ZFA STRUCTURAL ENGINEERS

san francisco
silicon valley
sacramento
santa rosa
napa

PRELIMINARY
NOT FOR CONSTRUCTION

Davidson Middle School Mechanical Upgrades Structural Calculations

San Rafael, CA

ZFA Project Number: 21650

Structural Calcs_V1

January 7, 2022

Prepared For:

QKA

Santa Rosa, CA

REGISTERED PROFESSIONAL ENGINEER
CHRIS S. WARNER
No. S4613
STRUCTURAL
STATE OF CALIFORNIA

01/10/2022

Prepared By:

Benny Cope, Designer

Dudley Mei, PE, Engineer

Chris Warner, SE, Principal-in-Charge

Santa Rosa, California

TABLE OF CONTENTS

STRUCTURAL NARRATIVE

The structural calculations contained herein reflect mechanical modifications at the annex, maker space, band room and music room of Davidson Middle School. The effective seismic weights of the buildings will not increase by 10% and the effective seismic weight tributary to each shear wall line will not increase by more than 5%, hence no structural rehabilitation is required per CAC 4-309(c).

At the annex, new intake louvers at the roof will not increase the total gravity load by more than 5%, therefore (E) framing is okay. A widened intake louver at an (E) shear wall will not reduce its stiffness by more than 5% and therefore does not require rehabilitation per CAC 4-309. Anchorage for a wall-mounted electrical panel in the annex was also calculated.

Additional anchorage calculations are provided for fan coil units, pipe supports and duct supports.

Calculations were not required for furnace, condensing and HP units which have a center of gravity less than four feet above ground and weigh under four-hundred pounds per the exemptions of CBC 1617A.1.18.

ZFA STRUCTURAL ENGINEERS

Job #21650
Design Criteria

Engineer: BVC; DM
1/3/2022

Davidson MS HVAC

DETAILED DESIGN CRITERIA

BUILDING CODE

Governing Code:	2019 California Building Code
Authority Having Jurisdiction:	DSA
Local Codes or Amendments:	0

01/10/2022
SEOR STAMP

BUILDING SYSTEM DESCRIPTION

No. Stories:	1
Footprint:	Varies ft^2
Floor Area:	Varies ft^2
Roof Area:	Varies ft^2
Mean Building Height:	11 ft
Roof Pitch:	Varies :12

Building Use:	Educational
Gravity System:	Wood Bearing Walls
Diaphragm System:	Plywood Sheathing
Foundation System:	Concrete Footings

ZFA STRUCTURAL ENGINEERS
Job #21650
Design Criteria

Engineer: BVC; DM
1/3/2022

Davidson MS HVAC

DETAILED DESIGN CRITERIA

ASCE 7-16 Reference UNO:

SEISMIC DESIGN PARAMETERS

Analysis Procedure Used:	EQ (Equiv. Lat. Force, 12.8)			*Section 12.6*
Latitude:	37.9659 deg	Longitude:	-122.5249 deg	
Risk Category:	III	Educational		*Table 1.5-1*
I_E =	1.25	Importance Factor, Seismic		*Table 1.5-1*
I_P =	1.00	Importance Factor, Nonstructural Components		*13.1.3*
Soil Site Class =	D (by default)	Per Geotech Report, Site Class D otherwise		*Table 20.3-1*
S_S =	1.500 g	Mapped spectral response acceleration parameter		*USGS*
S_1 =	0.600 g	Mapped spectral response acceleration parameter		*USGS*
F_a =	1.2	Site coefficient		*Table 11.4-1*
F_v =	1.7	Site coefficient		*Table 11.4-2*
S_{DS} =	1.200 g	Design spectral response acceleration parameter		*11.4-3*
S_{D1} =	0.680 g	Design spectral response acceleration parameter		*11.4-4*
Seismic Design Category:	D			*Section 11.6*
Building System, N-S:	A. BEARING WALL SYSTEMS	15. Light-framed (wood) walls sheathed with wood structural panels rated for shear resistance		*Table 12.2-1*
Building System, E-W:	A. BEARING WALL SYSTEMS	15. Light-framed (wood) walls sheathed with wood structural panels rated for shear resistance		*Table 12.2-1*
Diaphragm=	Flexible Diaphragm	Plywood Sheathing		
$\rho_{(N-S)}$ =	1.0	Redundancy factor, N-S		*12.3.4*
$\rho_{(E-W)}$ =	1.0	Redundancy factor, E-W		*12.3.4*
$R_{(N-S)}$ =	6.50	Response modification coefficient, N-S		*Table 12.2-1*
$R_{(E-W)}$ =	6.50	Response modification coefficient, E-W		*Table 12.2-1*
$\Omega_{o(N-S)}$ =	2.50	Overstrength factor, N-S		*Table 12.2-1*
$\Omega_{o(E-W)}$ =	2.50	Overstrength factor, E-W		*Table 12.2-1*
$C_{d(N-S)}$ =	4.00	Deflection amplification factor, N-S		*Table 12.2-1*
$C_{d(E-W)}$ =	4.00	Deflection amplification factor, E-W		*Table 12.2-1*
$T_{(N-S)}$ =	0.121 sec	Approximate Fundamental Period, N-S		*Section 12.8.2*
$T_{(E-W)}$ =	0.121 sec	Approximate Fundamental Period, E-W		*Section 12.8.2*
T_L =	8 sec	Long Period Transition Period		*USGS*
$V_{(N-S)}$ (ULT) =	0.231 *W	Base Shear, N-S, LRFD		*Section 12.8 or 12.14*
$V_{(N-S)}$ (ASD) =	0.162 *W	Base Shear, N-S, ASD		*Section 12.8 or 12.14*
$V_{(E-W)}$ (ULT) =	0.231 *W	Base Shear, E-W, LRFD		*Section 12.8 or 12.14*
$V_{(E-W)}$ (ASD) =	0.162 *W	Base Shear,E-W, LRFD		*Section 12.8 or 12.14*
Structural Irregularities	Horizontal:	None		*Table 12.3-1*
	Vertical:	None		*Table 12.3-2*

WIND DESIGN PARAMETERS

Wind Method Used:	Directional Procedure			*Chapter 27*
Basic Wind Speed =	98 MPH		Ultimate Design Wind Speed (3 second gust)	*Figure 26.5-1A,B or C*
Exposure Category:	C		Open Terrain	*26.7.3*
K_{zt} =	1.00		Topographic Factor	*26.8*
K_d =	0.85	Buildings	Directionality Factor	*Table 26.6-1*

DETAILED DESIGN CRITERIA

MATERIAL STRENGTH AND SPECIFICATIONS

STEEL CONNECTORS:

Shear stud connectors, f_u =	65	ksi	ASTM A108
Machine Bolts, f_u =	58	ksi	ASTM A307
High Strength Bolts, f_u =	120	ksi	ASTM A325
Anchor Bolts, f_y =	36	ksi	ASTM F1554, Grade 36 or ASTM A307
Anchor Bolts, f_u =	58	ksi	ASTM F1554, Grade 36 or ASTM A307
Threaded Rods, f_y =	36	ksi	ASTM F1554, Grade 36 or ASTM A307
Threaded Rods, f_u =	58	ksi	ASTM F1554, Grade 36 or ASTM A307
Weld, F_{EXX} =	70	ksi	Weld Strength

WOOD CONSTRUCTION:

6x Posts, F_b =	1200	psi	Douglas Fir #1
6x Beam, F_b =	1350	psi	Douglas Fir #1
4x Posts & Beams, F_b =	1000	psi	Douglas Fir #1
2x Joists & Rafters, F_b =	900	psi	Douglas Fir #2
2x Studs, F_b =	900	psi	Douglas Fir #2
Sheathing	PS1 / PS2		
Connections	Simpson Strong-Tie		
Glued-Laminated Beam (GLB), F_b =	2400	psi	24F-V4 (DF/DF) simple span, 24F-V8 (DF/DF) continuous span
Exterior GLB, F_b =	2000	psi	20F-V12 (AC/AC) simple span, 20F-V13 (AC/AC) continuous span
Parallel Strand Lumber (PSL), F_b =	2900	psi	Grade 2.0E
Laminated Veneer Lumber (LVL), F_b =	2600	psi	Grade 1.9E
Laminated Strand Lumber (LSL), F_b =	1700	psi	Grade 1.3E

