RMJ

Structural Engineers

Robinson
Meier
Juilly & Associates

Principals
Peter Robinson, S.E.
Jayson E. Haines, S.E.

Crenlo

DEFR Guardian Unit

Structural Calculations
For Seismic Anchorage

Prepared for:

Crenlo
June 29, 2018
RMJ Job No. 18183
Valid Thru December 31, 2019

241 Joaquin Avenue
San Leandro, CA 94577
(510) 991-0977

RMJ

DEFR Guardian Units

Table of Contents

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DEFR Guardian Unit Anchorage
Nationwide
RMJ Job# 14273 & 18183

Project Description:

This project involves providing server anchorage support for units located throughout the United States. Calculations have been assembled according to two distinct seismic regions low & moderate, and high. A map has been created based on Figures 3.3-1 & 3.3-2 of ASCE 7-10 to define the two different seismic regions. Please note our seismic map shows three distinct regions low, moderate, and high, but for simplicity of our calculations low and moderate were combined into one region. The map also shows a solid line near the New Madrid Fault where the value of S_s exceeds 2.75. In this area of extreme seismic potential, all anchorage is site specific. The other seismic regions have been determined according to the table included below:

Seismic Design Data			
Seismic design region	**Short period spectral response acceleration S_s**	**Short-period site coefficient F_a**	**Design spectral response acceleration at short periods S_{DS}**
Low	0.4	1.5	0.4
Moderate	1.5	1.0	1.0
High	2.75	1.0	2.0

Anchorage

Calculations are based ½" diameter Hilti Kwik Bolt KB-TZ Carbon Steel expansion bolts, with the assumptions that anchors are not located within any boundary edges, 4" thick concrete minimum thickness, 2" minimum embedment, and 3,000 psi regular weight concrete strength. See table below for allowable cabinet + content weight.

Allowable Values

MAX CABINET WT. WITH CONTENTS	LOW & MODERATE SEISMIC				HIGH SEISMIC			
	GROUND FLOOR		UPPER FLOOR		GROUND FLOOR		UPPER FLOOR	
	ON FLOOR	RAISED	ON FLOOR	RAISED	ON FLOOR	RAISED	ON FLOOR	RAISED
SINGLE UNIT (4 bolts)	1,600	1,000	1,000	1,000	700	400	600	400
GANGED UNIT (2 bolts/unit)	2,000	2,000	1,200	1,200	2,000	1,000	1,000	1,000

SS[1]- Site Specific Calculations Required

Anchor Capacities

Bolt Force (tension and shear) summary table.

Bolt Alignment	**Max Tension (lbf.)**	**Max Shear (lbf.)**	**% Tens. Capacity**	**% Shear Capacty**
Ground Level (Slab on Grade)	1,199	825	94%	76%
50% Bld. Ht. (Conc. filled deck)	1,110	733	87%	68%

Hilti output files along with and calculations are in the appendix section of this calculation packet. Site specific engineering is required where S_S is greater than 2.75. Design is in accordance with the 2015 International Building Code along with the 2016 California Building Code.

Robinson
Meier
Juilly & Associates

Principals
Peter Robinson, S.E.
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DEFR Guardian Units by Crenlo
Scope, Assumptions, and Limitations
RMJ Job #14273
November 11, 2015
Revised June 28, 2018

Special Note:
Server rack anchorage calculations are valid under the 2015 International Building Code thru date noted on cover sheet. After valid thru date, contact Crenlo for updates.

- Special Inspection shall be provided for expansion bolt installation.
- Existing concrete shall have a minimum compressive strength of 3,000 psi.
- Importance factor is assumed to be 1.0.
- Raised Units not to exceed 18".
- Soil class is assumed to be D.
- Calculations and anchorage are done in accordance with the 2015 IBC and ASCE7-10.
- Maximum S_s value is 2.75. Where value of S_s exceeds 2.75, site specific calculations are required for all anchorages. S_s values can exceed 2.75 near the New Madrid fault.
- The minimum slab on grade thickness is assumed to be 4".
- The minimum concrete fill over metal deck thickness is 3½" (with 1 ½" metal deck).
- Enclosure is assumed to stay rigid during seismic loading (design by others).
- Computer access floor shall have strength to support compression and lateral loads.
- Floor slab and concrete filled metal deck shall have strength to resist uplift caused by overturning moment of cabinets.
- Any installation located in a high seismic region above the upper half of building shall be site specific. The second floor of a 2 story building is not considered the upper half of the building.
- Ganged Units based on a **Minimum of 2 Units.**
- Calculations are for DEFR Guardian units.

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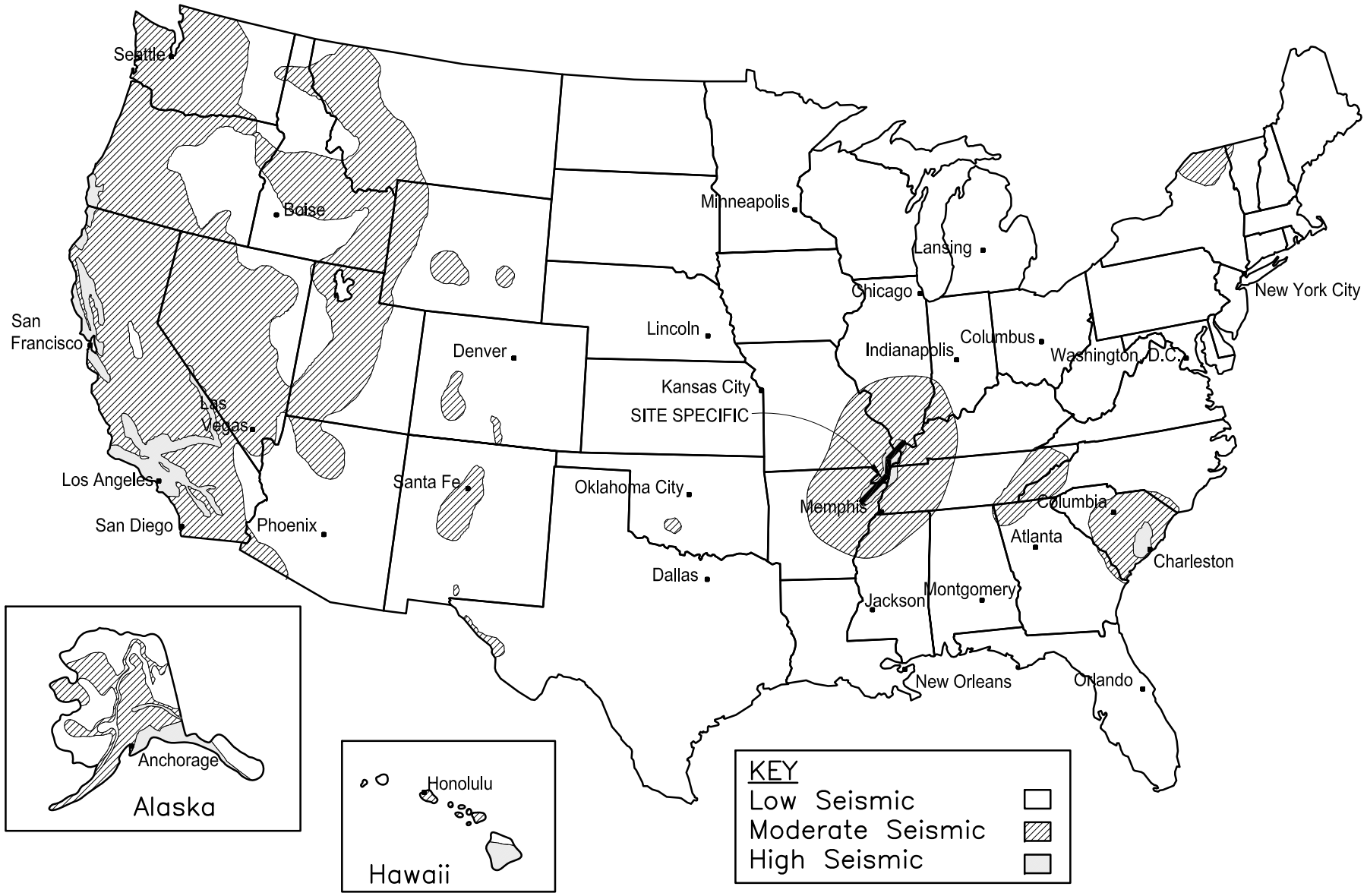
San Leandro, CA 94577
(510) 991-0977
www.rmjse.com



