WOOD RODGERS

October 8, 2014

Mr. James DiGiorgia, P.E.
Supervising Civil Engineer
Department of General Services
916 375-4268
James.digiorgio@dgs.ca.gov

Attention: Mr. DiGiorgio

Scaffolding at 450 N Street
Structural Capacity Review
WR Job 8482.XXX
Sacramento, California

Dear Mr. DiGiorgio:

Enclosed please find the results of our Structural Assessment Review of the Scaffolding framing at 450 N Street, Sacramento.

Please do not hesitate to call the undersigned should you have any questions or require any further information.

Sincerely,
WOOD RODGERS, INC.

Gerardo V. Calvillo, Jr., SE 2920
Principal Structural Engineer

Enclosure

Scaffolding at 450 N Street

Structural Assessment Review
Sacramento, California

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

Wood Rodgers, Inc. is pleased to submit this report summarizing the structural assessment review of the Scaffolding at 450 N Street conducted on August 29th and September 4th, 2014 by Gerardo V. Calvillo Jr., SE of Wood Rodgers, Inc. The main directive of this report is to offer information with regards to the general condition of existing construction.

The scope of services completed to accomplish the above included the following:

- Provide job site visit to visually inspect general structural condition of materials.
- Review existing available construction documents.
- View accessible spaces to identify structural components.
- Prepare short report summarizing structural system description and identify component considerations.

1.2 WARRANTY

Wood Rodgers, Inc. has performed the tasks outlined as a basis for providing an evaluation of the subject assemblies. This evaluation represents our professional opinion based on the recommendations and guidelines represented in the California Building Code for Protection of Pedestrians under Section 3306. This survey is prepared by visual observation only and no measurement devices or equipment were used.

2.0 GENERAL COMMENTS

Gerardo Calvillo was able to review the Kirk Tatman, PE documents provided by James DiGiorgio that pertained to the original design of the area of study. The calculations prepared by Kirk Tatman indicated that W8x10 beams provide the main support at the scaffold columns. Gerardo Calvillo verified at the site that 4x6 spaced at 16 inches span to the W8x10 members and support 5 ply – ¾ inch thick plywood. Steel clamps connect each end of the W8x10 to the scaffold frame column.

3.0 COMPONENT CONCLUSIONS

In general, the Scaffolding appears to be in good condition. The capacity of the Scaffolding has been checked by calculation. The calculation is included in this report. In summary, the approximate capacity of components follows:

- W8x10 – 291 pounds per square feet
- 4x6 @ 16" spacing – 195 pounds per square feet
- ¾ - 5 Ply plywood – 351 pounds per square feet
- Scaffold support – 390 pounds per square feet

The Beam clamp that connects the W8x10 to the Scaffolding column is sufficient for continuity of gravity loads. Our field survey review and independent calculations confirms that the installed scaffolding system and components is in compliance with code requirement section 3306 of the CBC.

We strive to perform our professional services in accordance with generally accepted engineering principles and practices currently employed in the area; no warranty is expressed or implied.

4.0 Photos

Photo 1 – View of Scaffolding looking North on 5th Street, note.

Photo 2 – Typical scaffold brace and column supports.

Photo 3 – Typical C-clamp.

Photo 4 – View of W8x10 Bearing at Scaffold Columns.

