLAST PAINT REMOVAL AND PAINTING OPERATIONS ON THE U.S ROUTE 4 BRIDGES, IN WEST RUTLAND, VT. A SSPC-GUIDE 6 CLASS 1A CONTAINMENT SYSTEMS WILL BE IMPLEMENTED FOR ALL ABRASIVE BLAST REMOVAL OPERATIONS PERFORMED UNDER THIS CONTRACT, AS DEPICTED ON THESE DRAWINGS.

2. DETAILS, MATERIALS OF CONSTRUCTION, AND SPECIFICATIONS ASSOCIATED WITH THE PROPOSED CONTAINMENT SYSTEM AND VENTILATION EQUIPMENT ARE PROVIDED WITHIN THE REPORT PACKAGE ENTITLED: "REPAINTING OF THE EAST HUBBARDTON ROAD BRIDGE OVER U.S ROUTE 4 AND THE U.S ROUTE 4 BRIDGES OVER CASTLETON RIVER, CASTLETON AND WEST RUTLAND, VT, DATED FEBRUARY 24, 2015.

3. THE VERTICAL IMPERMEABLE SHEETING WALL SHALL BE SEALED TO THE DECK BY WRAPPING THE SHEETING AROUND LUMBER OR FUR STRAPPING AND FASTENING TO THE BRIDGE DECK IN ORDER TO PREVENT EMISSIONS. THE ENTIRE PROPOSED CONTAINMENT SYSTEM WILL BE TESTED PRIOR TO USE TO INSURE PROPER SEAL OF THE IMPERMEABLE SHEETING BEFORE ANY ABRASIVE BLAST REMOVAL PROCESSES BEGIN.

4. A CROSS-DRAFT VENTILATION SYSTEM SHALL BE UTILIZED IN ALL CONTAINMENTS USED ON THE BRIDGE. THE RESULTING HORIZONTAL AIR FLOW VELOCITY THROUGH THE ENCLOSURE SHALL BE 100 FT./MIN.

5. THE VERTICAL SHEETING WALLS ARE DESIGNED TO HANDLE A MAXIMUM WIND LOAD OF 40 MPH. IN THE EVENT THE WIND LOAD EXCEEDS 40 MPH OR GUSTS OF 40 MPH ARE EXPECTED, THE IMPERMEABLE ENCLOSURE SHALL BE IMMEDIATELY DISSASSEMBLED, OR PARTIALLY DISASSEMBLED AS DIRECTED BY THE ENGINEER.

6. ADDITIONAL TARPS WILL BE LAID OUT ON THE GROUND BENEATH CONTAINMENT PLATFORMS TO CAPTURE ANYTHING THAT MIGHT ACCIDENTALLY ESCAPE PRIMARY CONTAINMENT.

Containment Design Schedule

	DESIGN PARAMETERS	SUSPENDED PLATFORM
Dimensions, feet	Length, L	99.0
	Width, W	35.3
	Height, H	8.50 AVG
	Area, A = W x H	301 sq.ft.
Ventilation	System	Cross-Draft
	Volume 'Q' (cfm)	35,250
	V = Q/A (ft/min)	**117**
Inlets	Min. Area 'A' (sq.ft.)	36
	V = Q/A (ft/min)	979
No. of Exhaust Ducts		3

No.	Description	Appd	Date
	REVISIONS		

DATE: FEBRUARY 24, 2015
SCALE: AS SHOWN
DESIGNED BY: GDG
DRAWN BY: SRP
APPROVED BY: DEE
PROJECT NO: 15-106
FILE NO: 15-106_PC

REPAINTING OF THE EAST HUBBARDTON RD BRIDGE OVER U.S ROUTE 4
U.S ROUTE 4 E.B & W.B BRIDGES OVER CASTLETON RIVER
CASTLETON & WEST RUTLAND, VERMONT

OWNER: Vermont Agency of Transportation, One National Life Drive, Montpelier, Vermont 05633

APPLICANT: MODERN PROTECTIVE COATINGS, 61 Robinson Road, Hudson, New Hampshire 03051

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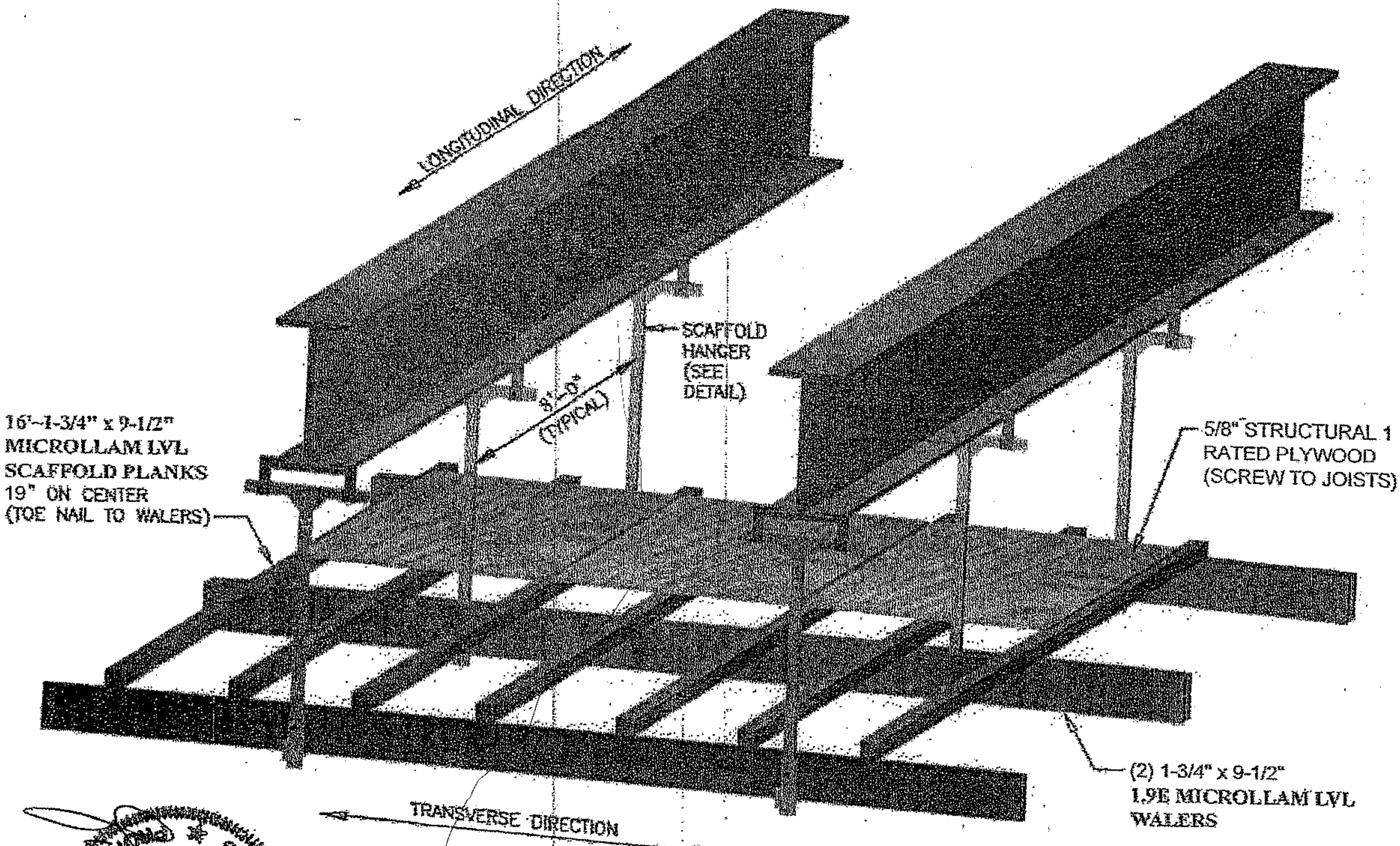
WEST RUTLAND CONTAINMENT SECTIONS

PC-7

APPENDIX "B"

Castleton Bridge - Work Scaffolding Platform & Beam Hanger Support System

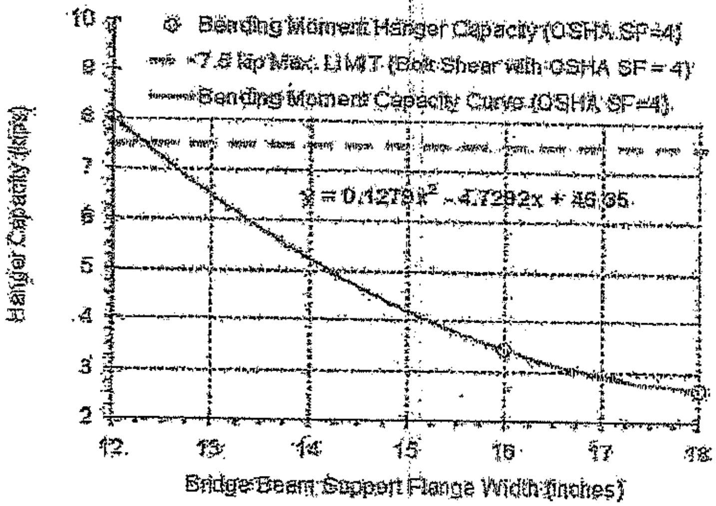


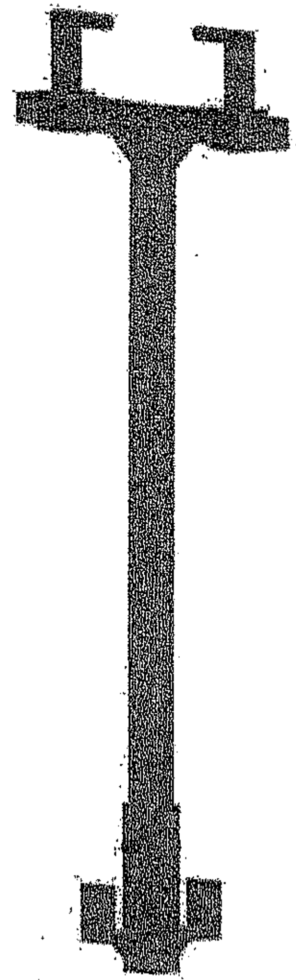
STATE OF VERMONT * DAVID E. ECKMAN * NO. 8211 CIVIL LICENSED * PROFESSIONAL ENGINEER *

6/4/13

DATE: JANUARY 4, 2002 SCALE: NOT TO SCALE DESIGNED BY: CML/DEE DRAWN BY: DPB APPROVED BY: DEE PROJECT NO: 02-950	ECKMAN Engineering, LLC 70 Heritage Ave., PO Box 2035, Portsmouth, NH 03802 Phone: (603) 433-1354, Fax (603) 433-2367	Modern Protective Coatings, Inc. 159 Robinson Road, Hudson, New Hampshire 03051 Phone: (603) 594-3722, Fax: (603) 594-3769	Work Scaffolding System

Allowable Hanger Capacity W/ OSHA SF = 4





Special Notes:

1) 5/16" Fillet welds with a minimum of 60 ksi weld material are typical.
2) ASTM A36 all-purpose steel is typical with Fy=36 ksi and Fu=58 ksi.
3) A490 bolts hold the double waler bracket.
4) A490 bolts shall not be be reused (per AISC).
5) Bolt threads shall not be located within the shear plane when loaded.
6) Hanger brackets to be slid snug against bridge beam support flange and locked into place with 1/2" grade 8 bolt.
7) Microllam walers to be wedged snug against hanger stem with plywood shim.
8) Hangers to be inspected before each use for deformation, rust, damage, or any sign of defects that will reduce their ability to function as designed. If defects are discovered the hanger shall be discarded or repaired to original condition

STATE OF VERMONT
DAVID E. ECKMAN
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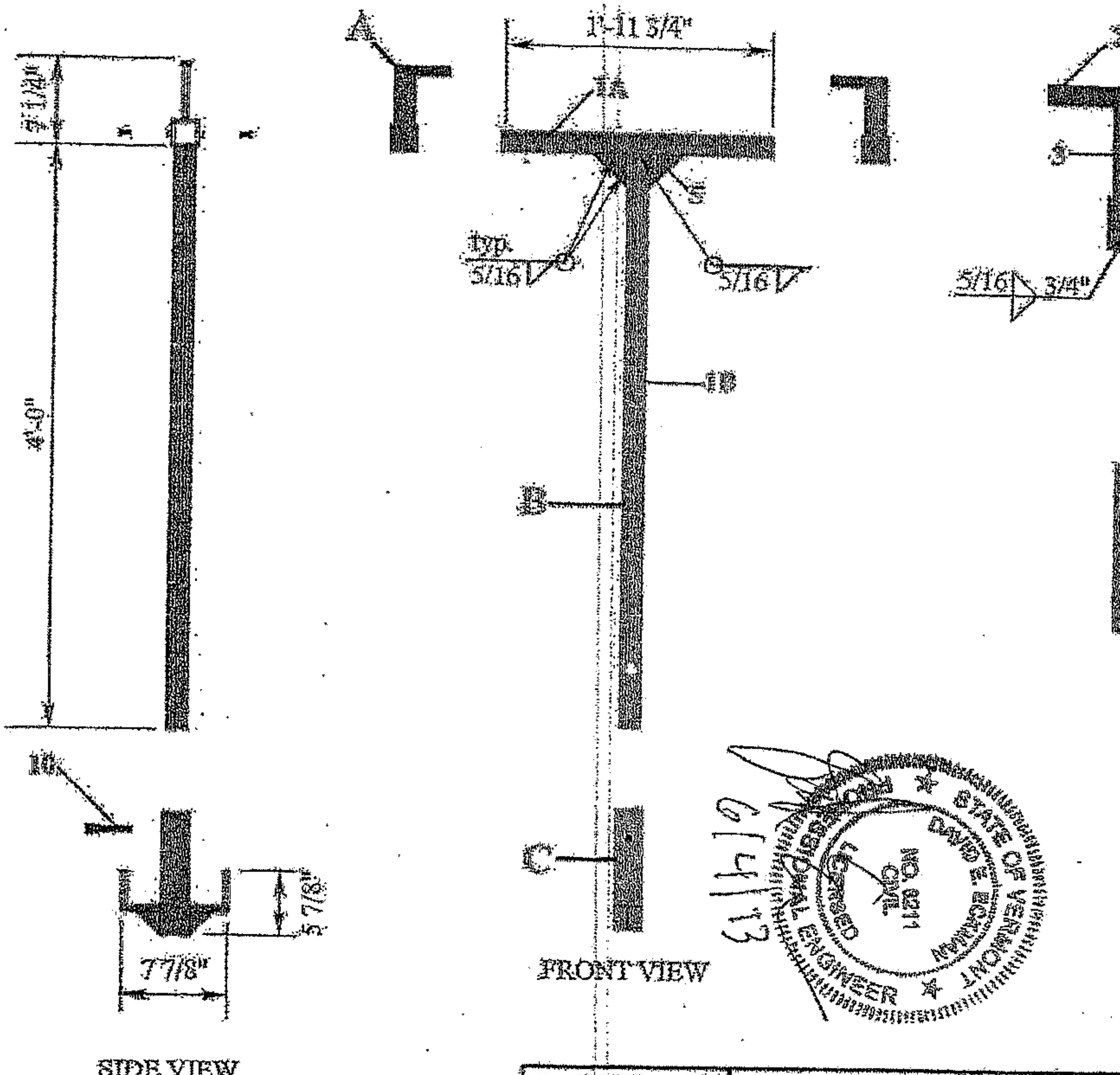
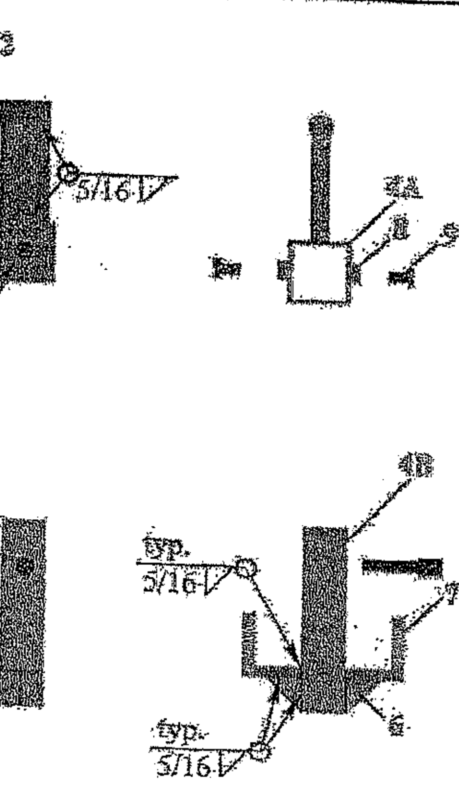
PROFESSIONAL ENGINEER

DATE: JANUARY 4, 2002 SCALE: NOT TO SCALE DESIGNED BY: CML/DEE DRAWN BY: DVB APPROVED BY: DEE PROJECT NO: 02-250	ECKMAN Engineering, LLC 70 Heritage Ave., PO Box 3035, Portsmouth, NH 03802 Phone: (603) 433-1384, Fax (603) 433-2367.	Modern Protective Coatings, Inc. 150 Robinson Road, Hudson, New Hampshire 03051 Phone: (603) 594-3722, Fax (603) 594-3768 **Scaffold Hanger Application**





Member Number	Member Size
1A	1'-11 3/4" 2 1/2" x 3/16" Square Tube
1B	4'-0" ~ 2 1/2" x 3/16" Square Tube
2	1" Diameter Bar
3	4" ~ 2" x 3/4" Rectangular Bar
4A	3" ~ 2 1/2" x 3/16" Square Tube
4B	6" ~ 2 1/2" x 3/16" Square Tube
5	3" Leg x 3" Leg x 1/4" Gusset
6	2" Leg x 2" Leg x 1/4" Gusset
7	2 1/2" ~ 2 5/8" x 3 7/8" x 3/16 Angle
8	3/4" Square Nut
9	1/2" Diameter Grade 8 Bolt
10	5/8" Diameter A490 Bolt

DATE: JANUARY 4, 2002
SCALE: NOT TO SCALE
DESIGNED BY: CML/DNE
DRAWN BY: DVE
APPROVED BY: DNE
PROJECT NO: 02-550

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Phone: (603) 594-3722, Fax: (603) 594-3766

Work Scaffolding Hanger

ECKMAN Engineering, LLC

Client: Modern Protective Coatings, Inc.
Project: Work Scaffold Hanger Analysis
Calculated By: CML/DEE Date: 1-4-02
Checked By: DEE Date: 1-7-02

STATE OF VERMONT
DAVID E. ECKMAN
NO. 3271
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PROFESSIONAL ENGINEER
6/4/13

Part A (Existing Beam-Hanger Bracket)

Fracture in the effective net area of part #4

Allowable stress shall not exceed $0.50F_u$ for effective net area. (AISC ASD D1)

t = 3/16", hole diameter = 9/16"

$A_{net} = 2(3")(3/16") - 2(3/16")(9/16") = 0.914\ in^2$

$A_e = 0.75\ A_{net} = 0.686\ in^2$

Maximum load = $0.50(58\ ksi)(.686\ in^2) = 19.89$ kip

Maximum factored load = 19.89 kip

Note: this value is an allowable value

Therefore, Maximum ultimate load = 39.8 kip

Weld between parts #3 and #4

The effective area of a fillet weld is defined by the product of the weld length and the effective throat thickness. Effective throat thickness = 0.707 = {COS(45) degrees} nominal fillet leg. All welds on this apparatus are 5/16" fillet welds with an effective throat thickness = 0.221 in. Because weld material is not specified the lower strength 60 ksi weld material is assumed.

Weld length = 5.5"

Effective area = $1.216\ in^2$ $\sigma = F/A$ $\sigma_{allowable} = 0.30$ nominal strength of the weld material (AISC J2.5)

$F_{allowable} = 0.30(60ksi)(1.216\ in^2) = 21.9$ kip Value checks with table 8-1 Spiegel and Limburnner

This value has an implied safety factor of 3.33 ∴ the maximum load is 72.9 kip

Maximum load = 72.9 kip

Weld between parts #2 and #3

This weld is virtually the same as analyzed above.

Therefore, by inspection: **Maximum load = 72.9 kip**

Site Development.....................Construction Services....................Bridge Design Services
* 1950 Lafayette Rd., PO Box 3035, Portsmouth, New Hampshire 03802,---Phone: (603) 433-1354 ---Fax (603) 433-2367 *

Part A (Existing Beam-Hanger Bracket) Continued

Shear of part #2

Area = $\pi(0.5)^2$ = 0.785 in² σ = F/A $\therefore$ F =0.785 in²(36 ksi) = 28.3 kip

Maximum load = 28.3 kip x 2 Sides = 56.6 Kip

Yield of part #3

Area = ¾"(2") = 1.5 in² F = 1.5 in²(36 ksi) = 54.0 kip

Maximum load = 54.0 kip x 2 Sides = 108 kips

Part B (T Shape – Hanger Stem

Yielding of gross area

$A_{g\ 2x2x3/16}$ = 1.27 in² (per AISC) σ_y = 36 ksi The $\sigma_{allowable}$ shall not exceed $0.6\sigma_y$ (AISC ASD D1)

σ = F/A Therefore, F = 0.6(36 ksi)(1.27 in²) = 27.4 kip

Maximum factored load = 27.4 kip

Maximum ultimate load = 45.7 kip

Fracture of effective net area

Allowable stress shall not exceed $0.50F_u$ for effective net area. (AISC ASD D1)

A_{net} = 1.27 in² - 4(11/16")(0.1875") = 0.754 in² A_e = 0.85 A_{net} = 0.641 in²

The $\sigma_{allowable}$ shall not exceed $0.5\sigma_u$ (AISC ASD D1) σ_u = 58ksi

σ = F/A $\therefore$ F = $0.50\sigma_u A_e$ = 0.50(58 ksi)(0.641 in²) = 18.59 kip

Maximum factored load = 18.59 kip

Maximum ultimate load = 37.2 kip

Part B (T Shape – Hanger Stem) continued

Weld of vertical tube to horizontal tube
2"x2"x3/16" square tube with 5/16" fillet welt around perimeter
$\sigma = F/A \quad \sigma_{allowable} = 0.30$ nominal strength of the weld material (AISC J2.5)

Effective area = 0.221 in (8 in) = 1.768 in^2

F = 0.3(60 ksi)(1.768 in^2) = 31.82 kip   Value checks with table 8-1 Spiegel and Limburnner

This value has an implied safety factor of 3.33 therefore, the maximum load is 105.96 kip

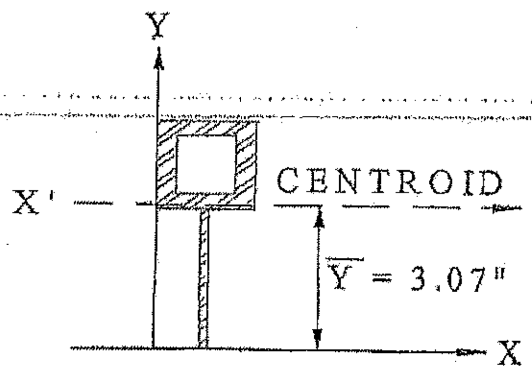
Maximum ultimate load = 106.0 kips

Note: This weld capacity alone far exceeds that of other elements therefore, no need to calculate the additional capacity gained by the gussets.

Max bending at intersection of gusset and vertical tube; worst case scenario 18" flange

section	area	y in	yA in^3	I in^4	d in
1	1.27	4	5.08	0.668	0.93
2	0.75	1.5	1.125	0.563	1.57
	Σ 2.02		Σ 6.205		

$Y\Sigma A = \Sigma yA \quad \therefore \quad Y = 3.07$ in $I_x = \Sigma(I + Ad^2) = 4.18$ in^4



Definition Sketch (not to scale)

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Part B (T Shape – Hanger Stem) continued

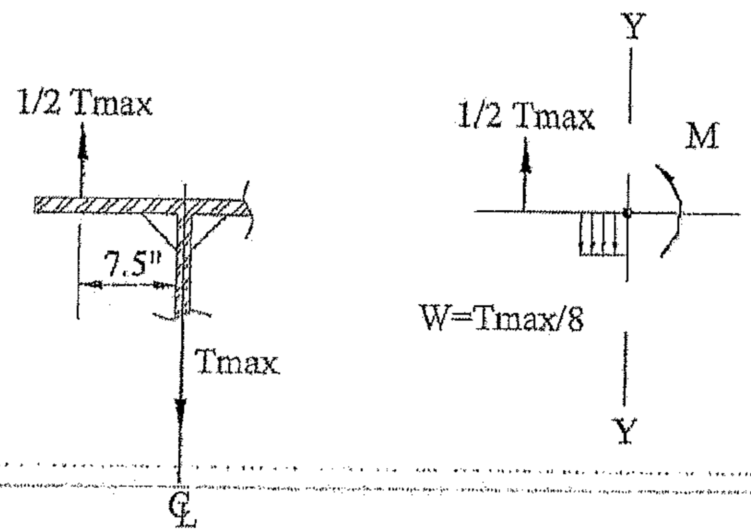
$\Sigma M_{y\text{-}y} \oplus$ clockwise = $0.5T(7.5") - (T/8)(3")(1.5") - M$

$M = (3.19")T$

$\sigma = Mc/I$ therefore, $36 \text{ ksi} = (T(3.19))(3.07)/4.18$

$T = 15.37$ kip

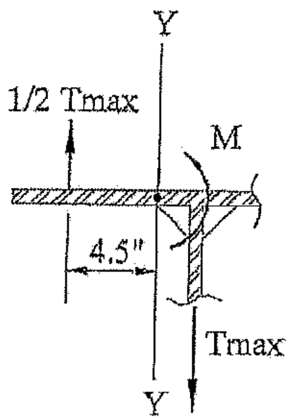
Maximum load = 15.37 kip, with 18" wide bridge beam support flange



Definition Sketch (not to scale)

Bending immediately outside gusset at plane y-y

2x2x3/16 tube; $A = 1.27\ in^2$, $I = 0.668\ in^4$



Definition Sketch (not to scale)

18" flange width

$\Sigma M_{y\text{-}y} \oplus$ clockwise = 0.5T(4.5) – M   therefore, M = 2.25" T

σ = Mc/I therefore, 36ksi = 2.25"T(1") / 0.668 in^4

T = 10.68 kip

Maximum Load = 10.68 kip

Maximum Load = 10.68 kip < 15.37 kip at intersection of gusset and vertical tube. Therefore, worst case is at the location immediately outside gusset plate at y-y.

16" flange width
*moment arm decreased by one inch

T = 13.74 kip

Maximum Load = 13.74 kip

12" flange width
*moment arm decreased by three inches

T = 32.06kip

Maximum Load = 32.06 kip

Bottom bolt in shear

Notes to user;

- A 490 bolts shall not be reused (AISC)
- Bolt threads should be clear of shear plane (AISC)

Allowable stress A 490 bolt = 21ksi; based on a safety factor of 2.35 (AISC ASD J3.2, commentary on A 490 bolts)

Factor of safety = σ_u / σ_a therefore, $\sigma_{u\ A490}$ = 49.4 ksi

Single shear; $\sigma = F/A$ therefore, $\sigma_u\ A_{A490} = F_u$

F_u = 49.4 ksi(0.307 in^2) = 15.15 kip

Total bolt capacity under double shear condition= 30.3 kip

Maximum load = 30 kip

Part C (Waler Support Bracket)

Note; By inspection part #4 being larger than part #1 and being only singularly drilled will have greater strength. Therefore, failure due to gross yield or net fracture in part #4 will not control.

Shear of welds

weld length = 9 in, throat thickness = 0.221 in, effective area = 1.989 in^2

$\sigma = F/A$ $\sigma_{allowable}$ = 0.30 nominal strength of the weld material (AISC J2.5)

$F_{allowable}$ = 0.30(60ksi)(1.989 in^2) = 35.8 kips

$F_{allowable}$ = 35.8 kips based on a safety factor of 3.33 ∴ F_u =119 kips

Maximum load = 119 kips

Summary

It can be hypothesized from the analysis that the area likely to fail in an over load situation is the Part B (horizontal tube just outside the triangular gusset). The exception to this occurs when the hanger is used on beams with flange widths measuring roughly 12". At this point the bolt shear becomes the failure mode. See the allowable hanger capacity graph with applied OSHA required SF = 4.0 on the Scaffold Hanger Application Plan.

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SUBJECT: Suspended Platform Design & Analysis of Existing Steel Girders for Platform Loads

References:

"AASHTO LRFD Bridge Design Specification", 2012

OSHA:

As required by OSHA, the platform is designed with a safety factor of 4.

$SF_{osha} := 4$

Bridge Information:

Girders are plate girders made of A36 steel spaced at maximum 7'-10" on-center (skewed distance).

$s_{girder} := 7ft + 10in$

Bridge is a four-span structure.

$L_1 := 34ft + 0in$ $L_2 := 89.05ft$ $L_3 := L_2 = 89.05 ft$ $L_4 := 49.01ft$

$L_{bridge} := L_1 + L_2 + L_3 + L_4$ $L_{bridge} = 261\ ft$

Calculate the Design Load for the Platform:

Minimum OSHA Load for Light-Duty Platforms is 25.0psf.

Dead & Live Loading Dead = 5/8" Structural 1 Rated Plywood
Live = Avg. worker loading
Live = 3/4" layer steel grit

Equivalent uniform weight for workers is based on (3) workers at 250lbs each distributed over one working bay (1 hanger spacing)

Walers are spaced at 8'-0" on-center along the bridge.

$s_{waler} := 8ft + 0in$

Calculate the hanger distance. Hangers are placed on interior and exterior girders making a uniform hanger spacing for all 4 bays.