ATC Hazards by Location

Search Information

Address: 280 Woodland Avenue San Rafael, California 94901

Coordinates: 37.965895, -122.524903

Elevation: 7 ft

Timestamp: 2021-01-26T23:46:02.257Z

Hazard Type: Seismic

Reference Document: ASCE7-16

Risk Category: III

Site Class: D-default

Basic Parameters

Name	Value	Description
S_S	1.5	MCE_R ground motion (period=0.2s)
S_1	0.6	MCE_R ground motion (period=1.0s)
S_{MS}	1.8	Site-modified spectral acceleration value
S_{M1}	* null	Site-modified spectral acceleration value
S_{DS}	1.2	Numeric seismic design value at 0.2s SA
S_{D1}	* null	Numeric seismic design value at 1.0s SA

* See Section 11.4.8

Additional Information

Name	Value	Description
SDC	* null	Seismic design category
F_a	1.2	Site amplification factor at 0.2s
F_v	* null	Site amplification factor at 1.0s
CR_S	0.921	Coefficient of risk (0.2s)
CR_1	0.906	Coefficient of risk (1.0s)
PGA	0.523	MCE_G peak ground acceleration
F_{PGA}	1.2	Site amplification factor at PGA
PGA_M	0.627	Site modified peak ground acceleration
T_L	12	Long-period transition period (s)
SsRT	1.733	Probabilistic risk-targeted ground motion (0.2s)
SsUH	1.881	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)

SsD	1.5	Factored deterministic acceleration value (0.2s)
S1RT	0.687	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.758	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.6	Factored deterministic acceleration value (1.0s)
PGAd	0.523	Factored deterministic acceleration value (PGA)

* See Section 11.4.8

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Disclaimer

Hazard loads are provided by the U.S. Geological Survey Seismic Design Web Services.

While the information presented on this website is believed to be correct, ATC and its sponsors and contributors assume no responsibility or liability for its accuracy. The material presented in the report should not be used or relied upon for any specific application without competent examination and verification of its accuracy, suitability and applicability by engineers or other licensed professionals. ATC does not intend that the use of this information replace the sound judgment of such competent professionals, having experience and knowledge in the field of practice, nor to substitute for the standard of care required of such professionals in interpreting and applying the results of the report provided by this website. Users of the information from this website assume all liability arising from such use. Use of the output of this website does not imply approval by the governing building code bodies responsible for building code approval and interpretation for the building site described by latitude/longitude location in the report.

ATC Hazards by Location

Search Information

Address:	280 Woodland Avenue San Rafael, California 94901
Coordinates:	37.965895, -122.524903
Elevation:	7 ft
Timestamp:	2021-01-26T23:46:55.686Z
Hazard Type:	Wind

ASCE 7-16

MRI 10-Year	63 mph
MRI 25-Year	70 mph
MRI 50-Year	74 mph
MRI 100-Year	78 mph
Risk Category I	86 mph
Risk Category II	91 mph
Risk Category III	98 mph
Risk Category IV	102 mph

ASCE 7-10

MRI 10-Year	72 mph
MRI 25-Year	79 mph
MRI 50-Year	85 mph
MRI 100-Year	91 mph
Risk Category I	100 mph
Risk Category II	110 mph
Risk Category III-IV	115 mph

ASCE 7-05

ASCE 7-05 Wind Speed	85 mph

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Disclaimer

Hazard loads are interpolated from data provided in ASCE 7 and rounded up to the nearest whole integer. Per ASCE 7, islands and coastal areas outside the last contour should use the last wind speed contour of the coastal area – in some cases, this website will extrapolate past the last wind speed contour and therefore, provide a wind speed that is slightly higher. NOTE: For queries near wind-borne debris region boundaries, the resulting determination is sensitive to rounding which may affect whether or not it is considered to be within a wind-borne debris region.

Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.

While the information presented on this website is believed to be correct, ATC and its sponsors and contributors assume no responsibility or liability for its accuracy. The material presented in the report should not be used or relied upon for any specific application without competent examination and verification of its accuracy, suitability and applicability by engineers or other licensed professionals. ATC does not intend that the use of this information replace the sound judgment of such competent professionals, having experience and knowledge in the field of practice, nor to substitute for the standard of care required of such professionals in interpreting and applying the results of the report provided by this website. Users of the information from this website assume all liability arising from such use. Use of the output of this website does not imply approval by the governing building code bodies responsible for building code approval and interpretation for the building site described by latitude/longitude location in the report.

ZFA STRUCTURAL ENGINEERS
Job #21650
Flat Weights

Engineer: BVC; DM
1/3/2022

Davidson MS HVAC

GRAVITY / SEISMIC FLAT WEIGHT TAKEOFF (PSF)

FLAT ROOF @ ANNEX

CBC Live Load Category: 26. Roof: ordinary [Table 1607.1]
Slope: 0.00:12 Balcony?: No

Material		Thickness (in)	Sloped	Deck	Joists	Girders	Columns	Seismic
Roofing:	Cap Sheet			3.0	3.0	3.0	3.0	3.0
Sheathing:	1/2 in. OSB			1.7	1.7	1.7	1.7	1.7
Decking:	Leveling Lightweight Conc t =	1.5		15.0	15.0	15.0	15.0	15.0
Insulation:	"Soft": Loose Fill, Blown-In, & Batt t =	3		0.6	0.6	0.6	0.6	0.6
Ceiling:	1/2 in. Gypsum Board				2.2	2.2	2.2	2.2
Framing:					0.0	0.0	0.0	0.0
Framing:	DF-L 3x12 @ 16"oc					5.5	5.5	5.5
Framing:							0.0	0.0
MEP:				0.0	0.0	0.0	0.0	0.0
MEP:	Typical			2.0	2.0	2.0	2.0	2.0
MEP:	Solar			3.0	3.0	3.0	3.0	3.0
Miscellaneous				1.5	1.5	1.5	1.5	1.5
Dead Load				26.8	29.0	34.5	34.5	34.5
Dead Load - Horiz Projection				26.8	29.0	34.5	34.5	34.5
Partitions (Office Buildings)			No	0.0	0.0	0.0	0.0	0.0
Live Load				20.0	20.0	20.0	20.0	0.0
Live Load - Reduced	**R_2 =** 1.00			20.0	20.0	20.0	20.0	0.0
Total Load				46.8	49.0	54.5	54.5	34.5

2:12 ROOF @ SHOP BLDG

CBC Live Load Category: 26. Roof: ordinary [Table 1607.1]
Slope: 2.00:12 Balcony?: No

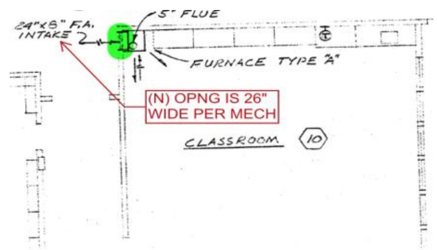
Material		Thickness (in)	Sloped	Deck	Joists	Girders	Columns	Seismic
Roofing:	Cap Sheet		Yes	3.0	3.0	3.0	3.0	3.0
Sheathing:	1/2 in. OSB		Yes	1.7	1.7	1.7	1.7	1.7
Decking:				0.0	0.0	0.0	0.0	0.0
Insulation:	"Soft": Loose Fill, Blown-In, & Batt t =	2	Yes	0.4	0.4	0.4	0.4	0.4
Ceiling:	Acoustical Fiber Tile		Yes		1.0	1.0	1.0	1.0
Framing:	DF-L 2x6 @ 24"oc				1.1	1.1	1.1	1.1
Framing:	GLB BEAMS					1.7	1.7	1.7
Framing:	GLB GIRDER						1.0	1.0
MEP:				0.0	0.0	0.0	0.0	0.0
MEP:	Typical			2.0	2.0	2.0	2.0	2.0
MEP:	Solar			3.0	3.0	3.0	3.0	3.0
Miscellaneous				1.8	1.7	2.0	2.0	2.0
Dead Load				11.9	13.9	15.9	16.9	16.9
Dead Load - Horiz Projection				12.0	14.0	16.0	17.0	17.0
Partitions (Office Buildings)			No	0.0	0.0	0.0	0.0	0.0
Live Load				20.0	20.0	20.0	20.0	0.0
Live Load - Reduced	**R_2 =** 1.00			20.0	20.0	20.0	20.0	0.0
Total Load				32.0	34.0	36.0	37.0	17.0

SHEAR WALL CAPACITY CHECK AT ANNEX

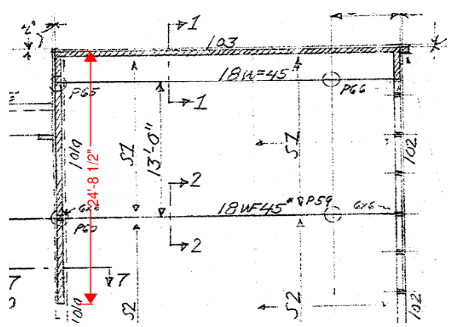
This calculation checks the reduced capacity of an (E) shear wall at the annex due to a widened louver opening.