5.0 DESIGN REQUIREMENT DATA

Steel Beam

Description : --None--

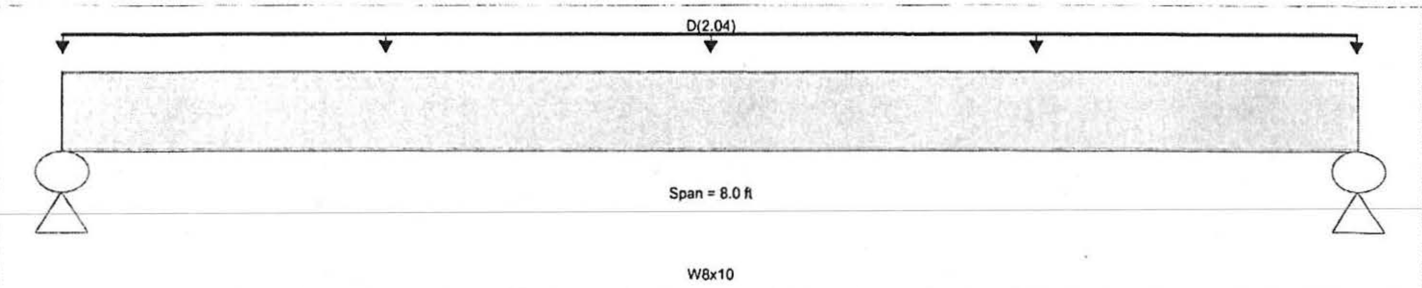
CODE REFERENCES

Calculations per
Load Combination Set : ASCE 7-05

Material Properties

Analysis Method : Allowable Strength Design
Beam Bracing : Completely Unbraced
Bending Axis : Major Axis Bending
Load Combination ASCE 7-05

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



Applied Loads

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

Beam self weight calculated and added to loads
Uniform Load : D = 2.040 k/ft, Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	**0.996 : 1**	Maximum Shear Stress Ratio =	**0.306 : 1**
Section used for this span	**W8x10**	Section used for this span	**W8x10**
Ma : Applied	16.401 k-ft	Va : Applied	8.20 k
Mn / Omega : Allowable	16.460 k-ft	Vn/Omega : Allowable	26.826 k
Load Combination	D Only	Load Combination	D Only
Location of maximum on span	4.000ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.213 in	Ratio =	450
Max Upward Total Deflection	0.000 in	Ratio =	0 <180

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios		Summary of Moment Values							Summary of Shear Values		
Segment Length	Span #	M	V	Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega
D Only													
Dsgn. L = 8.00 ft	1	0.996	0.306	16.40		16.40	27.49	16.46	1.14	1.00	8.20	40.24	26.83
+D+L+H													
Dsgn. L = 8.00 ft	1	0.996	0.306	16.40		16.40	27.49	16.46	1.14	1.00	8.20	40.24	26.83
+D+Lr+H													
Dsgn. L = 8.00 ft	1	0.996	0.306	16.40		16.40	27.49	16.46	1.14	1.00	8.20	40.24	26.83
+D+S+H													
Dsgn. L = 8.00 ft	1	0.996	0.306	16.40		16.40	27.49	16.46	1.14	1.00	8.20	40.24	26.83
+D+0.750Lr+0.750L+H													
Dsgn. L = 8.00 ft	1	0.996	0.306	16.40		16.40	27.49	16.46	1.14	1.00	8.20	40.24	26.83
+D+0.750L+0.750S+H													
Dsgn. L = 8.00 ft	1	0.996	0.306	16.40		16.40	27.49	16.46	1.14	1.00	8.20	40.24	26.83
+D+W+H													
Dsgn. L = 8.00 ft	1	0.996	0.306	16.40		16.40	27.49	16.46	1.14	1.00	8.20	40.24	26.83
+D+0.70E+H													
Dsgn. L = 8.00 ft	1	0.996	0.306	16.40		16.40	27.49	16.46	1.14	1.00	8.20	40.24	26.83
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 8.00 ft	1	0.996	0.306	16.40		16.40	27.49	16.46	1.14	1.00	8.20	40.24	26.83
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 8.00 ft	1	0.996	0.306	16.40		16.40	27.49	16.46	1.14	1.00	8.20	40.24	26.83
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 8.00 ft	1	0.996	0.306	16.40		16.40	27.49	16.46	1.14	1.00	8.20	40.24	26.83

Description : --None--

Load Combination		Max Stress Ratios		Summary of Moment Values							Summary of Shear Values		
Segment Length	Span #	M	V	Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega
+0.60D+W+H													
Dsgn. L = 8.00 ft	1	0.598	0.183	9.84		9.84	27.49	16.46	1.14	1.00	4.92	40.24	26.83
+0.60D+0.70E+H													
Dsgn. L = 8.00 ft	1	0.598	0.183	9.84		9.84	27.49	16.46	1.14	1.00	4.92	40.24	26.83

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D Only	1	0.2132	4.040		0.0000	0.000

Vertical Reactions - Unfactored

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	8.200	8.200
Overall MINimum	8.200	8.200
D Only	8.200	8.200

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ENERCALC, INC. 1983-2014, Build:6.14.6.15, Ver:6.14.6.15