$s_{hanger} := s_{girder}$ $s_{hanger} = 7.83\ ft$ $s_{over} := 4ft + 6in$

$P_{worker} := 250lbf$ $N_{worker} := 3$

$$Live_{worker} := \frac{P_{worker} \cdot N_{worker}}{(s_{waler}) \cdot (s_{hanger} + s_{over})} \quad Live_{worker} = 7.60 \cdot psf$$

Uniform weight of steel grit.

$t_{grit} := \frac{3}{4}in \qquad \gamma_{grit} := 240pcf$

$Live_{grit} := t_{grit} \cdot \gamma_{grit} \qquad Live_{grit} = 15.0 \cdot psf$

Total Design Loading

Dead = Plywood deck	$Dead_{ply} := 1.80psf$	
Live = Avg. worker loading	$Live_{worker} = 7.60 \cdot psf$	
Live = 3/4" layer steel grit	$Live_{grit} = 15.0 \cdot psf$	
Total Live Loading	$Live_{total} := Live_{worker} + Live_{grit}$	$Live_{total} = 22.6 \cdot psf$
Min. OSHA Light-Duty	$Live_{OSHA} := 25psf$	
Min. Required Live Loading	$Live_{design} := \max(Live_{total}, Live_{OSHA})$	$Live_{design} = 25.0 \cdot psf$
Total Design Loading	$Load_{design} := Dead_{ply} + Live_{design}$	$Load_{design} = 26.8 \cdot psf$

Plywood Analysis: (5/8" APA Structural 1 Rated Plywood)

Plywood Properties:

$F_b := 2000psi$ (See APA, Table 3, F_b for a Species Group 1 and an S-1 Grade Stress Level, Dry Condition)

$F_v := 190psi$ (See APA, Table 3, F_v for a Species Group 1 and an S-1 Grade Stress Level, Dry Condition)

$E_{ply} := 1.8 \times 10^6 psi$ (See APA, Table 3, E for a Species Group 1 and an S-1 Grade Stress Level, Dry Condition)

Properties from APA, Table 2, Unsanded

$KS := 0.240\frac{in^3}{ft} \qquad I_{ply} := 0.045\frac{in^4}{ft} \qquad RSC := 3.072\frac{in^2}{ft}$

Joists will be 1-3/4"x9-1/2" Microllam LVL Scaffold Planks

Joists are continuous at waler, therefore spacing is 2x the plank width

$b_{plank} := 9.5in \qquad d_{plank} := 1.75in \qquad s_{joist} := 2b_{plank} \qquad s_{joist} = 19.0 \cdot in$

The design span for the plywood will be the clear span between scaffold planks.

$L_{ply} := s_{joist} - b_{plank} \qquad L_{ply} = 9.50 \cdot in$

Check Bending Stress:

$$w_b := \frac{10 \cdot F_b \cdot KS}{L_{ply}^2} \qquad w_b = 638 \cdot psf$$

$$w_{allow} := \frac{w_b}{SF_{osha}} \qquad w_{allow} = 160 \cdot psf \qquad Load_{design} = 26.8 \cdot psf$$

Check := | "5/8" APA Structural 1 Rated Plywood Bending Stress OK" if $w_{allow} > Load_{design}$
| "Re-Design Plywood" otherwise

Check = "5/8" APA Structural 1 Rated Plywood Bending Stress OK"

Check Shear Stress:

$$w_v := \frac{20 \cdot F_v \cdot RSC}{12 L_{ply}} \qquad w_v = 1229 \cdot psf$$

$$w_{allow} := \frac{w_v}{SF_{osha}} \qquad w_{allow} = 307 \cdot psf \qquad Load_{design} = 26.8 \cdot psf$$

Check := | "5/8" APA Structural 1 Rated Plywood Shear Stress OK" if $w_{allow} > Load_{design}$
| "Re-Design Plywood" otherwise

Check = "5/8" APA Structural 1 Rated Plywood Shear Stress OK"

Check Deflection:

$$\Delta := \frac{12 \cdot Load_{design} \cdot L_{ply}^4}{1743 E_{ply} \cdot I_{ply}} \qquad \Delta = 0.002 \cdot in$$

$$\Delta_{limit} := \frac{L_{ply}}{360} \qquad \Delta_{limit} = 0.026 \cdot in$$

Check := | "5/8" APA Structural 1 Rated Plywood Deflection OK" if $\Delta < \Delta_{limit}$
| "Re-Design Plywood" otherwise

Check = "5/8" APA Structural 1 Rated Plywood Deflection OK"

Joist Analysis: (1-3/4" x 9-1/2" Microllam LVL Scaffold Plank)

Dimensional Properties:

$b_{plank} = 9.50 \cdot in$ $d_{plank} = 1.75 \cdot in$ $s_{joist} = 19.0 \cdot in$

$S_{plank} := \frac{b_{plank} \cdot d_{plank}^2}{6}$ $S_{plank} = 4.85 \cdot in^3$ $I_{plank} := \frac{1}{12} \cdot b_{plank} \cdot d_{plank}^3$ $I_{plank} = 4.24 \cdot in^4$

LVL Properties:

$F_b := 2175psi$ $E_{lvl} := 2.2 \times 10^6 psi$ $F_v := 109psi$

Calculate the Maximum Shear and Moment:

Platform Load (including plywood) $Load_{design} = 26.8 \cdot psf$

Scaffold Plank $w_{plank} := 5.10plf$

$w_{design} := w_{plank} + (Load_{design} \cdot s_{joist})$ $w_{design} = 47.5 \cdot plf$

$V_u := \frac{w_{design} \cdot s_{waler}}{2}$ $V_u = 190 \cdot lbf$

$M_u := \frac{w_{design} \cdot s_{waler}^2}{8}$ $M_u = 380 \, ft \cdot lbf$

Check the Allowable Shear:

$F_v = 109 \cdot psi$ Removing adjustment factors, the allowable shear stress can be increased by an applied adjustment factor of 3.15 (See ASTM D 5456 - 99a, Table 1)

$f_v := F_v \cdot 3.15$ $f_v = 343 \cdot psi$

$y_{bar} := \frac{d_{plank}}{4}$ $y_{bar} = 0.438 \cdot in$ $A_{plank} := b_{plank} \cdot d_{plank}$ $A_{plank} = 16.6 \cdot in^2$

$Q := A_{plank} \cdot y_{bar}$ $Q = 7.27 \cdot in^3$

$V_{ult} := \frac{f_v \cdot I_{plank} \cdot b_{plank}}{Q}$ $V_{ult} = 1903 \cdot lbf$

$V_{allow} := \frac{V_{ult}}{SF_{osha}}$ $V_{allow} = 476 \cdot lbf$ $V_u = 190 \cdot lbf$

Check := | "1-3/4" x 9-1/2" LVL Scaffold Plank Shear OK" if $V_{allow} > V_u$
| "Re-Design Scaffold Plank" otherwise

Check = "1-3/4" x 9-1/2" LVL Scaffold Plank Shear OK"

Check Bending Moment:

$F_b = 2175 \cdot psi$ Removing adjustment factors, the allowable bending stress can be increased by an applied adjustment factor of 2.10 (See ASTM D 5456 - 99a, Table 1)

$f_b := F_b \cdot 2.10$ $f_b = 4568 \cdot psi$

$c_{plank} := \frac{d_{plank}}{2}$ $c_{plank} = 0.875 \cdot in$ $I_{plank} = 4.24 \cdot in^4$

$M_{ult} := \frac{f_b \cdot I_{plank}}{c_{plank}}$ $M_{ult} = 1846\, ft \cdot lbf$

$M_{allow} := \frac{M_{ult}}{SF_{osha}}$ $M_{allow} = 461\, ft \cdot lbf$ $M_u = 380\, ft \cdot lbf$

Check := | "1-3/4" x 9-1/2" LVL Scaffold Plank Bending Moment OK" if $M_{allow} > M_u$
| "Re-Design Scaffold Plank" otherwise

Check = "1-3/4" x 9-1/2" LVL Scaffold Plank Bending Moment OK"

Check Deflection:

$s_{waler} = 8.0\, ft$

$\Delta := \frac{5 \cdot w_{design} \cdot s_{waler}^4}{384 \cdot E_{lvl} \cdot I_{plank}}$ $\Delta = 0.47 \cdot in$

Allowable Deflection: $\Delta_{allow} := \frac{s_{waler}}{120}$ $\Delta_{allow} = 0.80 \cdot in$

Check := | "1-3/4" x 9-1/2" LVL Scaffold Plank Deflection OK" if $\Delta < \Delta_{allow}$
| "Re-Design Scaffold Plank" otherwise

Check = "1-3/4" x 9-1/2" LVL Scaffold Plank Deflection OK"

Waler Analysis: (1-3/4" x 9-1/2" 1.9E Microllam LVL)

Dimensional Properties:

$b_{waler} := 1.75in$ $d_{waler} := 9.5in$

$S_{waler} := \dfrac{b_{waler} \cdot d_{waler}^{2}}{6}$ $S_{waler} = 26.3 \cdot in^{3}$ $I_{waler} := \dfrac{1}{12} \cdot b_{waler} \cdot d_{waler}^{3}$ $I_{waler} = 125 \cdot in^{4}$

$s_{hanger} = 7.83\ ft$ $s_{over} = 4.50\ ft$

LVL Properties:

$F_b := 2600psi$ $E_{lvl} := 1.9 \times 10^{6} psi$ $F_v := 285psi$

Calculate the Maximum Shear and Moment:

Platform Load (including plywood) $Load_{design} = 26.8 \cdot psf$

Scaffold Plank $w_{plank} = 5.10 \cdot plf$

$P_{plank} := w_{plank} \cdot s_{waler}$ $P_{plank} = 40.8 \cdot lbf$

$N_{plank} := ceil\left(\dfrac{s_{hanger} + 2s_{over}}{s_{joist}} + 1\right)$ $N_{plank} = 12$

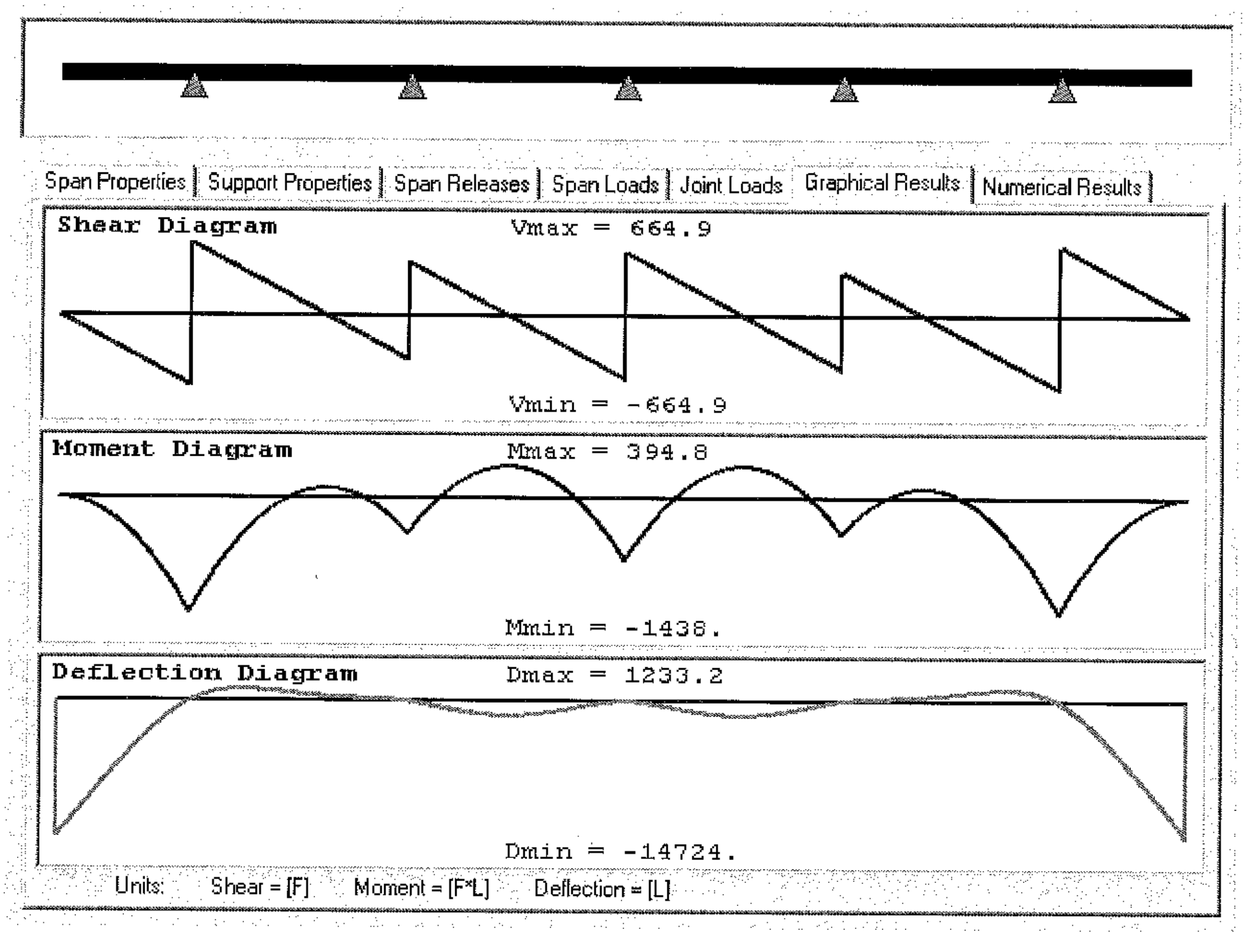
$w_{Pwaler} := \dfrac{N_{plank} \cdot P_{plank}}{s_{hanger} + 2s_{over}}$ $w_{Pwaler} = 29.1 \cdot plf$

Waler $w_{lvl} := 4.80plf$ $N_{lvl} := 1$ $w_{waler} := N_{lvl} \cdot w_{lvl}$ $w_{waler} = 4.80 \cdot plf$

$w_{design} := w_{waler} + w_{Pwaler} + \left(Load_{design} \cdot \dfrac{s_{waler}}{2}\right)$ $w_{design} = 141 \cdot plf$

Use DTBeam to Determine the Maximum Shear, Moment, and Deflection

$s_{hanger} = 7.83\ ft$ $s_{over} = 4.50\ ft$



SUPPORT JOINT REACTIONS (in direction of rotated joint axes)

JOINT	X-REACTION	Y-REACTION	Z-MOMENT
1	0.00000	0.00000	0.00000
2	0.00000	1303.86429	0.00000
3	0.00000	888.51429	0.00000
4	0.00000	1153.24286	0.00000
5	0.00000	888.51429	0.00000
6	0.00000	1303.86429	0.00000
7	0.00000	0.00000	0.00000

$V_u := 665lbf$ $M_u := 1438lbf \cdot ft$ $\Delta_{EI1} := 14724ft$ (EI = 1 lbf*in^2)

$R_1 := 1304lbf$ $R_2 := 889lbf$ $R_3 := 1154lbf$ $R_4 := 889lbf$

$R_5 := 1304lbf$

Check the Allowable Shear:

$F_v = 285 \cdot psi$ Removing adjustment factors, the allowable shear stress can be increased by an applied adjustment factor of 3.15 (See ASTM D 5456 - 99a, Table 1)

$f_v := F_v \cdot 3.15$ $f_v = 898 \cdot psi$

$y_{bar} := \frac{d_{waler}}{4}$ $y_{bar} = 2.375 \cdot in$ $A_{waler} := b_{waler} \cdot d_{waler}$ $A_{waler} = 16.6 \cdot in^2$

$Q := A_{waler} \cdot y_{bar}$ $Q = 39.5 \cdot in^3$

$V_{ult} := N_{lvl} \cdot \frac{f_v \cdot I_{waler} \cdot b_{waler}}{Q}$ $V_{ult} = 4975 \cdot lbf$

$V_{allow} := \frac{V_{ult}}{SF_{osha}}$ $V_{allow} = 1244 \cdot lbf$ $V_u = 665 \cdot lbf$

Check := "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Shear OK" if $V_{allow} > V_u$
"Re-Design Waler" otherwise

Check = "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Shear OK"

Check Bending Moment:

$F_b = 2600 \cdot psi$ Removing adjustment factors, the allowable bending stress can be increased by an applied adjustment factor of 2.10 (See ASTM D 5456 - 99a, Table 1)

$f_b := F_b \cdot 2.10$ $f_b = 5460 \cdot psi$

$c_{waler} := \frac{d_{waler}}{2}$ $c_{waler} = 4.75 \cdot in$ $I_{waler} = 125 \cdot in^4$

$M_{ult} := N_{lvl} \cdot \frac{f_b \cdot I_{waler}}{c_{waler}}$ $M_{ult} = 11977 \, ft \cdot lbf$

$M_{allow} := \frac{M_{ult}}{SF_{osha}}$ $M_{allow} = 2994 \, ft \cdot lbf$ $M_u = 1438 \, ft \cdot lbf$

Check := "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Bending Moment OK" if $M_{allow} > M_u$
"Re-Design Waler" otherwise

Check = "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Bending Moment OK"

Check Deflection:

$\Delta_{EI1} = 14724 \cdot ft$ $\quad \Delta := \Delta_{EI1} \cdot \frac{lbf \cdot ft^2}{N_{lvl} \cdot E_{lvl} \cdot I_{waler}}$ $\quad \Delta = 0.107 \cdot in$

Allowable Deflection: $\quad \Delta_{allow} := \frac{s_{hanger}}{120}$ $\quad \Delta_{allow} = 0.78 \cdot in$

Check := | "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Deflection OK" if $\Delta < \Delta_{allow}$
| "Re-Design Waler" otherwise

Check = "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Deflection OK"

Check Capacity of Bottom Flange to Support Beam Hanger:

Maximum Hanger Load

Containment Sheeting
T-plus sheeting, 10 mil LDPE, (67 lbs./roll) x 3 rolls=201 lbs/(136'x88')=0.017 psf (negligible therefore, exclude)

Rigid Containment Frame
No additional frame is required beyond the work platform and therefore no additional weight needs to be included.

$P_{hanger} := \max(R_1, R_2, R_3, R_4, R_5)$ $\quad P_{hanger} = 1304 \cdot lbf$ (Reactions calculated above for waler design)

Check Flexure Hanger Load on Bottom Flange of Girders

Girders are Plate Girders, A36 Steel
Smallest girder is a 30WF108

$b_f := 10.5in$ $\quad t_f := 0.760in$ $\quad t_w := 0.545in$ $\quad f_y := 36ksi$

Assume a section loss of approximately 10%.
Use 90% of the inventory capacity.

$Percent_{inv} := 90\%$

A 1-inch diameter bar is the part of the hanger sitting on top of the bottom flange.
The bar bears atleast 4-inches on the bottom flange.

$\phi_{bar} := 1in$ $\quad L_{bar} := 4in$

$b_{f.eff} := 0.5b_f - 0.5t_w$ $\quad b_{f.eff} = 4.98 \cdot in$

$L_{bf} := \phi_{bar} + 2 \cdot (b_{f.eff} - L_{bar})$ $\quad L_{bf} = 2.96 \cdot in$

$P_u := \frac{P_{hanger}}{2}$ $\quad P_u = 652 \cdot lbf$

$M_u := P_u \cdot \left(b_{f.eff} - \frac{L_{bar}}{2} \right)$ $\qquad M_u = 0.16 \, ft \cdot kip$

$S_x := Percent_{inv} \cdot \frac{L_{bf} \cdot t_f^{\,2}}{6}$ $\qquad S_x = 0.26 \cdot in^3$

$M_n := (0.55 f_y) \cdot S_x$ $\qquad M_n = 0.42 \, ft \cdot kip$

Check := | "Plate Girder Bottom Flange Flexure OK" if $M_n > M_u$
| "Re-Design Platform" otherwise

Check = "Plate Girder Bottom Flange Flexure OK"

Check Shear of Bottom Flange

Calculate the shear area.

$A_v := L_{bar} \cdot \phi_{bar}$ $\qquad A_v = 4.00 \cdot in^2$

Calculate the shear capacity.

$V_n := 0.60 \cdot (0.67 f_y) \cdot A_v$ $\qquad V_n = 57888 \cdot lbf$ $\qquad P_u = 652 \cdot lbf$

Check := | "Plate Girder Bottom Flange Shear OK" if $V_n > P_u$
| "Re-Design Platform" otherwise

Check = "Plate Girder Bottom Flange Shear OK"

Check Suspended Platform Load on the Existing Girders:

Existing Bridge was designed for an H20-44 Live Load.

Determine the allowable percent increase in load due to temporary loads using Inventory Rating versus Operating Rating.

Inventory Rating = $0.55F_y$ Operating Rating = $0.75F_y$

$Percent_{allow} := \left(\frac{0.75 - 0.55}{0.55}\right)$ $Percent_{allow} = 36.4 \cdot \%$

Check Span 1:

Determine the Maximum Moment Per Girder for an H20-44 Live Load

$L_1 = 34.0\,ft$ $s_{girder} = 7.83\,ft$

H20-44 Design Truck

$P_{front} := 8.0kip$ $P_{rear} := 32.0kip$

Use QuickBridge to Determine Maximum Moment

$M_{pos} := 286.1kip \cdot ft$

Calculate the Live Load Distribution Factor

AASHTO LRFD Bridge Design Specification, 2012
AASHTO 4.6.2.2.2b and AASHTO 4.6.2.2.3a

Two Design Lanes Loaded, Concrete Deck on Steel Beams

$$DF_{moment} = 0.075 + \left(\frac{s_{beam}}{9.5ft}\right)^{0.6} \cdot \left(\frac{s_{beam}}{L_{beam}}\right)^{0.2} \cdot \left(\frac{K_g}{12.0 \cdot L_{beam} \cdot t_s^{\,3}}\right)^{0.1}$$

$$DF_{shear} = 0.2 + \frac{s_{beam}}{12ft} - \left(\frac{s_{beam}}{35ft}\right)^2$$

Where K_g = longitudinal stiffness parameter
t_s = depth of concrete slab

The interior girders on Span 1 are the smallest, therefore, we will check the load on the interior girders.

30WF108 (W30x108) Properties

$A_b := 31.7in^2$ $d_b := 29.8in$ $I_x := 4470in^4$

$$K_g = n \cdot \left(I + A \cdot e_g^{\,2}\right)$$

$E_s := 29000ksi$ $f_c := 3000psi$ $t_{deck} := 8.0in$

$$E_c := 57000 \cdot \sqrt{\frac{f_c}{psi}} \cdot psi \qquad E_c = 3122 \cdot ksi$$

$$n := \frac{E_s}{E_c} \qquad n = 9.29$$

e_g = distance between the centers of gravity of the basic beam and deck

$$e_g := \frac{d_b}{2} + \frac{t_{deck}}{2} \qquad e_g = 18.9 \cdot in$$

$$K_g := n \cdot \left(I_x + A_b \cdot e_g^{\,2}\right) \qquad K_g = 146704 \cdot in^4$$

$$DF_{moment} := 0.075 + \left(\frac{s_{girder}}{9.5ft}\right)^{0.6} \cdot \left(\frac{s_{girder}}{L_1}\right)^{0.2} \cdot \left(\frac{K_g}{12.0 \cdot L_1 \cdot t_{deck}^{\,3}}\right)^{0.1}$$

$$DF_{moment} = 0.575$$

$$DF_{shear} := 0.2 + \frac{s_{girder}}{12ft} - \left(\frac{s_{girder}}{35ft}\right)^2 \qquad DF_{shear} = 0.803$$

$$DF := \min\left(DF_{moment}, DF_{shear}\right) \qquad DF = 0.575$$

Beam Live Load Design Moment

$$M_{design} := \left(DF \cdot M_{pos}\right) \cdot Percent_{inv} \qquad M_{design} = 148\ ft \cdot kip$$

Calculate the Moment Due to Platform Loads

$$Load_{design} = 26.8 \cdot psf$$

$$w_{platform} := Load_{design} \cdot s_{girder} \qquad w_{platform} = 210 \cdot plf$$

$$L_1 = 34.0\ ft$$

The platform will be installed under the entirety of Span 1.

$$V_{platform} := \frac{w_{platform} \cdot L_1}{2} \qquad V_{platform} = 3.57 \cdot kip$$

$$M_{platform} := \frac{w_{platform} \cdot L_1^{\,2}}{8} \qquad M_{platform} = 30.3\ ft \cdot kip$$

Calculate the Percent Increase in Moment

$$Percent_{inc} := \frac{M_{design} + M_{platform}}{M_{design}} - 1.0 \qquad Percent_{inc} = 20.5 \cdot \%$$

Platform Load Check

$$Check := \begin{cases} \text{"Suspended Platform Load on Bridge OK"} & \text{if } Percent_{inc} < Percent_{allow} \\ \text{"Suspended Platform Load on Bridge Not OK"} & \text{otherwise} \end{cases}$$

$Check = $ "Suspended Platform Load on Bridge OK"

Check Span 2:

Determine the Maximum Moment Per Girder for an H20-44 Live Load

$L_2 = 89.0\,ft$ $\qquad s_{girder} = 7.83\,ft$

H20-44 Design Truck

$P_{front} := 8.0kip$ $\qquad P_{rear} := 32.0kip$

Use QuickBridge to Determine Maximum Moment

$M_{pos} := 834.9kip\cdot ft$

Calculate the Live Load Distribution Factor

AASHTO LRFD Bridge Design Specification, 2012
AASHTO 4.6.2.2.2b and AASHTO 4.6.2.2.3a

Two Design Lanes Loaded, Concrete Deck on Steel Beams

$$DF_{moment} = 0.075 + \left(\frac{s_{beam}}{9.5ft}\right)^{0.6}\cdot\left(\frac{s_{beam}}{L_{beam}}\right)^{0.2}\cdot\left(\frac{K_g}{12.0\cdot L_{beam}\cdot t_s^{\,3}}\right)^{0.1}$$

$$DF_{shear} = 0.2 + \frac{s_{beam}}{12ft} - \left(\frac{s_{beam}}{35ft}\right)^2$$

Where $\qquad K_g$ = longitudinal stiffness parameter
$\qquad t_s$ = depth of concrete slab

36WF230 (W36x230) Properties

$A_b := 68.1in^2$ $\qquad d_b := 37.1in$ $\qquad I_x := 15000in^4$

$$K_g = n\cdot\left(I + A\cdot e_g^{\,2}\right)$$

$E_s := 29000ksi$ $\qquad f_c := 3000psi$ $\qquad t_{deck} := 8.0in$

$E_c := 57000\cdot\sqrt{\frac{f_c}{psi}}\cdot psi$ $\qquad E_c = 3122\cdot ksi$

$n := \frac{E_s}{E_c}$ $\qquad n = 9.29$

e_g = distance between the centers of gravity of the basic beam and deck

$$e_g := \frac{d_b}{2} + \frac{t_{deck}}{2} \qquad e_g = 22.6 \cdot in$$

$$K_g := n \cdot \left(I_x + A_b \cdot e_g^{\,2}\right) \qquad K_g = 460997 \cdot in^4$$

$$DF_{moment} := 0.075 + \left(\frac{s_{girder}}{9.5ft}\right)^{0.6} \cdot \left(\frac{s_{girder}}{L_2}\right)^{0.2} \cdot \left(\frac{K_g}{12.0 \cdot L_2 \cdot t_{deck}^{\,3}}\right)^{0.1}$$

$$DF_{moment} = 0.495$$

$$DF_{shear} := 0.2 + \frac{s_{girder}}{12ft} - \left(\frac{s_{girder}}{35ft}\right)^2 \qquad DF_{shear} = 0.803$$

$$DF := \min\left(DF_{moment}, DF_{shear}\right) \qquad DF = 0.495$$

Beam Live Load Design Moment

$$M_{design} := \left(DF \cdot M_{pos}\right) \cdot Percent_{inv} \qquad M_{design} = 372\ ft \cdot kip$$

Calculate the Moment Due to Platform Loads

$$Load_{design} = 26.8 \cdot psf$$

$$w_{platform} := Load_{design} \cdot s_{girder} \qquad w_{platform} = 210 \cdot plf$$

$$L_2 = 89.0\ ft$$

The platform will be installed under the beginning portion and ending portion of Span 2.
Simple Beam - Uniform Load Partially Distributed at Each End

$$l_a := 21ft + 0in \qquad l_b := 28ft + 0in$$

$$R_1 := \frac{w_{platform} \cdot l_a \cdot \left(2L_2 - l_a\right) + w_{platform} \cdot l_b^{\,2}}{2 \cdot L_2} \qquad R_1 = 4.81 \cdot kip$$

$$R_2 := \frac{w_{platform} \cdot l_b \cdot \left(2L_2 - l_b\right) + w_{platform} \cdot l_a^{\,2}}{2 \cdot L_2} \qquad R_2 = 5.47 \cdot kip$$

$$V_{platform} := \max\left(R_1, R_2\right) \qquad V_{platform} = 5.47 \cdot kip$$

$$M_{platform} := \max\left(\frac{R_1^{\,2}}{2 \cdot w_{platform}}, \frac{R_2^{\,2}}{2 \cdot w_{platform}}\right) \qquad M_{platform} = 71.4\ ft \cdot kip$$

Calculate the Percent Increase in Moment

$$\text{Percent}_{inc} := \frac{M_{design} + M_{platform}}{M_{design}} - 1.0 \qquad \text{Percent}_{inc} = 19.2\cdot\%$$

Platform Load Check

$$\text{Check} := \begin{cases} \text{"Suspended Platform Load on Bridge OK"} & \text{if } \text{Percent}_{inc} < \text{Percent}_{allow} \\ \text{"Suspended Platform Load on Bridge Not OK"} & \text{otherwise} \end{cases}$$

$$\text{Check} = \text{"Suspended Platform Load on Bridge OK"}$$

Check Span 3:

Determine the Maximum Moment Per Girder for an H20-44 Live Load

$L_3 = 89.0\,\text{ft}$ $\qquad$ $s_{girder} = 7.83\,\text{ft}$

H20-44 Design Truck

$P_{front} := 8.0\text{kip}$ $\qquad$ $P_{rear} := 32.0\text{kip}$

Use QuickBridge to Determine Maximum Moment

$M_{pos} := 834.9\text{kip}\cdot\text{ft}$

Calculate the Live Load Distribution Factor

AASHTO LRFD Bridge Design Specification, 2012
AASHTO 4.6.2.2.2b and AASHTO 4.6.2.2.3a

Two Design Lanes Loaded, Concrete Deck on Steel Beams

$$DF_{moment} = 0.075 + \left(\frac{s_{beam}}{9.5\text{ft}}\right)^{0.6}\cdot\left(\frac{s_{beam}}{L_{beam}}\right)^{0.2}\cdot\left(\frac{K_g}{12.0\cdot L_{beam}\cdot t_s^{\,3}}\right)^{0.1}$$

$$DF_{shear} = 0.2 + \frac{s_{beam}}{12\text{ft}} - \left(\frac{s_{beam}}{35\text{ft}}\right)^2$$

Where $\qquad$ K_g = longitudinal stiffness parameter
t_s = depth of concrete slab

36WF230 (W36x230) Properties

$A_b := 68.1\text{in}^2$ $\qquad$ $d_b := 37.1\text{in}$ $\qquad$ $I_x := 15000\text{in}^4$

$$K_g = n\cdot\left(I + A\cdot e_g^{\,2}\right)$$

$E_s := 29000\text{ksi}$ $\qquad$ $f_c := 3000\text{psi}$ $\qquad$ $t_{deck} := 8.0\text{in}$

$E_c := 57000 \cdot \sqrt{\frac{f_c}{psi}} \cdot psi \qquad E_c = 3122 \cdot ksi$

$n := \frac{E_s}{E_c} \qquad n = 9.29$

e_g = distance between the centers of gravity of the basic beam and deck

$e_g := \frac{d_b}{2} + \frac{t_{deck}}{2} \qquad e_g = 22.6 \cdot in$

$K_g := n \cdot \left(I_x + A_b \cdot e_g^{\ 2}\right) \qquad K_g = 460997 \cdot in^4$

$$DF_{moment} := 0.075 + \left(\frac{s_{girder}}{9.5ft}\right)^{0.6} \cdot \left(\frac{s_{girder}}{L_2}\right)^{0.2} \cdot \left(\frac{K_g}{12.0 \cdot L_2 \cdot t_{deck}^{\ 3}}\right)^{0.1}$$

$DF_{moment} = 0.495$

$DF_{shear} := 0.2 + \frac{s_{girder}}{12ft} - \left(\frac{s_{girder}}{35ft}\right)^2 \qquad DF_{shear} = 0.803$

$DF := \min\left(DF_{moment}, DF_{shear}\right) \qquad DF = 0.495$

Beam Live Load Design Moment

$M_{design} := \left(DF \cdot M_{pos}\right) \cdot Percent_{inv} \qquad M_{design} = 372\ ft \cdot kip$

Calculate the Moment Due to Platform Loads

$Load_{design} = 26.8 \cdot psf$

$w_{platform} := Load_{design} \cdot s_{girder} \qquad w_{platform} = 210 \cdot plf$

$L_3 = 89.0\ ft$

The platform will be installed under the beginning portion and ending portion of Span 2.
Simple Beam - Uniform Load Partially Distributed at Each End

$l_a := 16ft + 0in \qquad l_b := 25ft + 0in$

$R_1 := \frac{w_{platform} \cdot l_a \cdot \left(2L_2 - l_a\right) + w_{platform} \cdot l_b^{\ 2}}{2 \cdot L_2} \qquad R_1 = 3.79 \cdot kip$

$R_2 := \frac{w_{platform} \cdot l_b \cdot \left(2L_2 - l_b\right) + w_{platform} \cdot l_a^{\ 2}}{2 \cdot L_2} \qquad R_2 = 4.81 \cdot kip$

$V_{platform} := \max(R_1, R_2)$ $V_{platform} = 4.81 \cdot kip$

$$M_{platform} := \max\left(\frac{R_1^2}{2 \cdot w_{platform}}, \frac{R_2^2}{2 \cdot w_{platform}}\right)$$ $M_{platform} = 55.2\,ft \cdot kip$

Calculate the Percent Increase in Moment

$$Percent_{inc} := \frac{M_{design} + M_{platform}}{M_{design}} - 1.0$$ $Percent_{inc} = 14.8 \cdot \%$

Platform Load Check

Check := | "Suspended Platform Load on Bridge OK" if $Percent_{inc} < Percent_{allow}$
| "Suspended Platform Load on Bridge Not OK" otherwise

Check = "Suspended Platform Load on Bridge OK"

Check Span 4:

Determine the Maximum Moment Per Girder for an H20-44 Live Load

$L_4 = 49.0\,ft$ $s_{girder} = 7.83\,ft$

H20-44 Design Truck

$P_{front} := 8.0kip$ $P_{rear} := 32.0kip$

Use QuickBridge to Determine Maximum Moment

$M_{pos} := 435.6kip \cdot ft$

Calculate the Live Load Distribution Factor

AASHTO LRFD Bridge Design Specification, 2012
AASHTO 4.6.2.2.2b and AASHTO 4.6.2.2.3a

Two Design Lanes Loaded, Concrete Deck on Steel Beams

$$DF_{moment} = 0.075 + \left(\frac{s_{beam}}{9.5ft}\right)^{0.6} \cdot \left(\frac{s_{beam}}{L_{beam}}\right)^{0.2} \cdot \left(\frac{K_g}{12.0 \cdot L_{beam} \cdot t_s^3}\right)^{0.1}$$

$$DF_{shear} = 0.2 + \frac{s_{beam}}{12ft} - \left(\frac{s_{beam}}{35ft}\right)^2$$

Where K_g = longitudinal stiffness parameter
t_s = depth of concrete slab

36WF230 (W36x230) Properties

$A_b := 68.1in^2$ $d_b := 37.1in$ $I_x := 15000in^4$

$K_g = n \cdot \left(I + A \cdot e_g^{2}\right)$

$E_s := 29000ksi$ $f_c := 3000psi$ $t_{deck} := 8.0in$

$E_c := 57000 \cdot \sqrt{\frac{f_c}{psi}} \cdot psi$ $E_c = 3122 \cdot ksi$

$n := \frac{E_s}{E_c}$ $n = 9.29$

e_g = distance between the centers of gravity of the basic beam and deck

$e_g := \frac{d_b}{2} + \frac{t_{deck}}{2}$ $e_g = 22.6 \cdot in$

$K_g := n \cdot \left(I_x + A_b \cdot e_g^{2}\right)$ $K_g = 460997 \cdot in^4$

$$DF_{moment} := 0.075 + \left(\frac{s_{girder}}{9.5ft}\right)^{0.6} \cdot \left(\frac{s_{girder}}{L_1}\right)^{0.2} \cdot \left(\frac{K_g}{12.0 \cdot L_1 \cdot t_{deck}^{3}}\right)^{0.1}$$

$DF_{moment} = 0.636$

$DF_{shear} := 0.2 + \frac{s_{girder}}{12ft} - \left(\frac{s_{girder}}{35ft}\right)^{2}$ $DF_{shear} = 0.803$

$DF := \min\left(DF_{moment}, DF_{shear}\right)$ $DF = 0.636$

Beam Live Load Design Moment

$M_{design} := \left(DF \cdot M_{pos}\right) \cdot Percent_{inv}$ $M_{design} = 249 \; ft \cdot kip$

Calculate the Moment Due to Platform Loads

$Load_{design} = 26.8 \cdot psf$

$w_{platform} := Load_{design} \cdot s_{girder}$ $w_{platform} = 210 \cdot plf$

$L_1 = 34.0 \; ft$

The platform will be installed under the entirety of Span 1.

$V_{platform} := \frac{w_{platform} \cdot L_1}{2}$ $V_{platform} = 3.57 \cdot kip$

$M_{platform} := \frac{w_{platform} \cdot L_1^{2}}{8}$ $M_{platform} = 30.3 \; ft \cdot kip$

Calculate the Percent Increase in Moment

$$Percent_{inc} := \frac{M_{design} + M_{platform}}{M_{design}} - 1.0 \qquad Percent_{inc} = 12.2 \cdot \%$$

Platform Load Check

$$Check := \begin{cases} \text{"Suspended Platform Load on Bridge OK"} & \text{if } Percent_{inc} < Percent_{allow} \\ \text{"Suspended Platform Load on Bridge Not OK"} & \text{otherwise} \end{cases}$$

$$Check = \text{"Suspended Platform Load on Bridge OK"}$$

Check the Wind Load on the Structure:

We are going to limit the wind speed at which the platform/containment will be used to 40mph. If winds are anticipated to reach 40mph, the containment tarps shall be taken down until winds subside.

$$V_{DZ} := 40mph$$

Calculate the Design Wind Pressure

$$P_D = P_B \cdot \frac{\left(\frac{V_{DZ}}{mph}\right)^2}{10000}$$ (AASHTO Eq. 3.8.1.2.1-1)

$P_B := 0.050ksf$ (AASHTO Table 3.8.1.2.1-1, Windward Load, Beams)

$$P_D := P_B \cdot \frac{\left(\frac{V_{DZ}}{mph}\right)^2}{10000} \qquad P_D = 8.00 \cdot psf$$

AASHTO Minimum Required Design Wind Load

AASHTO Section 3.8.1.2.1 requires that beam bridges be designed for a minimum wind load of 300plf.

$Design_{wind.min} := 300plf$ (Per AASHTO Section 3.8.1.2.1)

Calculate the Depth of the Containment

The containment will be from the top of the bridge to approximately 3'-0" below the bottom flange of the plate girders.

$D_{fascia} := 20.5in$ (from Contract Plans)

$D_{beam} := d_b \qquad D_{beam} = 37.1 \cdot in \qquad D_{haunch} := 1.0in$ (from Contract Plans)

$$D_{containment} := D_{fascia} + D_{beam} + D_{haunch} + 3ft \qquad D_{containment} = 7.88\,ft$$

Calculate the Wind Load Per Foot on the Containment

$Wind_{containment} := P_D \cdot D_{containment}$ $\qquad$ $Wind_{containment} = 63.1 \cdot plf$

$$Check := \begin{cases} \text{"Bridge Wind Load from Containment OK"} & \text{if } Wind_{containment} < Design_{wind.min} \\ \text{"Reduce Allowable Wind Speed"} & \text{otherwise} \end{cases}$$

Check = "Bridge Wind Load from Containment OK"

Since the actual wind load on the bridge from containment is less than the required minimum AASHTO wind load, the bridge is OK for wind.

QuickBridge - AASHTO HS20 - Span 1

Truck definition

Number of axles

2

Axle No	X	W
1	0.0	8.0
2	14.0	32.0

X is the coordinate and
W the weight of the axle
Coordinate of axle 1 is 0

QuickBridge - AASHTO H20 - Span 1

Bridge geometry

Number of span

1

Span No	L	q	div
1	34	0	34

L is the length,
q uniform load and
div number of divisions
on a particular span
L and div must be > 0

QuickBridge - AASHTO H20 - Span 1

Results

X	Vmax	Mmin	Mmax
0.00	36.7	0.0	0.0
1.00	35.5	0.0	35.5
2.00	34.4	0.0	68.7
3.00	33.2	0.0	99.5
4.00	32.0	0.0	128.0
5.00	30.8	0.0	154.1
6.00	29.6	0.0	177.9
7.00	28.5	0.0	199.3
8.00	27.3	0.0	218.4
9.00	26.1	0.0	235.1
10.00	24.9	0.0	249.4
11.00	23.8	0.0	261.4
12.00	22.6	0.0	271.1
13.00	21.4	0.0	278.4
14.00	20.2	0.0	283.3
15.00	19.1	0.0	285.9
16.00	17.9	0.0	286.1
17.00	16.7	0.0	284.0
18.00	15.5	0.0	279.5
19.00	16.5	0.0	272.7
20.00	17.6	0.0	263.5
21.00	18.8	0.0	256.9
22.00	19.8	0.0	248.5
23.00	20.7	0.0	238.1
24.00	21.6	0.0	225.9
25.00	22.6	0.0	211.8
26.00	23.5	0.0	195.8
27.00	24.5	0.0	177.9
28.00	25.4	0.0	158.1
29.00	26.4	0.0	136.5
30.00	27.3	0.0	112.9
31.00	28.2	0.0	87.5
32.00	29.2	0.0	60.2
33.00	30.1	0.0	31.1
34.00	32.0	0.0	0.0

No	Rmin	Rmax
1	0.0	36.7
2	0.0	32.0

QuickBridge - AASHTO H20 - Spans 2&3

Truck definition

Number of axles

2

Axle No	X	W
1	0.0	8.0
2	14.0	32.0

X is the coordinate and
W the weight of the axle
Coordinate of axle 1 is 0

QuickBridge - AASHTO H20 - Spans 2 & 3

Bridge geometry

Number of span

1

Span No	L	q	div
1	89	0	89

L is the length,
q uniform load and
div number of divisions
on a particular span
L and div must be > 0

QuickBridge - AASHTO H20 - Spans 2 & 3

Results

X	Vmax	Mmin	Mmax
0.00	38.7	0.0	0.0
1.00	38.3	0.0	38.3
2.00	37.8	0.0	75.7
3.00	37.4	0.0	112.2
4.00	36.9	0.0	147.8
5.00	36.5	0.0	182.5
6.00	36.0	0.0	216.3
7.00	35.6	0.0	249.2
8.00	35.1	0.0	281.2
9.00	34.7	0.0	312.3
10.00	34.2	0.0	342.5
11.00	33.8	0.0	371.8
12.00	33.3	0.0	400.2
13.00	32.9	0.0	427.7
14.00	32.4	0.0	454.3
15.00	32.0	0.0	480.0
16.00	31.6	0.0	504.8
17.00	31.1	0.0	528.7
18.00	30.7	0.0	551.7
19.00	30.2	0.0	573.8
20.00	29.8	0.0	595.1
21.00	29.3	0.0	615.4
22.00	28.9	0.0	634.8
23.00	28.4	0.0	653.3
24.00	28.0	0.0	670.9
25.00	27.5	0.0	687.6
26.00	27.1	0.0	703.5
27.00	26.6	0.0	718.4
28.00	26.2	0.0	732.4
29.00	25.7	0.0	745.5
30.00	25.3	0.0	757.8
31.00	24.8	0.0	769.1
32.00	24.4	0.0	779.5
33.00	23.9	0.0	789.0
34.00	23.5	0.0	797.7
35.00	23.0	0.0	805.4
36.00	22.6	0.0	812.2
37.00	22.1	0.0	818.2
38.00	21.7	0.0	823.2
39.00	21.2	0.0	827.3
40.00	20.8	0.0	830.6
41.00	20.3	0.0	832.9
42.00	19.9	0.0	834.3
43.00	19.4	0.0	834.9
44.00	19.0	0.0	834.5
45.00	18.5	0.0	833.3
46.00	18.1	0.0	831.1
47.00	17.6	0.0	828.0
48.00	17.2	0.0	824.1

No	Rmin	Rmax
1	0.0	38.7
2	0.0	35.0

QuickBridge - AASHTO H20 - Spans 2 & 3

49.00	16.7	0.0	819.2
50.00	17.0	0.0	813.5
51.00	17.4	0.0	806.8
52.00	17.9	0.0	799.3
53.00	18.3	0.0	790.8
54.00	18.8	0.0	781.5
55.00	19.2	0.0	771.2
56.00	19.7	0.0	760.1
57.00	20.1	0.0	748.0
58.00	20.6	0.0	735.1
59.00	21.0	0.0	721.3
60.00	21.5	0.0	706.5
61.00	21.9	0.0	690.9
62.00	22.4	0.0	674.3
63.00	22.8	0.0	656.9
64.00	23.3	0.0	638.6
65.00	23.7	0.0	619.3
66.00	24.2	0.0	599.2
67.00	24.6	0.0	578.2
68.00	25.1	0.0	556.2
69.00	25.5	0.0	533.4
70.00	26.0	0.0	509.7
71.00	26.4	0.0	485.0
72.00	26.9	0.0	464.5
73.00	27.3	0.0	444.4
74.00	27.8	0.0	423.4
75.00	28.2	0.0	401.4
76.00	28.7	0.0	378.6
77.00	29.1	0.0	354.9
78.00	29.6	0.0	330.2
79.00	30.0	0.0	304.7
80.00	30.5	0.0	278.3
81.00	30.9	0.0	251.0
82.00	31.4	0.0	222.7
83.00	31.8	0.0	193.6
84.00	32.3	0.0	163.6
85.00	32.7	0.0	132.7
86.00	33.2	0.0	100.9
87.00	33.6	0.0	68.1
88.00	34.1	0.0	34.5
89.00	35.0	0.0	0.0

QuickBridge - AASHTO H20 - Span 4

Truck definition

Number of axles

2

Axle No	X	W
1	0.0	8.0
2	14.0	32.0

X is the coordinate and
W the weight of the axle
Coordinate of axle 1 is 0

QuickBridge - AASHTO H20 - Span 4

Bridge geometry

Number of span

1

Span No	L	q	div
1	49	0	49

L is the length,
q uniform load and
div number of divisions
on a particular span
L and div must be > 0

QuickBridge - AASHTO H20 - Span 4

Results

X	Vmax	Mmin	Mmax
0.00	37.7	0.0	0.0
1.00	36.9	0.0	36.9
2.00	36.1	0.0	72.2
3.00	35.3	0.0	105.8
4.00	34.4	0.0	137.8
5.00	33.6	0.0	168.2
6.00	32.8	0.0	196.9
7.00	32.0	0.0	224.0
8.00	31.2	0.0	249.5
9.00	30.4	0.0	273.3
10.00	29.6	0.0	295.5
11.00	28.7	0.0	316.1
12.00	27.9	0.0	335.0
13.00	27.1	0.0	352.3
14.00	26.3	0.0	368.0
15.00	25.5	0.0	382.0
16.00	24.7	0.0	394.4
17.00	23.8	0.0	405.2
18.00	23.0	0.0	414.4
19.00	22.2	0.0	421.9
20.00	21.4	0.0	427.8
21.00	20.6	0.0	432.0
22.00	19.8	0.0	434.6
23.00	18.9	0.0	435.6
24.00	18.1	0.0	434.9
25.00	17.3	0.0	432.7
26.00	16.5	0.0	428.7
27.00	15.7	0.0	423.2
28.00	16.3	0.0	416.0
29.00	17.1	0.0	407.2
30.00	18.0	0.0	396.7
31.00	18.8	0.0	384.7
32.00	19.6	0.0	370.9
33.00	20.4	0.0	355.6
34.00	21.2	0.0	338.6
35.00	22.0	0.0	320.0
36.00	22.9	0.0	305.6
37.00	23.5	0.0	290.0
38.00	24.2	0.0	273.0
39.00	24.8	0.0	254.7
40.00	25.5	0.0	235.1
41.00	26.1	0.0	214.2
42.00	26.8	0.0	192.0
43.00	27.4	0.0	168.5
44.00	28.1	0.0	143.7
45.00	28.7	0.0	117.6
46.00	29.4	0.0	90.1
47.00	30.0	0.0	61.4
48.00	30.7	0.0	31.3
49.00	32.0	0.0	0.0

No	Rmin	Rmax
1	0.0	37.7
2	0.0	32.0

APPENDIX "C"

West Rutland W.B. Bridge - Work Scaffolding Platform & Beam Hanger Support System

Eckman Engineering, LLC
1950 Lafayette Road Suite 301, PO Box 3035
Portsmouth, NH 03801
(603) 433-1354 FAX (603) 433-2367

Client: Modern Protective Coatings

PROJECT: U.S. Route 4 W.B. Over Railroad
PROJECT NUMBER: 15-106
CALCULATED BY: GDG DATE: 02/26/15
REVISED BY: DATE:
CHECKED BY: DEE DATE: 02/27/15

SUBJECT: Suspended Platform Design & Analysis of Existing Steel Girders for Platform Loads

References:

"AASHTO LRFD Bridge Design Specification", 2012

OSHA:

As required by OSHA, the platform is designed with a safety factor of 4.

$SF_{osha} := 4$

Bridge Information:

Girders are plate girders made of A36 steel spaced at maximum 7'-6" on-center.

$s_{girder} := 7ft + 6in$ $\theta_{skew} := \left[93 + \left(\frac{15}{60}\right) + \left(\frac{45}{3600}\right)\right]deg = 93.3 \cdot deg$

$s_{skew} := \frac{s_{girder}}{\cos(\theta_{skew} - 90deg)}$ $s_{skew} = 7.51\ ft$

Bridge is a five-span structure.

$L_1 := 54ft$ $L_2 := 54ft$ $L_3 := 99ft$ $L_4 := 54ft$ $L_5 := 54ft$

$L_{bridge} := L_1 + L_2 + L_3 + L_4 + L_5$ $L_{bridge} = 315\ ft$

Calculate the Design Load for the Platform:

Minimum OSHA Load for Light-Duty Platforms is 25.0psf.

Dead & Live Loading — Dead = 5/8" Structural 1 Rated Plywood
Live = Avg. worker loading
Live = 3/4" layer steel grit

Equivalent uniform weight for workers is based on (3) workers at 250lbs each distributed over one working bay (1 hanger spacing)

Walers are spaced at 8'-0" on-center along the bridge.

$s_{waler} := 8ft + 0in$

Calculate the hanger distance. Hangers are placed on interior and exterior girders making a uniform hanger spacing for all 4 bays.

$s_{hanger} := s_{skew}$ $s_{hanger} = 7.51\ ft$ $s_{over} := 2ft + 8in$

$P_{worker} := 250lbf$ $N_{worker} := 3$

$$Live_{worker} := \frac{P_{worker} \cdot N_{worker}}{(s_{waler}) \cdot (s_{hanger} + s_{over})} \qquad Live_{worker} = 9.21 \cdot psf$$

Uniform weight of steel grit.

$t_{grit} := \frac{3}{4} in$ $\gamma_{grit} := 240pcf$

$Live_{grit} := t_{grit} \cdot \gamma_{grit}$ $Live_{grit} = 15.0 \cdot psf$

Total Design Loading

Dead = Plywood deck	$Dead_{ply} := 1.80psf$	
Live = Avg. worker loading	$Live_{worker} = 9.21 \cdot psf$	
Live = 3/4" layer steel grit	$Live_{grit} = 15.0 \cdot psf$	
Total Live Loading	$Live_{total} := Live_{worker} + Live_{grit}$	$Live_{total} = 24.2 \cdot psf$
Min. OSHA Light-Duty	$Live_{OSHA} := 25psf$	
Min. Required Live Loading	$Live_{design} := \max(Live_{total}, Live_{OSHA})$	$Live_{design} = 25.0 \cdot psf$
Total Design Loading	$Load_{design} := Dead_{ply} + Live_{design}$	$Load_{design} = 26.8 \cdot psf$

Plywood Analysis: (5/8" APA Structural 1 Rated Plywood)

Plywood Properties:

$F_b := 2000psi$ (See APA, Table 3, F_b for a Species Group 1 and an S-1 Grade Stress Level, Dry Condition)

$F_v := 190psi$ (See APA, Table 3, F_v for a Species Group 1 and an S-1 Grade Stress Level, Dry Condition)

$E_{ply} := 1.8 \times 10^6 psi$ (See APA, Table 3, E for a Species Group 1 and an S-1 Grade Stress Level, Dry Condition)

Properties from APA, Table 2, Unsanded

$KS := 0.240 \frac{in^3}{ft}$ $I_{ply} := 0.045 \frac{in^4}{ft}$ $RSC := 3.072 \frac{in^2}{ft}$

Joists will be 1-3/4"x9-1/2" Microllam LVL Scaffold Planks

Joists are continuous at waler, therefore spacing is 2x the plank width

$b_{plank} := 9.5in$ $d_{plank} := 1.75in$ $s_{joist} := 2b_{plank}$ $s_{joist} = 19.0 \cdot in$

The design span for the plywood will be the clear span between scaffold planks.

$L_{ply} := s_{joist} - b_{plank} \qquad L_{ply} = 9.50 \cdot in$

Check Bending Stress:

$w_b := \dfrac{10 \cdot F_b \cdot KS}{L_{ply}^{2}} \qquad w_b = 638 \cdot psf$

$w_{allow} := \dfrac{w_b}{SF_{osha}} \qquad w_{allow} = 160 \cdot psf \qquad Load_{design} = 26.8 \cdot psf$

Check := | "5/8" APA Structural 1 Rated Plywood Bending Stress OK" if $w_{allow} > Load_{design}$
"Re-Design Plywood" otherwise

Check = "5/8" APA Structural 1 Rated Plywood Bending Stress OK"

Check Shear Stress:

$w_v := \dfrac{20 \cdot F_v \cdot RSC}{12L_{ply}} \qquad w_v = 1229 \cdot psf$

$w_{allow} := \dfrac{w_v}{SF_{osha}} \qquad w_{allow} = 307 \cdot psf \qquad Load_{design} = 26.8 \cdot psf$

Check := | "5/8" APA Structural 1 Rated Plywood Shear Stress OK" if $w_{allow} > Load_{design}$
"Re-Design Plywood" otherwise

Check = "5/8" APA Structural 1 Rated Plywood Shear Stress OK"

Check Deflection:

$\Delta := \dfrac{12 \cdot Load_{design} \cdot L_{ply}^{4}}{1743 E_{ply} \cdot I_{ply}} \qquad \Delta = 0.002 \cdot in$

$\Delta_{limit} := \dfrac{L_{ply}}{360} \qquad \Delta_{limit} = 0.026 \cdot in$

Check := | "5/8" APA Structural 1 Rated Plywood Deflection OK" if $\Delta < \Delta_{limit}$
"Re-Design Plywood" otherwise

Check = "5/8" APA Structural 1 Rated Plywood Deflection OK"

Joist Analysis: (1-3/4" x 9-1/2" Microllam LVL Scaffold Plank)

Dimensional Properties:

$b_{plank} = 9.50 \cdot in$ $d_{plank} = 1.75 \cdot in$ $s_{joist} = 19.0 \cdot in$

$S_{plank} := \frac{b_{plank} \cdot d_{plank}^2}{6}$ $S_{plank} = 4.85 \cdot in^3$ $I_{plank} := \frac{1}{12} \cdot b_{plank} \cdot d_{plank}^3$ $I_{plank} = 4.24 \cdot in^4$

LVL Properties:

$F_b := 2175psi$ $E_{lvl} := 2.2 \times 10^6 psi$ $F_v := 109psi$

Calculate the Maximum Shear and Moment:

Platform Load (including plywood) $Load_{design} = 26.8 \cdot psf$

Scaffold Plank $w_{plank} := 5.10plf$

$w_{design} := w_{plank} + \left(Load_{design} \cdot s_{joist}\right)$ $w_{design} = 47.5 \cdot plf$

$V_u := \frac{w_{design} \cdot s_{waler}}{2}$ $V_u = 190 \cdot lbf$

$M_u := \frac{w_{design} \cdot s_{waler}^2}{8}$ $M_u = 380\ ft \cdot lbf$

Check the Allowable Shear:

$F_v = 109 \cdot psi$ Removing adjustment factors, the allowable shear stress can be increased by an applied adjustment factor of 3.15 (See ASTM D 5456 - 99a, Table 1)

$f_v := F_v \cdot 3.15$ $f_v = 343 \cdot psi$

$y_{bar} := \frac{d_{plank}}{4}$ $y_{bar} = 0.438 \cdot in$ $A_{plank} := b_{plank} \cdot d_{plank}$ $A_{plank} = 16.6 \cdot in^2$

$Q := A_{plank} \cdot y_{bar}$ $Q = 7.27 \cdot in^3$

$V_{ult} := \frac{f_v \cdot I_{plank} \cdot b_{plank}}{Q}$ $V_{ult} = 1903 \cdot lbf$

$V_{allow} := \frac{V_{ult}}{SF_{osha}}$ $V_{allow} = 476 \cdot lbf$ $V_u = 190 \cdot lbf$

Check := | "1-3/4" x 9-1/2" LVL Scaffold Plank Shear OK" if $V_{allow} > V_u$
| "Re-Design Scaffold Plank" otherwise

Check = "1-3/4" x 9-1/2" LVL Scaffold Plank Shear OK"

Check Bending Moment:

$F_b = 2175 \cdot psi$ — Removing adjustment factors, the allowable bending stress can be increased by an applied adjustment factor of 2.10 (See ASTM D 5456 - 99a, Table 1)

$f_b := F_b \cdot 2.10$ $\quad f_b = 4568 \cdot psi$

$c_{plank} := \frac{d_{plank}}{2}$ $\quad c_{plank} = 0.875 \cdot in$ $\quad I_{plank} = 4.24 \cdot in^4$

$M_{ult} := \frac{f_b \cdot I_{plank}}{c_{plank}}$ $\quad M_{ult} = 1846\, ft \cdot lbf$

$M_{allow} := \frac{M_{ult}}{SF_{osha}}$ $\quad M_{allow} = 461\, ft \cdot lbf$ $\quad M_u = 380\, ft \cdot lbf$

Check := | "1-3/4" x 9-1/2" LVL Scaffold Plank Bending Moment OK" if $M_{allow} > M_u$
| "Re-Design Scaffold Plank" otherwise

Check = "1-3/4" x 9-1/2" LVL Scaffold Plank Bending Moment OK"

Check Deflection:

$s_{waler} = 8.0\, ft$

$\Delta := \frac{5 \cdot w_{design} \cdot s_{waler}^4}{384 \cdot E_{lvl} \cdot I_{plank}}$ $\quad \Delta = 0.47 \cdot in$

Allowable Deflection: $\Delta_{allow} := \frac{s_{waler}}{120}$ $\quad \Delta_{allow} = 0.80 \cdot in$

Check := | "1-3/4" x 9-1/2" LVL Scaffold Plank Deflection OK" if $\Delta < \Delta_{allow}$
| "Re-Design Scaffold Plank" otherwise

Check = "1-3/4" x 9-1/2" LVL Scaffold Plank Deflection OK"

Waler Analysis: (1-3/4" x 9-1/2" 1.9E Microllam LVL)

Dimensional Properties:

$b_{waler} := 1.75in$ $d_{waler} := 9.5in$

$S_{waler} := \frac{b_{waler} \cdot d_{waler}^2}{6}$ $S_{waler} = 26.3 \cdot in^3$ $I_{waler} := \frac{1}{12} \cdot b_{waler} \cdot d_{waler}^3$ $I_{waler} = 125 \cdot in^4$

$s_{hanger} = 7.51\,ft$ $s_{over} = 2.67\,ft$

LVL Properties:

$F_b := 2600psi$ $E_{lvl} := 1.9 \times 10^6 psi$ $F_v := 285psi$

Calculate the Maximum Shear and Moment:

Platform Load (including plywood) $Load_{design} = 26.8 \cdot psf$

Scaffold Plank $w_{plank} = 5.10 \cdot plf$

$P_{plank} := w_{plank} \cdot s_{waler}$ $P_{plank} = 40.8 \cdot lbf$

$N_{plank} := ceil\left(\frac{s_{hanger} + 2s_{over}}{s_{joist}} + 1\right)$ $N_{plank} = 10$

$w_{Pwaler} := \frac{N_{plank} \cdot P_{plank}}{s_{hanger} + 2s_{over}}$ $w_{Pwaler} = 31.8 \cdot plf$

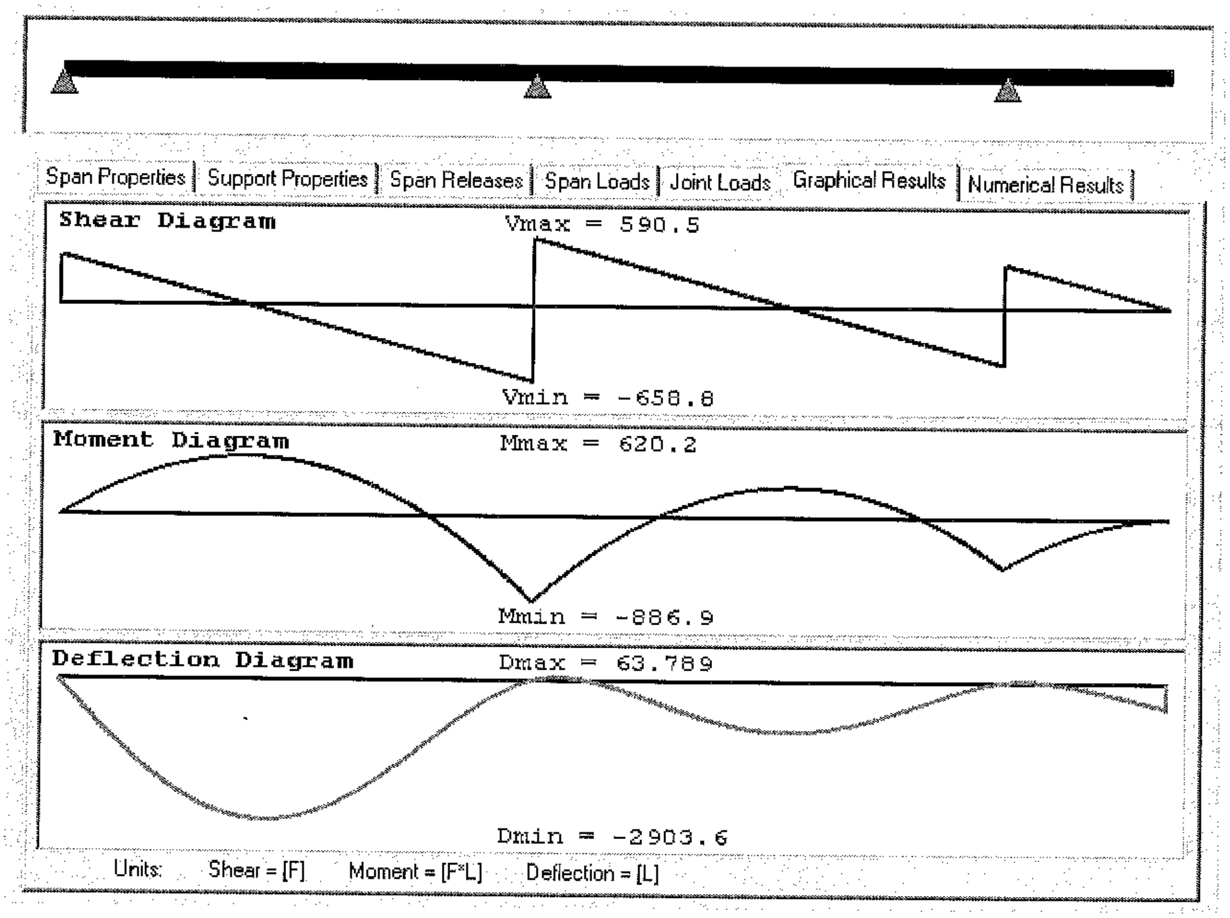
Waler $w_{lvl} := 4.80plf$ $N_{lvl} := 1$ $w_{waler} := N_{lvl} \cdot w_{lvl}$ $w_{waler} = 4.80 \cdot plf$

$w_{design} := w_{waler} + w_{Pwaler} + \left(Load_{design} \cdot \frac{s_{waler}}{2}\right)$ $w_{design} = 144 \cdot plf$

Use DTBeam to Determine the Maximum Shear, Moment, and Deflection

$s_{hanger} = 7.51\ ft$ $\qquad$ $s_{over} = 2.67\ ft$

Assume that the waler spans from the center beam to the overhang.



SUPPORT JOINT REACTIONS (in direction of rotated joint axes)

JOINT	X-REACTION	Y-REACTION	Z-MOMENT
1	0.00000	422.62658	0.00000
2	0.00000	1249.28053	0.00000
3	0.00000	875.45289	0.00000
4	0.00000	0.00000	0.00000

$V_u := 659\,lbf$ $\qquad$ $M_u := 887\,lbf\cdot ft$ $\qquad$ $\Delta_{EI1} := 2904\,ft$ $\qquad$ (EI = 1 lbf*in^2)

$R_1 := 423\,lbf$ $\qquad$ $R_2 := 1250\,lbf$ $\qquad$ $R_3 := 876\,lbf$

Check the Allowable Shear:

$F_v = 285 \cdot psi$ — Removing adjustment factors, the allowable shear stress can be increased by an applied adjustment factor of 3.15 (See ASTM D 5456 - 99a, Table 1)

$f_v := F_v \cdot 3.15$ $\quad f_v = 898 \cdot psi$

$y_{bar} := \dfrac{d_{waler}}{4}$ $\quad y_{bar} = 2.375 \cdot in$ $\quad A_{waler} := b_{waler} \cdot d_{waler}$ $\quad A_{waler} = 16.6 \cdot in^2$

$Q := A_{waler} \cdot y_{bar}$ $\quad Q = 39.5 \cdot in^3$

$V_{ult} := N_{lvl} \cdot \dfrac{f_v \cdot I_{waler} \cdot b_{waler}}{Q}$ $\quad V_{ult} = 4975 \cdot lbf$

$V_{allow} := \dfrac{V_{ult}}{SF_{osha}}$ $\quad V_{allow} = 1244 \cdot lbf$ $\quad V_u = 659 \cdot lbf$

Check := | "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Shear OK" if $V_{allow} > V_u$
| "Re-Design Waler" otherwise

Check = "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Shear OK"

Check Bending Moment:

$F_b = 2600 \cdot psi$ — Removing adjustment factors, the allowable bending stress can be increased by an applied adjustment factor of 2.10 (See ASTM D 5456 - 99a, Table 1)

$f_b := F_b \cdot 2.10$ $\quad f_b = 5460 \cdot psi$

$c_{waler} := \dfrac{d_{waler}}{2}$ $\quad c_{waler} = 4.75 \cdot in$ $\quad I_{waler} = 125 \cdot in^4$

$M_{ult} := N_{lvl} \cdot \dfrac{f_b \cdot I_{waler}}{c_{waler}}$ $\quad M_{ult} = 11977\ ft \cdot lbf$

$M_{allow} := \dfrac{M_{ult}}{SF_{osha}}$ $\quad M_{allow} = 2994\ ft \cdot lbf$ $\quad M_u = 887\ ft \cdot lbf$

Check := | "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Bending Moment OK" if $M_{allow} > M_u$
| "Re-Design Waler" otherwise

Check = "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Bending Moment OK"

Check Deflection:

$\Delta_{EI1} = 2904 \cdot ft$ $\quad\quad \Delta := \Delta_{EI1} \cdot \frac{lbf \cdot ft^2}{N_{lvl} \cdot E_{lvl} \cdot I_{waler}}$ $\quad\quad \Delta = 0.021 \cdot in$

Allowable Deflection: $\quad \Delta_{allow} := \frac{s_{hanger}}{120}$ $\quad\quad \Delta_{allow} = 0.75 \cdot in$

Check := | "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Deflection OK" if $\Delta < \Delta_{allow}$
| "Re-Design Waler" otherwise

Check = "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Deflection OK"

Check Capacity of Bottom Flange to Support Beam Hanger:

Maximum Hanger Load

Containment Sheeting
T-plus sheeting, 10 mil LDPE, (67 lbs./roll) x 3 rolls=201 lbs/(136'x88')=0.017 psf (negligible therefore, exclude)

Rigid Containment Frame
No additional frame is required beyond the work platform and therefore no additional weight needs to be included.

$P_{hanger} := \max(2R_1, R_2, R_3)$ $\quad\quad P_{hanger} = 1250 \cdot lbf$ $\quad$ (Reactions calculated above for waler design)

Check Flexure Hanger Load on Bottom Flange of Girders

Girders are Plate Girders, A36 Steel
Smallest girder is a 36WF135

$b_f := 12.0in$ $\quad t_f := 0.790in$ $\quad t_w := 0.600in$ $\quad f_y := 36ksi$

Assume a section loss of approximately 10%.
Use 90% of the inventory capacity.

$Percent_{inv} := 90\%$

A 1-inch diameter bar is the part of the hanger sitting on top of the bottom flange.
The bar bears atleast 4-inches on the bottom flange.

$\phi_{bar} := 1in$ $\quad\quad L_{bar} := 4in$

$b_{f.eff} := 0.5b_f - 0.5t_w$ $\quad\quad b_{f.eff} = 5.70 \cdot in$

$L_{bf} := \phi_{bar} + 2 \cdot (b_{f.eff} - L_{bar})$ $\quad\quad L_{bf} = 4.40 \cdot in$

$P_u := \frac{P_{hanger}}{2}$ $\quad\quad P_u = 625 \cdot lbf$

$M_u := P_u \cdot \left(b_{f.eff} - \frac{L_{bar}}{2} \right)$ $\qquad M_u = 0.19\,ft \cdot kip$

$S_x := Percent_{inv} \cdot \frac{L_{bf} \cdot t_f^2}{6}$ $\qquad S_x = 0.41 \cdot in^3$

$M_n := (0.55 f_y) \cdot S_x$ $\qquad M_n = 0.68\,ft \cdot kip$

Check := | "Plate Girder Bottom Flange Flexure OK" if $M_n > M_u$
| "Re-Design Platform" otherwise

Check = "Plate Girder Bottom Flange Flexure OK"

Check Shear of Bottom Flange

Calculate the shear area.

$A_v := L_{bar} \cdot \phi_{bar}$ $\qquad A_v = 4.00 \cdot in^2$

Calculate the shear capacity.

$V_n := 0.60 \cdot (0.67 f_y) \cdot A_v$ $\qquad V_n = 57888 \cdot lbf$ $\qquad P_u = 625 \cdot lbf$

Check := | "Plate Girder Bottom Flange Shear OK" if $V_n > P_u$
| "Re-Design Platform" otherwise

Check = "Plate Girder Bottom Flange Shear OK"

Check Suspended Platform Load on the Existing Girders:

Existing Bridge was designed for an H20-44 Live Load.

Determine the allowable percent increase in load due to temporary loads using Inventory Rating versus Operating Rating.

Inventory Rating = $0.55F_y$ $\qquad$ Operating Rating = $0.75F_y$

$Percent_{allow} := \left(\frac{0.75 - 0.55}{0.55} \right)$ $\qquad Percent_{allow} = 36.4 \cdot \%$

Check Span 1, 2, 4, and 5:

Determine the Maximum Moment Per Girder for an H20-44 Live Load

$L_1 = 54.0\,ft$ $\qquad L_2 = 54\,ft$ $\qquad L_4 = 54\,ft$ $\qquad L_5 = 54\,ft$

$s_{girder} = 7.50\,ft$

H20-44 Design Truck

$P_{front} := 8.0kip$ $\qquad$ $P_{rear} := 32.0kip$

Use QuickBridge to Determine Maximum Moment

$M_{pos} := 485.3kip \cdot ft$

Calculate the Live Load Distribution Factor

AASHTO LRFD Bridge Design Specification, 2012
AASHTO 4.6.2.2.2b and AASHTO 4.6.2.2.3a

Two Design Lanes Loaded, Concrete Deck on Steel Beams

$$DF_{moment} = 0.075 + \left(\frac{s_{beam}}{9.5ft}\right)^{0.6} \cdot \left(\frac{s_{beam}}{L_{beam}}\right)^{0.2} \cdot \left(\frac{K_g}{12.0 \cdot L_{beam} \cdot t_s^{\,3}}\right)^{0.1}$$

$$DF_{shear} = 0.2 + \frac{s_{beam}}{12ft} - \left(\frac{s_{beam}}{35ft}\right)^2$$

Where $\qquad$ K_g = longitudinal stiffness parameter
t_s = depth of concrete slab

36WF135 (W36x135) Properties

$A_b := 39.7in^2$ $\qquad$ $d_b := 35.6in$ $\qquad$ $I_x := 7800in^4$

$$K_g = n \cdot \left(I + A \cdot e_g^{\,2}\right)$$

$E_s := 29000ksi$ $\qquad$ $f_c := 3000psi$ $\qquad$ $t_{deck} := 8.0in$

$E_c := 57000 \cdot \sqrt{\frac{f_c}{psi}} \cdot psi$ $\qquad$ $E_c = 3122 \cdot ksi$

$n := \frac{E_s}{E_c}$ $\qquad$ $n = 9.29$

e_g = distance between the centers of gravity of the basic beam and deck

$e_g := \frac{d_b}{2} + \frac{t_{deck}}{2}$ $\qquad$ $e_g = 21.8 \cdot in$

$K_g := n \cdot \left(I_x + A_b \cdot e_g^{\,2}\right)$ $\qquad$ $K_g = 247706 \cdot in^4$

$$DF_{moment} := 0.075 + \left(\frac{s_{girder}}{9.5ft}\right)^{0.6} \cdot \left(\frac{s_{girder}}{L_1}\right)^{0.2} \cdot \left(\frac{K_g}{12.0 \cdot L_1 \cdot t_{deck}^{\,3}}\right)^{0.1}$$

$DF_{moment} = 0.518$

$$DF_{shear} := 0.2 + \frac{s_{girder}}{12ft} - \left(\frac{s_{girder}}{35ft}\right)^2 \qquad DF_{shear} = 0.779$$

$$DF := \min(DF_{moment}, DF_{shear}) \qquad DF = 0.518$$

Beam Live Load Design Moment

$$M_{design} := (DF \cdot M_{pos}) \cdot Percent_{inv} \qquad M_{design} = 226\, ft \cdot kip$$

Calculate the Moment Due to Platform Loads

$Load_{design} = 26.8 \cdot psf$

$w_{platform} := Load_{design} \cdot s_{girder} \qquad w_{platform} = 201 \cdot plf$

$L_1 = 54.0\, ft$

The platform will be installed under the entirety of Spans 1, 2, 4, and 5.

$$V_{platform} := \frac{w_{platform} \cdot L_1}{2} \qquad V_{platform} = 5.43 \cdot kip$$

$$M_{platform} := \frac{w_{platform} \cdot L_1^{\,2}}{8} \qquad M_{platform} = 73.3\, ft \cdot kip$$

Calculate the Percent Increase in Moment

$$Percent_{inc} := \frac{M_{design} + M_{platform}}{M_{design}} - 1.0 \qquad Percent_{inc} = 32.4 \cdot \%$$

Platform Load Check

Check := | "Suspended Platform Load on Bridge OK" if $Percent_{inc} < Percent_{allow}$
| "Suspended Platform Load on Bridge Not OK" otherwise

Check = "Suspended Platform Load on Bridge OK"

Check Span 3:

Determine the Maximum Moment Per Girder for an H20-44 Live Load

$L_3 = 99.0\, ft \qquad s_{girder} = 7.50\, ft$

H20-44 Design Truck

$P_{front} := 8.0 kip \qquad P_{rear} := 32.0 kip$

Use QuickBridge to Determine Maximum Moment

$M_{pos} := 934.8 kip \cdot ft$

Calculate the Live Load Distribution Factor

AASHTO LRFD Bridge Design Specification, 2012
AASHTO 4.6.2.2.2b and AASHTO 4.6.2.2.3a

Two Design Lanes Loaded, Concrete Deck on Steel Beams

$$DF_{moment} = 0.075 + \left(\frac{s_{beam}}{9.5ft}\right)^{0.6} \cdot \left(\frac{s_{beam}}{L_{beam}}\right)^{0.2} \cdot \left(\frac{K_g}{12.0 \cdot L_{beam} \cdot t_s^{3}}\right)^{0.1}$$

$$DF_{shear} = 0.2 + \frac{s_{beam}}{12ft} - \left(\frac{s_{beam}}{35ft}\right)^{2}$$

Where K_g = longitudinal stiffness parameter
t_s = depth of concrete slab

36WF280 (W36x280) Properties

$A_b := 82.9in^2$ $\quad d_b := 37.1in$ $\quad I_x := 19600in^4$

$$K_g = n \cdot \left(I + A \cdot e_g^{2}\right)$$

$E_s := 29000ksi$ $\quad f_c := 3000psi$ $\quad t_{deck} := 8.0in$

$$E_c := 57000 \cdot \sqrt{\frac{f_c}{psi}} \cdot psi \qquad E_c = 3122 \cdot ksi$$

$$n := \frac{E_s}{E_c} \qquad n = 9.29$$

e_g = distance between the centers of gravity of the basic beam and deck

$$e_g := \frac{d_b}{2} + \frac{t_{deck}}{2} \qquad e_g = 22.6 \cdot in$$

$$K_g := n \cdot \left(I_x + A_b \cdot e_g^{2}\right) \qquad K_g = 573632 \cdot in^4$$

$$DF_{moment} := 0.075 + \left(\frac{s_{girder}}{9.5ft}\right)^{0.6} \cdot \left(\frac{s_{girder}}{L_3}\right)^{0.2} \cdot \left(\frac{K_g}{12.0 \cdot L_3 \cdot t_{deck}^{3}}\right)^{0.1}$$

$$DF_{moment} = 0.477$$

$$DF_{shear} := 0.2 + \frac{s_{girder}}{12ft} - \left(\frac{s_{girder}}{35ft}\right)^{2} \qquad DF_{shear} = 0.779$$

$$DF := \min\left(DF_{moment}, DF_{shear}\right) \qquad DF = 0.477$$

Beam Live Load Design Moment

$$M_{design} := (DF \cdot M_{pos}) \cdot Percent_{inv} \qquad M_{design} = 401\ ft \cdot kip$$

Calculate the Moment Due to Platform Loads

$$Load_{design} = 26.8 \cdot psf$$

$$w_{platform} := Load_{design} \cdot s_{girder} \qquad w_{platform} = 201 \cdot plf$$

The work area shall be limited to a third of the span at a time.

$$DL := (5psf) + Dead_{ply} \qquad DL = 6.80 \cdot psf$$

$$w_{DL} := DL \cdot s_{girder} \qquad w_{DL} = 51 \cdot plf$$

$$L_3 = 99.0\ ft \qquad L_{plat} := 33.3\% L_3 = 33.0\ ft \qquad L_{DL} := L_3 - L_{plat} = 66.0\ ft$$

The platform will be installed under the entirety of Span 3.

$$R_{1.plat} := \frac{w_{platform} \cdot (L_{plat})}{2 \cdot L_3} \cdot (2 \cdot L_3 - L_{plat}) \qquad R_{1.plat} = 5.52 \cdot kip$$

$$R_{1.DL} := \frac{w_{DL} \cdot (L_{DL})^2}{2 \cdot L_3} \qquad R_{1.DL} = 1.12 \cdot kip$$

$$R_{2.plat} := \frac{w_{platform} \cdot (L_{plat})^2}{2 \cdot L_3} \qquad R_{2.plat} = 1.10 \cdot kip$$

$$R_{2.DL} := \frac{w_{DL} \cdot (L_{DL})}{2 \cdot L_3} \cdot (2 \cdot L_3 - L_{DL}) \qquad R_{2.DL} = 2.24 \cdot kip$$

$$V_1 := R_{1.plat} + R_{2.DL} = 7.77 \cdot kip \qquad V_2 := R_{2.plat} + R_{2.DL} = 3.35 \cdot kip$$

$$V_{platform} := \max(V_1, V_2) \qquad V_{platform} = 7.77 \cdot kip$$

$$M_{platform} := \frac{R_{1.plat}^{\ 2}}{2 \cdot w_{platform}} + \frac{R_{2.DL}^{\ 2}}{2 \cdot w_{DL}} \qquad M_{platform} = 125\ ft \cdot kip$$

Calculate the Percent Increase in Moment

$$Percent_{inc} := \frac{M_{design} + M_{platform}}{M_{design}} - 1.0 \qquad Percent_{inc} = 31.2 \cdot \%$$

Platform Load Check

$$Check := \begin{cases} \text{"Suspended Platform Load on Bridge OK"} & \text{if } Percent_{inc} < Percent_{allow} \\ \text{"Suspended Platform Load on Bridge Not OK"} & \text{otherwise} \end{cases}$$

$$Check = \text{"Suspended Platform Load on Bridge OK"}$$

Check the Wind Load on the Structure:

We are going to limit the wind speed at which the platform/containment will be used to 40mph. If winds are anticipated to reach 40mph, the containment tarps shall be taken down until winds subside.

$$V_{DZ} := 40mph$$

Calculate the Design Wind Pressure

$$P_D = P_B \cdot \frac{\left(\frac{V_{DZ}}{mph}\right)^2}{10000}$$ (AASHTO Eq. 3.8.1.2.1-1)

$$P_B := 0.050ksf$$ (AASHTO Table 3.8.1.2.1-1, Windward Load, Beams)

$$P_D := P_B \cdot \frac{\left(\frac{V_{DZ}}{mph}\right)^2}{10000} \qquad P_D = 8.00 \cdot psf$$

AASHTO Minimum Required Design Wind Load

AASHTO Section 3.8.1.2.1 requires that beam bridges be designed for a minimum wind load of 300plf.

$$Design_{wind.min} := 300plf$$ (Per AASHTO Section 3.8.1.2.1)

Calculate the Depth of the Containment

The containment will be from the top of the bridge to approximately 3'-0" below the bottom flange of the plate girders.

$$D_{fascia} := 24in$$ (Assumed)

$$D_{beam} := d_b \qquad D_{beam} = 37.1 \cdot in \qquad D_{haunch} := 1.0in$$ (from Contract Plans)

$$D_{containment} := D_{fascia} + D_{beam} + D_{haunch} + 3ft \qquad D_{containment} = 8.17\,ft$$

Calculate the Wind Load Per Foot on the Containment

$Wind_{containment} := P_D \cdot D_{containment}$ $\quad$ $Wind_{containment} = 65.4 \cdot plf$

Check := | "Bridge Wind Load from Containment OK" if $Wind_{containment} < Design_{wind.min}$
| "Reduce Allowable Wind Speed" otherwise

Check = "Bridge Wind Load from Containment OK"

Since the actual wind load on the bridge from containment is less than the required minimum AASHTO wind load, the bridge is OK for wind.

QuickBridge - AASHTO H20 - Spans 1, 2, 4, 5

Truck definition

Number of axles

2

Axle No	X	W
1	0.0	8.0
2	14.0	32.0

X is the coordinate and
W the weight of the axle
Coordinate of axle 1 is 0

QuickBridge - AASHTO H20 - Spans 1,2,4,5

Bridge geometry

Number of span

1

Span No	L	q	div
1	54	0	54

L is the length,
q uniform load and
div number of divisions
on a particular span
L and div must be > 0

QuickBridge - AASHTO H20 - Spans 1,2,4,5

Results

X	Vmax	Mmin	Mmax
0.00	37.9	0.0	0.0
1.00	37.2	0.0	37.2
2.00	36.4	0.0	72.9
3.00	35.7	0.0	107.1
4.00	35.0	0.0	139.9
5.00	34.2	0.0	171.1
6.00	33.5	0.0	200.9
7.00	32.7	0.0	229.2
8.00	32.0	0.0	256.0
9.00	31.3	0.0	281.3
10.00	30.5	0.0	305.2
11.00	29.8	0.0	327.6
12.00	29.0	0.0	348.4
13.00	28.3	0.0	367.9
14.00	27.6	0.0	385.8
15.00	26.8	0.0	402.2
16.00	26.1	0.0	417.2
17.00	25.3	0.0	430.7
18.00	24.6	0.0	442.7
19.00	23.9	0.0	453.2
20.00	23.1	0.0	462.2
21.00	22.4	0.0	469.8
22.00	21.6	0.0	475.9
23.00	20.9	0.0	480.4
24.00	20.1	0.0	483.6
25.00	19.4	0.0	485.2
26.00	18.7	0.0	485.3
27.00	17.9	0.0	484.0
28.00	17.2	0.0	481.2
29.00	16.4	0.0	476.9
30.00	15.7	0.0	471.1
31.00	16.3	0.0	463.9
32.00	17.0	0.0	455.1
33.00	17.8	0.0	444.9
34.00	18.5	0.0	433.2
35.00	19.3	0.0	420.0
36.00	20.0	0.0	405.3
37.00	20.7	0.0	389.2
38.00	21.5	0.0	371.6
39.00	22.2	0.0	352.4
40.00	23.0	0.0	331.9
41.00	23.7	0.0	315.9
42.00	24.3	0.0	298.7
43.00	24.9	0.0	280.3
44.00	25.5	0.0	260.7
45.00	26.1	0.0	240.0
46.00	26.7	0.0	218.1
47.00	27.3	0.0	195.0
48.00	27.9	0.0	170.7

No	Rmin	Rmax
1	0.0	37.9
2	0.0	32.0

QuickBridge - AASHTO H20 - Spans 1,2,4,5

49.00	28.4	0.0	145.2
50.00	29.0	0.0	118.5
51.00	29.6	0.0	90.7
52.00	30.2	0.0	61.6
53.00	30.8	0.0	31.4
54.00	32.0	0.0	0.0

QuickBridge - AASHTO H20 - Span 3

Truck definition

Number of axles

2

Axle No	X	W
1	0.0	8.0
2	14.0	32.0

X is the coordinate and
W the weight of the axle
Coordinate of axle 1 is 0

QuickBridge - AASHTO H20 - Span 3

Bridge geometry

Number of span

1

Span No	L	q	div
1	99	0	99

L is the length,
q uniform load and
div number of divisions
on a particular span
L and div must be > 0

QuickBridge - AASHTO H20 - Span 3

Results

X	Vmax	Mmin	Mmax
0.00	38.9	0.0	0.0
1.00	38.5	0.0	38.5
2.00	38.1	0.0	76.1
3.00	37.7	0.0	113.0
4.00	37.3	0.0	149.0
5.00	36.8	0.0	184.2
6.00	36.4	0.0	218.7
7.00	36.0	0.0	252.3
8.00	35.6	0.0	285.1
9.00	35.2	0.0	317.1
10.00	34.8	0.0	348.3
11.00	34.4	0.0	378.7
12.00	34.0	0.0	408.2
13.00	33.6	0.0	437.0
14.00	33.2	0.0	465.0
15.00	32.8	0.0	492.1
16.00	32.4	0.0	518.5
17.00	32.0	0.0	544.0
18.00	31.6	0.0	568.7
19.00	31.2	0.0	592.6
20.00	30.8	0.0	615.8
21.00	30.4	0.0	638.1
22.00	30.0	0.0	659.6
23.00	29.6	0.0	680.2
24.00	29.2	0.0	700.1
25.00	28.8	0.0	719.2
26.00	28.4	0.0	737.5
27.00	28.0	0.0	754.9
28.00	27.6	0.0	771.6
29.00	27.2	0.0	787.4
30.00	26.7	0.0	802.4
31.00	26.3	0.0	816.6
32.00	25.9	0.0	830.1
33.00	25.5	0.0	842.7
34.00	25.1	0.0	854.5
35.00	24.7	0.0	865.5
36.00	24.3	0.0	875.6
37.00	23.9	0.0	885.0
38.00	23.5	0.0	893.6
39.00	23.1	0.0	901.3
40.00	22.7	0.0	908.3
41.00	22.3	0.0	914.4
42.00	21.9	0.0	919.8
43.00	21.5	0.0	924.3
44.00	21.1	0.0	928.0
45.00	20.7	0.0	930.9
46.00	20.3	0.0	933.0
47.00	19.9	0.0	934.3
48.00	19.5	0.0	934.8

No	Rmin	Rmax
1	0.0	38.9
2	0.0	35.5

QuickBridge - AASHTO H20 - Span 3

49.00	19.1	0.0	934.5
50.00	18.7	0.0	933.3
51.00	18.3	0.0	931.4
52.00	17.9	0.0	928.6
53.00	17.5	0.0	925.1
54.00	17.1	0.0	920.7
55.00	17.3	0.0	915.6
56.00	17.7	0.0	909.6
57.00	18.1	0.0	902.8
58.00	18.5	0.0	895.2
59.00	18.9	0.0	886.8
60.00	19.3	0.0	877.6
61.00	19.7	0.0	867.6
62.00	20.1	0.0	856.7
63.00	20.5	0.0	845.1
64.00	20.9	0.0	832.6
65.00	21.3	0.0	819.4
66.00	21.7	0.0	805.3
67.00	22.1	0.0	790.5
68.00	22.5	0.0	774.8
69.00	22.9	0.0	758.3
70.00	23.4	0.0	741.0
71.00	23.8	0.0	722.9
72.00	24.2	0.0	704.0
73.00	24.6	0.0	684.3
74.00	25.0	0.0	663.8
75.00	25.4	0.0	642.4
76.00	25.8	0.0	620.3
77.00	26.2	0.0	597.3
78.00	26.6	0.0	573.6
79.00	27.0	0.0	549.0
80.00	27.4	0.0	528.2
81.00	27.8	0.0	507.6
82.00	28.2	0.0	486.3
83.00	28.6	0.0	464.2
84.00	29.0	0.0	441.2
85.00	29.4	0.0	417.5
86.00	29.8	0.0	392.9
87.00	30.2	0.0	367.5
88.00	30.6	0.0	341.3
89.00	31.0	0.0	314.3
90.00	31.4	0.0	286.5
91.00	31.8	0.0	257.9
92.00	32.2	0.0	228.5
93.00	32.6	0.0	198.3
94.00	33.1	0.0	167.3
95.00	33.5	0.0	135.4
96.00	33.9	0.0	102.8
97.00	34.3	0.0	69.3
98.00	34.7	0.0	35.1
99.00	35.5	0.0	0.0

APPENDIX "D"

West Rutland E.B. Bridge - Work Scaffolding Platform & Beam Hanger Support System

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Client: Modern Protective Coatings
PROJECT: U.S. Route 4 E.B. Over Railroad
PROJECT NUMBER: 15-106
CALCULATED BY: GDG DATE: 02/26/15
REVISED BY: DATE:
CHECKED BY: DEE DATE: 02/27/15

SUBJECT: Suspended Platform Design & Analysis of Existing Steel Girders for Platform Loads

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References:

"AASHTO LRFD Bridge Design Specification", 2012

OSHA:

As required by OSHA, the platform is designed with a safety factor of 4.