Opening location:

--->



Existing shear wall (length of wall is approximate):



Check shear wall:

Wall length	=	24.0	ft	(conservative)

Existing:

(E) OPNG	=	24	in
(E) effective SW length	=	22.0	ft

New:

(N) OPNG	=	26	in
(N) effective SW length	=	21.8	ft

Conclude:

Reduction in length	=	0.2	ft		
% reduction of original	=	0.69	%	< 5% ?	(for CAC check)

PER CAC 4-309, DOES NOT EXCEED 5% RULE

ANCHORAGE

The following calculations check anchorage for a wall-mounted electrical panel and various pieces of mechanical equipment.

ZFA STRUCTURAL ENGINEERS
Job #21650 Engineer: BVC; DM Davidson MS HVAC
Wall-Mounted Electrical Panel 1/3/2022

WALL-MOUNTED ELECTRICAL PANEL

CBC2019, ASCE 7-16 CHAPTER 11, 12, 13 SEISMIC DESIGN CRITERIA

Soil Site Class	D (by default)	Table 20.3-1	
Response Spectral Acc. (0.2 sec) Ss =	**1.500g**	= 150.00%g	Figure 22-1, 22-3, 22-5, and 22-6
Response Spectral Acc.(1.0 sec) S1 =	**0.600g**	= 60.00%g	Figure 22-2, 22-4, 22-5, and 22-6
Site Coefficient F_a =	1.200		Table 11.4-1
Site Coefficient F_v =	1.7		Table 11.4-2
Max Considered Earthquake Acc. S_{MS} =	$F_a \cdot S_s$	= 1.800	(11.4-1)
Max Considered Earthquake Acc. S_{M1} =	$F_v \cdot S_1$	= 1.020	(11.4-2)
@ 5% Damped Design S_{DS} =	$2/3(S_{MS})$	= 1.200	(11.4-3)
S_{D1} =	$2/3(S_{M1})$	= 0.680	(11.4-4)
Building Risk Categories	III	Public hazard	Table 1.5-1
Design Category Consideration:	Flexible Diaphragm	with dist. between seismic resisting system >40ft	
Seismic Design Category for 0.1sec	D		
Seismic Design Category for 1.0sec	D		
S1 < .75g	NA		

Comply with Seismic Design Category D

13.3 Seismic Demands on Nonstructural Components

Component Name: Wall-Mounted Electrical Panel "LAA"

Component Description: Motor control centers, panel boards, switch gear, instrumentation cabinets, and other components constructed of sheet metal framing

$$F_p = \frac{0.4 a_p S_{DS} W_p (1+2z/h)}{(R_p/I_p)}$$ (13.3-1)

S_{DS} = 1.200

a_p = **2.5**	R_p = **6.0**		T-13.5-1 or 13.6-1
Ω_o = **2.0**			T-13.5-1 or 13.6-1
I_p = **1.0**			13.1.3
z (assumed) = **4 ft**	h = **11 ft**	F_p = 0.345 Wp	
Max F_p = $1.6 S_{DS} I_p W_p$	= 1.920Wp		(13.3-2)
Min F_p = $0.3 S_{DS} I_p W_p$	= 0.360Wp		(13.3-3)
F_p = **0.360 Wp**			

$F_{p\ \text{Anchorage to Concrete IF using}\ \Omega_o}$ = 0.720 Wp (not reqd since on wood SW)
T-13.5-1 footnote b or 13.6-1 footnote c

NOTE:

W_{panel} =	87	lbs	(DL)
$F_{p,LRFD}$ =	31	lbs	
$F_{p,ASD}$ =	22	lbs	

Incorporate Horizontal & Vertical Seismic Forces (ASD):

E_h =	22	lbs	(EQ 12.4-3)
E_v =	21	lbs	(EQ 12.4-4a)
using ASD load combinations:			
$Load_8$ =	117	lbs	(2.4.5(8))
$Load_9$ =	109	lbs	(2.4.5(9))
$Load_{10}$ =	53	lbs	(2.4.5(10))
total applied panel load (TAPL) =	117	**lbs GOVERNS**	

Check Hardware Capacity < TAPL:

$Capacity_{A34}$ =	395	lb	(see SST screenshot below)
$Capacity_{\#14\ wood\ screw}$ =	160	lb	(see NDS calc screenshot below)

CONCLUDE: **capacity of a single #14 wood screw / single A34 > applied panel load… OKAY**

Model No.	Type of Connection	Fasteners (in.)	Direction of Load	DF/SP Allowable Loads Floor (100)	DF/SP Roof (125)	DF/SP (160)	SPF/HF Allowable Loads Floor (100)	SPF/HF Roof (125)	SPF/HF (160)	Code Ref.
A34	1	(8) 0.131 x 1 ½	F_1	395	465	465	340	400	400	IBC, FL, LA
			F_2	395	430	430	340	370	370	
	1	(8) #9 x 1 ½ SD	F_1	640	640	640	550	550	550	
			F_2	495	495	495	425	425	425	
			Uplift	240	240	240	170	170	170	—

Connection Calculator

Design Method	Allowable Stress Design (ASD)
Connection Type	Lateral loading
Fastener Type	Wood Screw
Loading Scenario	Single Shear

Main Member Type	Douglas Fir-Larch
Main Member Thickness	5.5 in.
Main Member: Angle of Load to Grain	90
Side Member Type	Plywood (other grades)
Side Member Thickness	3/8 in.
Side Member: Angle of Load to Grain	0
Wood Screw Number	14 (D = 0.242 in.)
Length	4 in.
Load Duration Factor	C_D = 1.6
Wet Service Factor	C_M = 1.0
End Grain Factor	C_eg = 1.0
Temperature Factor	C_t = 1.0

Connection Yield Modes

Im	2149 lbs.
Is	160 lbs.
II	720 lbs.
IIIm	689 lbs.
IIIs	168 lbs.
IV	238 lbs.

Adjusted ASD Capacity	**160 lbs.**

- Wood Screw bending yield strength of 70000 psi is assumed.
- Dowel bearing strengths for wood screws with nominal diameter greater than 1/4 in. are calculated and rounded to the nearest 50 psi in accordance with NDS Table 11.3.2.
- Length of tapered tip is assumed to be two times the nominal wood screw diameter for calculating dowel bearing length in the main member.

While every effort has been made to insure the accuracy of the information presented, and special effort has been made to assure that the information reflects the state-of-the-art, neither the American Wood Council nor its members assume any responsibility for any particular design prepared from this on-line Connection Calculator. Those using this on-line Connection Calculator assume all liability from its use.

The Connection Calculator was designed and created by Cameron Knudson, Michael Dodson and David Pollock at Washington State University. Support for development of the Connection Calculator was provided by American Wood Council.