Wood Beam

Lic. # : KW-06003316 **Licensee : wood rodgers**

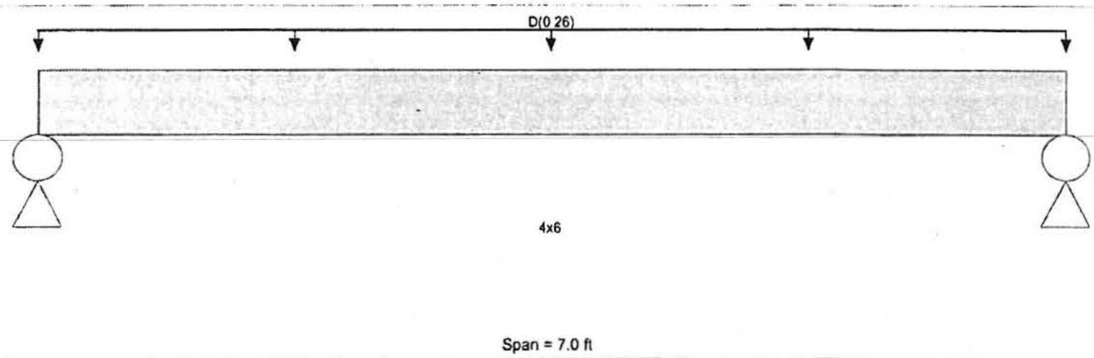
Description : 4x6 Joists

CODE REFERENCES

Calculations per
Load Combination Set : ASCE 7-05

Material Properties

Analysis Method :	Allowable Stress Design	Fb - Tension	850 psi	*E : Modulus of Elasticity*	
Load Combination	ASCE 7-05	Fb - Compr	850 psi	Ebend- xx	1600 ksi
		Fc - Prll	1400 psi	Eminbend - xx	580 ksi
Wood Species	: Douglas Fir - Larch (North)	Fc - Perp	625 psi		
Wood Grade	: No. 1/No. 2	Fv	180 psi		
		Ft	500 psi	Density	31.57 pcf
Beam Bracing	: Completely Unbraced				



Applied Loads

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

Beam self weight calculated and added to loads
Uniform Load : D = 0.260 , Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.999 : 1	Maximum Shear Stress Ratio	=	0.351 : 1
Section used for this span		4x6	Section used for this span		4x6
fb : Actual	=	1,100.55psi	fv : Actual	=	63.12 psi
FB : Allowable	=	1,101.50psi	Fv : Allowable	=	180.00 psi
Load Combination		D Only	Load Combination		D Only
Location of maximum on span	=	3.500ft	Location of maximum on span	=	6.566 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.185 in	Ratio =	454
Max Upward Total Deflection	0.000 in	Ratio =	0 <180

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios									Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
D Only					1.300	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.0 ft	1	0.999	0.351	1.00	1.300	1.00	1.00	1.00	1.00	1.00	1.62	1,100.55	1101.50	0.81	63.12	180.00
+D+L+H					1.300	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.0 ft	1	0.999	0.351	1.00	1.300	1.00	1.00	1.00	1.00	1.00	1.62	1,100.55	1101.50	0.81	63.12	180.00
+D+Lr+H					1.300	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.0 ft	1	0.999	0.351	1.00	1.300	1.00	1.00	1.00	1.00	1.00	1.62	1,100.55	1101.50	0.81	63.12	180.00
+D+S+H					1.300	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.0 ft	1	0.999	0.351	1.00	1.300	1.00	1.00	1.00	1.00	1.00	1.62	1,100.55	1101.50	0.81	63.12	180.00
+D+0.750Lr+0.750L+H					1.300	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.0 ft	1	0.999	0.351	1.00	1.300	1.00	1.00	1.00	1.00	1.00	1.62	1,100 55	1101.50	0.81	63.12	180.00
+D+0.750L+0.750S+H					1.300	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00

Wood Beam

File = C:\PROGRA~2\ENERCA~1
ENERCALC, INC. 1983-2014, Build:6.14.6.15, Ver:6.14.6.15