$SF_{osha} := 4$

Bridge Information:

Girders are plate girders made of A36 steel spaced at maximum 7'-6" on-center.

$s_{girder} := 7ft + 6in$ $\qquad \theta_{skew} := \left[94 + \left(\frac{57}{60}\right) + \left(\frac{54}{3600}\right)\right]deg = 95.0 \cdot deg$

$s_{skew} := \frac{s_{girder}}{\cos(\theta_{skew} - 90deg)}$ $\qquad s_{skew} = 7.53\ ft$

Bridge is a five-span structure.

$L_1 := 79ft$ $\quad L_2 := 84ft$ $\quad L_3 := 74ft$ $\quad L_4 := 89ft$ $\quad L_5 := 84ft$

$L_{bridge} := L_1 + L_2 + L_3 + L_4 + L_5$ $\qquad L_{bridge} = 410\ ft$

Calculate the Design Load for the Platform:

Minimum OSHA Load for Light-Duty Platforms is 25.0psf.

Dead & Live Loading

Dead = 5/8" Structural 1 Rated Plywood
Live = Avg. worker loading
Live = 3/4" layer steel grit

Equivalent uniform weight for workers is based on (3) workers at 250lbs each distributed over one working bay (1 hanger spacing)

Walers are spaced at 8'-0" on-center along the bridge.

$s_{waler} := 8ft + 0in$

Calculate the hanger distance. Hangers are placed on interior and exterior girders making a uniform hanger spacing for all 4 bays.

$s_{hanger} := s_{skew}$ $\qquad s_{hanger} = 7.53\ ft$ $\qquad s_{over} := 2ft + 8in$

$P_{worker} := 250lbf$ $\quad N_{worker} := 3$

$$Live_{worker} := \frac{P_{worker} \cdot N_{worker}}{(s_{waler}) \cdot (s_{hanger} + s_{over})} \quad Live_{worker} = 9.20 \cdot psf$$

Uniform weight of steel grit.

$t_{grit} := \frac{3}{4} in$ $\quad \gamma_{grit} := 240pcf$

$Live_{grit} := t_{grit} \cdot \gamma_{grit}$ $\quad Live_{grit} = 15.0 \cdot psf$

Total Design Loading

Dead = Plywood deck	$Dead_{ply} := 1.80psf$	
Live = Avg. worker loading	$Live_{worker} = 9.20 \cdot psf$	
Live = 3/4" layer steel grit	$Live_{grit} = 15.0 \cdot psf$	
Total Live Loading	$Live_{total} := Live_{worker} + Live_{grit}$	$Live_{total} = 24.2 \cdot psf$
Min. OSHA Light-Duty	$Live_{OSHA} := 25psf$	
Min. Required Live Loading	$Live_{design} := \max(Live_{total}, Live_{OSHA})$	$Live_{design} = 25.0 \cdot psf$
Total Design Loading	$Load_{design} := Dead_{ply} + Live_{design}$	$Load_{design} = 26.8 \cdot psf$

Plywood Analysis: (5/8" APA Structural 1 Rated Plywood)

Plywood Properties:

$F_b := 2000psi$ (See APA, Table 3, F_b for a Species Group 1 and an S-1 Grade Stress Level, Dry Condition)

$F_v := 190psi$ (See APA, Table 3, F_v for a Species Group 1 and an S-1 Grade Stress Level, Dry Condition)

$E_{ply} := 1.8 \times 10^6 psi$ (See APA, Table 3, E for a Species Group 1 and an S-1 Grade Stress Level, Dry Condition)

Properties from APA, Table 2, Unsanded

$KS := 0.240 \frac{in^3}{ft}$ $\quad I_{ply} := 0.045 \frac{in^4}{ft}$ $\quad RSC := 3.072 \frac{in^2}{ft}$

Joists will be 1-3/4"x9-1/2" Microllam LVL Scaffold Planks

Joists are continuous at waler, therefore spacing is 2x the plank width

$b_{plank} := 9.5in$ $\quad d_{plank} := 1.75in$ $\quad s_{joist} := 2b_{plank}$ $\quad s_{joist} = 19.0 \cdot in$

The design span for the plywood will be the clear span between scaffold planks.

$$L_{ply} := s_{joist} - b_{plank} \qquad L_{ply} = 9.50 \cdot in$$

Check Bending Stress:

$$w_b := \frac{10 \cdot F_b \cdot KS}{L_{ply}^2} \qquad w_b = 638 \cdot psf$$

$$w_{allow} := \frac{w_b}{SF_{osha}} \qquad w_{allow} = 160 \cdot psf \qquad Load_{design} = 26.8 \cdot psf$$

Check := | "5/8" APA Structural 1 Rated Plywood Bending Stress OK" if $w_{allow} > Load_{design}$
| "Re-Design Plywood" otherwise

Check = "5/8" APA Structural 1 Rated Plywood Bending Stress OK"

Check Shear Stress:

$$w_v := \frac{20 \cdot F_v \cdot RSC}{12 L_{ply}} \qquad w_v = 1229 \cdot psf$$

$$w_{allow} := \frac{w_v}{SF_{osha}} \qquad w_{allow} = 307 \cdot psf \qquad Load_{design} = 26.8 \cdot psf$$

Check := | "5/8" APA Structural 1 Rated Plywood Shear Stress OK" if $w_{allow} > Load_{design}$
| "Re-Design Plywood" otherwise

Check = "5/8" APA Structural 1 Rated Plywood Shear Stress OK"

Check Deflection:

$$\Delta := \frac{12 \cdot Load_{design} \cdot L_{ply}^4}{1743 E_{ply} \cdot I_{ply}} \qquad \Delta = 0.002 \cdot in$$

$$\Delta_{limit} := \frac{L_{ply}}{360} \qquad \Delta_{limit} = 0.026 \cdot in$$

Check := | "5/8" APA Structural 1 Rated Plywood Deflection OK" if $\Delta < \Delta_{limit}$
| "Re-Design Plywood" otherwise

Check = "5/8" APA Structural 1 Rated Plywood Deflection OK"

Joist Analysis: (1-3/4" x 9-1/2" Microllam LVL Scaffold Plank)

Dimensional Properties:

$b_{plank} = 9.50 \cdot in$ $d_{plank} = 1.75 \cdot in$ $s_{joist} = 19.0 \cdot in$

$S_{plank} := \frac{b_{plank} \cdot d_{plank}^2}{6}$ $S_{plank} = 4.85 \cdot in^3$ $I_{plank} := \frac{1}{12} \cdot b_{plank} \cdot d_{plank}^3$ $I_{plank} = 4.24 \cdot in^4$

LVL Properties:

$F_b := 2175psi$ $E_{lvl} := 2.2 \times 10^6 psi$ $F_v := 109psi$

Calculate the Maximum Shear and Moment:

Platform Load (including plywood) $Load_{design} = 26.8 \cdot psf$

Scaffold Plank $w_{plank} := 5.10plf$

$w_{design} := w_{plank} + (Load_{design} \cdot s_{joist})$ $w_{design} = 47.5 \cdot plf$

$V_u := \frac{w_{design} \cdot s_{waler}}{2}$ $V_u = 190 \cdot lbf$

$M_u := \frac{w_{design} \cdot s_{waler}^2}{8}$ $M_u = 380\ ft \cdot lbf$

Check the Allowable Shear:

$F_v = 109 \cdot psi$ Removing adjustment factors, the allowable shear stress can be increased by an applied adjustment factor of 3.15 (See ASTM D 5456 - 99a, Table 1)

$f_v := F_v \cdot 3.15$ $f_v = 343 \cdot psi$

$y_{bar} := \frac{d_{plank}}{4}$ $y_{bar} = 0.438 \cdot in$ $A_{plank} := b_{plank} \cdot d_{plank}$ $A_{plank} = 16.6 \cdot in^2$

$Q := A_{plank} \cdot y_{bar}$ $Q = 7.27 \cdot in^3$

$V_{ult} := \frac{f_v \cdot I_{plank} \cdot b_{plank}}{Q}$ $V_{ult} = 1903 \cdot lbf$

$V_{allow} := \frac{V_{ult}}{SF_{osha}}$ $V_{allow} = 476 \cdot lbf$ $V_u = 190 \cdot lbf$

Check := | "1-3/4" x 9-1/2" LVL Scaffold Plank Shear OK" if $V_{allow} > V_u$
| "Re-Design Scaffold Plank" otherwise

Check = "1-3/4" x 9-1/2" LVL Scaffold Plank Shear OK"

Check Bending Moment:

$F_b = 2175 \cdot psi$

Removing adjustment factors, the allowable bending stress can be increased by an applied adjustment factor of 2.10 (See ASTM D 5456 - 99a, Table 1)

$f_b := F_b \cdot 2.10$ $\qquad f_b = 4568 \cdot psi$

$c_{plank} := \frac{d_{plank}}{2}$ $\qquad c_{plank} = 0.875 \cdot in$ $\qquad I_{plank} = 4.24 \cdot in^4$

$M_{ult} := \frac{f_b \cdot I_{plank}}{c_{plank}}$ $\qquad M_{ult} = 1846\, ft \cdot lbf$

$M_{allow} := \frac{M_{ult}}{SF_{osha}}$ $\qquad M_{allow} = 461\, ft \cdot lbf$ $\qquad M_u = 380\, ft \cdot lbf$

Check := | "1-3/4" x 9-1/2" LVL Scaffold Plank Bending Moment OK" if $M_{allow} > M_u$
| "Re-Design Scaffold Plank" otherwise

Check = "1-3/4" x 9-1/2" LVL Scaffold Plank Bending Moment OK"

Check Deflection:

$s_{waler} = 8.0\, ft$

$\Delta := \frac{5 \cdot w_{design} \cdot s_{waler}^4}{384 \cdot E_{lvl} \cdot I_{plank}}$ $\qquad \Delta = 0.47 \cdot in$

Allowable Deflection: $\qquad \Delta_{allow} := \frac{s_{waler}}{120}$ $\qquad \Delta_{allow} = 0.80 \cdot in$

Check := | "1-3/4" x 9-1/2" LVL Scaffold Plank Deflection OK" if $\Delta < \Delta_{allow}$
| "Re-Design Scaffold Plank" otherwise

Check = "1-3/4" x 9-1/2" LVL Scaffold Plank Deflection OK"

Waler Analysis: (1-3/4" x 9-1/2" 1.9E Microllam LVL)

Dimensional Properties:

$b_{waler} := 1.75in$ $d_{waler} := 9.5in$

$S_{waler} := \frac{b_{waler} \cdot d_{waler}^2}{6}$ $S_{waler} = 26.3 \cdot in^3$ $I_{waler} := \frac{1}{12} \cdot b_{waler} \cdot d_{waler}^3$ $I_{waler} = 125 \cdot in^4$

$s_{hanger} = 7.53\ ft$ $s_{over} = 2.67\ ft$

LVL Properties:

$F_b := 2600psi$ $E_{lvl} := 1.9 \times 10^6 psi$ $F_v := 285psi$

Calculate the Maximum Shear and Moment:

Platform Load (including plywood) $Load_{design} = 26.8 \cdot psf$

Scaffold Plank $w_{plank} = 5.10 \cdot plf$

$P_{plank} := w_{plank} \cdot s_{waler}$ $P_{plank} = 40.8 \cdot lbf$

$N_{plank} := ceil\left(\frac{s_{hanger} + 2s_{over}}{s_{joist}} + 1\right)$ $N_{plank} = 10$

$w_{Pwaler} := \frac{N_{plank} \cdot P_{plank}}{s_{hanger} + 2s_{over}}$ $w_{Pwaler} = 31.7 \cdot plf$

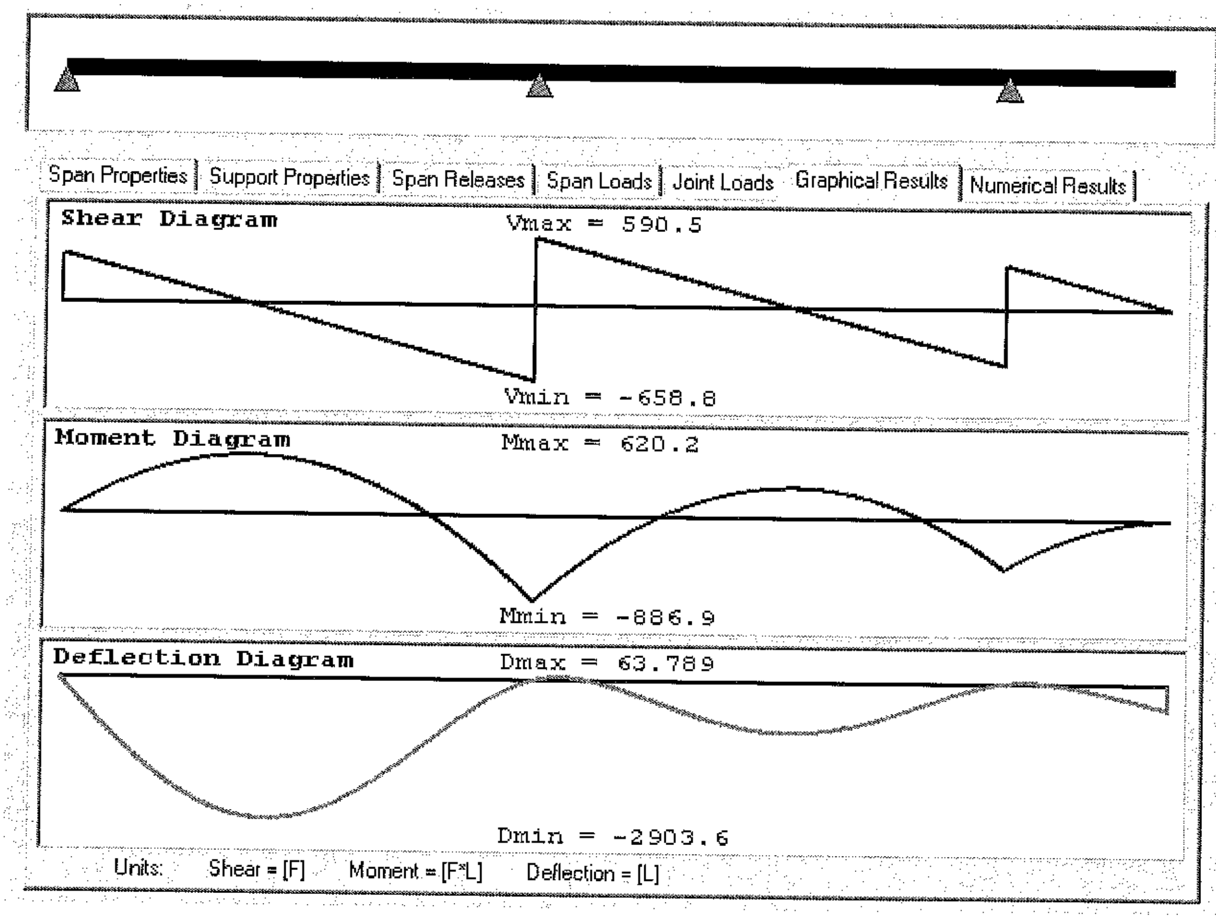
Waler $w_{lvl} := 4.80plf$ $N_{lvl} := 1$ $w_{waler} := N_{lvl} \cdot w_{lvl}$ $w_{waler} = 4.80 \cdot plf$

$w_{design} := w_{waler} + w_{Pwaler} + \left(Load_{design} \cdot \frac{s_{waler}}{2}\right)$ $w_{design} = 144 \cdot plf$

Use DTBeam to Determine the Maximum Shear, Moment, and Deflection

$s_{hanger} = 7.53\ \text{ft}$ $\qquad$ $s_{over} = 2.67\ \text{ft}$

Assume that the waler spans from the center beam to the overhang.



SUPPORT JOINT REACTIONS (in direction of rotated joint axes)

JOINT	X-REACTION	Y-REACTION	Z-MOMENT
1	0.00000	422.62658	0.00000
2	0.00000	1249.28053	0.00000
3	0.00000	875.45289	0.00000
4	0.00000	0.00000	0.00000

$V_u := 659\text{lbf}$ $\qquad$ $M_u := 887\text{lbf}\cdot\text{ft}$ $\qquad$ $\Delta_{EI1} := 2904\text{ft}$ $\qquad$ (EI = 1 lbf*in^2)

$R_1 := 423\text{lbf}$ $\qquad$ $R_2 := 1250\text{lbf}$ $\qquad$ $R_3 := 876\text{lbf}$

Check the Allowable Shear:

$F_v = 285 \cdot psi$ Removing adjustment factors, the allowable shear stress can be increased by an applied adjustment factor of 3.15 (See ASTM D 5456 - 99a, Table 1)

$f_v := F_v \cdot 3.15$ $f_v = 898 \cdot psi$

$y_{bar} := \frac{d_{waler}}{4}$ $y_{bar} = 2.375 \cdot in$ $A_{waler} := b_{waler} \cdot d_{waler}$ $A_{waler} = 16.6 \cdot in^2$

$Q := A_{waler} \cdot y_{bar}$ $Q = 39.5 \cdot in^3$

$V_{ult} := N_{lvl} \cdot \frac{f_v \cdot I_{waler} \cdot b_{waler}}{Q}$ $V_{ult} = 4975 \cdot lbf$

$V_{allow} := \frac{V_{ult}}{SF_{osha}}$ $V_{allow} = 1244 \cdot lbf$ $V_u = 659 \cdot lbf$

Check := | "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Shear OK" if $V_{allow} > V_u$
| "Re-Design Waler" otherwise

Check = "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Shear OK"

Check Bending Moment:

$F_b = 2600 \cdot psi$ Removing adjustment factors, the allowable bending stress can be increased by an applied adjustment factor of 2.10 (See ASTM D 5456 - 99a, Table 1)

$f_b := F_b \cdot 2.10$ $f_b = 5460 \cdot psi$

$c_{waler} := \frac{d_{waler}}{2}$ $c_{waler} = 4.75 \cdot in$ $I_{waler} = 125 \cdot in^4$

$M_{ult} := N_{lvl} \cdot \frac{f_b \cdot I_{waler}}{c_{waler}}$ $M_{ult} = 11977\ ft \cdot lbf$

$M_{allow} := \frac{M_{ult}}{SF_{osha}}$ $M_{allow} = 2994\ ft \cdot lbf$ $M_u = 887\ ft \cdot lbf$

Check := | "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Bending Moment OK" if $M_{allow} > M_u$
| "Re-Design Waler" otherwise

Check = "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Bending Moment OK"

Check Deflection:

$\Delta_{EI1} = 2904 \cdot ft$ $\qquad \Delta := \Delta_{EI1} \cdot \frac{lbf \cdot ft^2}{N_{lvl} \cdot E_{lvl} \cdot I_{waler}}$ $\qquad \Delta = 0.021 \cdot in$

Allowable Deflection: $\qquad \Delta_{allow} := \frac{s_{hanger}}{120}$ $\qquad \Delta_{allow} = 0.75 \cdot in$

Check := | "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Deflection OK" if $\Delta < \Delta_{allow}$
| "Re-Design Waler" otherwise

Check = "1-3/4" x 9-1/2" 1.9E Microllam LVL Waler Deflection OK"

Check Capacity of Bottom Flange to Support Beam Hanger:

Maximum Hanger Load

Containment Sheeting
T-plus sheeting, 10 mil LDPE, (67 lbs./roll) x 3 rolls=201 lbs/(136'x88')=0.017 psf (negligible therefore, exclude)

Rigid Containment Frame
No additional frame is required beyond the work platform and therefore no additional weight needs to be included.

$P_{hanger} := \max(2R_1, R_2, R_3)$ $\qquad P_{hanger} = 1250 \cdot lbf$ $\qquad$ (Reactions calculated above for waler design)

Check Flexure Hanger Load on Bottom Flange of Girders

Girders are Plate Girders, A36 Steel
Smallest girder is a 36WF194

$b_f := 12.1in$ $\qquad t_f := 1.26in$ $\qquad t_w := 0.765in$ $\qquad f_y := 36ksi$

Assume a section loss of approximately 10%.
Use 90% of the inventory capacity.

$Percent_{inv} := 90\%$

A 1-inch diameter bar is the part of the hanger sitting on top of the bottom flange.
The bar bears atleast 4-inches on the bottom flange.

$\phi_{bar} := 1in$ $\qquad L_{bar} := 4in$

$b_{f.eff} := 0.5b_f - 0.5t_w$ $\qquad b_{f.eff} = 5.67 \cdot in$

$L_{bf} := \phi_{bar} + 2 \cdot (b_{f.eff} - L_{bar})$ $\qquad L_{bf} = 4.34 \cdot in$

$P_u := \frac{P_{hanger}}{2}$ $\qquad P_u = 625 \cdot lbf$

$M_u := P_u \cdot \left(b_{f.eff} - \frac{L_{bar}}{2} \right)$ $\quad M_u = 0.19\, ft \cdot kip$

$S_x := Percent_{inv} \cdot \frac{L_{bf} \cdot t_f^2}{6}$ $\quad S_x = 1.03 \cdot in^3$

$M_n := (0.55 f_y) \cdot S_x$ $\quad M_n = 1.70\, ft \cdot kip$

Check := "Plate Girder Bottom Flange Flexure OK" if $M_n > M_u$
"Re-Design Platform" otherwise

Check = "Plate Girder Bottom Flange Flexure OK"

Check Shear of Bottom Flange

Calculate the shear area.

$A_v := L_{bar} \cdot \phi_{bar}$ $\quad A_v = 4.00 \cdot in^2$

Calculate the shear capacity.

$V_n := 0.60 \cdot (0.67 f_y) \cdot A_v$ $\quad V_n = 57888 \cdot lbf$ $\quad P_u = 625 \cdot lbf$

Check := "Plate Girder Bottom Flange Shear OK" if $V_n > P_u$
"Re-Design Platform" otherwise

Check = "Plate Girder Bottom Flange Shear OK"

Check Suspended Platform Load on the Existing Girders:

Existing Bridge was designed for an H20-44 Live Load.

Determine the allowable percent increase in load due to temporary loads using Inventory Rating versus Operating Rating.

Inventory Rating = $0.55F_y$ $\quad$ Operating Rating = $0.75F_y$

$Percent_{allow} := \left(\frac{0.75 - 0.55}{0.55} \right)$ $\quad Percent_{allow} = 36.4 \cdot \%$

Check for the maximum span.

Determine the Maximum Moment Per Girder for an H20-44 Live Load

$L_{max} := \max(L_1, L_2, L_3, L_4, L_5)$ $\quad L_{max} = 89\, ft$

$s_{girder} = 7.50\, ft$

H20-44 Design Truck

$P_{front} := 8.0kip \qquad P_{rear} := 32.0kip$

Use QuickBridge to Determine Maximum Moment

$M_{pos} := 834.9kip \cdot ft$

Calculate the Live Load Distribution Factor

AASHTO LRFD Bridge Design Specification, 2012
AASHTO 4.6.2.2.2b and AASHTO 4.6.2.2.3a

Two Design Lanes Loaded, Concrete Deck on Steel Beams

$$DF_{moment} = 0.075 + \left(\frac{s_{beam}}{9.5ft}\right)^{0.6} \cdot \left(\frac{s_{beam}}{L_{beam}}\right)^{0.2} \cdot \left(\frac{K_g}{12.0 \cdot L_{beam} \cdot t_s^3}\right)^{0.1}$$

$$DF_{shear} = 0.2 + \frac{s_{beam}}{12ft} - \left(\frac{s_{beam}}{35ft}\right)^2$$

Where K_g = longitudinal stiffness parameter
t_s = depth of concrete slab

36WF135 (W36x135) Properties

$A_b := 39.7in^2 \qquad d_b := 35.6in \qquad I_x := 7800in^4$

$$K_g = n \cdot \left(I + A \cdot e_g^2\right)$$

$E_s := 29000ksi \qquad f_c := 3000psi \qquad t_{deck} := 8.0in$

$$E_c := 57000 \cdot \sqrt{\frac{f_c}{psi}} \cdot psi \qquad E_c = 3122 \cdot ksi$$

$$n := \frac{E_s}{E_c} \qquad n = 9.29$$

e_g = distance between the centers of gravity of the basic beam and deck

$$e_g := \frac{d_b}{2} + \frac{t_{deck}}{2} \qquad e_g = 21.8 \cdot in$$

$$K_g := n \cdot \left(I_x + A_b \cdot e_g^2\right) \qquad K_g = 247706 \cdot in^4$$

$$DF_{moment} := 0.075 + \left(\frac{s_{girder}}{9.5ft}\right)^{0.6} \cdot \left(\frac{s_{girder}}{L_4}\right)^{0.2} \cdot \left(\frac{K_g}{12.0 \cdot L_4 \cdot t_{deck}^3}\right)^{0.1}$$

$DF_{moment} = 0.456$

$$DF_{shear} := 0.2 + \frac{s_{girder}}{12ft} - \left(\frac{s_{girder}}{35ft}\right)^2 \qquad DF_{shear} = 0.779$$

$$DF := \min(DF_{moment}, DF_{shear}) \qquad DF = 0.456$$

Beam Live Load Design Moment

$$M_{design} := (DF \cdot M_{pos}) \cdot Percent_{inv} \qquad M_{design} = 343\ ft \cdot kip$$

Calculate the Moment Due to Platform Loads

$$Load_{design} = 26.8 \cdot psf$$

$$w_{platform} := Load_{design} \cdot s_{girder} \qquad w_{platform} = 201 \cdot plf$$

The work area shall be limited to a third of the span at a time.

$$DL := (5psf) + Dead_{ply} \qquad DL = 6.80 \cdot psf$$

$$w_{DL} := DL \cdot s_{girder} \qquad w_{DL} = 51 \cdot plf$$

$$L_4 = 89.0\ ft \qquad L_{plat} := 40\% L_4 = 35.6\ ft \qquad L_{DL} := L_4 - L_{plat} = 53.4\ ft$$

The platform will be installed under the entirety of Span 3.

$$R_{1.plat} := \frac{w_{platform} \cdot (L_{plat})}{2 \cdot L_3} \cdot (2 \cdot L_3 - L_{plat}) \qquad R_{1.plat} = 5.43 \cdot kip$$

$$R_{1.DL} := \frac{w_{DL} \cdot (L_{DL})^2}{2 \cdot L_3} \qquad R_{1.DL} = 0.98 \cdot kip$$

$$R_{2.plat} := \frac{w_{platform} \cdot (L_{plat})^2}{2 \cdot L_3} \qquad R_{2.plat} = 1.72 \cdot kip$$

$$R_{2.DL} := \frac{w_{DL} \cdot (L_{DL})}{2 \cdot L_3} \cdot (2 \cdot L_3 - L_{DL}) \qquad R_{2.DL} = 1.74 \cdot kip$$

$$V_1 := R_{1.plat} + R_{2.DL} = 7.18 \cdot kip \qquad V_2 := R_{2.plat} + R_{2.DL} = 3.46 \cdot kip$$

$$V_{platform} := \max(V_1, V_2) \qquad V_{platform} = 7.2 \cdot kip$$

$$M_{platform} := \frac{R_{1.plat}^{\ 2}}{2 \cdot w_{platform}} + \frac{R_{2.DL}^{\ 2}}{2 \cdot w_{DL}} \qquad M_{platform} = 103\ ft \cdot kip$$

Calculate the Percent Increase in Moment

$$Percent_{inc} := \frac{M_{design} + M_{platform}}{M_{design}} - 1.0 \qquad Percent_{inc} = 30.1 \cdot \%$$

Platform Load Check

Check := | "Suspended Platform Load on Bridge OK" if $Percent_{inc} < Percent_{allow}$
| "Suspended Platform Load on Bridge Not OK" otherwise

Check = "Suspended Platform Load on Bridge OK"

Check the Wind Load on the Structure:

We are going to limit the wind speed at which the platform/containment will be used to 40mph. If winds are anticipated to reach 40mph, the containment tarps shall be taken down until winds subside.