RMJ
Robinson Meier Juilly & Associates
Structural Engineers
103 Linden Avenue
So. San Francisco, CA 94080
650 871-2282 Fax: 871-2459

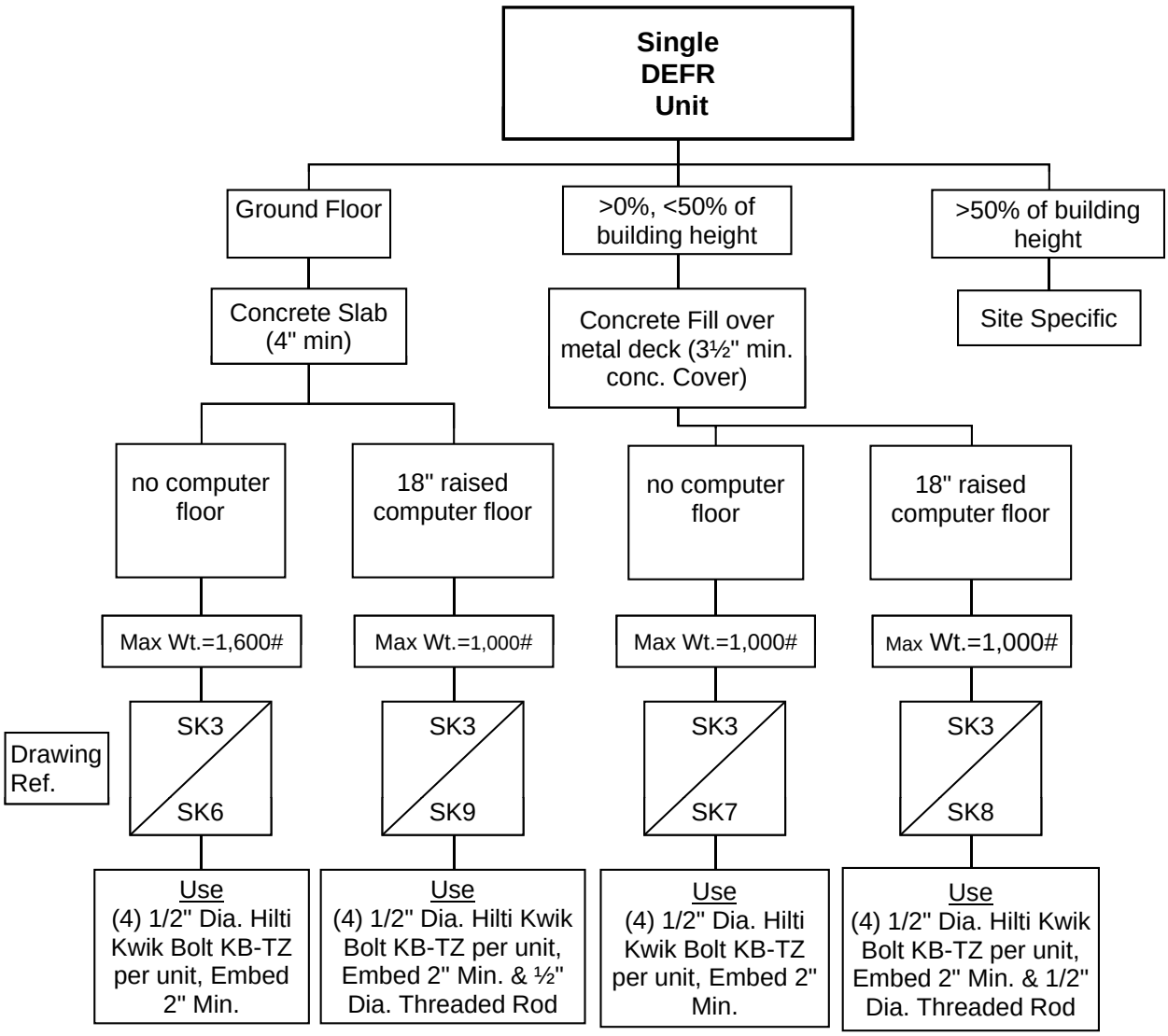
Seismic Risk Location Map
Crenlo DEFR Guardian Unit
USA