Lic. # : KW-06003316 | **Licensee : wood rodgers**

Description : 4x6 Joists

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	Moment Values M	fb	F'b	Shear Values V	fv	F'v
Length = 7.0 ft	1	0.999	0.351	1.00	1.300	1.00	1.00	1.00	1.00	1.00	1.62	1,100.55	1101.50	0.81	63.12	180.00
+D+W+H					1.300	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.0 ft	1	0.999	0.351	1.00	1.300	1.00	1.00	1.00	1.00	1.00	1.62	1,100.55	1101.50	0.81	63.12	180.00
+D+0.70E+H					1.300	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.0 ft	1	0.999	0.351	1.00	1.300	1.00	1.00	1.00	1.00	1.00	1.62	1,100.55	1101.50	0.81	63.12	180.00
+D+0.750Lr+0.750L+0.750W+H					1.300	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.0 ft	1	0.999	0.351	1.00	1.300	1.00	1.00	1.00	1.00	1.00	1.62	1,100.55	1101.50	0.81	63.12	180.00
+D+0.750L+0.750S+0.750W+H					1.300	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.0 ft	1	0.999	0.351	1.00	1.300	1.00	1.00	1.00	1.00	1.00	1.62	1,100.55	1101.50	0.81	63.12	180.00
+D+0.750Lr+0.750L+0.5250E+H					1.300	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.0 ft	1	0.999	0.351	1.00	1.300	1.00	1.00	1.00	1.00	1.00	1.62	1,100.55	1101.50	0.81	63.12	180.00
+D+0.750L+0.750S+0.5250E+H					1.300	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.0 ft	1	0.999	0.351	1.00	1.300	1.00	1.00	1.00	1.00	1.00	1.62	1,100.55	1101.50	0.81	63.12	180.00
+0.60D+W+H					1.300	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.0 ft	1	0.599	0.210	1.00	1.300	1.00	1.00	1.00	1.00	1.00	0.97	660.33	1101.50	0.49	37.87	180.00
+0.60D+0.70E+H					1.300	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 7.0 ft	1	0.599	0.210	1.00	1.300	1.00	1.00	1.00	1.00	1.00	0.97	660.33	1101.50	0.49	37.87	180.00

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D Only	1	0.1849	3.526		0.0000	0.000

Vertical Reactions - Unfactored

Support notation : Far left is #1 — Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	0.925	0.925
Overall MINimum	0.925	0.925
D Only	0.925	0.925

TECO
BUILDING CONFIDENCE

TECH TIP

Design Capacities for Structural Plywood

Allowable Stress Design (ASD)

The design values in this document correspond with those published in the 2005 edition of the AF&PA American Wood Council's *Allowable Stress Deign (ASD)/LRFD Manual for Engineered Wood Construction*. TECO has chosen to do so to provide harmony among users--architects, engineers, specifiers and the regulatory community. These are "Industry Recommended" values, but are not rigorously evaluated for on-going verification.

Load capacities, which are presented here for allowable stress design (ASD) (Table A), are applicable to plywood panels qualified in accordance with TECO test protocol. Nominal panel thickness (Table B) assists in calculation of geometric cross-sectional properties. The applicable section properties (Table C) can be divided into load capacity to determine design strength and stiffness. Load capacities in Table A are based on normal duration of load for untreated panels under dry conditions. Because these values are plywood-specific, the appropriate panel grade and construction adjustment factors, C_G, have already been applied. Designers must be careful to avoid making the C_G adjustments again.

Adjustment factors for other conditions are permitted in accordance with applicable code provisions. The *National Design Specification for Wood Construction* (NDS) provides guidance on the use of adjustment factors.

General Design Information

Methods presented in this section may be used to calculate uniform load capacity of structural-use panels in floor, roof and wall applications. The design capacities presented in Table A include the grade and construction factor, C_G. Other applicable adjustment factors as specified in Section 9.3 of the 2005 edition of the ANSI/AF&PA NDS-2005, National Design Specifications (NDS) for Wood Construction ASD/LRFD and Section C9.3 of the 2005 Edition of the AF&PA American Wood Councils' *Commentary National Design Specification (NDS) for Wood Construction ASD/LRFD*, should be applied to the design capacities.

There are three possible span conditions to consider when computing the uniform load capacities of structural-use panels depending on the size and orientation of the panel and the spacing of the framing support members. These include single-span, two-span and three-span (see below). For normal framing practice and standard panel size (i.e., 4x8 foot), when the panel strength axis is perpendicular to framing supports, the three-span condition is used for support spacing up to and including 32 inches on center. Use the two-span condition for support spacing greater than 32 inches on center but no greater than 48 inches on center. When the panel strength axis is placed parallel to framing supports, the three-span condition is used for support spacing up to and including 16 inches on center. Use the two-span condition for support spacing greater than 16 inches but no greater than 24 inches on center. Use the single-span condition for support spacing greater than 24 inches on center.