Vert Fan Coil

Calculation checks worst loading case for vertical fan coils, using information from A/M-4.1

ZFA STRUCTURAL ENGINEERS

Job #21650 | Engineer: BVC; DM | Davidson MS HVAC

Vert FC - Fp | 1/3/2022

VERTICAL FAN COIL (167 lb)

CBC2019, ASCE 7-16 CHAPTER 11, 12, 13 SEISMIC DESIGN CRITERIA

Soil Site Class	D (by default)	Table 20.3-1	
Response Spectral Acc. (0.2 sec) Ss =	**1.500g**	= 150.00%g	Figure 22-1, 22-3, 22-5, and 22-6
Response Spectral Acc.(1.0 sec) S1 =	**0.600g**	= 60.00%g	Figure 22-2, 22-4, 22-5, and 22-6
Site Coefficient F_a =	1.200		Table 11.4-1
Site Coefficient F_v =	1.7		Table 11.4-2
Max Considered Earthquake Acc. S_{MS} =	$F_a.S_s$	= 1.800	(11.4-1)
Max Considered Earthquake Acc. S_{M1} =	$F_v.S_1$	= 1.020	(11.4-2)
@ 5% Damped Design S_{DS} =	$2/3(S_{MS})$	= 1.200	(11.4-3)
S_{D1} =	$2/3(S_{M1})$	= 0.680	(11.4-4)
Building Risk Categories	III	Public hazard	Table 1.5-1
Design Category Consideration:	Flexible Diaphragm	with dist. between seismic resisting system >40ft	
Seismic Design Category for 0.1sec	D		
Seismic Design Category for 1.0sec	D		
S1 < .75g	NA		

Comply with Seismic Design Category D

13.3 Seismic Demands on Nonstructural Components

Component Name: Vertical Fan Coil FC 27-1

Component Description: Air coolers (fin fans), air-cooled heat exchangers, condensing units, dry coolers, remote radiators and other mechanical components elevated on integral structural steel or sheet metal supports

$$F_p = \frac{0.4 a_p S_{DS} W_p (1+2z/h)}{(R_p/I_p)}$$ (13.3-1)

S_{DS} = 1.200

a_p = **2.5**		R_p = **3.0**		T-13.5-1 or 13.6-1
Ω_o = **1.5**				T-13.5-1 or 13.6-1
I_p = **1.0**				13.1.3
z = **4 ft**		h = **11 ft**	F_p = 0.691 Wp	
Max F_p =	$1.6S_{DS}I_pW_p$	= 1.920Wp		(13.3-2)
Min F_p =	$0.3S_{DS}I_pW_p$	= 0.360Wp		(13.3-3)

F_p = **0.691 Wp**

$F_{p\ \text{Anchorage to Concrete IF using}}\ \Omega_o$ = 1.036 Wp — T-13.5-1 footnote b or 13.6-1 footnote c

W_p =	**167.0**	lb	
F_p =	**115.4**	lb	(LRFD)
$F_{p\ \text{Anchorage to Concrete IF using}}\ \Omega_o$ =	**173.1**	lb	

VERTICAL FAN COIL ANCHORAGE

Calculations for detail A/M-4.1… use identical anchorage for C/M-4.1 and D/M-4.1 since A/M-4.1 has the heaviest unit. See also "Vert Fan Coil Fp" calc.

Fan coil weight = 167 lb (FC 27-1 from MECH drawings)

From "Vert Fan Coil Fp" sheet:

$F_{p,\ LRFD}$ = 115 lb
$F_{p,\ ASD}$ = 80.8 lb

Incorporate Horizontal & Vertical Seismic Forces (ASD):

E_h = 81 lbs (EQ 12.4-3)
E_v = 40 lbs (EQ 12.4-4a)

using ASD load combinations:

$Load_8$ = 252 lbs (2.4.5(8))
$Load_9$ = 230 lbs (2.4.5(9))
$Load_{10}$ = 129 lbs (2.4.5(10))

total load (TL) = 252 lbs GOVERNS

<u>Seismic strap fasteners:</u>

Lag screws:

quantity = 4
load/fastener = 62.9 lb (ASD) *use for tension and shear load*
dia = 0.38 in (from mech detail)
embed = 2.5 in (from mech detail)

check shear…

check using AWC connection calculator:

fastener capacity = 327 lb (ASD)

CONCLUDE:
DCR = 0.19
shear OK

Design Method	Allowable Stress Design (ASD)
Connection Type	Lateral loading
Fastener Type	Lag Screw
Loading Scenario	Single Shear

Main Member Type	Douglas Fir-Larch
Main Member Thickness	3.5 in.
Main Member: Angle of Load to Grain	0
Side Member Type	Steel
Side Member Thickness	12 gage
Side Member: Angle of Load to Grain	0
Washer Thickness	0 in.
Nominal Diameter	3/8 in.
Length	2.5 in.
Load Duration Factor	C_D = 1.6
Wet Service Factor	C_M = 1.0
End Grain Factor	C_eg = 1.0
Temperature Factor	C_t = 1.0

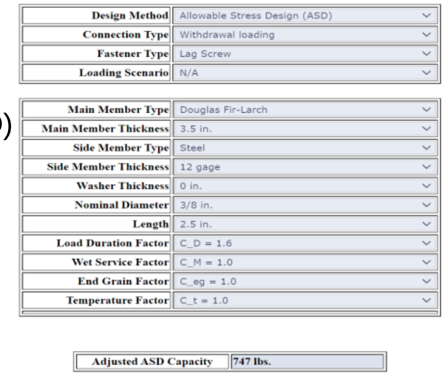
Connection Yield Modes

Im	1292 lbs.
Is	688 lbs.
II	580 lbs.
IIIm	695 lbs.
IIIs	327 lbs.
IV	436 lbs.

Adjusted ASD Capacity	**327 lbs.**

check tension…

check using AWC connection calculator:



Design Method	Allowable Stress Design (ASD)
Connection Type	Withdrawal loading
Fastener Type	Lag Screw
Loading Scenario	N/A
Main Member Type	Douglas Fir-Larch
Main Member Thickness	3.5 in.
Side Member Type	Steel
Side Member Thickness	12 gage
Washer Thickness	0 in.
Nominal Diameter	3/8 in.
Length	2.5 in.
Load Duration Factor	C_D = 1.6
Wet Service Factor	C_M = 1.0
End Grain Factor	C_eg = 1.0
Temperature Factor	C_t = 1.0
Adjusted ASD Capacity	747 lbs.

fastener capacity = 747 lb (ASD)

CONCLUDE:
DCR = 0.08
tension OK

CONCLUDE:
USE… 0.38 dia 2.5 embed (inches)

Machine bolts:

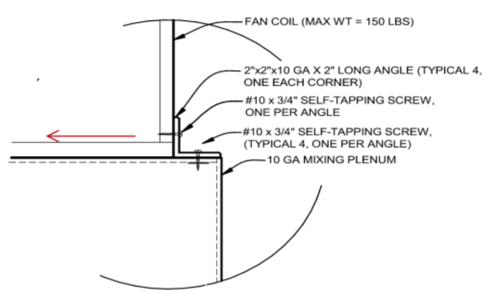
quantity	=	4		
load/fastener	=	62.9	lb	(ASD) *use for tension and shear load*
dia	=	0.38	in	(from mech detail)
embed	=	0	in	(from mech detail)

NOTE: conservatively apply "load/fastener" as shear & tension to MB for combined check

shear & tension checks on "Vert FC - MB Check" sheet

CONCLUDE:
USE… 0.38 dia 0 embed (inches)

Screws:



worst loading case shown to left

quantity in shear	=	4		
load/fastener in shear	=	62.9	lb	(ASD)
quantity in tension	=	2		
load/fastener in tension	=	126	lb	(ASD)
dia	=	0.19	in	(from mech detail)
material gauge	=	10	g	(from mech detail)

CONCLUDE:
USE… #10 screws

VERTICAL FAN COIL BOLT CAPACITY

Loading: MACHINE BOLT - VERT FAN COIL ANCHORAGE

see also: "Vert Fan Coil Anchorage" sheet

Design Methodology		ASD	
Shear Demand	V =	0.1	k
Tension Demand	T =	0.1	k

Design Strength (§J3.6 & §J3.7): Ω = 2.00

Bolt Description		A307	
Nominal Tensile Stress	F_{nt} =	45	ksi
Nominal Shear Stress	F_{nv} =	27	ksi
Bolt Diameter	d =	0.38	in
Bolt Area	A_b =	0.11	in^2

Allowable Shear Strength	**Fnv Ab / Ω =**	**1.5**	**k**
Shear Utilization Ratio	**DCR =**	**0.04**	

Required Shear Stress	frv =	0.6	ksi
Modified Tensile Stress	Fnt' = min[Fnt, 1.3 Fnt - (Ω Fnt / Fnv) frv] =	45.0	ksi

Available Tensile Strength	Fnt' Ab / Ω =	**2.5**	**k**
Tension Utilization Ratio	**DCR =**	**0.03**	

Design Bearing Strength (§J3.10): Ω = 2.00

Minimum Tensile Strength of Connected Material	Fu =	50	ksi
Clear Distance from Hole to Hole or Edge	lc =	0.81	in
Thickness of Connected Material	t =	0.06	in