Job No. 11205

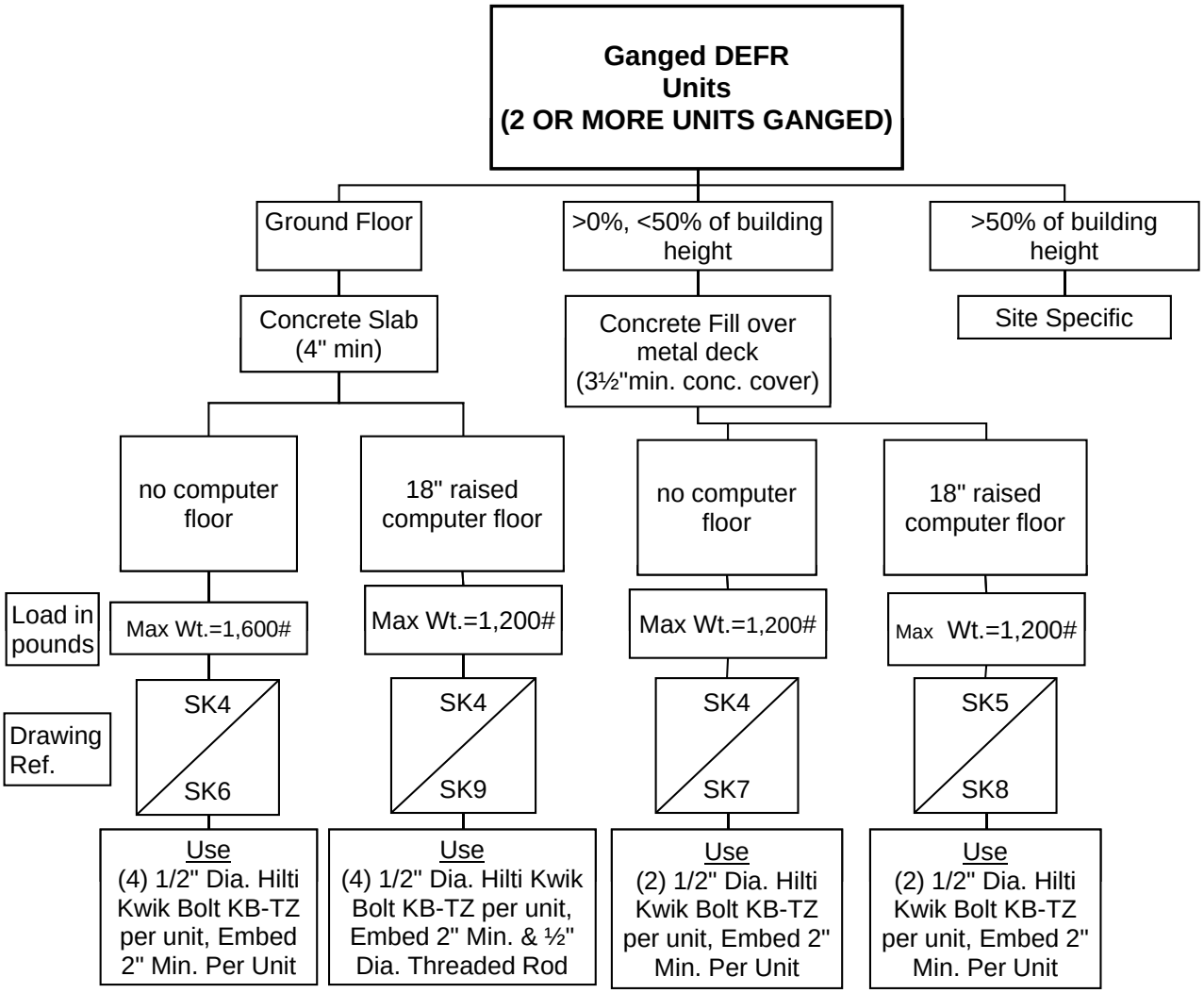
Sheet No. 1 OF 1

Date 06–11

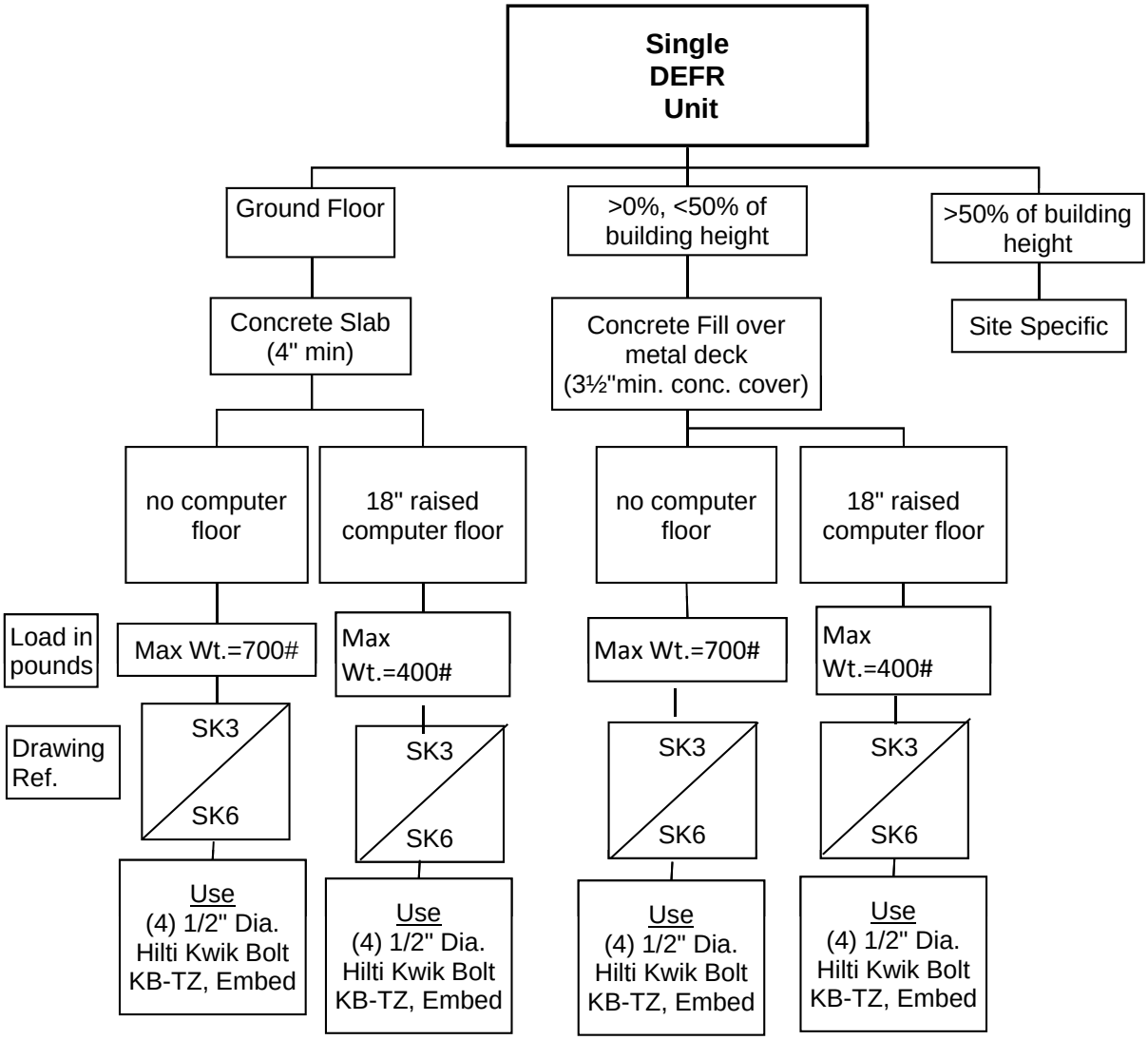
Summary: DEFR - Low & Moderate Seismic



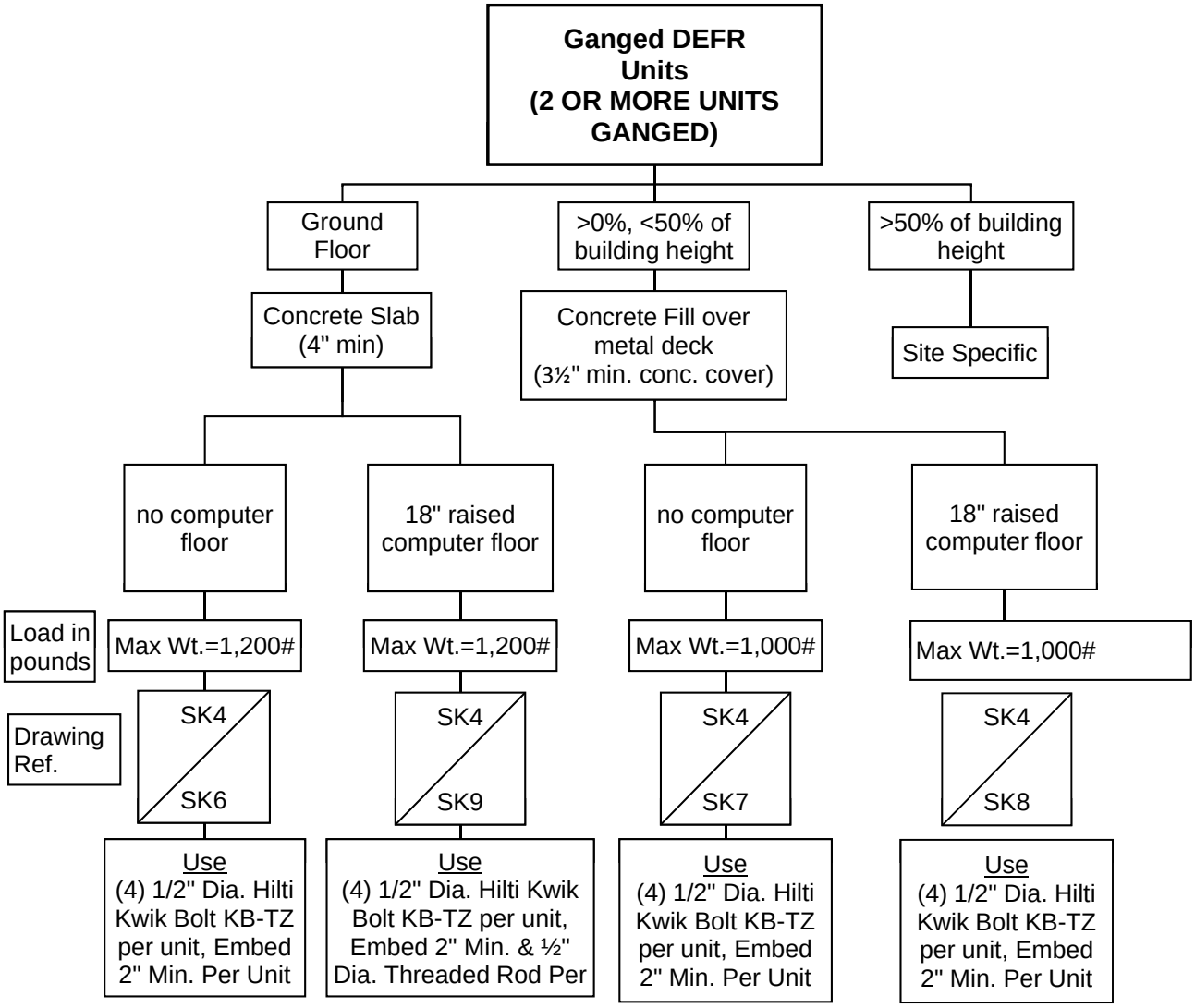
Summary: DEFR - Low & Moderate Seismic



Summary: DEFR - High Seismic



Summary: DEFR - High Seismic



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Low & Moderate Seismic Calculations

241 Joaquin Avenue
San Leandro CA 94577
(510)991-0977

Find the Seismic Design Category (SDC) **Unit : DEFR**

Project Location: Low & Moderate Seismic
Latitude: Varies Longitude: Varies

Soil Classification: D Table 1613.5.2 & Section 1613.5.2
Occupancy Category: II Table 1604.5

Information from U.S. Geological Survey Website
http://earthquake.usgs.gov/research/hazmaps/

S_S=	1.500	g	
S_1=	1.070	g	
F_a=	1.000		Table 1613.5.3(1)
F_v=	1.500		Table 1613.5.3(2)
S_{MS}=	1.50	g	(Equation 16-37)
S_{M1}=	1.61	g	(Equation 16-38)
S_{DS}=	1.000	g	(Equation 16-39)
S_{D1}=	1.070	g	(Equation 16-40)

Seismic Design Category (SDC): Varies

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Crenlo
Low & Moderate Seismic
Job No. : 14273 Date: 06/29/18
By: JH Page: 13

Load Case: ***Single Unit (Ground floor)***