The formulas presented are for computing uniform loads on structural-use panels applied over conventional framing. These equations are based on standard beam formulas altered to accept the mixed units. For support spacing less than 48 inches, nominal two-inch framing members are assumed. For support spacing 48 inches and greater, nominal four-inch framing members are assumed. Since the formulas assume that no blocking is used, the formulas are for one-way "beam" action rather than two-way "plate" action. The resulting loads are for the structural panels only and do not account for the design of the framing support members. The resulting loads calculated from the equations are assumed to apply to full size panels in standard sheathing applications. Considerations for concentrated loads should be made in compliance with local building codes and maximum span recommendations.

Table A
Wood Structural Panel Design Capacities Based on Span Ratings[a]

Span Rating		Strength							Planar Shear		Stiffness and Rigidity				
		Bending F_bS (lb-in/ft of width)		Axial Tension F_tA (lb/ft of width)		Axial Compression F_cA (lb/ft of width)		Shear through the thickness[b,c] $F_v t_v$ (lb/in of shear-resisting panel length)	Planar Shear F_s (lb/Q) (lb/ft of width)		Bending EI (lb-in^2/ft of width)		Axial EA (lb/ft of width x 10^6)		Rigidity through the thickness $G_v t_v$ (lb/in of panel depth)
		Capacities relative to strength axis[d]													
		0°	90°	0°	90°	0°	90°	0° / 90°	0°	90°	0°	90°	0°	90°	0° / 90°
Sheathing Span®															
24/0	3-ply	250	54	2,300	600	2,850	2,500	53	156	273	66,000	3,600	3.35	2.90	25,000
32/16	3-ply	370	92	2,800	1,250	3,550	3,100	62	198	347	126,500	8,100	4.15	3.60	27,000
	4-ply	407	110	2,800	1,250	5,325	4,650	81	198	479	126,500	17,820	4.15	3.60	35,100
	5-ply	444	166	3,640	1,625	5,325	4,650	93	215	165	126,500	25,110	4.15	3.60	40,500
40/20	3-ply	625	150	2,900	1,600	4,200	4,000	68	246	431	247,500	18,000	5.00	4.50	28,500
	4-ply	688	180	2,900	1,600	6,300	6,000	88	246	595	247,500	39,600	5.00	4.50	37,050
	5-ply	750	270	3,770	2,080	6,300	6,000	102	267	205	247,500	55,800	5.00	4.50	42,750
48/24	4-ply	930	270	4,000	1,950	7,500	7,200	98	300	725	440,000	64,900	5.85	5.00	40,300
	5-ply	1,014	405	5,200	2,535	7,500	7,200	113	325	250	440,000	91,450	5.85	5.00	46,500
Floor Span®															
20 oc	4-ply	528	168	2,900	1,600	6,300	6,000	87	246	595	231,000	28,600	5.00	4.50	36,400
	5-ply	576	252	3,770	2,080	6,300	6,000	101	267	205	231,000	40,300	5.00	4.50	42,000
24 oc	4-ply	704	258	3,350	1,950	7,500	7,200	96	300	725	330,000	57,200	5.85	5.00	39,000
	5-ply	768	387	4,355	2,535	7,500	7,200	111	325	250	330,000	80,600	5.85	5.00	45,000
32 oc	5-ply	1,044	684	5,200	3,250	9,450	9,300	120	390	300	715,000	232,500	7.50	7.30	54,000
48 oc	5-ply	1,920	1,224	7,280	4,745	12,150	10,800	158	501	385	1,265,000	496,000	8.20	7.30	75,750

(a) The design values in this table correspond with those published in the 2005 edition of the AF&PA American Wood Council's *Allowable Stress Deign (ASD)/LRFD Manual for Engineered Wood Construction* Tables M9.2.1- M9.2.4, which are available from the AF&PA American Wood Council. The appropriate panel grade and construction adjustment factor, C_G, has already been incorporated into these design values—do not apply the C_G factor a second time. These values do not apply to Structural I panels. See Tables M9.2.1 – M9.2.4 for the appropriate multipliers for Structural I panels.

(b) Shear through the thickness design capacities are limited to sections two feet or less in width; wider sections may require further reductions.