Bearing Condition	Deformation at bolt hole at service load is considered		
Nominal Bearing Strength	Rn = min[1.2 lc t Fu, 2.4 d t Fu] =	2.8	k

Available Bearing Strength	**Rn / Ω =**	**1.4**	**k**
Bearing Utilization Ratio	**DCR =**	**0.04**	

ZFA STRUCTURAL ENGINEERS
Job #21650
Vert FC - Screw Check

Engineer: BVC; DM
1/3/2022

Davidson MS HVAC

VERTICAL FAN COIL SCREW CAPACITY

Reference: AISI S100-16 Section J4

Applies to 0.08 ≤ d ≤ 0.25
See Section I2 for diaphragms
Minimum spacing between fastener centers = 3d
Minimum edge distance to fastener center = 1.5d

SMS #10
d 0.19 in Nominal screw diameter

Mils	Gauge	Thickness
18	25	0.0188
27	22	0.0283
30	20	0.0312
33	20	0.0346
43	18	0.0451
54	16	0.0566
68	14	0.0713
97	12	0.1017
118	10	0.1242

Member in contact with screw head

Mils 118
Grade 50 Conforming to A3.1.1
t_1= 0.124 in
F_{y1}= 50 ksi
F_{u1}= 65 ksi

Member not in contact with screw head

Mils 118
Grade 50 Conforming to A3.1.1
t_2= 0.124 in
F_{y2}= 50 ksi
F_{u2}= 65 ksi

Demands to Screw

V_{max} = 0.063 kips ASD Load Input
T_{max} = 0.126 kips

Shear Strength of Screw Connection (per Section J4.3)

t_2/t_1= 1.00

P_{nv1}= $4.2 (t_2^3 d)^{1/2} F_{u2}$ = 5.209 kips (Eq J4.3.1-1)
P_{nv2}= $2.7\ t_1\ d\ F_{u1}$ = 4.141 kips (Eq J4.3.1-2), (Eq J4.3.1-4)
P_{nv3}= $2.7\ t_2\ d\ F_{u2}$ = 4.141 kips (Eq J4.3.1-3), (Eq J4.3.1-5)

$P_{nv,min,1}$= $\min(P_{nv1},P_{nv2},P_{nv3})$ = 4.141 kips for $t_2/t_1 \le 1.0$
$P_{nv,min,2}$= $\min(P_{nv2},P_{nv3})$ = 4.141 kips for $t_2/t_1 \ge 2.5$

P_{nv}= 4.141 kips Shear resistance of sheet
P_{nvs}= 1.644 kips Shear resistance of screw

Ω	3.00	J4.3.2	ASD
Pnv/Ω=	0.548	kips	
DCR =	0.11		

Tension Strength of Screw Connection (per Section J4.4)

d_h= 0.340 in Screw head diameter
d_w= 0.000 in Steel washer diameter (5/16" min)
t_w= 0.000 in Steel washer thickness
d'_w= 0.340 in (J4.4.2-2), J4.4.2 (a), (b), (c)
t_c= 0.124 in assume full penetration of t_2

P_{not}= $0.85\ t_c\ d\ F_{u2}$ = 1.304 kips (J4.4.1-1)
P_{nov}= $1.5\ t_1\ d'_w\ F_{u1}$ = 4.117 kips (J4.4.2-1)
P_{nts}= 1.158 kips Tension resistance of screw

Ω	3.00	J4.4.3	ASD
Pnts/Ω=	0.386	kips	
DCR =	0.33		

ZFA STRUCTURAL ENGINEERS
Job #21650
Vert FC - Screw Check

Engineer: BVC; DM
1/3/2022

Davidson MS HVAC

Combined Shear and Pull-Over Screw Connection (per Section J4.5.1)

$$\frac{\overline{V}}{P_{nv}} + 0.71\frac{\overline{T}}{P_{nov}} \leq \frac{1.10}{\Omega} \quad (ASD) \quad (Eq.\ J4.5.1\text{-}1a)$$

$$\frac{\overline{V}}{P_{nv}} + 0.71\frac{\overline{T}}{P_{nov}} \leq 1.10\phi \quad (LRFD,\ LSD) \quad (Eq.\ J4.5.1\text{-}1b)$$

P_{nv} = 4.14 kips
P_{nov} = 4.12 kips
V/P_{nv} = 0.02
T/P_{nov} = 0.03

Ω	2.35	J4.5.1	ASD
1.10/Ω=	0.468		
Stress Ratio =	0.037		
DCR =	0.08		

Combined Shear and Pull-Out Screw Connection (per Section J4.5.2)

$$\frac{\overline{V}}{P_{nv}} + \frac{\overline{T}}{P_{not}} \leq \frac{1.15}{\Omega} \quad (ASD) \quad (Eq.\ J4.5.2\text{-}1a)$$

$$\frac{\overline{V}}{P_{nv}} + \frac{\overline{T}}{P_{not}} \leq 1.15\phi \quad (LRFD,\ LSD) \quad (Eq.\ J4.5.2\text{-}1b)$$

P_{nv} = 4.14 kips
P_{not} = 1.30 kips
V/P_{nv} = 0.02
T/P_{not} = 0.10

Ω	2.55	J4.5.2	ASD
1.15/Ω=	0.451		
Stress Ratio =	0.112		
DCR =	0.25		

Combined Shear and Tension in Screw (per Section J4.5.3)

$$\frac{\overline{V}}{P_{nvs}} + \frac{\overline{T}}{P_{nts}} \leq \frac{1.3}{\Omega} \quad (ASD) \quad (Eq.\ J4.5.3\text{-}1a)$$

$$\frac{\overline{V}}{P_{nvs}} + \frac{\overline{T}}{P_{nts}} \leq 1.3\phi \quad (LRFD,\ LSD) \quad (Eq.\ J4.5.3\text{-}1b)$$

P_{nvs} = 1.64 kips
P_{nts} = 1.16 kips
V/P_{nvs} = 0.04
T/P_{nts} = 0.11

Ω	3.00	J4.5.3	ASD
1.3/Ω=	0.433		
Stress Ratio =	0.147		
DCR =	0.34		

Horiz Fan Coil

Calculation checks worst loading case for horizontal fan coils, using information from B/M-4.1 and the associated detail D/M-4.3

ZFA STRUCTURAL ENGINEERS

Job #21650
Horiz FC - Fp

Engineer: BVC; DM
1/3/2022

Davidson MS HVAC

HORIZONTAL FAN COIL (167 lb)

CBC2019, ASCE 7-16 CHAPTER 11, 12, 13 SEISMIC DESIGN CRITERIA

Soil Site Class	D (by default)	Table 20.3-1	
Response Spectral Acc. (0.2 sec) Ss =	**1.500g**	= 150.00%g	Figure 22-1, 22-3, 22-5, and 22-6
Response Spectral Acc.(1.0 sec) S1 =	**0.600g**	= 60.00%g	Figure 22-2, 22-4, 22-5, and 22-6
Site Coefficient F_a =	1.200		Table 11.4-1
Site Coefficient F_v =	1.7		Table 11.4-2
Max Considered Earthquake Acc. S_{MS} =	$F_a.S_s$	= 1.800	(11.4-1)
Max Considered Earthquake Acc. S_{M1} =	$F_v.S_1$	= 1.020	(11.4-2)
@ 5% Damped Design S_{DS} =	$2/3(S_{MS})$	= 1.200	(11.4-3)
S_{D1} =	$2/3(S_{M1})$	= 0.680	(11.4-4)
Building Risk Categories	III	Public hazard	Table 1.5-1
Design Category Consideration:	Flexible Diaphragm	with dist. between seismic resisting system >40ft	
Seismic Design Category for 0.1sec	D		
Seismic Design Category for 1.0sec	D		
S1 < .75g	NA		