Cabinet Dimensions

Depth (D) (in) =	40
Width (W) (in) =	24.00
Height (H) (in) =	82.750
Unit Weight (lb.) =	1,600

			Center of Gravity Location		
Unit	**Part**	**Weight (lbs)**	**X (in)**	**Y (in)**	**Z (in)**
DEFR	Frame+Contents	1,600	12.000	20	41.375

Transverse Anchorage Spacing (in) = 36.00
Longitudinal Anchorage Spacing (in) = 14

Seismic Force

S_{DS} =	1.0	Low & Moderate Seismic
I_p =	1.0	(Importance)
a_p =	1.0	(Cabinets)
R_p =	2.5	(Cabinets)
z/h =	0.0	(Ground Floor)
F_p =	0.160	W
$F_{p,min}$ =	0.30	W
$F_{p,max}$ =	1.60	W
Use F_p =	**0.30**	**W**
Ω =	2.5	Overstrength

Longitudinal Overturning

Overturning Moment = 0.30 (41.375 in. x 1600lbs.) = 19,860 lb-in

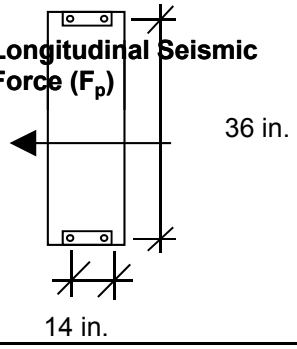
0.9xResisting Moment = 0.9 [1600 lbs. x (12in)]= 17,280 lb-in

Total # of Bolts = 4

Anchorage Force =	230	lbs/per bolt
Shear Force =	600	lbs/per bolt

Anchorage and Shear Force Increased by Overstrength Factor

DEFR unit Plan



Design Bolts for 230 lbs tension, 600 lbs. shear, longitudinal direction

Transverse Overturning

Overturning Moment = 0.30 (41.375 in. x 1600lbs.) = 19,860 lb-in

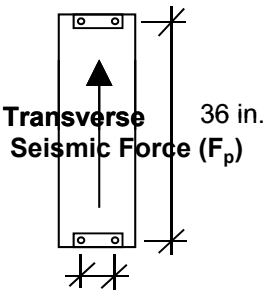
0.9xResisting Moment = 0.9 [1600 lbs. x (20in.)]= 28,800 lb-in