$V_{DZ} := 40mph$

Calculate the Design Wind Pressure

$$P_D = P_B \cdot \frac{\left(\frac{V_{DZ}}{mph}\right)^2}{10000}$$ (AASHTO Eq. 3.8.1.2.1-1)

$P_B := 0.050ksf$ (AASHTO Table 3.8.1.2.1-1, Windward Load, Beams)

$$P_D := P_B \cdot \frac{\left(\frac{V_{DZ}}{mph}\right)^2}{10000} \qquad P_D = 8.00 \cdot psf$$

AASHTO Minimum Required Design Wind Load

AASHTO Section 3.8.1.2.1 requires that beam bridges be designed for a minimum wind load of 300plf.

$Design_{wind.min} := 300plf$ (Per AASHTO Section 3.8.1.2.1)

Calculate the Depth of the Containment

The containment will be from the top of the bridge to approximately 3'-0" below the bottom flange of the plate girders.

$D_{fascia} := 24in$ (Assumed)

$D_{beam} := d_b$ $\qquad D_{beam} = 35.6 \cdot in$ $\qquad D_{haunch} := 1.0in$ (from Contract Plans)

$D_{containment} := D_{fascia} + D_{beam} + D_{haunch} + 3ft \qquad D_{containment} = 8.05\,ft$

Calculate the Wind Load Per Foot on the Containment

$Wind_{containment} := P_D \cdot D_{containment}$ $\qquad Wind_{containment} = 64.4 \cdot plf$

Check := | "Bridge Wind Load from Containment OK" if $Wind_{containment} < Design_{wind.min}$
| "Reduce Allowable Wind Speed" otherwise

Check = "Bridge Wind Load from Containment OK"

Since the actual wind load on the bridge from containment is less than the required minimum AASHTO wind load, the bridge is OK for wind.

QuickBridge - AASHTO H20 - Max. Span

Truck definition

Number of axles

2

Axle No	X	W
1	0.0	8.0
2	14.0	32.0

X is the coordinate and
W the weight of the axle
Coordinate of axle 1 is 0

QuickBridge - AASHTO H20 - Max. Span

Bridge geometry

Number of span

1

Span No	L	q	div
1	89	0	89

L is the length,
q uniform load and
div number of divisions
on a particular span
L and div must be > 0

QuickBridge - AASHTO H20 - Max. Span

Results

X	Vmax	Mmin	Mmax
0.00	38.7	0.0	0.0
1.00	38.3	0.0	38.3
2.00	37.8	0.0	75.7
3.00	37.4	0.0	112.2
4.00	36.9	0.0	147.8
5.00	36.5	0.0	182.5
6.00	36.0	0.0	216.3
7.00	35.6	0.0	249.2
8.00	35.1	0.0	281.2
9.00	34.7	0.0	312.3
10.00	34.2	0.0	342.5
11.00	33.8	0.0	371.8
12.00	33.3	0.0	400.2
13.00	32.9	0.0	427.7
14.00	32.4	0.0	454.3
15.00	32.0	0.0	480.0
16.00	31.6	0.0	504.8
17.00	31.1	0.0	528.7
18.00	30.7	0.0	551.7
19.00	30.2	0.0	573.8
20.00	29.8	0.0	595.1
21.00	29.3	0.0	615.4
22.00	28.9	0.0	634.8
23.00	28.4	0.0	653.3
24.00	28.0	0.0	670.9
25.00	27.5	0.0	687.6
26.00	27.1	0.0	703.5
27.00	26.6	0.0	718.4
28.00	26.2	0.0	732.4
29.00	25.7	0.0	745.5
30.00	25.3	0.0	757.8
31.00	24.8	0.0	769.1
32.00	24.4	0.0	779.5
33.00	23.9	0.0	789.0
34.00	23.5	0.0	797.7
35.00	23.0	0.0	805.4
36.00	22.6	0.0	812.2
37.00	22.1	0.0	818.2
38.00	21.7	0.0	823.2
39.00	21.2	0.0	827.3
40.00	20.8	0.0	830.6
41.00	20.3	0.0	832.9
42.00	19.9	0.0	834.3
43.00	19.4	0.0	834.9
44.00	19.0	0.0	834.5
45.00	18.5	0.0	833.3
46.00	18.1	0.0	831.1
47.00	17.6	0.0	828.0
48.00	17.2	0.0	824.1

No	Rmin	Rmax
1	0.0	38.7
2	0.0	35.0

QuickBridge - AASHTO H20 - Max. Span

49.00	16.7	0.0	819.2
50.00	17.0	0.0	813.5
51.00	17.4	0.0	806.8
52.00	17.9	0.0	799.3
53.00	18.3	0.0	790.8
54.00	18.8	0.0	781.5
55.00	19.2	0.0	771.2
56.00	19.7	0.0	760.1
57.00	20.1	0.0	748.0
58.00	20.6	0.0	735.1
59.00	21.0	0.0	721.3
60.00	21.5	0.0	706.5
61.00	21.9	0.0	690.9
62.00	22.4	0.0	674.3
63.00	22.8	0.0	656.9
64.00	23.3	0.0	638.6
65.00	23.7	0.0	619.3
66.00	24.2	0.0	599.2
67.00	24.6	0.0	578.2
68.00	25.1	0.0	556.2
69.00	25.5	0.0	533.4
70.00	26.0	0.0	509.7
71.00	26.4	0.0	485.0
72.00	26.9	0.0	464.5
73.00	27.3	0.0	444.4
74.00	27.8	0.0	423.4
75.00	28.2	0.0	401.4
76.00	28.7	0.0	378.6
77.00	29.1	0.0	354.9
78.00	29.6	0.0	330.2
79.00	30.0	0.0	304.7
80.00	30.5	0.0	278.3
81.00	30.9	0.0	251.0
82.00	31.4	0.0	222.7
83.00	31.8	0.0	193.6
84.00	32.3	0.0	163.6
85.00	32.7	0.0	132.7
86.00	33.2	0.0	100.9
87.00	33.6	0.0	68.1
88.00	34.1	0.0	34.5
89.00	35.0	0.0	0.0

APPENDIX "E"

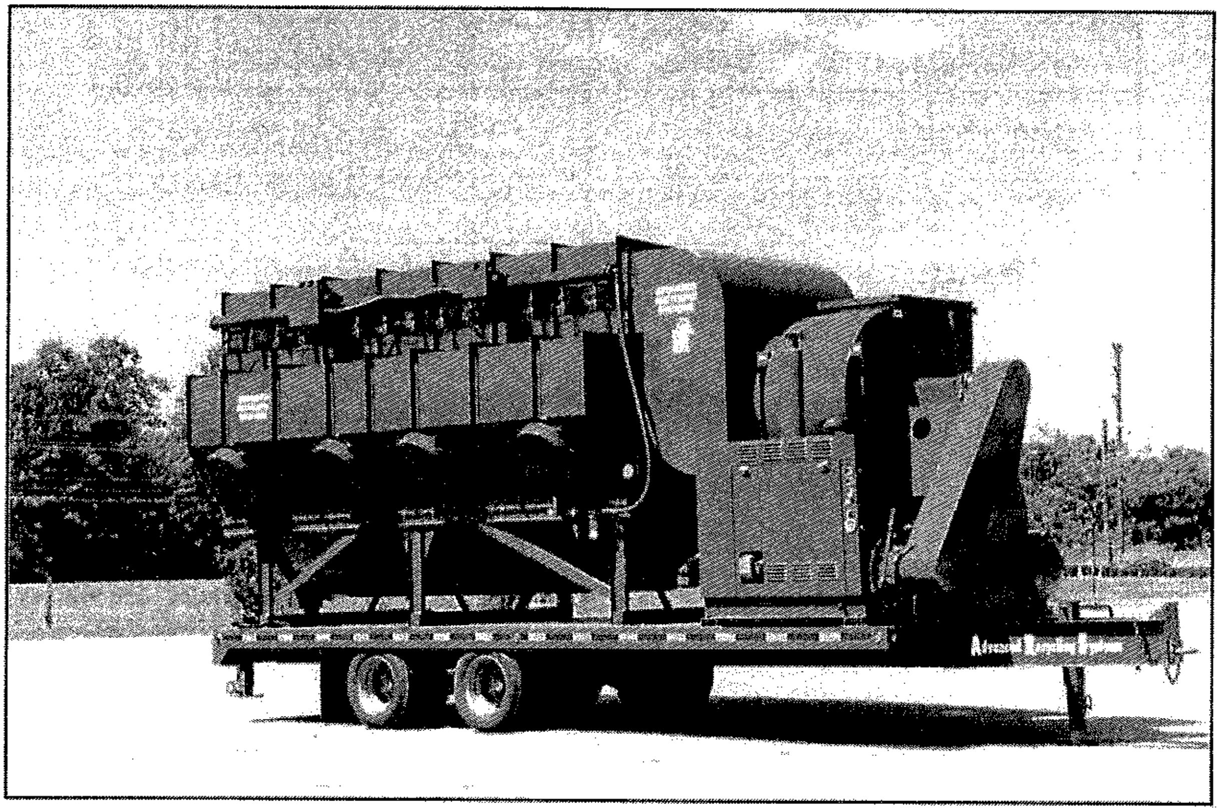
Technical Data: ARS, Inc. 45,000 cfm Dust Collector

Advanced Recycling Systems, Inc.

Designers and Builders of Mobile Blasting Systems

1089 N. HUBBARD ROAD • LOWELLVILLE, OHIO 44436-9737 • Tel. (330) 534-3330 • FAX (330) 534-9249

45,000 CFM Dust Collector at 13" Wg.



- ***Hydraulic Auger***
- ***Only 28 ft. long***
- ***Long Life Filter Cartridges***

Low Drag-High Airflow Design

Advanced Recycling Systems, Inc.
Designers and Builders of Mobile Blasting Systems
1089 N. HUBBARD ROAD • LOWELLVILLE, OHIO 44436-9737 • Tel. (330) 534-3330 • FAX (330) 534-9249

45,000 CFM Dust Collector

SPECIFICATIONS	
AIR RATE PER UNIT	45,000 CFM @ 13 Wg. 40,000 CFM @ 16 Wg.
CARTRIDGE EFFICIENCY	99.9% @ 0.5 microns
ARRANGEMENT OF ELEMENTS	Vertical
CARTRIDGE CLEANING	Ram Injection, Pulse Type
NUMBER OF CARTRIDGES	84
FILTER MEDIA AREA	12,600 sq. ft.
AIR-TO-CLOTH RATIO	3.5 TO 1 @ 45,000 CFM 3.1 TO 1 @ 40,000 CFM
DUCTING CONNECTIONS	4 @ 20" Dia.
FAN	Class IV Non-overloading Type "C" Spark Resistant
DRIVE	Banded V-Belt with clutch
TYPE OF ENGINE	165 H.P. Diesel
FUEL TANK	90 Gallon
AUGER DRIVE	Hydraulic
TRAILER	28'L x 8"W x 12'3"H
BRAKES	Electric
OPTIONS:	Dual Rear Inlets

APPENDIX "F"

Technical Data: Monarflex T-plus Sheeting

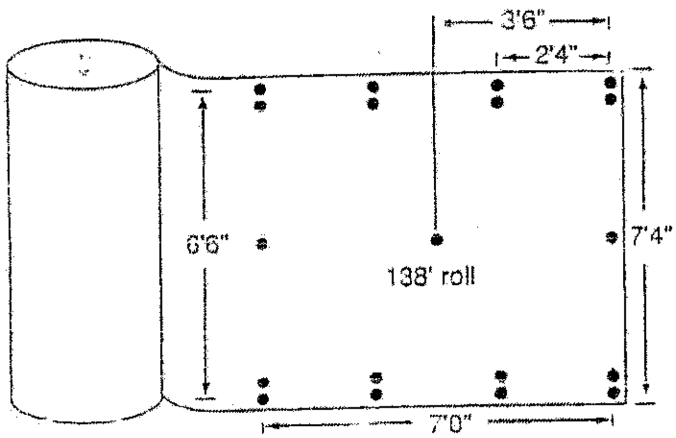
T-PLUS Scaffold Sheeting

T-Plus is the ultimate in scaffold sheeting. Made of reinforced 10 mil thick low density polyethylene (LDPE), T-Plus has a 1500 denier scrim, making it extremely durable, yet manageable and easy to use.

Like all Monarflex® sheeting products, T-Plus features the internationally patented Monarflex® grommet system. T-Plus sheeting has been designed to conform to all U.S. standard scaffold configurations.

T-Plus is designed to withstand high winds, and can be used in temperatures ranging from -40° (F) to +140° (F). The versatility and durability of T-Plus, combined with its environmental qualitie has established T-Plus as a market leader in many countries over the last 20 years.

T-Plus is the ideal material for projects requiring full containment, including steel structure maintenance involving blasting and painting, as well as general construction projects.



Approximate dimensions

TECHNICAL DETAILS

Composition: LDPE reinforced with 1500 denier polyester yarn

Roll Size: 7'4" x 138'

Roll Weight: 67 lbs.

Thickness: 10 mil

Scrim: 1500 denier

Color: Clear

Usable in Temperatures: -40° (F) to +140° (F)

Light Transmitting: 90%

UV Resistance: Maximum UV resistance

Tensile Strength: 10KN/M

Monarflex®
PROTECTION SYSTEM

Monarflex, Inc
80 Pine Street, Peterborough, NH 03-
Phone: 800-225-7704 or 603-924-42
Fax: 603-924-2179

Reverse of leaflet contains Product Liability Clause

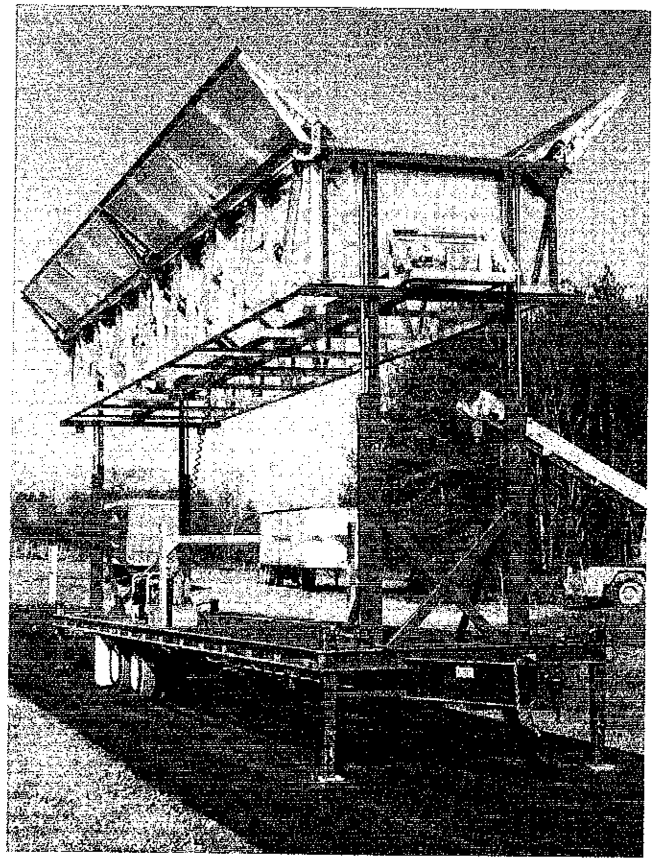
APPENDIX "G"

Technical Data: ARK Overpass Master

SPIDER
A FLOW INTERNATIONAL COMPANY

Technical Data: **ARK Systems Products**

ARK's Overpass Master integrates with ARK modules to provide a safe ground base for roadway overpass work during active traffic conditions.



The Overpass Master

ARK's modular platform containment systems offer contractors complete coating removal and containment solutions for lead paint abatement, surface preparation, inspection and painting operations on bridges and roadway overpasses.

Description

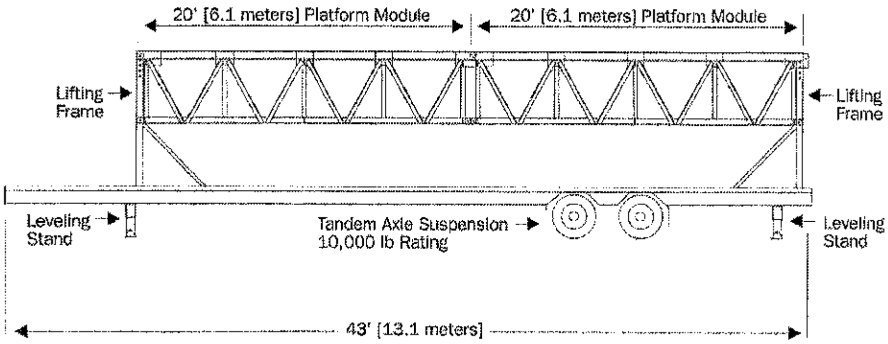
The Overpass Master® is an invaluable accessory for the ARK modules, providing a safe ground base for roadway overpass work. Mounted on a trailer for easy mobility, the Overpass Master uses four hydraulic cylinders to raise the ARK modules into the work area — all in a matter of minutes! Two standard ARK modules can be used with the Overpass Master and can be easily removed for other rigging situations.

Specifications

- ❒ Weight: Approximately 10,000 lbs [4540 kg] (including two modules).
- ❒ Material: Trailer is a welded steel heavy-duty unit with pintle hinch. Mounted to the trailer are tube steel lifting frames, four hydraulic cylinders and a control box. The trailer is available with or without modules and is DOT approved.
- ❒ Size: Approximately 43 ft L x 8.5 ft W [13.1 meters x 2.6 meters]. Retractable wings open up to a 12 ft [3.6 meters] width — ideal for lane work. Work deck raises to approximately 17 ft [5.2 meters] from ground level.
- ❒ Operation: After modules are connected to lifting frame and the unit is in place, the hydraulic unit is attached to the power source and raised into position. Lift to full height takes less than 5 minutes.
- ❒ Design Load: 30 psf live load on work deck of platform.

(Continued on back)

Specifications (cont'd)



Side Elevation

Spider Staging Corporation

is North America's leading manufacturer of powered access equipment with distributors located worldwide. ARK Systems Products are manufactured and distributed exclusively by Spider Staging Corporation.

Corporate Headquarters

23500 64th Avenue South
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Kent, Washington 98064-9740
Telephone: (206) 850-3500
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TOLL-FREE (800) 446-3569

ARK Systems Products

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2610 Wilrijk-Antwerpen
Belgium
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Fax: 011.32-3-877.37.35

Australia, Central & South America

Please contact Corporate Headquarters.

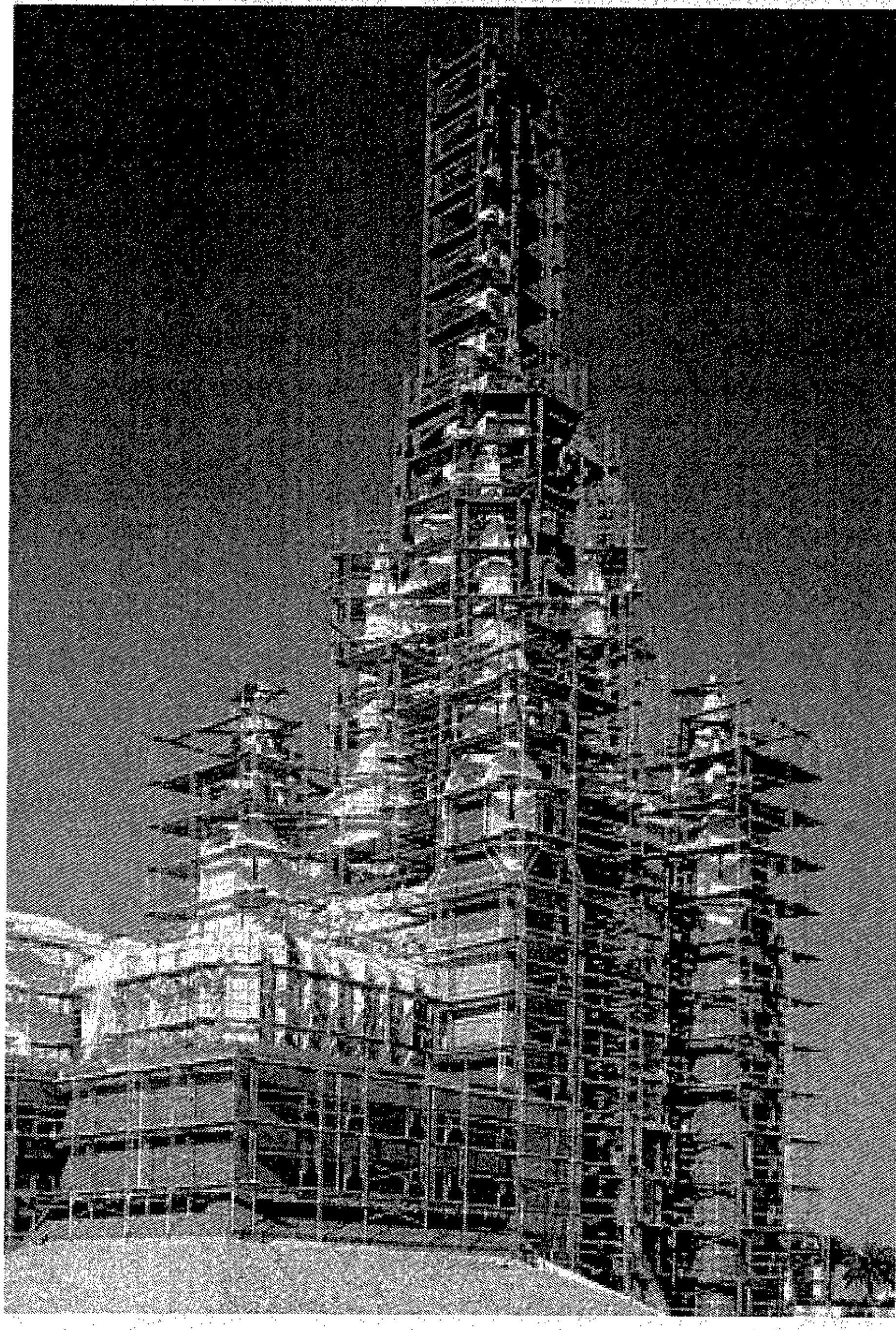
SPIDER
A FLOW INTERNATIONAL COMPANY

SSC-S004 Printed in U.S.A. on Recycled Paper

APPENDIX "H"

Technical Data: Microllam LVL Walers & Scaffold Planks

TrusJoist®
A Weyerhaeuser Business



#3060 APPLICATION GUIDE

Microllam® LVL Scaffold Plank

Scaffolding takes a beating. Planks sit on frames and hang from supports, and are subjected to the affronts of rain, snow, heat, cold, heavy loads, and wear from numerous assembly/knock-down cycles. Scaffold companies need planks that they can rely on—planks that have minimal twist and bow after that type of exposure. Trus Joist Industrial has the solution: planks made of Microllam® laminated veneer lumber (LVL).

- **Safety.** Safety is a scaffold user's main concern. Microllam® LVL scaffold plank is proof-loaded by machine to ensure that the product meets Trus Joist Industrial quality standards and OSHA deflection limits when it leaves the mill.

- **Reliable consistency.** Microllam® LVL scaffold plank is made from many layers of thin veneer, so there are no cross-grain or concentrated areas of knots to contend with.

- **Made to order.** Microllam® LVL scaffold plank isn't sold as stock lumber— it's manufactured to scaffold plank specifications.

Industrial
TrusJoist®

1-877-856-9663
www.trusjoist.com

PRODUCT WARRANTY

Trus Joist warrants Microllam® LVL scaffold planks to be free from defects in materials, workmanship and design. Microllam® LVL scaffold planks will carry the loads specified when used in accordance with the design information included herein, provided that the product is not misused or otherwise subjected to conditions which reduce the product's strength (see Storage Recommendations, Cautions, Visual Evaluation and Testing). The above warranties are in lieu of all other warranties, express or implied. The implied warranties of merchantability and fitness for a particular purpose are excluded from this warranty. Consequential and indirect damages are hereby excluded.

Industrial
Trus Joist®
200 East Mallard Drive
Boise, Idaho 83706
1-877-856-9663

Tom Denig, President

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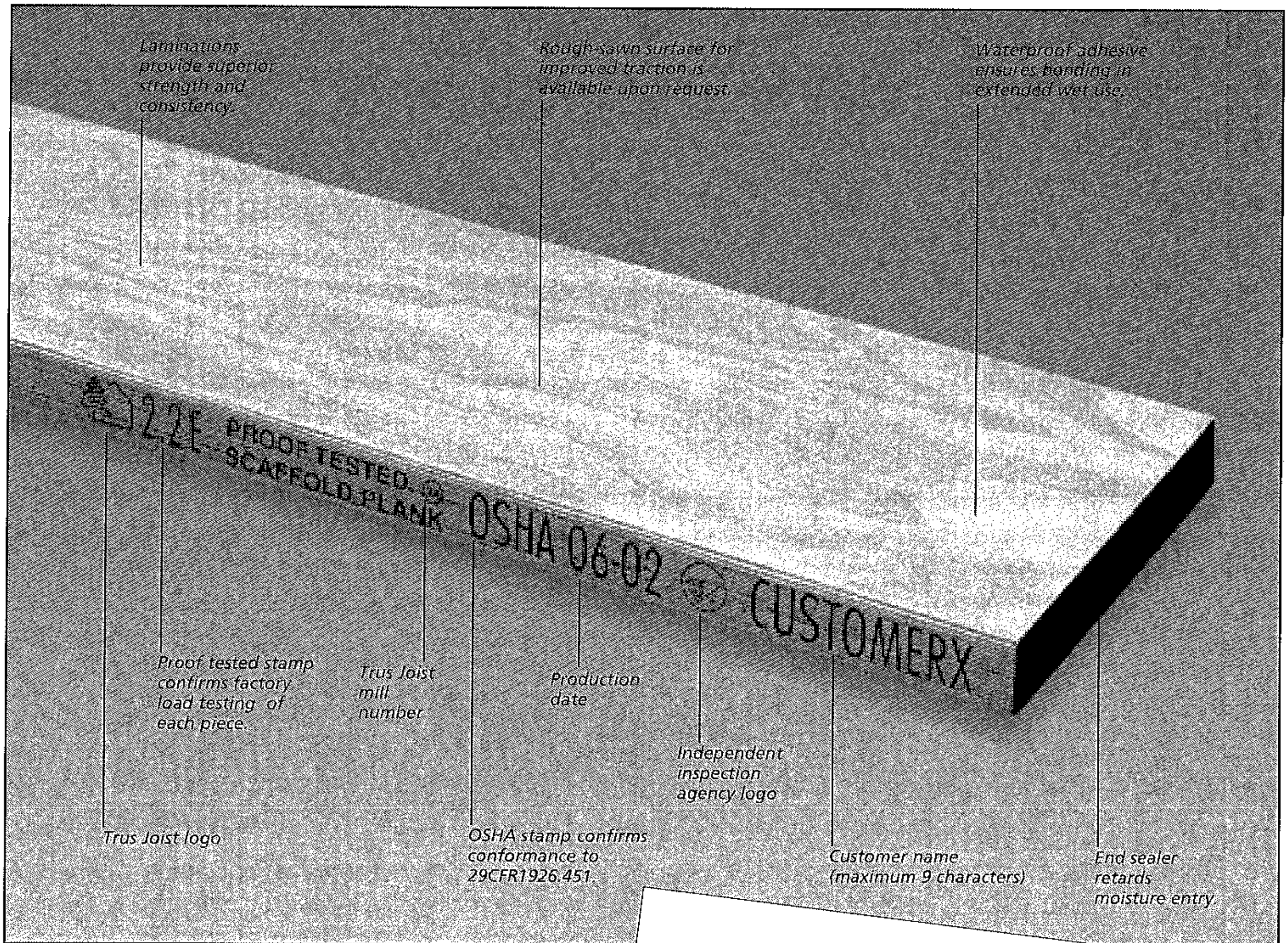
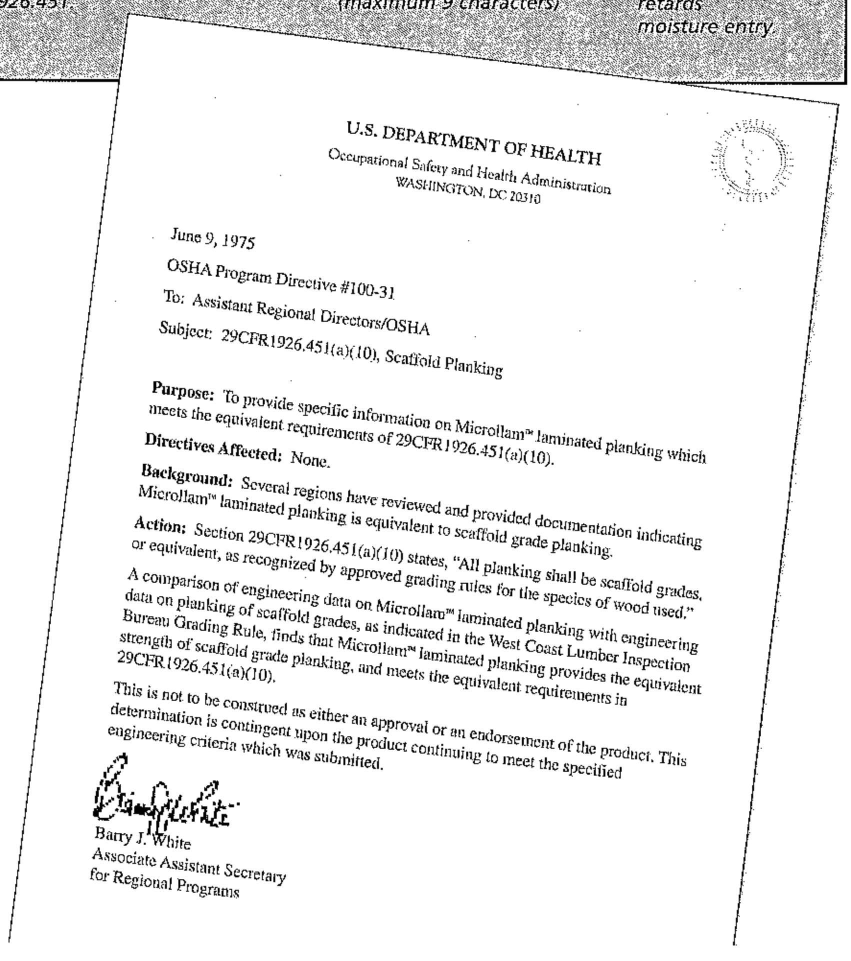
MEMBER
SCAFFOLD INDUSTRY ASSOCIATION SIA

PRODUCT APPLICATION ASSURANCE

DO IT RIGHT FIRST!!