(c) 5-ply applies to plywood with 5 or more layers; for 5-ply/3-layer plywood, use values for 4-ply plywood.

(d) Strength axis is defined as the axis parallel to the face and back orientation of the grain (veneer), which is generally the long panel direction, unless otherwise marked.

Table B
Relationship Between Span Rating and Nominal Thickness for Plywood[a]

Span Rating	Nominal Thickness[b] (in.)										
	3/8	7/16	15/32	1/2	19/32	5/8	23/32	3/4	7/8	1	1-1/8
	Sheathing Span®										
24/0	**0.375**	0.437	0.469	0.500							
24/16		**0.437**	0.469	0.500							
32/16			**0.469**	0.500	0.594	0.625					
40/20					**0.594**	0.625	0.719	0.750			
48/24							**0.719**	0.750	0.875		
	Floor Span®										
16 oc					**0.594**	0.625					
20 oc					**0.594**	0.625					
24 oc							**0.719**	0.750			
32 oc									**0.875**	1.000	
48 oc											**1.125**

(a) The values in this table correspond with those published in the 2005 edition of the AF&PA American Wood Council's *Commentary National Design Specification (NDS) for Wood Construction ASD/LRFD* Table C9.2.3, which is available from the AF&PA American Wood Council.
(b) The predominant thickness for each span rating is highlighted in **bold**.

Table C
Panel Section Properties[a,b] for Plywood

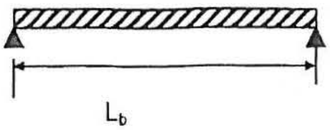
Nominal Thickness, t (in.)		Weight[c] (psf)	Cross Sectional Area, A (in.^{2}/ft)	Moment of Inertia, I (in.^{4}/ft)	Section Modulus, S (in.^{3}/ft)	Statical Moment, Q (in.^{3}/ft)	Shear Constant, Ib/Q (in.^{2}/ft)
Fraction	Decimal						
3/8	0.375	1.1	4.500	0.053	0.281	0.211	3.00
7/16	0.437	1.3	5.250	0.084	0.383	0.287	3.50
15/32	0.469	1.4	5.625	0.103	0.440	0.330	3.75
½	0.500	1.5	6.000	0.125	0.500	0.375	4.00
19/32	0.594	1.8	7.125	0.209	0.705	0.529	4.75
5/8	0.625	1.9	7.500	0.244	0.781	0.586	5.00
23/32	0.719	2.2	8.625	0.371	1.033	0.775	5.75
¾	0.750	2.3	9.000	0.422	1.125	0.844	6.00
7/8	0.875	2.6	10.500	0.670	1.531	1.148	7.00
1	1.000	3.0	12.000	1.000	2.000	1.500	8.00
1-1/8	1.125	3.4	13.500	1.424	2.531	1.898	9.00

(a) The values in this table correspond with those published in the 2005 edition of the AF&PA American Wood Council's *Commentary National Design Specification (NDS) for Wood Construction ASD/LRFD* Table C9.2.4, which is available from the AF&PA American Wood Council.
(b) Based on a rectangular cross sectional width of one foot
(c) Weight is based on an assumed panel density of 36 pcf.

Uniform Load Formulas for Structural-Use Panels [1]

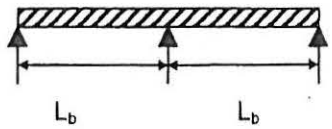
Uniform Loads Based on Bending

The following formulas may be used to calculate loads based on design bending (M):



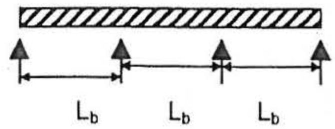
Single span:

$$w_b = \frac{96\,M}{L_b^{\,2}}$$



Two-span condition:

$$w_b = \frac{96\,M}{L_b^{\,2}}$$



Three-span condition:

$$w_b = \frac{120\,M}{L_b^{\,2}}$$

where:

w_b = uniform load based on bending strength (psf)
M = Bending Strength Capacity, F_bS in (lb.-in./ft.)
L_b = span (center-to-center of supports, in.)