Total # of Bolts = 4

Anchorage Force =	0	lbs/per bolt
Shear Force =	600	lbs/per bolt

Anchorage and Shear Force Increased by Overstrength Factor

DEFR unit Plan



Design Bolts for 0 lbs tension, 600 lbs. shear, transverse direction

Drawing Reference See: SK3 & SK6

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Crenlo
Low & Moderate Seismic
Job No. : 14273 Date: 06/29/18
By: JH Page: 14

Load Case: ***Single Units on 18in raised computer floor (Ground floor)***

Unit Dimensions	
Depth (D) (in) =	40
Width (W) (in) =	24.00
Height (H) (in) =	82.750
Unit Weight (lb) =	1,000

Raised Floor = 18 in

Unit	Part	Weight (lbs)	Center of Gravity Location X (in)	Y (in)	Z (in)
DEFR	Frame+Contents	1,000	12.000	20	59.375

Transverse Anchorage Spacing (in) = 36.00
Longitudinal Anchorage Spacing (in) = 14

Seismic Force

S_{DS} =	1.0	Low & Moderate Seismic
I_p =	1.0	(Importance)
a_p =	1.0	(Cabinets)
R_p =	2.5	(Cabinets)
z/h =	0.0	(Ground Floor)
F_p =	0.160	W
$F_{p,min}$ =	0.30	W
$F_{p,max}$ =	1.60	W
Use F_p =	**0.30**	**W**
Ω =	2.5	Overstrength

Longitudinal Overturning

Overturning Moment = 0.30 (59.375 in. x 1000lbs.) = 17,813 lb-in

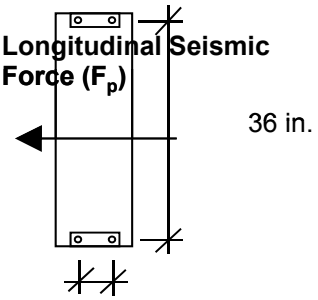
0.9xResisting Moment = 0.9 [1000 lbs. x (12in.)]= 10,800 lb-in

Total # of Bolts = 4

Anchorage Force = 626 lbs/per bolt
Shear Force = 375 lbs/per bolt

Anchorage and Shear Force Increased by Overstrength Factor

DEFR unit Plan



Design Bolts for 626 lbs tension, 375 lbs. shear, longitudinal direction

Transverse Overturning

Overturning Moment = 0.30 (59.375 in. x 1000lbs.) = 17,813 lb-in

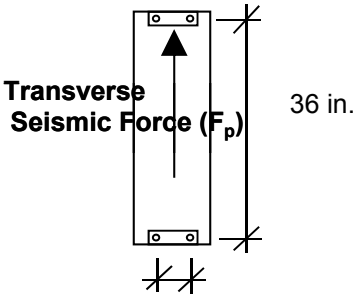
0.9xResisting Moment = 0.9 [1000 lbs. x (20in)]= 18,000 lb-in

Total # of Bolts = 4

Anchorage Force = 0 lbs/per bolt
Shear Force = 375 lbs/per bolt

Anchorage and Shear Force Increased by Overstrength Factor

DEFR unit Plan



Design Bolts for 00 lbs tension, 375 lbs. shear, transverse direction

Drawing Reference See: SK3 & SK9

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Low & Moderate Seismic
Job No. : 14273 Date: 06/29/18
By: JH Page: 15

Load Case: ***Ganged Unit (Ground floor)***

# of Units ganged (min.)= 2

Single Unit Dimension	
Depth (D) (in) =	40
Width (W) (in) =	24.00
Height (H) (in) =	82.750
Frame Weight (lb.) =	1,600

			Center of Gravity Location		
Unit	**Part**	**Weight (lbs)**	**X (in)**	**Y (in)**	**Z (in)**
2 - DEFR	Frame+Contents	3,200	24	20	41.375

Longitudinal Anchorage Spacing (in) = 30.00
Transverse Anchorage Spacing (in) = 36.00

Seismic Force

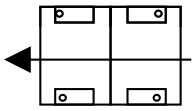
S_{DS} =	1.0	Low & Moderate Seismic
I_p =	1.0	(Importance)
a_p =	1.0	(Cabinets)
R_p =	2.5	(Cabinets)
z/h =	0.0	(Ground Floor)
F_p =	0.160	W
$F_{p,min}$ =	0.30	W
$F_{p,max}$ =	1.60	W
Use F_p =	**0.30**	**W**
Ω =	2.5	Overstrength

Longitudinal Overturning

Overturning Moment = 0.30 (41.375 in. x 3200lbs.) = 39,720 lb-in

0.9xResisting Moment = 0.9 (3200 lbs. x24 in.)= 69,120 lb-in

DEFR unit Plan
Longitudinal Seismic Force



Anchorage Force =	0	lbs
Shear Force =	1,200	lbs/per bolt

2 ganged units
Total # of bolts/Unit = 2

Anchorage and Shear Force Increased by Overstrength Factor

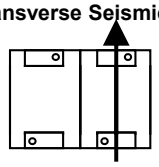
Design Bolts for 0 lbs tension, 1,200 lbs. shear, transverse direction

Transverse Overturning

Overturning Moment = 0.30 (41.375 in. x 3200lbs.) = 39,720 lb-in

0.9xResisting Moment = 0.9 (3200 lbs x20 in.) = 57,600 lb-in

Ganged DEFR unit Plan
Transverse Seismic Force



Anchorage Force =	0	lbs/per bolt
Shear Force =	1,200	lbs/per bolt

2 ganged units
Total # of bolts/Unit = 2

Anchorage and Shear Force Increased by Overstrength Factor

Design Bolts for 0 lbs tension, 1,200 lbs. shear, transverse direction

Drawing Reference See: SK4 & SK6

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241 Joaquin Ave.
San Leandro, CA 94577
510.991.0977

Crenlo
Low & Moderate Seismic
Job No. : 14273 Date: 06/29/18
By: JH Page: 16

Load Case: ***Ganged units on 18in raised computer floor (Ground Floor)***

# of Units ganged (min.)= 3

Single Unit Dimension	
Depth (D) (in) =	40
Width (W) (in) =	24.00
Height (H) (in) =	82.750
Frame Weight (lb.) =	1,200

Raised Floor = 18 in

			Center of Gravity Location		
Unit	**Part**	**Weight (lbs)**	**X (in)**	**Y (in)**	**Z (in)**
3 - DEFR	Frame+Contents	3,600	24	20	59.375

Longitudinal Anchorage Spacing (in) = 30.00
Transverse Anchorage Spacing (in) = 36.00