Comply with Seismic Design Category D

13.3 Seismic Demands on Nonstructural Components

Component Name: Horizontal Fan Coil FC 37-1

Component Description: Air-side HVAC, fans, air handlers, air conditioning units, cabinet heaters, air distribution boxes, and other mechanical components constructed of sheet metal framing

$$F_p = \frac{0.4 a_p S_{DS} W_p (1+2z/h)}{(R_p/I_p)}$$

S_{DS} = 1.200

(13.3-1)

a_p =	**2.5**	R_p =	**6.0**	T-13.5-1 or 13.6-1
Ω_o =	**2.0**			T-13.5-1 or 13.6-1
I_p =	**1.0**			13.1.3
z =	**11 ft**	h =	**11 ft**	F_p = 0.600 Wp
Max F_p =	$1.6 S_{DS} I_p W_p$	=	1.920Wp	(13.3-2)
Min F_p =	$0.3 S_{DS} I_p W_p$	=	0.360Wp	(13.3-3)
F_p =	**0.600 Wp**			
$F_{p\ \text{Anchorage to Concrete IF using}\ \Omega_o}$ =	1.200 Wp			T-13.5-1 footnote b or 13.6-1 footnote c

W_p =	**167.0**	lb	
F_p =	**100.2**	lb	(LRFD)
$F_{p\ \text{Anchorage to Concrete IF using}\ \Omega_o}$ =	**200.4**	lb	

ZFA STRUCTURAL ENGINEERS
Job #21650
Horiz FC - Anchorage

Engineer: BVC; DM
1/3/2022

Davidson MS HVAC

VERTICAL FAN COIL ANCHORAGE

Calculations for detail B/M-4.1. See also "Horiz Fan Coil Fp" calc.

Fan coil weight = 167 lb (FC 27-1 from MECH drawings)

From "Horiz Fan Coil Fp" sheet:

$F_{p,\ LRFD}$ = 100 lb
$F_{p,\ ASD}$ = 70.1 lb

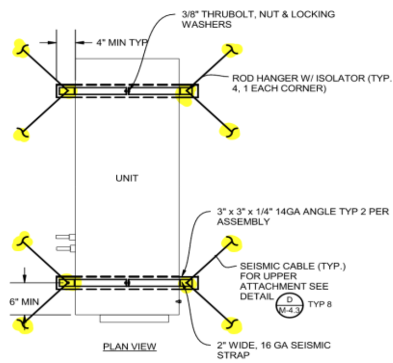
Incorporate Horizontal & Vertical Seismic Forces (ASD):

E_h	=	70	lbs	(EQ 12.4-3)
E_v	=	40	lbs	(EQ 12.4-4a)
using ASD load combinations:				
$Load_8$	=	244	lbs	(2.4.5(8))
$Load_9$	=	225	lbs	(2.4.5(9))
$Load_{10}$	=	121	lbs	(2.4.5(10))
total load (TL) =		**244**	**lbs GOVERNS**	

Loading:

Vertical restraints:

quantity in tension	=	12		
vertical load/restraint	=	20.3	lb	(ASD)
tension in rod (vertical)	=	20.3	lb	
tension in cable (1:1 slope)	=	28.8	lb	



Horizontal restraints:

quantity in tension	=	4		
horizontal load/restraint	=	61	lb	(ASD)
tension in cable (1:1 slope)	=	86.3	lb	

check rod for...	T	=	61	lb	(assume no "help" from seismic bracing)
check cable for…	T	=	86.3	lb	

Check cable:

F_y	=	33	ksi	(assumed)
dia	=	0.09	in	(from mech detail)
A_s	=	0.01	in	(from mech detail)
Ω_t	=	2	(rupture)	
A_sF_y/Ω_t	=	114	lb	

CONCLUDE:
USE… 0.09 dia DCR 0.76

Check vertical rod:

F_y	=	36	ksi	(assumed)
dia	=	0.38	in	(from mech detail)
A_s	=	0.11	in	(from mech detail)
Ω_t	=	2	(rupture)	
A_sF_y/Ω_t	=	1988	lb	

CONCLUDE:
USE… 0.38 dia DCR 0.03

Check bolt connecting rod brace to blocking:

check using AWC connection calculator:

fastener capacity = 821 lb (ASD)

CONCLUDE:
DCR = 0.07
shear OK

Design Method	Allowable Stress Design (ASD)
Connection Type	Lateral loading
Fastener Type	Bolt
Loading Scenario	Single Shear - Wood Main Member

Main Member Type	Douglas Fir-Larch
Main Member Thickness	3.5 in.
Main Member: Angle of Load to Grain	90
Side Member Type	Steel
Side Member Thickness	1/4 in.
Side Member: Angle of Load to Grain	0
Fastener Diameter	1/2 in.
Load Duration Factor	C_D = 1.6
Wet Service Factor	C_M = 1.0
Temperature Factor	C_t = 1.0

Connection Yield Modes

Im	1764 lbs.
Is	3480 lbs.
II	861 lbs.
IIIm	1049 lbs.
IIIs	821 lbs.
IV	955 lbs.

Adjusted ASD Capacity	**821 lbs.**

ZFA STRUCTURAL ENGINEERS
Job #21650
Horiz FC - Anchorage

Engineer: BVC; DM
1/3/2022

Davidson MS HVAC

Check angle for bending:

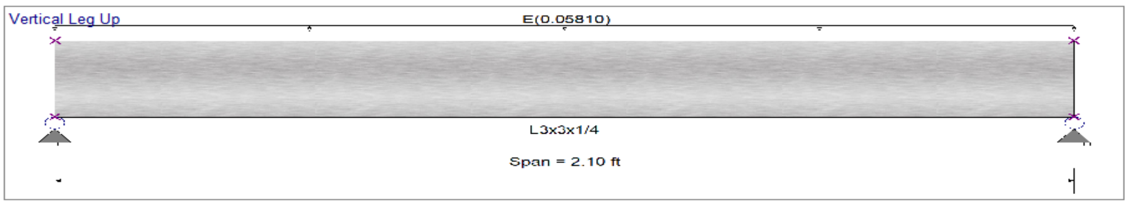
L_{angle}	=	2.1	ft	(approx)
force	=	122	lb	(1/2 of tot since 2 angles)
load	=	58.1	plf	

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : ASCE 7-16

Material Properties

Analysis Method :	Allowable Strength Design	Fy : Steel Yield :	36.0 ksi
Beam Bracing :	Completely Unbraced	E: Modulus :	29,000.0 ksi
Bending Axis :	Major Axis Bending		



Applied Loads

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

Beam self weight NOT internally calculated and added
Uniform Load : E = 0.05810 k/ft, Tributary Width = 1.0 ft, (horiz FC)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	0.018 : 1	Maximum Shear Stress Ratio =	0.004 : 1
Section used for this span	**L3x3x1/4**	Section used for this span	**L3x3x1/4**
Ma : Applied	0.022 k-ft	Va : Applied	0.04270 k
Mn / Omega : Allowable	1.216 k-ft	Vn/Omega : Allowable	9.701 k
Load Combination	E Only * 0.70	Load Combination	E Only * 0.70
Location of maximum on span	1.050 ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	0.000 in	Ratio =	0	<360	
Max Upward Transient Deflection	0.000 in	Ratio =	0	<360	Span: 1 : E Only
Max Downward Total Deflection	0.001 in	Ratio =	50279	>=180	Span: 1 : E Only * 0.70
Max Upward Total Deflection	0.000 in	Ratio =	0	<180	

Check machine bolt connecting seismic brace to blocking:

(bolts under worst loading when FC moves horizontally in either direction)

quantity	=	1		(per cable/seismic brace)
load/fastener	=	61	lb	(ASD) *use for shear*
dia	=	0.38	in	(from mech detail)
embed	=	3.5	in	(from mech detail)

check shear…

check using AWC connection calculator:

Design Method	Allowable Stress Design (ASD)
Connection Type	Lateral loading
Fastener Type	Bolt
Loading Scenario	Single Shear - Wood Main Member

Main Member Type	Douglas Fir-Larch
Main Member Thickness	3.5 in.
Main Member: Angle of Load to Grain	0
Side Member Type	Steel
Side Member Thickness	12 gage
Side Member: Angle of Load to Grain	0
Fastener Diameter	3/8 in.
Load Duration Factor	C_D = 1.6
Wet Service Factor	C_M = 1.0
Temperature Factor	C_t = 1.0

Connection Yield Modes

Im	2940 lbs.
Is	974 lbs.
II	1319 lbs.
IIIm	1560 lbs.
IIIs	629 lbs.
IV	873 lbs.