Uniform Loads Based on Shear

The following formulas may be used to calculate uniform loads based on planar shear (V_s):

Single span:

$$w_s = \frac{24\,V_s}{L_s}$$

Two-span condition:

$$w_s = \frac{(19.2)\,V_s}{L_s}$$

Three-span condition:

$$w_s = \frac{20\,V_s}{L_s}$$

where:

w_s = uniform load based on shear strength (psf)
V_s = Planar Shear Capacity, $F_s(IB/Q)$ in (lb./ft.)
L_s = clear span (in., center-to-center of supports minus support width, in.)

Uniform Loads Based on Deflection Requirements

The following formulas may be used to calculate deflection under uniform load, or allowable loads based on deflection requirements.

Single span:

$$\Delta = \frac{w L_\Delta^4}{(921.6)EI}$$

Two-span condition:

$$\Delta = \frac{w L_\Delta^4}{(2220)EI}$$

Three-span condition:

$$\Delta = \frac{w L_\Delta^4}{(1743)EI}$$

where:

Δ = deflection (in.)
$w = w_{LL}$ = uniform live load (psf)
— Or —
$w = w_{TL}$ = uniform total load (psf)
EI = Bending Stiffness Capacity (lb.-in.^{2}/ft.)
L_Δ = clear span + SW (in.)
SW = support width factor, 0.25 inch for two-inch nominal lumber framing and 0.625 inch for four- inch nominal lumber framing.

[1]The formulas are standard beam formulas adjusted to accept mixed units. It is assumed the resulting loads are applied on all spans to full-sized panels in standard sheathing applications. Refer to the 2005 edition of the ANSI/AF&PA NDS-2005, National Design Specifications (NDS) for Wood Construction ASD/LRFD, for further requirements regarding the use of these formulas and appropriate adjustment factors available from the AF&PA American Wood Council.

Plywood Roof Design Example Calculations Using ASD

4x8 foot, 32/16, 4-ply, TECO SHEATHING SPAN® plywood panels are installed as roof sheathing over roof trusses (nominal 2 inch wide) spaced at 32 inches on-center. The panels are installed with the long panel direction (strength axis) perpendicular to the roof truss members. The job specifications indicate that the roof is to be designed to support a 20 psf snow load @ 1.15 load duration with an allowable live load deflection (w_{LL}) of span/240 and an allowable total load deflection (w_{TL}) of span/180. Determine if the specified panel will adequately meet these requirements.

Bending Strength

From Table A, the F_bS (bending capacity) of a 32/16, 4-ply SHEATHING SPAN panel installed with the stress applied parallel to the strength axis is equal to 407 lb-in/ft of width. The C_G factor (panel grade and construction factor) has already been applied to this capacity, but the load duration factor, C_D, of 1.15 can also be applied for snow load. Since the trusses are spaced at 32 in. on center and the panels are oriented with their 8 ft dimension perpendicular to the framing, use the equation for the three-span condition.

$$w_b = \frac{120\ F_bS}{L_b^{\ 2}}$$

$$w_b = \frac{120\ (407\ \text{lb-in/ft})\ (1.15)}{(32\ \text{in})^2}$$

$$\underline{w_b = 55\ \text{psf}}$$

Shear in the Plane Strength

From Table A, the $F_s(lb/Q)$, planar shear capacity, of a 32/16, 4-ply SHEATHING SPAN panel installed with the stress applied parallel to the strength axis is equal to 198 lb/ft of width. The C_G factor (panel grade and construction factor) has already been applied to this capacity, but the load duration factor, C_D, of 1.15 can also be applied for snow load.

$$w_s = \frac{20\ F_s(\text{lb/Q})}{L_s}$$

$$w_s = \frac{20\ (198\ \text{lb/ft})\ (1.15)}{(32\ \text{in} - 1.5\ \text{in})}$$

$$\underline{w_s = 149\ \text{psf}}$$

Bending Stiffness

From Table A, the EI (bending stiffness capacity) of a 32/16, 4-ply SHEATHING SPAN panel installed with the stress applied parallel to the strength axis is equal to 126,500 lb-in^2/ft of width. The C_G factor (panel grade and construction factor) has already been applied to this capacity. Notice that the load duration factor, C_D does not apply to bending stiffness.