Seismic Force

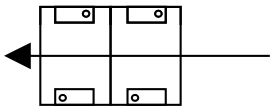
S_{DS} =	1.0	Low & Moderate Seismic
I_p =	1.0	(Importance)
a_p =	1.0	(Cabinets)
R_p =	2.5	(Cabinets)
z/h =	0.0	(Ground Floor)
F_p =	0.160	W
$F_{p,min}$ =	0.30	W
$F_{p,max}$ =	1.60	W
Use F_p =	**0.30**	**W**
Ω =	2.5	Overstrength

Longitudinal Overturning

Overturning Moment = 0.3 (59.375 in. x 3600lbs.) = 64,125 lb-in

0.9xResisting Moment = 0.9 (3600 lbs. x24 in.)= 77,760 lb-in

Ganged DEFR unit Plan
Longitudinal Seismic Force



Anchorage Force =	0	lbs/per bolt
Shear Force =	900	lbs/per bolt

3 ganged units
Total # of bolts/Unit = 2

Anchorage and Shear Force Increased by Overstrength Factor

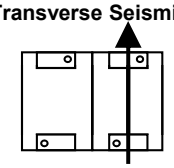
Design Bolts for 0 lbs tension, 900 lbs. shear, longitudinal direction

Transverse Overturning

Overturning Moment = 0.3 (59.375in. x 3600lbs.) = 64,125 lb-in

0.9xResisting Moment = 0.9 (3600 lbs x20 in.) = 64,800 lb-in

Ganged DEFR unit Plan
Transverse Seismic Force



Anchorage Force =	0	lbs/per bolt
Shear Force =	900	lbs/per bolt

3 ganged units
Total # of bolts/Unit = 2

Anchorage and Shear Force Increased by Overstrength Factor

Design Bolts for 0 lbs tension, 900 lbs. shear, transverse direction

Drawing Reference See: SK4 & SK9

RMJ
241 Joaquin Ave.
San Leandro, CA 94577
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Low & Moderate Seismic
Job No. : 14273 Date: 06/29/18
By: JH Page: 17

Load Case: ***Single Unit (≤ 50% of Bldg. Ht.)***
(i.e. 2nd floor of a 4 story building or 4th floor of an 8 story building)

Unit Dimensions	
Depth (D) (in) =	40
Width (W) (in) =	24.00
Height (H) (in) =	82.750
Unit Weight (lb) =	1,200

Unit	Part	Weight (lbs)	Center of Gravity Location X (in)	Y (in)	Z (in)
DEFR	Frame+Contents	1,200	12	20	41.375

Longitudinal Anchorage Spacing (in) = 36.00
Transverse Anchorage Spacing (in) = 14

Seismic Force

S_{DS} =	1.0	Low & Moderate Seismic
I_p =	1.0	(Importance)
a_p =	1.0	(Cabinets)
R_p =	2.5	(Cabinets)
z/h =	0.5	(50% of bldg ht.)
F_p =	0.320	W
$F_{p,min}$ =	0.30	W
$F_{p,max}$ =	1.60	W
Use F_p =	**0.320**	**W**
Ω =	2.5	Overstrength

Longitudinal Overturning

Overturning Moment = 0.32 (41.375 in. x 1200lbs.) = 15,888 lb-in

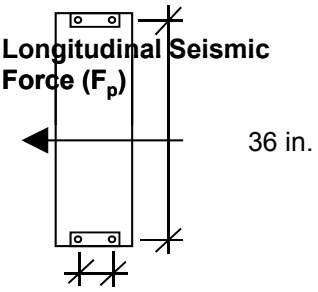
0.9xResisting Moment = 0.9 [1200 lbs. x (12in.)]= 12,960 lb-in

Total # of Bolts = 4

Anchorage Force = 261 lbs/per bolt
Shear Force = 480 lbs/per bolt

Anchorage and Shear Force Increased by Overstrength Factor

DEFR unit Plan



Design Bolts for 261 lbs tension, 480 lbs. shear, longitudinal direction

Transverse Overturning

Overturning Moment = 0.32 (41.375 in. x 1200lbs.) = 15,888 lb-in

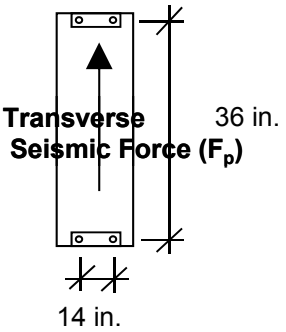
0.9xResisting Moment = 0.9 [1200 lbs. x (20in)]= 21,600 lb-in

Total # of Bolts = 4

Anchorage Force = 0 lbs/per bolt
Shear Force = 480 lbs/per bolt

Anchorage and Shear Force Increased by Overstrength Factor

DEFR unit Plan



Design Bolts for 0 lbs tension, 480 lbs. shear, transverse direction

Drawing Reference See: SK3 & SK7

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San Leandro, CA 94577
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Crenlo
Low & Moderate Seismic
Job No. : 14273 Date: 06/29/18
By: JH Page: 18

Load Case: ***Single Units on 18in Raised Comp. floor (≤50% of Bldg. Ht.)***
(i.e. 2nd floor of a 4 story building or 4th floor of an 8 story building)

Unit Dimensions	
Depth (D) (in) =	40
Width (W) (in) =	24.00
Height (H) (in) =	82.750
Unit Weight (lb) =	1,000

Raised Floor = 18 in

Unit	Part	Weight (lbs)	Center of Gravity Location X (in)	Y (in)	Z (in)
DEFR	Frame+Contents	1,000	12	20	59.375

Longitudinal Anchorage Spacing (in) = 36.00
Transverse Anchorage Spacing (in) = 14

Seismic Force		
S_{DS} =	1.0	Low & Moderate Seismic
I_p =	1.0	(Importance)
a_p =	1.0	(Cabinets)
R_p =	2.5	(Cabinets)
z/h =	0.5	(50% of bldg ht.)
F_p =	0.320	W
$F_{p,min}$ =	0.30	W
$F_{p,max}$ =	1.60	W
Use F_p =	**0.320**	**W**
Ω =	2.5	Overstrength

Longitudinal Overturning

Overturning Moment = 0.32 (59.375 in. x 1000lbs.) = 19,000 lb-in

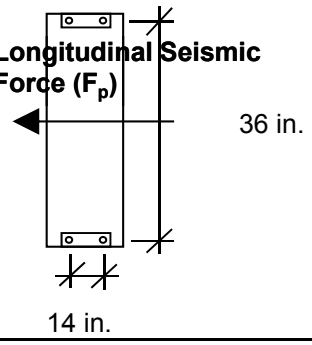
0.9xResisting Moment = 0.9 [1000 lbs. x (12in)]= 10,800 lb-in