There are many grades of Microllam® laminated veneer lumber (LVL). Use only scaffold grade for planking.



U.S. DEPARTMENT OF HEALTH
Occupational Safety and Health Administration
WASHINGTON, DC 20310

June 9, 1975

OSHA Program Directive #100-31

To: Assistant Regional Directors/OSHA

Subject: 29CFR1926.451(a)(10), Scaffold Planking

Purpose: To provide specific information on Microllam™ laminated planking which meets the equivalent requirements of 29CFR1926.451(a)(10).

Directives Affected: None.

Background: Several regions have reviewed and provided documentation indicating Microllam™ laminated planking is equivalent to scaffold grade planking.

Action: Section 29CFR1926.451(a)(10) states, "All planking shall be scaffold grades, or equivalent, as recognized by approved grading rules for the species of wood used."

A comparison of engineering data on Microllam™ laminated planking with engineering data on planking of scaffold grades, as indicated in the West Coast Lumber Inspection Bureau Grading Rule, finds that Microllam™ laminated planking provides the equivalent strength of scaffold grade planking, and meets the equivalent requirements in 29CFR1926.451(a)(10).

This is not to be construed as either an approval or an endorsement of the product. This determination is contingent upon the product continuing to meet the specified engineering criteria which was submitted.

Barry J. White
Associate Assistant Secretary
for Regional Programs

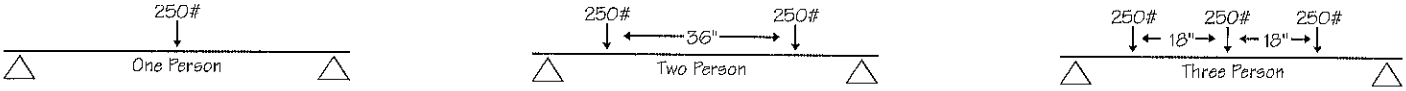
Untreated—U.S.

Condition		Live Loading	1½" x 9¼"	1½" x 9½"	1½" x 11¾"	1¾" x 9"	1¾" x 9½"	1¾" x 11¾"
Dry Use Moisture Content < 19%	Simple Span	50 psf	10'-6"	10'-6"	10'-6"	12'-0"	12'-0"	12'-0"
		75 psf	9'-0"	9'-0"	9'-0"	10'-6"	10'-6"	10'-6"
		One Person	10'-6"	10'-6"	11'-6"	13'-0"	13'-0"	14'-6"
		Two Person	8'-6"	8'-6"	9'-0"	10'-0"	10'-0"	11'-0"
		Three Person	6'-0"	6'-0"	7'-0"	7'-6"	8'-0"	9'-0"
	Two Span(1)	50 psf	11'-6"	11'-6"	11'-6"	13'-6"	13'-6"	13'-6"
		75 psf	9'-6"	9'-6"	9'-6"	11'-6"	11'-6"	11'-6"
		One Person	12'-0"	12'-6"	14'-6"	16'-0"	17'-0"	21'-0"
		Two Person	9'-0"	9'-0"	10'-0"	11'-0"	11'-0"	12'-6"
		Three Person	6'-6"	6'-6"	7'-6"	8'-0"	8'-0"	10'-0"
Wet Use Moisture Content < 30%	Simple Span	50 psf	9'-6"	9'-6"	9'-6"	11'-0"	11'-0"	11'-0"
		75 psf	8'-6"	8'-6"	8'-6"	10'-0"	10'-0"	10'-0"
		One Person	9'-6"	9'-6"	10'-6"	11'-6"	12'-0"	13'-0"
		Two Person	7'-6"	7'-6"	8'-6"	9'-0"	9'-0"	10'-0"
		Three Person	5'-0"	5'-6"	6'-0"	6'-6"	6'-6"	7'-6"
	Two Span(1)	50 psf	10'-6"	10'-6"	10'-6"	12'-6"	12'-6"	12'-6"
		75 psf	9'-0"	9'-0"	9'-0"	10'-6"	10'-6"	10'-6"
		One Person	10'-6"	11'-0"	12'-6"	14'-0"	14'-6"	18'-0"
		Two Person	7'-6"	8'-0"	9'-0"	9'-6"	10'-0"	11'-0"
		Three Person	5'-6"	5'-6"	6'-6"	6'-6"	7'-0"	8'-0"

Fire-Retardant Treated—U.S.(2)

Condition		Live Loading	1¾" x 9"	1¾" x 9½"	1¾" x 11¾"	2" x 12"	2¼" x 11¾"	2½" x 11¾"
Dry Use Moisture Content < 19%	Simple Span	50 psf	11'-6"	12'-0"	12'-0"	12'-6"	14'-0"	15'-6"
		75 psf	10'-0"	10'-0"	10'-0"	10'-6"	12'-0"	13'-0"
		One Person	11'-6"	12'-6"	14'-6"	15'-6"	18'-6"	21'-0"
		Two Person	9'-0"	9'-6"	10'-6"	11'-6"	13'-0"	15'-6"
		Three Person	6'-0"	6'-6"	7'-6"	8'-0"	9'-0"	11'-0"
	Two Span(1)	50 psf	12'-6"	12'-6"	12'-6"	12'-6"	14'-0"	15'-6"
		75 psf	10'-0"	10'-0"	10'-0"	10'-6"	12'-0"	13'-0"
		One Person	14'-6"	15'-6"	18'-6"	19'-6"	23'-0"	27'-0"
		Two Person	9'-0"	9'-6"	11'-0"	12'-0"	14'-0"	16'-6"
		Three Person	6'-6"	6'-6"	8'-0"	8'-6"	10'-0"	12'-0"
Wet Use Moisture Content < 30%	Simple Span	50 psf	9'-6"	10'-0"	11'-0"	11'-6"	12'-6"	14'-0"
		75 psf	9'-0"	9'-0"	9'-0"	9'-6"	10'-6"	11'-6"
		One Person	9'-6"	10'-0"	12'-0"	12'-6"	15'-0"	17'-6"
		Two Person	8'-0"	8'-0"	9'-0"	9'-6"	11'-0"	13'-0"
		Three Person	5'-0"	5'-6"	6'-0"	6'-6"	8'-0"	9'-0"
	Two Span(1)	50 psf	11'-0"	11'-0"	11'-0"	11'-6"	12'-6"	14'-0"
		75 psf	9'-0"	9'-0"	9'-0"	9'-6"	10'-6"	11'-6"
		One Person	11'-6"	12'-6"	15'-0"	16'-0"	19'-0"	22'-6"
		Two Person	7'-6"	8'-0"	9'-6"	10'-0"	11'-6"	14'-0"
		Three Person	5'-6"	5'-6"	6'-6"	7'-0"	8'-6"	10'-0"

(1) Two-span table indicates the most restrictive span lengths considering live loads on one or both spans.
(2) Covers plank treated by Trus Joist only. No outside treating permitted.



1. Dry use conditions for new or like new scaffold.
2. Design load deflection is limited to L/60.
3. Spans shown are considered the distance between the center lines of bearers. Actual Microllam® LVL scaffold plank lengths will be greater due to overhangs or overlaps specified in ANSI A10.8. Contact Trus Joist for additional span information.
4. Two-span tables assume both spans have equal lengths. Contact Trus Joist for other than equal two-span configurations.
5. Uniform and person loads shown are defined in ANSI A10.8. Proper Microllam® LVL scaffold plank selection must be based on the most restrictive load case anticipated in service.
6. Microllam® LVL scaffold planks treated with Hoover Treated Wood Products' Exterior Fire-X® fire-retardant treatment are on the "Qualified Products List of Products Qualified Under Military Specification MIL-L-19140 (QPL 19140)."
7. Microllam® LVL scaffold planks treated with Hoover Treated Wood Products' Exterior Fire-X® fire-retardant treatment are a UL®-listed building material with the designation "FR-S." This designation denotes that the flame spread rating and smoke developed values are 25 or less, and that the product has been subjected to tests of thirty minutes duration during which the flame spread did not progress more than 10'-6" beyond the centerline of the burners, with no evidence of significant progressive combustion. There is no increase in the listed Classification when the product is subjected to the Standard Rain Test (UL790).

Untreated—Canada

		Live Loading	1½" x 9½"	1¾" x 9½"	1¾" x 11¾"
Dry Use Moisture Content ≤ 19%	Simple Span	50 psf	10'-0"	11'-6"	11'-6"
		2.40 kN/m²	3.0 m	3.5 m	3.5 m
		75 psf	8'-6"	10'-0"	10'-0"
		3.60 kN/m²	2.6 m	3.1 m	3.1 m
		500 lbs	6'-6"	8'-6"	9'-6"
		2.22 kN	2.0 m	2.6 m	2.9 m
		Workers and Tools (25 psf + 250 plf)	8'-6"	10'-6"	10'-6"
		(1.20 kN/m² + 3.63 kN/m)	2.7 m	3.2 m	3.2 m
		Workers and Materials (75 psf + 265 plf)	7'-0"	8'-6"	8'-6"
		(3.60 kN/m² + 3.88 kN/m)	2.1 m	2.6 m	2.6 m
Wet Use Moisture Content < 30%	Simple Span	50 psf	9'-0"	10'-6"	10'-6"
		2.40 kN/m²	2.8 m	3.2 m	3.2 m
		75 psf	8'-0"	9'-0"	9'-0"
		3.60 kN/m²	2.4 m	2.8 m	2.8 m
		500 lbs	5'-0"	7'-0"	8'-6"
		7.26 kN	1.6 m	2.1 m	2.6 m
		Workers and Tools (25 psf + 250 plf)	8'-0"	9'-6"	9'-6"
		(1.20 kN/m² + 3.63 kN/m)	2.4 m	3.0 m	3.0 m
		Workers and Materials (75 psf + 265 plf)	6'-6"	7'-6"	7'-6"
		(3.60 kN/m² + 3.88 kN/m)	2.0 m	2.4 m	2.4 m

1. Live load deflection is limited to L/80.
2. No increases in allowable unit stresses are included for load-sharing systems.
3. PLF loads are applied across the plank direction at centerline.

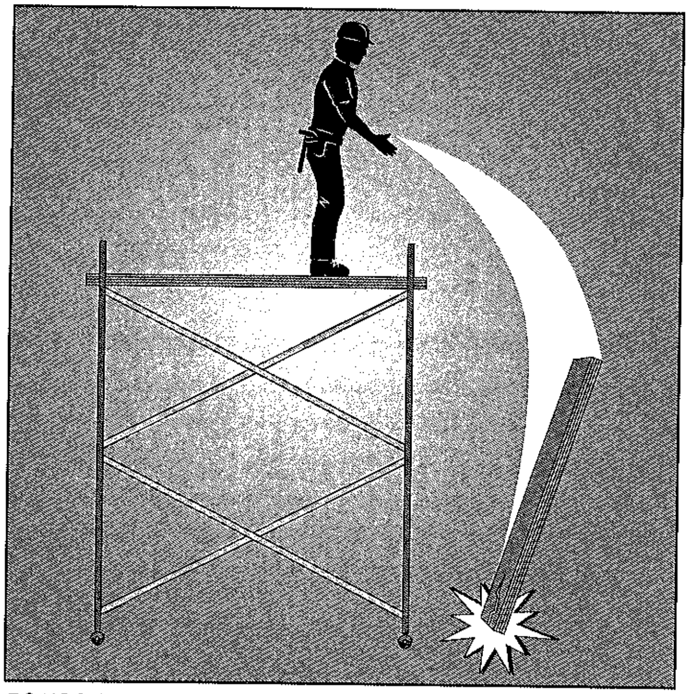
Design Properties

Microllam® LVL Scaffold Plank Design Properties

	Untreated		Fire-Retardant Treated	
Plank Thickness	1¾" and less	Greater than 1¾"	1¾" and less	Greater than 1¾"
Flexural Stress, F_b	2,900 psi	2,400 psi	2,175 psi	1,800 psi
Modulus of Elasticity, E	2.2 x 10^6	2.2 x 10^6	2.2 x 10^6	2.2 x 10^6
Horizontal Shear Stress, F_v	145 psi	145 psi	109 psi	109 psi
Coefficient of Variation (MOR)	12%	12%	12%	12%

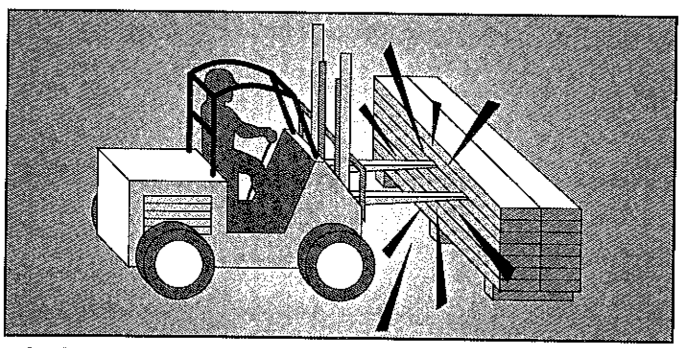
1. Design properties are determined in accordance with ANSI A10.8-1988, Appendix C.
2. These properties apply only to Microllam® LVL scaffold planks used in conditions where the moisture content of the plank is not expected to exceed 19%. These values apply only to planks used in the flat orientation.
3. F_b, E and F_v shall be adjusted by a factor of 0.80 when conditions of use are such that the moisture content of the plank is expected to exceed 19%.
4. Fastener values (nails, bolts, screws) shall be as provided for sawn Douglas fir per the *National Design Specification® for Wood Construction* (NDS®), 2001 edition, or per CSA O86-01, *Engineering Design in Wood.*
5. Values are for new or like-new product.

■ **Proper handling.** Scaffold planks can be damaged when thrown from a scaffold. Lower scaffold planks in an orderly manner. Scaffold planks that have been thrown from scaffolding or had heavy objects dropped on them should be removed from service and evaluated before reuse.

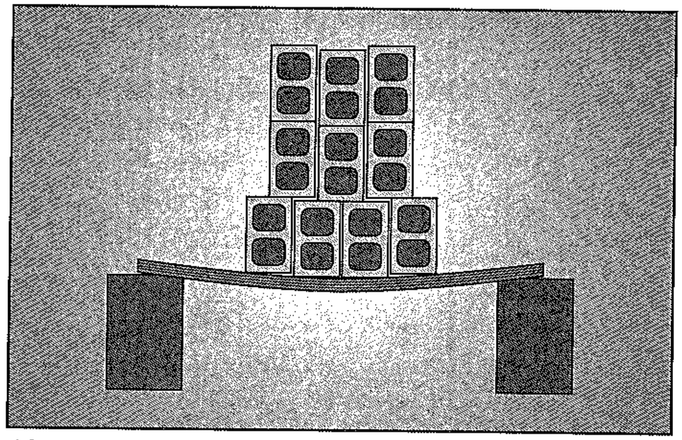


DO NOT throw scaffold planks

Forklifts or other mechanical lifting devices should always be used to lift and lower bundles of scaffold planks. Bundle stickers should be thick enough to allow easy access for forks. Corner protection should be used when moving bundles with chain or cable swings. Do not dump scaffold planks from trucks. Do not push bundles of scaffold planks with the ends of forks.



DO NOT push bundles of scaffold planks with the ends of forks



DO NOT overload scaffold planks (See **Maximum Allowable Deflection** chart below)

■ **Overloading.** Heavy materials should never be stored on scaffold planks unless permitted by the scaffold designer. The maximum allowable deflection for scaffold planks is about 1⅝" for an 8' span and 2" for a 10' span (1¼" and 1½" in Canada); see **Maximum Allowable Deflection** chart below. If a scaffold plank deflects more than this, or makes cracking noises, it is being overloaded. Scaffold planks that have been overloaded should be immediately removed from service, then visually inspected and field tested before reuse. See **Visual Evaluation** on page 9.

■ **Misuse.** Scaffold planks should never be used for loading ramps, walkways through mud, or anything other than scaffold planking. Improper use might cause damage that makes the scaffold planks unsafe.

■ **Notches.** Consult the scaffold designer when a plank must be notched to clear an obstruction. Provide additional support in the area of the notch if the modified plank cannot properly support design loads.

■ **Improper storage.** Scaffold planks that are improperly stored are subject to biological attack and mechanical damage. See **Storage Recommendations** on page 8 for proper storage techniques.

■ **Jumping.** Never jump or bounce on scaffold planks.

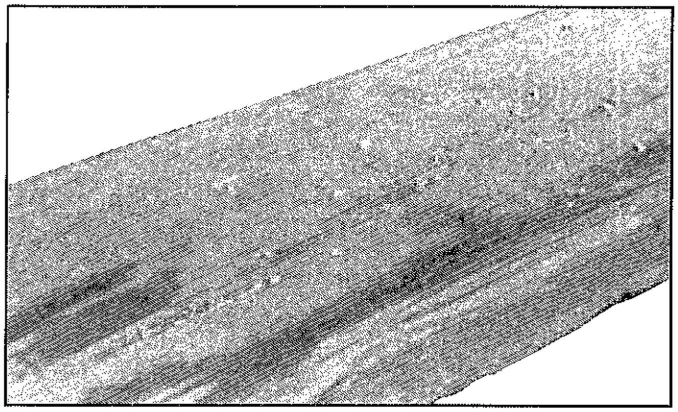
Maximum Allowable Deflection

Plank Span	6'	8'	10'	12'	14'	16'
United States (L/60)	1¼"	1⅝"	2"	2½"	2⅞"	3¼"
Canada (L/80)	1"	1¼"	1½"	1⅞"	2"	2½"

■ **Chemicals.** The phenolic resin used to make Microllam® laminated veneer lumber (LVL) is highly resistant to the action of chemicals. The wood component is, however, susceptible to attack. The risk of damage is related to the concentration, pH, and temperature of the chemical solution. The most hazardous chemical solutions have a pH less than or equal to 3 or a pH greater than or equal to 9, or temperatures higher than 120° F. All oxidizing chemicals are hazardous.

Obtain Material Safety Data Sheets (MSDS) for any chemicals being used on a job that are likely to come in contact with scaffold planks. Refer to the **Handling and Storage** section of each applicable MSDS. Planks contaminated with hazardous chemicals should be immediately removed from service, then properly evaluated before reuse.

- **Polar liquids** (such as water and alcohol) temporarily weaken wood. Their effect is reversible. Non-polar liquids (such as petroleum products and creosote) have a negligible effect on strength.
- **Acids** attack wood. The rate of decomposition increases as solution temperature increases. Strong acids with a pH of 1 to 3 (such as hydrochloric, nitric, and sulfuric) react with wood more quickly than weak acids (such as, formic, acetic, propionic, and lactic).
- **Strong alkalis** with a pH of 12 to 13 (such as sodium hydroxide, potassium hydroxide, and ammonium hydroxide) attack wood. The rate of decomposition increases as solution temperature increases.
- **Salts** affect wood in relation to their pH. Acid salts are generally weak acids and pose a minor threat at low temperatures. Neutral salts are not a problem. Alkaline salts with a pH greater than 9 are very damaging. Sodium chloride (common salt) does not react chemically with wood, but can cause the wood structure on the surface to rupture over time.
- **Oxidizing chemicals** (such as peroxides, chlorates, and nitrates) are very damaging to wood.



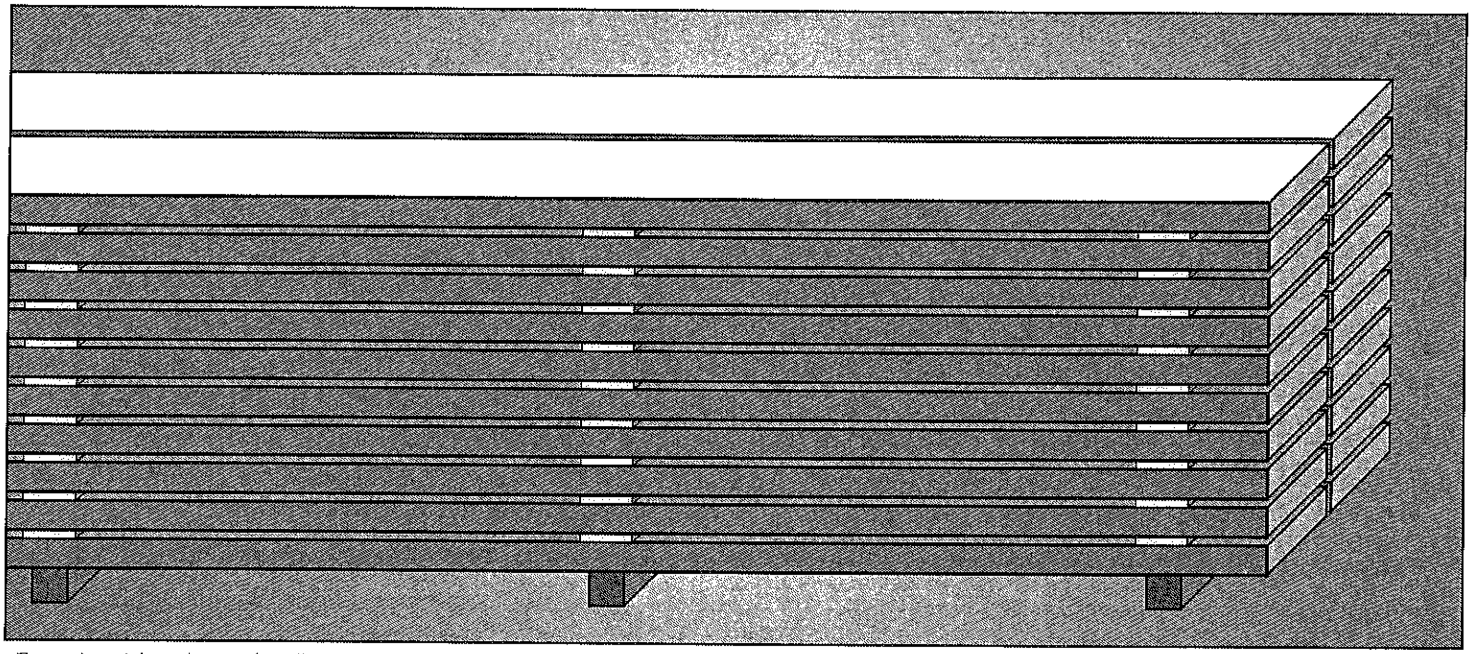
Fungus

■ **Decay.** Fungi require food (wood), oxygen, a favorable temperature, and water to thrive. Of these four factors, water offers the best potential for control. See **Storage Recommendations** on page 8. Two basic rules should form the basis for storage practices:

- Keep dry planks dry
- Allow wet planks to dry quickly by providing air circulation

■ **Heat.** The phenolic resin used to make Microllam® LVL belongs to a class of adhesives known as thermosets. These adhesives require heat to cure, but once cured, additional applications of heat cannot reverse the process. Phenolic resins will not begin to decompose until reaching a temperature of about 625° F in an inert atmosphere. Wood, on the other hand, can suffer permanent loss of strength under prolonged exposures to temperatures above 150° F, and chars at about 425° F. Wood scaffold planks should not be exposed to temperatures that exceed 150° F.

■ **Wet conditions.** Scaffold planks are generally used in elevated locations with good air circulation. This environment is conducive to the drying of wood fibers. For this reason, allowable stresses for scaffold use may be based on a dry-service condition (where moisture content is less than or equal to 19%). Allowable stresses representing the wet condition should be used when planks are used in applications where moisture content between 19% and 30% is likely. See **Wet Use Span Tables** on pages 4 (U.S.) and 5 (Canada).



Properly stickered, neat bundles

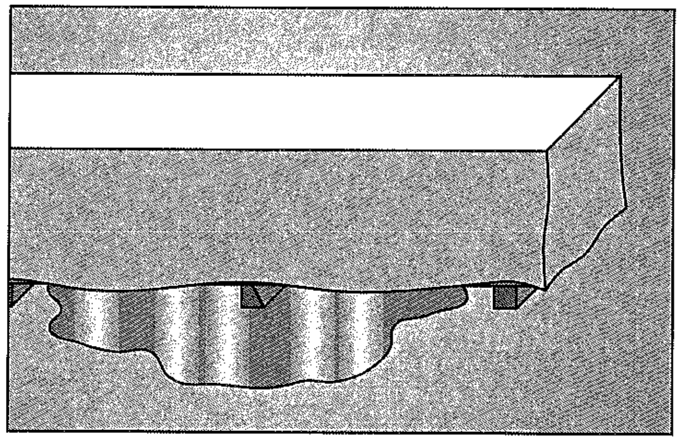
Microllam® LVL Scaffold Planks Are Valuable! Store Them Properly!

Stack scaffold planks neatly and sticker bundles properly!

■ The proper storage and handling of wood scaffold planks can prevent unnecessary damage. Plank strength and stiffness properties are affected by moisture content. It is important that scaffold planks be stacked off the ground. Bundles of scaffold planks should be supported on stickers spaced no more than 8' on-center to provide air circulation and easy access for forklifts. Stickers between bundles should line up with stickers on the ground. Misaligned stickers can cause bowed or damaged scaffold planks.

To prevent decay, store wet scaffold planks in a manner that allows for proper air circulation. When stacking, improve air circulation within a bundle of wet scaffold planks by separating each layer with stickers. Stickers should be spaced no more than 8' on-center and should line up vertically. Bands should line up with stickers. Bands that are misaligned with stickers can cause bowed or damaged scaffold planks.

■ Bundles of scaffold planks should be assembled neatly and contain planks of similar lengths. Scaffold planks sticking out from the ends of bundles can be snagged and damaged.



Properly covered storage

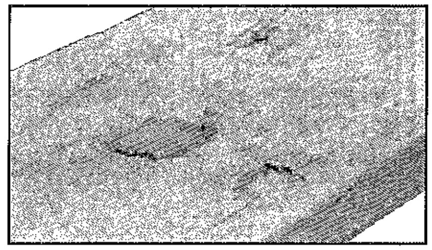
Keep scaffold planks dry when they are in storage!

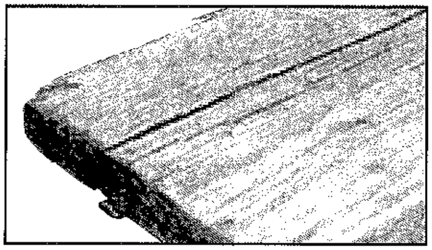
■ Certain geographical areas experience extreme weather conditions. In those areas, decay may be more likely to occur and the following precautions should be followed:

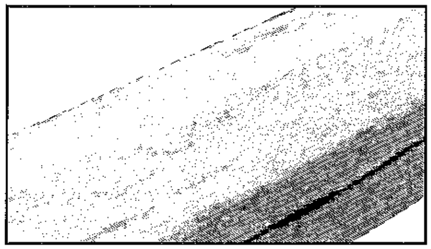
- Scaffold planks should be stored in a level, well-drained location.
- Scaffold planks should be protected from weather by being placed under a roof or under a material that will shed water but is porous enough to allow moisture to escape.


Saw Cuts


Face Break


Dent


End Split


Narrow Face Split

It is the responsibility of Trus Joist to deliver defect-free scaffold planks to each of its customers.

Systematic visual inspection prior to each scaffold erection, along with proper storage, handling, and use, are the best means of ensuring safe performance of all wood scaffold planks.

Damaged scaffold planks should be removed from service as soon as the damage is discovered. Failure to remove damaged scaffold planks from service might result in injury or death. Although some damage to scaffold plank may be difficult to detect visually, some of the more common types of damage are:

- **Saw kerfs, saw cuts, drilled holes, and notches.** A saw kerf across the wide face of a scaffold plank lowers its capacity by effectively making the plank thinner. A saw cut, or notch in the narrow face, or a drilled hole has a similar effect. Scaffold planks with saw kerfs, saw cuts, drilled holes, or notches in them should be removed from service.
- **Face breaks.** A break on the wide face of a scaffold plank is the result of overloading. This type of damage might be difficult to detect; therefore, a policy of prevention will be more effective than to rely completely on detection. See **Cautions** on pages 6 and 7.