Adjusted ASD Capacity	629 lbs.

fastener capacity = 629 lb (ASD)

CONCLUDE:
DCR = 0.1
shear OK

CONCLUDE:
USE… 0.38 dia 3.5 embed (inches)

Check seismic brace connector:

(load applied to brace connector is equivalent to cable force)

from mech dwgs:

BRACE ANGLE RANGE q	MAX ALLOWABLE FORCE PER SEISMIC BRACE ASSEMBLY, Fp
30° - 45°	270 LBS
46° - 60°	190 LBS

F_{pmax} = 190 lb (ASD)

CONCLUDE:
by observation, seismic braces OKAY

Refrig Pipe

Calculation checks anchorage for refrigeration pipe from A/M-4.3

ZFA STRUCTURAL ENGINEERS
Job #21650
Refrig Pipe - Fp

Engineer: BVC; DM
1/3/2022

Davidson MS HVAC

REFRIGERATION PIPE SUPPORT

CBC2019, ASCE 7-16 CHAPTER 11, 12, 13 SEISMIC DESIGN CRITERIA

Soil Site Class	D (by default)	Table 20.3-1	
Response Spectral Acc. (0.2 sec) Ss =	**1.500g**	= 150.00%g	Figure 22-1, 22-3, 22-5, and 22-6
Response Spectral Acc.(1.0 sec) S1 =	**0.600g**	= 60.00%g	Figure 22-2, 22-4, 22-5, and 22-6
Site Coefficient F_a =	1.200		Table 11.4-1
Site Coefficient F_v =	1.7		Table 11.4-2
Max Considered Earthquake Acc. S_{MS} =	$F_a.S_s$	= 1.800	(11.4-1)
Max Considered Earthquake Acc. S_{M1} =	$F_v.S_1$	= 1.020	(11.4-2)
@ 5% Damped Design S_{DS} =	$2/3(S_{MS})$	= 1.200	(11.4-3)
S_{D1} =	$2/3(S_{M1})$	= 0.680	(11.4-4)
Building Risk Categories	III	Public hazard	Table 1.5-1
Design Category Consideration:	Flexible Diaphragm	with dist. between seismic resisting system >40ft	
Seismic Design Category for 0.1sec	D		
Seismic Design Category for 1.0sec	D		
S1 < .75g	NA		

Comply with Seismic Design Category D

13.3 Seismic Demands on Nonstructural Components

Component Name: Refrigeration pipe along wall (CONSIDERED PER 8' SUPPORT SPCG)

Component Description: Piping and tubing not in accordance with ASME B31, including in-line components, constructed of high- or limited-deformability materials, with joints made by threading, bonding, compression couplings, or grooved couplings

$$F_p = \frac{0.4a_pS_{DS}W_p(1+2z/h)}{(R_p/I_p)}$$

S_{DS} = 1.200

(13.3-1)

a_p = **2.5**	R_p = **4.5**		T-13.5-1 or 13.6-1
Ω_o = **2.0**			T-13.5-1 or 13.6-1
I_p = **1.0**			13.1.3
z = **4 ft**	h = **11 ft**	F_p = 0.461 Wp	
Max F_p = $1.6S_{DS}I_pW_p$	= 1.920Wp		(13.3-2)
Min F_p = $0.3S_{DS}I_pW_p$	= 0.360Wp		(13.3-3)
F_p = **0.461 Wp**			
$F_{p\ \text{Anchorage to Concrete IF using}}\ \Omega_o$= 0.921 Wp			T-13.5-1 footnote b or 13.6-1 footnote c

W_p =	**160.0**	lb	(assumed ~20 psf)
F_p =	**73.7**	lb	(LRFD)
$F_{p\ \text{Anchorage to Concrete IF using}}\ \Omega_o$=	**147.4**	lb	

REFRIGERATION PIPE ALONG WALL

Calculations for detail A/M-4.3. See also "Refrig Pipe - Fp" calc.

pipe = 160 lb

From "Refrig Pipe Fp" sheet:

$F_{p,\ LRFD}$ = 73.7 lb
$F_{p,\ ASD}$ = 51.6 lb

Incorporate Horizontal & Vertical Seismic Forces (ASD):

E_h = 52 lbs (EQ 12.4-3)
E_v = 38 lbs (EQ 12.4-4a)

using ASD load combinations:

$Load_8$ = 223 lbs (2.4.5(8))
$Load_9$ = 207 lbs (2.4.5(9))
$Load_{10}$ = 105 lbs (2.4.5(10))

total load (TL) = 223 lbs GOVERNS

Seismic strap fasteners:

Lag screws:

quantity	=	2		
load/fastener	=	111	lb	(ASD) *use for tension and shear load*
dia	=	0.38	in	(from mech detail)
embed	=	2.5	in	(from mech detail)

check shear…

check using AWC connection calculator:

fastener capacity = 327 lb (ASD)

CONCLUDE:
DCR = 0.34
shear OK

Design Method	Allowable Stress Design (ASD)
Connection Type	Lateral loading
Fastener Type	Lag Screw
Loading Scenario	Single Shear

Main Member Type	Douglas Fir-Larch
Main Member Thickness	3.5 in.
Main Member: Angle of Load to Grain	0
Side Member Type	Steel
Side Member Thickness	12 gage
Side Member: Angle of Load to Grain	0
Washer Thickness	0 in.
Nominal Diameter	3/8 in.
Length	2 in.
Load Duration Factor	C_D = 1.6
Wet Service Factor	C_M = 1.0
End Grain Factor	C_eg = 1.0
Temperature Factor	C_t = 1.0

Connection Yield Modes

Im	995 lbs.
Is	688 lbs.
II	449 lbs.
IIIm	558 lbs.
IIIs	327 lbs.
IV	436 lbs.

Adjusted ASD Capacity	327 lbs.

ZFA STRUCTURAL ENGINEERS
Job #21650
Refrig Pipe - Anchorage

Engineer: BVC; DM
1/3/2022

Davidson MS HVAC

check tension…

check using AWC connection calculator:

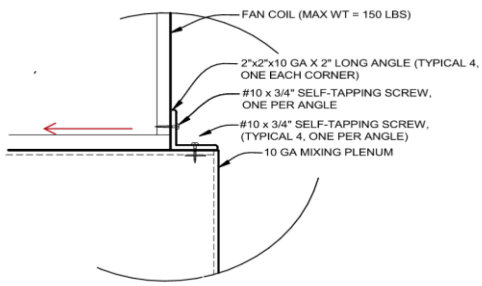
Design Method	Allowable Stress Design (ASD)
Connection Type	Withdrawal loading
Fastener Type	Lag Screw
Loading Scenario	N/A
Main Member Type	Douglas Fir-Larch
Main Member Thickness	3.5 in.
Side Member Type	Steel
Side Member Thickness	12 gage
Washer Thickness	0 in.
Nominal Diameter	3/8 in.
Length	2 in.
Load Duration Factor	C_D = 1.6
Wet Service Factor	C_M = 1.0
End Grain Factor	C_eg = 1.0
Temperature Factor	C_t = 1.0

Adjusted ASD Capacity	625 lbs.

fastener capacity = 625 lb (ASD)

CONCLUDE:
DCR = 0.18
tension OK

CONCLUDE:
USE… 0.38 dia 2.5 embed (inches)



Small Duct Support

Calculation checks anchorage for small duct support from C/M-4.3

ZFA STRUCTURAL ENGINEERS
Job #21650
Small Duct - Fp

Engineer: BVC; DM
1/3/2022

Davidson MS HVAC

SMALL DUCT SUPPORT

CBC2019, ASCE 7-16 CHAPTER 11, 12, 13 SEISMIC DESIGN CRITERIA

Soil Site Class	D (by default)	Table 20.3-1	
Response Spectral Acc. (0.2 sec) Ss =	**1.500g**	= 150.00%g	Figure 22-1, 22-3, 22-5, and 22-6
Response Spectral Acc.(1.0 sec) S1 =	**0.600g**	= 60.00%g	Figure 22-2, 22-4, 22-5, and 22-6
Site Coefficient F_a =	1.200		Table 11.4-1
Site Coefficient F_v =	1.7		Table 11.4-2
Max Considered Earthquake Acc. S_{MS} =	$F_a.S_s$	= 1.800	(11.4-1)
Max Considered Earthquake Acc. S_{M1} =	$F_v.S_1$	= 1.020	(11.4-2)
@ 5% Damped Design S_{DS} =	$2/3(S_{MS})$	= 1.200	(11.4-3)
S_{D1} =	$2/3(S_{M1})$	= 0.680	(11.4-4)
Building Risk Categories	III	Public hazard	Table 1.5-1
Design Category Consideration:	Flexible Diaphragm	with dist. between seismic resisting system >40ft	
Seismic Design Category for 0.1sec	D		
Seismic Design Category for 1.0sec	D		
S1 < .75g	NA		