Total # of Bolts = 4

Anchorage Force = 732 lbs/per bolt
Shear Force = 400 lbs/per bolt

Anchorage and Shear Force Increased by Overstrength Factor

DEFR unit Plan



Design Bolts for 732 lbs tension, 400 lbs. shear, longitudinal direction

Transverse Overturning

Overturning Moment = 0.32 (59.375 in. x 1000lbs.) = 19,000 lb-in

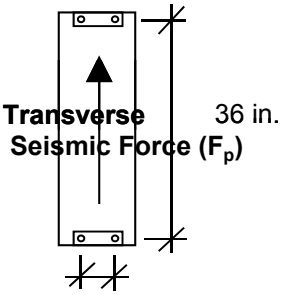
0.9xResisting Moment = 0.9 [1000 lbs. x (20in.)]= 18,000 lb-in

Total # of Bolts = 4

Anchorage Force = 35 lbs/per bolt
Shear Force = 400 lbs/per bolt

Anchorage and Shear Force Increased by Overstrength Factor

DEFR unit Plan



Design Bolts for 35 lbs tension, 400 lbs. shear, transverse direction

Drawing Reference See: SK3 & SK8

RMJ
241 Joaquin Ave.
San Leandro, CA 94577
510.991.0977

Crenlo
Low & Moderate Seismic
Job No. : 14273 Date: 06/29/18
By: JH Page: 19

Load Case: ***Ganged Unit (≤ 50% of Bldg. Ht.)***

# of Units ganged (max)= 2

Single Unit Dimension

Depth (D) (in) =	40
Width (W) (in) =	24.00
Height (H) (in) =	82.750
Frame Weight (lb.) =	1,200

Unit	Part	Weight (lbs)	Center of Gravity Location X (in)	Y (in)	Z (in)
2 - DEFR	Frame+Contents	2,400	24	20	41.375

Longitudinal Anchorage Spacing (in) = 30.00
Transverse Anchorage Spacing (in) = 36.00

Seismic Force

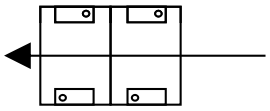
S_{DS} =	1.0	Low & Moderate Seismic
I_p =	1.0	(Importance)
a_p =	1.0	(Cabinets)
R_p =	2.5	(Cabinets)
z/h =	0.5	(50% of bldg ht.)
F_p =	0.320	W
$F_{p,min}$ =	0.30	W
$F_{p,max}$ =	1.60	W
Use F_p =	**0.320**	**W**
Ω =	2.5	Overstrength

Longitudinal Overturning

Overturning Moment = 0.32 (82.75/2 in. x 2400lbs.) = 31,776 lb-in

0.9xResisting Moment = 0.9 (2400 lbs. x24 in.)= 51,840 lb-in

Ganged DEFR unit Plan
Longitudinal Seismic Force



Anchorage Force = 0 lbs
Shear Force = 960 lbs/per bolt

2 ganged units
Total # of bolts/Unit = 2

Anchorage and Shear Force Increased by Overstrength Factor

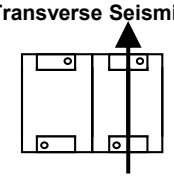
Design Bolts for 0 lbs tension, 960 lbs. shear, longitudinal direction

Transverse Overturning

Overturning Moment = 0.32 (82.75/2 in. x 2400lbs.) = 31,776 lb-in

0.9xResisting Moment = 0.9 (2400 lbs x20 in.) = 43,200 lb-in

Ganged DEFR unit Plan
Transverse Seismic Force



Anchorage Force = 0 lbs/per bolt
Shear Force = 960 lbs/per bolt

2 ganged units
Total # of bolts/Unit = 2

Anchorage and Shear Force Increased by Overstrength Factor

Design Bolts for 0 lbs tension, 960 lbs. shear, transverse direction

Drawing Reference See: SK4 & SK7

RMJ
241 Joaquin Ave.
San Leandro, CA 94577
510.991.0977

Crenlo
Low & Moderate Seismic
Job No. : 14273 Date: 06/29/18
By: JH Page: 20

Load Case: ***Ganged units on 18in raised computer floor (≤50% of Bldg. Ht.)***

# of Units ganged (max)= 2

Single Unit Dimension	
Depth (D) (in) =	40
Width (W) (in) =	24.00
Height (H) (in) =	82.750
Frame Weight (lb.) =	1,200

Raised Floor = 18 in

			Center of Gravity Location		
Unit	**Part**	**Weight (lbs)**	**X (in)**	**Y (in)**	**Z (in)**
2 - DEFR	Frame+Contents	2,400	12.000	20	59.375

Longitudinal Anchorage Spacing (in) = 24
Transverse Anchorage Spacing (in) = 36.00

Seismic Force

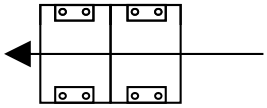
S_{DS} =	1.0	Low & Moderate Seismic
I_p =	1.0	(Importance)
a_p =	1.0	(Cabinets)
R_p =	2.5	(Cabinets)
z/h =	0.5	(50% of bldg ht.)
F_p =	0.320	W
$F_{p,min}$ =	0.30	W
$F_{p,max}$ =	1.60	W
Use F_p =	**0.320**	**W**
Ω =	2.5	Overstrength

Longitudinal Overturning

Overturning Moment = 0.32 (59.375 in. x 2400lbs.) = 45,600 lb-in

0.9xResisting Moment = 0.9 (2400 lbs. x12 in.)= 25,920 lb-in

Ganged DEFR unit Plan
Longitudinal Seismic Force



2 ganged units

Anchorage Force = 513 lbs/per bolt
Shear Force = 240 lbs/per bolt

Total # of bolts/Unit = 4

Anchorage and Shear Force Increased by Overstrength Factor

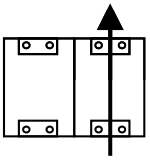
Design Bolts for 513 lbs tension, 240 lbs. shear, longitudinal direction

Transverse Overturning

Overturning Moment = 0.3 (59.375in. x 2400lbs.) = 45,600 lb-in

0.9xResisting Moment = 0.9 (2400 lbs x20 in.) = 43,200 lb-in

Ganged DEFR unit Plan
Transverse Seismic orce



2 ganged units

Anchorage Force = 42 lbs/per bolt
Shear Force = 240 lbs/per bolt

Total # of bolts/Unit = 4

Anchorage and Shear Force Increased by Overstrength Factor

Design Bolts for 42 lbs tension, 240 lbs. shear, transverse direction

Drawing Reference See: SK5 & SK8

RMJ

Structural Engineers

Robinson
Meier
Juilly & Associates

Principals
Peter Robinson, S.E.
Jayson E. Haines, S.E.