A face break looks like an irregular crack across the tension face (bottom) of the scaffold plank, or a small, straight wrinkle across the compression face (top). Face breaks result in a dangerous loss of strength. Scaffold planks showing face breaks should be removed from service.

- **Dents.** A dent could be caused by a dropped scaffold plank striking an object, or by a dropped object striking a plank. The dent itself might have little effect on plank strength, but it could be a sign of internal damage that will seriously affect plank performance. Scaffold planks with dents should be removed from service, then visually evaluated and field tested before reuse.
- **Gouges and depressions.** Gouges or depressions (where pieces of wood have been torn or eaten away from the plank) might be the result of careless forklift operation, decay, or chemical attack. Scaffold planks with gouges or depressions in them should be removed from service.
- **End splits.** An end split is a separation that extends through the plank from one face to another. End splits are normally the result of abuse or repeated wet/dry cycles. End splits of lengths shorter than ½ of the plank width do not necessarily weaken the plank. Longer end splits, up to 18" long, should be arrested and reinforced with straps or rodding. Planks with end splits longer than 18" should be removed from service.
- **Narrow face splits.** An open split on the narrow face of the plank might have been caused by a forklift. An open split that migrates diagonally across adjacent veneers might have been caused by overloading. Diagonal splits are likely to be accompanied by face breaks. It may be necessary to use a thin, stiff probe to distinguish a split from a shallow weathering check. Scaffold planks containing open splits on the narrow face should be removed from service.
- **Discoloration.** Discoloration might indicate exposure to high temperatures, chemical attack, or decay. Scaffold planks that are entirely or partially discolored should be removed from service until the cause of the discoloration has been determined to be harmless to the planks.
- **Other.** Soft or crumbly wood might indicate chemical attack or decay. Odd odor might also indicate chemical attack. Scaffold planks that have soft or crumbly areas on them should be removed from service until the cause has been determined to be harmless to the planks.

If you choose to mechanically test your wooden scaffold planks, avoid traditional industry test procedures that involve jumping or bouncing on them. These methods could actually cause damage. Instead, use nondestructive test procedures such as the following:

1. Make sure the plank is free from built-up dirt and debris.

2. Center the plank on a scaffold frame, or similar structure, that has been set up on a level surface. The plank may overhang one or both sides of the frame without affecting the test results, provided the plank touches both supports.

3. Identify a stationary point of reference, separate from the frame, from which to measure the location of the plank before and after loading. This could be the ground directly below the plank where measurements could be made with a tape measure, or a vertical pole with a measuring tape attached to it that stands up next to the plank.

4. Preload the plank with approximately 20 lbs to settle the plank on the frame. Measure and record the deflection of the plank under the preload.

5. Determine the test load to be applied to the plank from Table 2 on page 11. **Place the load slowly on the plank.** Measure and record the deflection of the plank under the test load plus the preload.

6. The difference between the first and second measurements (steps 4 and 5) is the deflection of the plank under the test load. Compare this number to the limits shown in Table 2.

7. Examine the bottom of the plank for face breaks while the plank is loaded. If face breaks can be seen, remove the plank from service.

8. If cracking noises can be heard during the test, remove the plank from service.

9. Turn the plank over and repeat this procedure.

10. Any plank that deflects more than the maximum amount shown in Table 2 should be removed from service.

11. Planks that fail a load test, yet show no signs of damage, may be too wet. To determine whether the moisture content of a plank is high, compare its weight to the limits stated in Table 1 below. If the plank's weight exceeds these limits, set it aside to dry, then retest it.

Table 1—Approximate Weight of Microllam® LVL Scaffold Planks (lbs/ft)

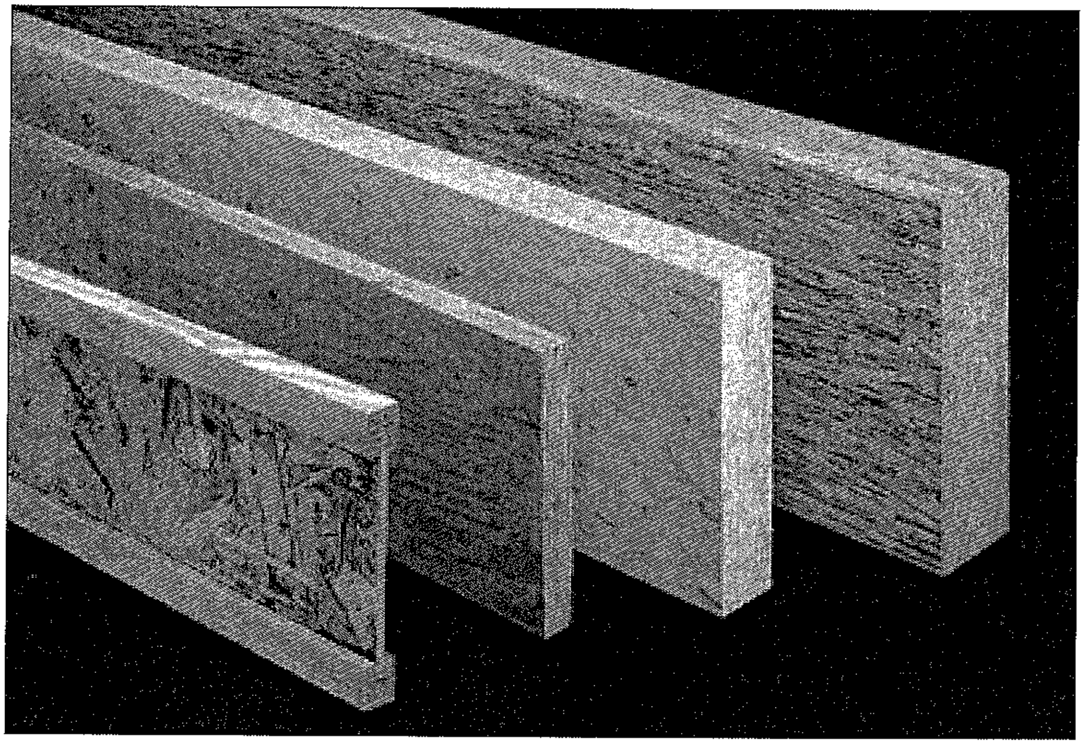
Plank Size	Plank Species			
	Douglas Fir		Southern Pine	
	Dry (m.c. ≤ 19%)	Wet (m.c. < 30%)	Dry (m.c. ≤ 19%)	Wet (m.c. < 30%)
1½" x 9¼"	3.8	4.6	4.2	4.8
1½" x 9½"	3.9	4.8	4.4	4.9
1½" x 11¾"	4.8	5.9	5.4	6.1
1¾" x 9"	4.3	5.3	4.8	5.5
1¾" x 9½"	4.5	5.5	5.1	5.8
1¾" x 11¾"	5.6	6.9	6.3	7.1
2" x 12"	6.5	8.0	7.3	8.3
2¼" x 11¾"	7.2	8.8	8.1	9.2
2½" x 11¾"	8.0	9.8	9.0	10.2

A handheld, needle-probe, electrical-resistance meter provides an alternative method of determining whether the moisture content of a plank is high. Generally, the recommended procedure is to drive the probes in about ¼ of the plank's thickness to get the average of the section. If the meter has two probes, they should be inserted so they read along the grain. Measurements should be taken in a few different locations. The glue lines in Microllam® LVL affect electrical resistance, making it necessary to adjust the meter reading by a factor of approximately ⅝. This factor is likely to vary, depending on the make and model of the meter. The moisture meter manufacturer will provide other adjustment factors for species and temperature. If the surface of the plank is wet, dirty, or contaminated, or if the plank has been fire-retardant treated, the meter will give false readings. If the meter reading suggests a high moisture content, set the plank aside to dry and retest it.

Table 2—Microllam® LVL Scaffold Plank Test Loads

Plank Size	Test Span (ft)	Test Load (lbs)	Maximum Deflection (in.)
1½" x 9¼"	7	480	1.29
	8	420	1.69
	10	340	2.67
	14	240	5.18
1½" x 9½"	7	490	1.29
	8	430	1.69
	10	340	2.60
	14	250	5.25
1½" x 11¾"	7	610	1.30
	8	530	1.68
	10	430	2.66
	14	300	5.10
1¾" x 9"	7	480	0.84
	8	420	1.09
	10	330	1.68
	14	240	3.35
1¾" x 9½"	7	500	0.83
	8	440	1.09
	10	350	1.69
	14	250	3.31
1¾" x 11¾"	7	620	0.83
	8	540	1.08
	10	430	1.68
	14	310	3.32
2" x 12"	14	340	2.39
	16	300	3.14
	18	270	4.03
	20	240	4.91
2¼" x 11¾"	14	420	2.11
	16	370	2.78
	18	330	3.53
	20	300	4.40
2½" x 11¾"	14	520	1.91
	16	460	2.52
	18	410	3.20
	20	370	3.96

1. Bending stresses induced by the test loads approximate allowable design stresses for dry, untreated planks.
2. The maximum deflection shown is 25% higher than the amount calculated using the design modulus of elasticity. This is intended to account for the variability of the material and moisture content of 19% or less.
3. Deflection is directly proportional to load. If the test load used is 20% lower than the test load shown above, the maximum deflection shown above should be decreased by 20%.



Wood this good doesn't grow on trees

Trus Joist's family of engineered wood products offers a wide range of creative scaffolding and concrete formwork solutions. Contact your Trus Joist representative for assistance with needle beam, long-span work deck, and custom scaffolding applications.

PRODUCT APPLICATION ASSURANCE

DO IT RIGHT FIRST!!

BUILD SAFELY

Please be sure you read, understand, and follow all OSHA fall protection guidelines.

We at Trus Joist are committed to working safely and want to remind you to do the same. We encourage you to follow the recommendations of OSHA (www.osha.gov) in the U.S. or provincial regulations (www.canoshweb.org/en/) in Canada regarding:

- Personal protective equipment (PPE) for hands, feet, head, and eyes
- Fall protection
- Use of pneumatic nailers and other hand tools
- Forklift safety

Please adhere to the Trus Joist product installation details, including the installation of safety strut lines on unsheathed floors and roofs.

For more information about Trus Joist or to contact your nearest technical representative, call us toll-free:

1-877-856-9663

www.trusjoist.com

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September 2004 JM/5M
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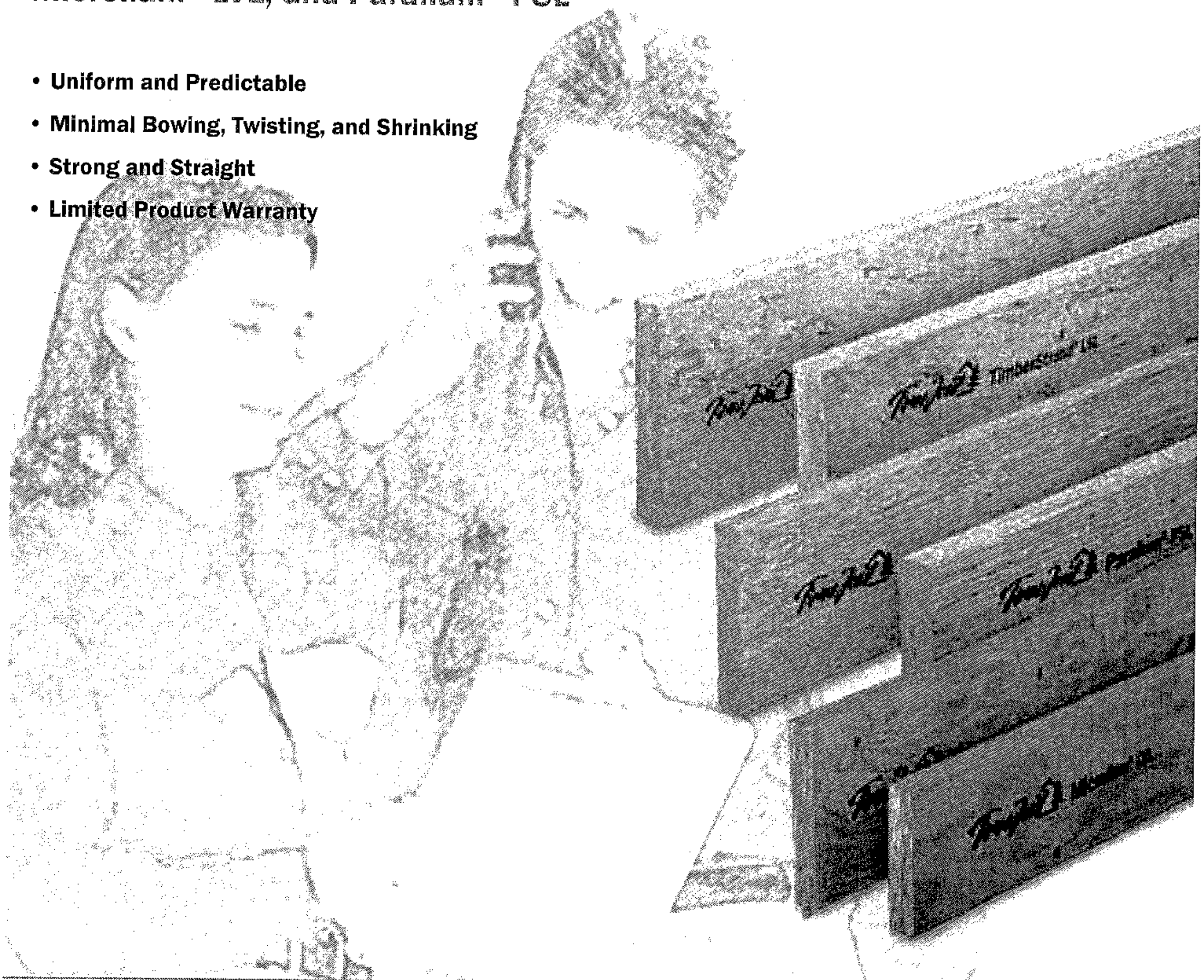
ENGINEERED WOOD PRODUCTS

#TJ-9000 SPECIFIER'S GUIDE

BEAMS, HEADERS, AND COLUMNS

Featuring Trus Joist® TimberStrand® LSL, Microllam® LVL, and Parallam® PSL

- **Uniform and Predictable**
- **Minimal Bowing, Twisting, and Shrinking**
- **Strong and Straight**
- **Limited Product Warranty**



The products in this guide are readily available through our nationwide network of distributors and dealers. For more information on other applications or other Trus Joist products, contact your Weyerhaeuser representative.

TABLE OF CONTENTS

SUSTAINABLE FORESTRY INITIATIVE

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SFI-00008

Why Choose Trus Joist® Beams, Columns, and Headers?

- Reliable performance
- Consistent quality and dependable uniformity
- Flexible solutions for your beam and header needs
- Backed by a limited product warranty

Using advanced technology, Weyerhaeuser manufactures engineered lumber that is consistently straight and strong, and resists bowing, twisting, and shrinking. That means less waste, easier installation, and higher design values for starters; plus fewer callbacks, shorter cycle times, more design flexibility, and lower overall installed cost in the end. Trus Joist® TimberStrand® LSL, Microllam® LVL, and Parallam® PSL are structural solutions you can count on—guaranteed.

This guide features Trus Joist® engineered lumber in the following widths and depths:

• TimberStrand® LSL

1.55E TimberStrand® LSL sizes:
Widths: 1¾" and 3½"
Depths: 9¼", 9½", 11¼", 11⅞", 14", and 16"

1.3E TimberStrand® LSL header sizes:
Width: 3½"
Depths: 4⅜", 5½", 7¼", 8⅝", 9¼", and 11¼"

1.3E TimberStrand® LSL column and post sizes:
3½" x 3½"   3½" x 4⅜"   3½" x 5½"   3½" x 7¼"   3½" x 8⅝"

• Microllam® LVL

1.9E Microllam® LVL header and beam sizes:
Width: 1¾"
Depths: 5½", 7¼", 9¼", 9½", 11¼", 11⅞", 14", 16", 18", and 20"

• Parallam® PSL

2.0E Parallam® PSL header and beam sizes:
Widths: 3½", 5¼", and 7"
Depths: 9¼", 9½", 11¼", 11⅞", 14", 16", and 18"

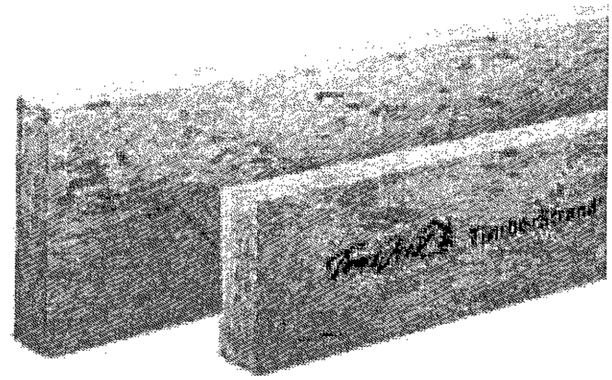
1.8E Parallam® PSL column and post sizes:
3½" x 3½"   3½" x 5¼"   3½" x 7"   5¼" x 5¼"   5¼" x 7"   7" x 7"

For deeper depth Parallam® PSL beams, see the Trus Joist® 2.2E Parallam® PSL Deep Beam guide, #TJ-7001, or contact your Weyerhaeuser representative.

Some sizes may not be available in your region.

Trus Joist® TimberStrand®
Laminated Strand Lumber (LSL)

- One-piece members reduce labor time
- Every piece is straight and strong
- Unique properties allow you to drill larger holes through 1.55E TimberStrand® LSL. See Allowable Holes on page 36.



TimberStrand® LSL Grade Verification

TimberStrand® LSL is available in more than one grade. The product is stamped with its grade information, as shown in the examples below. With 1.55E TimberStrand® LSL, larger holes can be drilled through the beam.

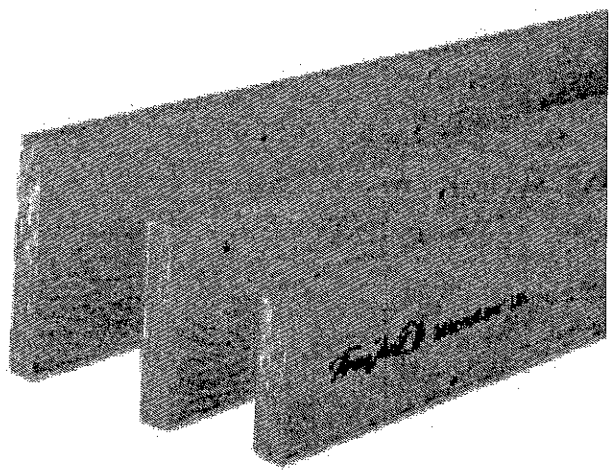
TrusJoist TimberStrand® LSL 1.3E ICCES ESR-1387 CCMC 12627-R SFI Certified Sourcing SFI-00008 PFS 0572 Made in Canada 09-15-11 02 03:20

TrusJoist TimberStrand® LSL 1.55E ROUND HOLE ZONE NO holes within 8" of beam ends ICCES ESR-1387 CCMC 12627-R SFI Certified Sourcing SFI-00008 PFS 0572 Made in Canada 09-15-11 02 03:20

Actual stamps shown.

Code Evaluations: See ICC ES ESR-1387 and HUD MR 1265

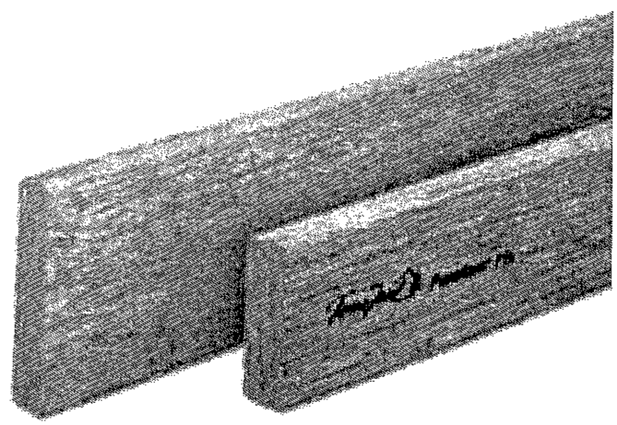
Trus Joist® Microllam®
Laminated Veneer Lumber (LVL)



- Can easily be built up on site to reduce heavy lifting
- Offers reliable and economical solutions for beam and header applications
- Manufacturing process minimizes many of the natural inconsistencies found in wood
- Available in some regions with a Watershed™ overlay for on-site weather protection

Code Evaluations: See ICC ES ESR-1387 and HUD MR 925

Trus Joist® Parallam®
Parallel Strand Lumber (PSL)



- Allows long spans for open floor plans without intermediate posts or columns
- Has warm, unique grain that is perfect for applications with exposed beams
- Provides ideal solutions for cantilever and multi-span applications
- Solid sections save time on site assembly
- Available in some regions with preservative treatment for exterior applications

Code Evaluations: See ICC ES ESR-1387 and HUD MR 1303

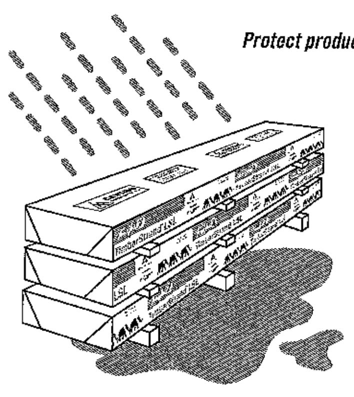
Allowable Design Properties(1) (100% Load Duration)

Grade	Width	Design Property	Depth 4⅜"	5½"	5½" Plank Orientation	7¼"	8⅝"	9¼"	9½"	11¼"	11⅞"	14"	16"	18"	20"
TimberStrand® LSL															
1.3E	3½"	Moment (ft-lbs)	1,735	2,685	1,780	4,550	6,335	7,240		10,520					
		Shear (lbs)	4,085	5,135	1,925	6,765	8,050	8,635		10,500					
		Moment of Inertia (in.⁴)	24	49	20	111	187	231		415					
		Weight (plf)	4.5	5.6	5.6	7.4	8.8	9.4		11.5					
1.55E	1¾"	Moment (ft-lbs)						4,950	5,210	7,195	7,975	10,920	14,090		
		Shear (lbs)						3,345	3,435	4,070	4,295	5,065	5,785		
		Moment of Inertia (in.⁴)						115	125	208	244	400	597		
		Weight (plf)						5.1	5.2	6.2	6.5	7.7	8.8		
	3½"	Moment (ft-lbs)						9,905	10,420	14,390	15,955	21,840	28,180		
		Shear (lbs)						6,690	6,870	8,140	8,590	10,125	11,575		
		Moment of Inertia (in.⁴)						231	250	415	488	800	1,195		
		Weight (plf)						10.1	10.4	12.3	13	15.3	17.5		
Microllam® LVL															
1.9E	1¾"	Moment (ft-lbs)		2,125		3,555		5,600	5,885	8,070	8,925	12,130	15,555	19,375	23,580
		Shear (lbs)		1,830		2,410		3,075	3,160	3,740	3,950	4,655	5,320	5,985	6,650
		Moment of Inertia (in.⁴)		24		56		115	125	208	244	400	597	851	1,167
		Weight (plf)		2.8		3.7		4.7	4.8	5.7	6.1	7.1	8.2	9.2	10.2
Parallam® PSL															
2.0E	3½"	Moment (ft-lbs)						12,415	13,055	17,970	19,900	27,160	34,955	43,665	
		Shear (lbs)						6,260	6,430	7,615	8,035	9,475	10,825	12,180	
		Moment of Inertia (in.⁴)						231	250	415	488	800	1,195	1,701	
		Weight (plf)						10.1	10.4	12.3	13.0	15.3	17.5	19.7	
	5¼"	Moment (ft-lbs)						18,625	19,585	26,955	29,855	40,740	52,430	65,495	
		Shear (lbs)						9,390	9,645	11,420	12,055	14,210	16,240	18,270	
		Moment of Inertia (in.⁴)						346	375	623	733	1,201	1,792	2,552	
		Weight (plf)						15.2	15.6	18.5	19.5	23.0	26.3	29.5	
	7"	Moment (ft-lbs)						24,830	26,115	35,940	39,805	54,325	69,905	87,325	
		Shear (lbs)						12,520	12,855	15,225	16,070	18,945	21,655	24,360	
		Moment of Inertia (in.⁴)						462	500	831	977	1,601	2,389	3,402	
		Weight (plf)						20.2	20.8	24.6	26.0	30.6	35.0	39.4	

(1) For product in beam orientation, unless otherwise noted.

Some sizes may not be available in your region.

PRODUCT STORAGE



Protect product from sun and water

CAUTION:
Wrap is slippery when wet or icy

Use support blocks at 10' on-center to keep bundles out of mud and water

Design Stresses(1) (100% Load Duration)

Grade	Orientation	G Shear Modulus of Elasticity (psi)	E Modulus of Elasticity (psi)	E_{min} Adjusted Modulus of Elasticity(2) (psi)	F_b Flexural Stress(3) (psi)	F_t Tension Stress(4) (psi)	$F_{c\perp}$ Compression Perpendicular to Grain(5) (psi)	$F_{c\parallel}$ Compression Parallel to Grain (psi)	F_v Horizontal Shear Parallel to Grain (psi)	SG Equivalent Specific Gravity(6)
TimberStrand® LSL										
1.3E	Beam/Column	81,250	1.3×10^6	660,750	1,700	1,075	680	1,400	400	0.50(7)
1.3E	Plank	81,250	1.3×10^6	660,750	1,900(8)	1,075	435	1,400	150	0.50(7)
1.55E	Beam	96,875	1.55×10^6	787,815	2,325	1,070(9)	800	2,050	310(9)	0.50(7)
Microllam® LVL										
1.9E	Beam	118,750	1.9×10^6	965,710	2,600	1,555	750	2,510	285	0.50
Parallam® PSL										
1.8E	Column	112,500	1.8×10^6	914,880	2,400(10)	1,755	425(10)	2,500	190(10)	0.50
2.0E	Beam	125,000	2.0×10^6	1,016,535	2,900	2,025	750	2,900(11)	290	0.50

(1) Unless otherwise noted, adjustment to the design stresses for duration of load are permitted in accordance with the applicable code.

(2) Reference modulus of elasticity for beam stability and column stability calculations, per NDS® 2005.

(3) For 12" depth. For other depths, multiply F_b by the appropriate factor as follows:

- For TimberStrand® LSL, multiply by $\left[\frac{12}{d}\right]^{0.092}$
- For Microllam® LVL, multiply by $\left[\frac{12}{d}\right]^{0.136}$
- For Parallam® PSL, multiply by $\left[\frac{12}{d}\right]^{0.111}$

(4) F_t has been adjusted to reflect the volume effects for most standard applications.

(5) $F_{c\perp}$ may not be increased for duration of load.

(6) For lateral connection design only.

(7) Specific gravity of 0.58 may be used for bolts installed perpendicular to face and loaded perpendicular to grain.

(8) Values are for thickness up to 3½".

(9) Values account for large hole capabilities. See **Allowable Holes** on page 36.

(10) Values are for plank orientation.

(11) For column applications, use $F_{c\parallel}$ of 500 psi.

General Assumptions for Trus Joist® Beams

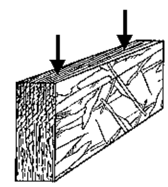
- Lateral support is required at bearing and along the span at 24" on-center, maximum.
- Bearing lengths are based on each product's bearing stress for applicable grade and orientation.
- All members 7¼" and less in depth are restricted to a maximum deflection of 5⁄16".
- Beams that are 1¾" x 16" and deeper require multiple plies.
- No camber.
- Beams and columns must remain straight to within $\frac{5L^2}{4608}$ (in.) of true alignment. L is the unrestrained length of the member in feet.
- Tables on pages 8–15 include load reductions applied in accordance with code.

For applications not covered in this brochure, contact your Weyerhaeuser representative.

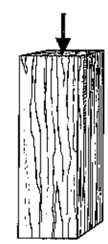
See pages 38 and 39 for multiple-member beam connections.

TimberStrand® LSL, Microllam® LVL, and untreated Parallam® PSL are intended for dry-use applications

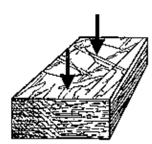
Beam Orientation



Column Orientation



Plank Orientation



APPENDIX "I"

Technical Data: Sherwin Williams HangTuf Tarps

HangTuf Containment TARPS

INDUSTRIAL & MARINE COATINGS

CN-1 FR Coated 6.5 oz. |Class: 1,2,&3

Material Type	Airbag
Thread Count Per Inch	41x41
Weave	Plain
Thickness	14 mils
Weight Coated	6.5 oz./yd.2
Tensile Strength ASTM D-5034-5 | Grab Method	Warp: 535 lbs. Fill: 507 lbs.
Tear Strength ASTM D-4533-91 | Trap Method	Warp: 151 lbs. Fill: 122 lbs.
Burst Strength ASTM D-3786 | Mullen	1,050 PSI
Flame Resistance	FMVSS 302 PASS

Physical Tests are Based on Uncoated Fabrics. These Values are Typical Data and are not Intended as Limiting Specifications.

- Custom Designs Available
- Standard Sizes in Deluxe Construction Available
- Grommet Spacing: To Customer Spec (Standard Every 2 ft.)
- Hem & Seam Construction: Heat Sealed or Double Stitched
- 2" Nylon Webbing Reinforcment for Stiched Hems & Seams
- Priced By Square Foot

Manufactured exclusively for

THE SHERWIN-WILLIAMS COMPANY

Industrial & Marine Coatings Division

by:

Polytuf Brands Inc.

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