Comply with Seismic Design Category D

13.3 Seismic Demands on Nonstructural Components

Component Name: Small ductwork (CONSIDERED PER 8' SUPPORT SPCG)

Component Description: Ductwork, including in-line components, constructed of high- or limited-deformability materials with joints made by means other than welding or brazing

$$F_p = \frac{0.4 a_p S_{DS} W_p (1+2z/h)}{(R_p/I_p)}$$ (13.3-1)

S_{DS} = 1.200

a_p = **2.5**	R_p = **6.0**		T-13.5-1 or 13.6-1
Ω_o = **2.0**			T-13.5-1 or 13.6-1
I_p = **1.0**			13.1.3
z = **11 ft**	h = **11 ft**	F_p = 0.600 Wp	
Max F_p = $1.6 S_{DS} I_p W_p$	= 1.920Wp		(13.3-2)
Min F_p = $0.3 S_{DS} I_p W_p$	= 0.360Wp		(13.3-3)
F_p = **0.600 Wp**			
$F_{p\ \text{Anchorage to Concrete IF using}}\ \Omega_o$ = 1.200 Wp			T-13.5-1 footnote b or 13.6-1 footnote c

W_p =	**64.0**	lb	(assumed 4 psf, 2 ft diameter)
F_p =	**38.4**	lb	(LRFD)
$F_{p\ \text{Anchorage to Concrete IF using}}\ \Omega_o$ =	**76.8**	lb	

SMALL DUCT SUPPORT

Calculations for detail C/M-4.3. See also "Small Duct - Fp" calc.

small duct = 64 lb

From "Small Duct Fp" sheet:

$F_{p,\ LRFD}$ = 38.4 lb
$F_{p,\ ASD}$ = 26.9 lb

Incorporate Horizontal & Vertical Seismic Forces (ASD):

E_h = 27 lbs (EQ 12.4-3)
E_v = 15 lbs (EQ 12.4-4a)

using ASD load combinations:

$Load_8$ = 94 lbs (2.4.5(8))
$Load_9$ = 86 lbs (2.4.5(9))
$Load_{10}$ = 46 lbs (2.4.5(10))
total load (TL) = 94 lbs GOVERNS

Steel strap fasteners:

Lag screws:

quantity = 2
load/fastener = 46.8 lb (ASD) *use for shear load*
dia = 0.25 in (from mech detail)
embed = 3 in (from mech detail)

check shear…

check using AWC connection calculator:

fastener capacity = 169 lb (ASD)

CONCLUDE:
DCR = 0.28
shear OK

Design Method	Allowable Stress Design (ASD)
Connection Type	Lateral loading
Fastener Type	Lag Screw
Loading Scenario	Single Shear

Main Member Type	Douglas Fir-Larch
Main Member Thickness	3.5 in.
Main Member: Angle of Load to Grain	90
Side Member Type	Steel
Side Member Thickness	20 gage
Side Member: Angle of Load to Grain	0
Washer Thickness	0 in.
Nominal Diameter	1/4 in.
Length	3 in.
Load Duration Factor	C_D = 1.6
Wet Service Factor	C_M = 1.0
End Grain Factor	C_eg = 1.0
Temperature Factor	C_t = 1.0

Connection Yield Modes

Im	1310 lbs.
Is	221 lbs.
II	533 lbs.
IIIm	547 lbs.
IIIs	169 lbs.
IV	239 lbs.

Adjusted ASD Capacity	169 lbs.

CONCLUDE:
USE… 0.25 dia 3 embed (inches)

Check sheet metal strap:

F_y	=	33	ksi	(assumed)
l	=	2	in	(from mech detail)
w	=	0.01	in	(assumed 28g)
A_s	=	0.03	in	(from mech detail)
Ω_t	=	2	(rupture)	
A_sF_y/Ω_t	=	488	lb	

CONCLUDE:
USE… 0.01 in. w DCR 0.19

Pipe Support

Calculation checks anchorage for pipe support from E/M-4.3

ZFA STRUCTURAL ENGINEERS
Job #21650
Pipe Supp - Fp

Engineer: BVC; DM
1/3/2022

Davidson MS HVAC

PIPE SUPPORT

CBC2019, ASCE 7-16 CHAPTER 11, 12, 13 SEISMIC DESIGN CRITERIA

Soil Site Class	D (by default)	Table 20.3-1		
Response Spectral Acc. (0.2 sec) Ss =	**1.500g**	= 150.00%g		Figure 22-1, 22-3, 22-5, and 22-6
Response Spectral Acc.(1.0 sec) S1 =	**0.600g**	= 60.00%g		Figure 22-2, 22-4, 22-5, and 22-6
Site Coefficient F_a =	1.200			Table 11.4-1
Site Coefficient F_v =	1.7			Table 11.4-2
Max Considered Earthquake Acc. S_{MS} =	$F_a.S_s$	= 1.800		(11.4-1)
Max Considered Earthquake Acc. S_{M1} =	$F_v.S_1$	= 1.020		(11.4-2)
@ 5% Damped Design S_{DS} =	$2/3(S_{MS})$	= 1.200		(11.4-3)
S_{D1} =	$2/3(S_{M1})$	= 0.680		(11.4-4)
Building Risk Categories	III	Public hazard		Table 1.5-1
Design Category Consideration:	Flexible Diaphragm		with dist. between seismic resisting system >40ft	
Seismic Design Category for 0.1sec	D			
Seismic Design Category for 1.0sec	D			
S1 < .75g	NA			

Comply with Seismic Design Category D

13.3 Seismic Demands on Nonstructural Components

Component Name: Pipe support (CONSIDERED PER 10' SUPPORT SPCG)
Component Description: Ductwork, including in-line components, constructed of high- or limited-deformability materials with joints made by means other than welding or brazing

$$F_p = \frac{0.4 a_p S_{DS} W_p (1+2z/h)}{(R_p/I_p)}$$

S_{DS} = 1.200

(13.3-1)

a_p = **2.5**		R_p = **6.0**		T-13.5-1 or 13.6-1
Ω_o = **2.0**				T-13.5-1 or 13.6-1
I_p = **1.0**				13.1.3
z = **11 ft**		h = **11 ft**	F_p = 0.600 Wp	
Max F_p =	$1.6S_{DS}I_pW_p$	= 1.920Wp		(13.3-2)
Min F_p =	$0.3S_{DS}I_pW_p$	= 0.360Wp		(13.3-3)
F_p = **0.600 Wp**				
$F_{p\text{ Anchorage to Concrete IF using }\Omega_o}$ = 1.200 Wp				T-13.5-1 footnote b or 13.6-1 footnote c

W_p =	**10.0**	lb	(assumed 4 psf, 3" dia pipe)
F_p =	**6.0**	lb	(LRFD)
$F_{p\text{ Anchorage to Concrete IF using }\Omega_o}$ =	**12.0**	lb	

ZFA STRUCTURAL ENGINEERS
Job #21650
Pipe Supp - Anchorage

Engineer: BVC; DM
1/3/2022

Davidson MS HVAC

VERTICAL FAN COIL ANCHORAGE

Calculations for detail E/M-4.3. See also "Pipe Supp Fp" calc.

pipe weight = 10 lb

From "Pipe Supp Fp" sheet:

$F_{p,\,LRFD}$ = 6 lb
$F_{p,\,ASD}$ = 4.2 lb

Incorporate Horizontal & Vertical Seismic Forces (ASD):

E_h	=	4	lbs	(EQ 12.4-3)
E_v	=	2	lbs	(EQ 12.4-4a)
using ASD load combinations:				
$Load_8$	=	15	lbs	(2.4.5(8))
$Load_9$	=	13	lbs	(2.4.5(9))
$Load_{10}$	=	7	lbs	(2.4.5(10))
total load (TL) =		**15**	**lbs GOVERNS**	

Loading:

CONCLUDE:
by inspection, anchorage components can withstand a load <= 15 lbs