$$\Delta_{LL} = \frac{w_{LL}\, L_\Delta^{\,4}}{(1743)\ EI}$$

$$w_{LL} = \frac{(1743)EI\,\Delta_{LL}}{L_\Delta^{\,4}} \quad \text{where } \Delta_{LL} = L/240$$

$$w_{LL} = \frac{(1743)(126{,}500\ \text{lb-in}^2/\text{ft})(32/240)}{(32\ \text{in} - 1.5\ \text{in} + .25\ \text{in})^4}$$

$$\underline{w_{LL} \approx 33\ \text{psf}}$$

$$\Delta_{TL} = \frac{w_{TL}\, L_\Delta^{\,4}}{(1743)\ EI}$$

$$w_{TL} = \frac{(1743)EI\,\Delta_{TL}}{L_\Delta^{\,4}} \quad \text{where } \Delta_{TL} = \text{span}/180$$

$$w_{TL} = \frac{(1743)(126{,}500\ \text{lb-in}^2/\text{ft})(32/180)}{(32\ \text{in} - 1.5\ \text{in} + .25\ \text{in})^4}$$

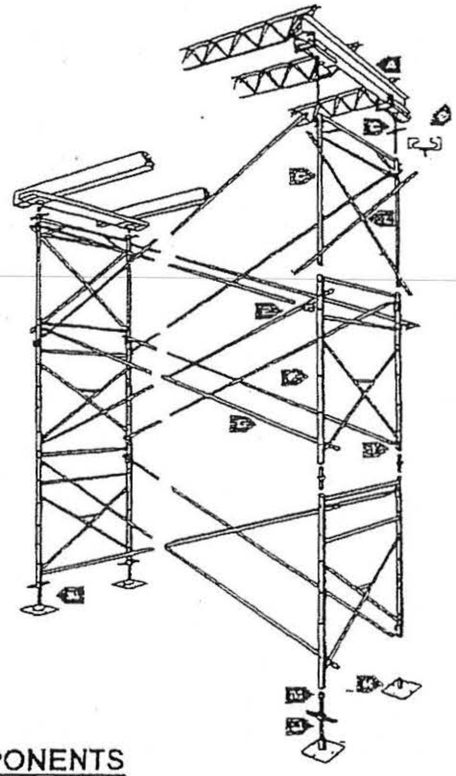
$$\underline{\underline{w_{TL} \approx 44\ \text{psf}}}$$

Based on the specifications for this design example, the design capacity of the 32/16, 4-ply SHEATHING SPAN plywood panels is controlled by bending stiffness. The 44 psf represents the maximum uniform load that can be applied to the panels before the deflection criterion of span/180 is exceeded. As long as the dead load of the roof system (i.e., weight of panels, shingles, etc.) does not exceed 24 psf (i.e. 44 psf total load – 20 psf snow load), the 32/16, 4-ply SHEATHING SPAN plywood will meet the design specifications for this project.

SHORING - 11K PER LEG

Shore "X"® Shoring

THE FULLY BRACED
ADJUSTABLE SHORING SYSTEM



COMPONENTS

A. Junior Beams
B. Beam Clamps
C. "J" Headed Screw Jack
D. Extension Frames
E. Adapter Pins
F. Base Frames
G. Cross Braces
H. Coupling Pins
I. Studs
J. Swivel Screw Jack
K. Fixed Base Plates

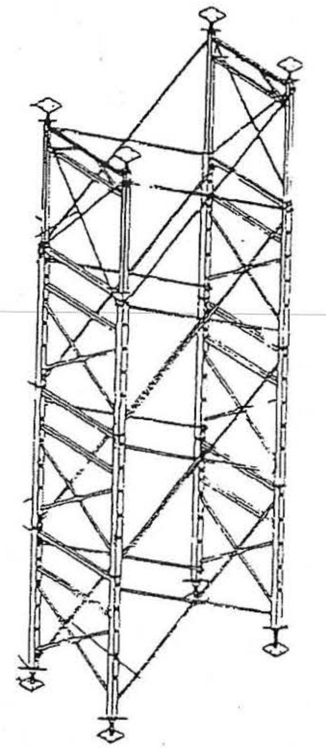
SHORE X IS A TRADE-MARK OF WACO SCAFFOLD & EQUIPMENT CO

RENTAL

Vertical Steel Shoring

Waco Shore "X"®
11K/leg & 25K/leg

SHORING - 25K PER LEG



Shore "X" 25k shoring as the same features as Shore "X" 11k. The leg tubing is larger which allows for the greater capacity. Both Shore "X" 11k & 25k feature a two frame & one size brace that works on both of the frames.