High Seismic Calculations

241 Joaquin Avenue
San Leandro CA 94577
(510)991-0977

RMJ
241 Joaquin Ave.
San Leandro, CA 94577
510.991.0977

Find the Seismic Design Category (SDC) **Unit : DEFR**

Project Location: High Seismic
Latitude: Varies Longitude: Varies

Soil Classification: D Table 1613.5.2 & Section 1613.5.2
Occupancy Category: II Table 1604.5

Information from U.S. Geological Survey Website
http://earthquake.usgs.gov/research/hazmaps/

S_S=	2.750	g	
S_1=	1.070	g	
F_a=	1.000		Table 1613.5.3(1)
F_v=	1.500		Table 1613.5.3(2)
S_{MS}=	2.75	g	(Equation 16-37)
S_{M1}=	1.61	g	(Equation 16-38)
S_{DS}=	1.833	g	(Equation 16-39)
S_{D1}=	1.070	g	(Equation 16-40)

Seismic Design Category (SDC): Varies

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Crenlo
High Seismic

Job No. : 14273 Date: 11/12/15
By: MAS Page: 23

Load Case: Single unit (Ground floor)

Unit Dimensions	
Depth (D) (in) =	40
Width (W) (in) =	24.00
Frame Height (in) =	82.750
Max Weight (lb.) =	700

Unit	Part	Weight (lbs)	Center of Gravity Location X (in)	Y (in)	Z (in)
DEFR	Frame+Contents	700	12.000	20	41.375

Longitudinal Anchorage Spacing (in) = 14
Transverse Anchorage Spacing (in) = 36.00

Seismic Force		
S_{DS} =	1.83	High Seismic
I_p =	1.0	(Importance)
a_p =	1.0	(Cabinets)
R_p =	2.5	(Cabinets)
z/h =	0.0	(Ground Floor)
F_p =	0.293	W
$F_{p,min}$ =	0.55	W
$F_{p,max}$ =	2.93	W
Use F_p =	**0.550**	**W**
Ω =	2.5	Overstrength

Longitudinal Overturning

Overturning Moment = 0.55 (41.375 in. x 700lbs.) = 15,929 lb-in

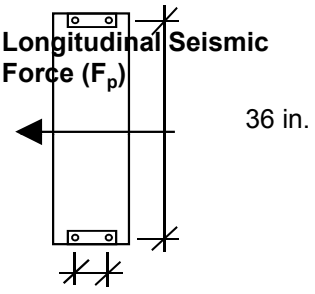
0.9xResisting Moment = 0.9 [(700 lbs. - Vert. Comp.) x 12in.]= 4,788 lb-in
Vertical Component (0.2*SDS*Wp) = 257 lbs

Total # of Bolts = 4

Anchorage Force =	995	lbs/per bolt
Shear Force =	481	lbs/per bolt

Anchorage and Shear Force Increased by Overstrength Factor

DEFR unit Plan



Design Bolts for 995 lbs tension, 481 lbs. shear, longitudinal direction

Transverse Overturning

Overturning Moment = 0.55 (41.375 in. x 700lbs.) = 15,929 lb-in

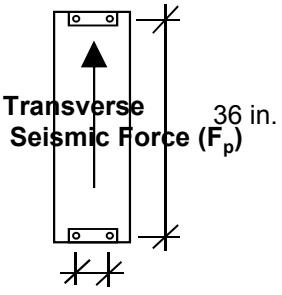
0.9xResisting Moment = 0.9 [(700 lbs. - Vert. Comp.) x (20in.)]= 7,980 lb-in
Vertical Component (0.2*SDS*Wp) = 257 lbs

Total # of Bolts = 4

Anchorage Force =	276	lbs/per bolt
Shear Force =	481	lbs/per bolt

Anchorage and Shear Force Increased by Overstrength Factor

DEFR unit Plan



Design Bolts for 276 lbs tension, 481 lbs. shear, longitudinal direction

Drawing Reference See: SK3 & SK6

Load Case: ***<u>Single units on 18in raised computer floor (Ground floor)</u>***

Unit Dimensions	
Depth (D) (in) =	40
Width (W) (in) =	24.00
Frame Height (in) =	82.750
Max Weight (lb.) =	400

Raised Floor = 18 in

			Center of Gravity Location		
Unit	**Part**	**Weight (lbs)**	**X (in)**	**Y (in)**	**Z (in)**
DEFR	Frame+Contents	400	12.000	20	59.375

Transverse Anchorage Spacing (in) = 36.00

Longitudinal Anchorage Spacing (in) = 14

Seismic Force		
S_{DS} =	1.83	High Seismic
I_p =	1.0	(Importance)
a_p =	1.0	(Cabinets)
R_p =	2.5	(Cabinets)
z/h =	0.0	(Ground Floor)
F_p =	0.293	W
$F_{p,min}$ =	0.55	W
$F_{p,max}$ =	2.93	W
Use F_p =	**0.550**	**W**
Ω =	2.5	Overstrength

Longitudinal Overturning

Overturning Moment = 0.55 (59.375 in. x 400lbs.) = 13,063 lb-in

0.9xResisting Moment = 0.9 [(400 lbs. - Vert. Comp.) x (12in.)]= 2,736 lb-in

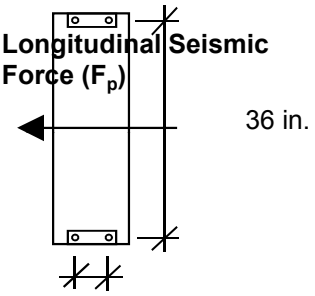
Vertical Component (0.2*SDS*Wp) = 147 lbs

Total # of Bolts = 4

Anchorage Force =	922	lbs/per bolt
Shear Force =	275	lbs./per bolt

Anchorage and Shear Force Increased by Overstrength Factor

<u>DEFR unit Plan</u>



Design Bolts for 922 lbs tension, 275 lbs. shear, longitudinal direction

Transverse Overturning

Overturning Moment = 0.55 (59.375 in. x 400lbs.) = 13,063 lb-in

0.9xResisting Moment = 0.9 [(400 lbs. - Vert. Comp.) x (20in)]= 4,560 lb-in

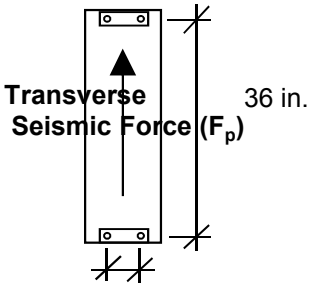
Vertical Component (0.2*SDS*Wp) = 147 lbs

Total # of Bolts = 4

Anchorage Force =	295	lbs/per bolt
Shear Force =	481	lbs/per bolt

Anchorage and Shear Force Increased by Overstrength Factor

<u>DEFR unit Plan</u>



Design Bolts for 295 lbs tension, 481 lbs. shear, longitudinal direction

****Site Specific Engineering Required****

RMJ
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Crenlo
High Seismic

Job No. : 14273 Date: 06/29/18
By: JH Page: 25

Load Case: <u>Ganged Unit (Ground floor)</u>

# of Units ganged (min)= 2

Single Unit Dimension	
Width (W) (in) =	40
Depth (D) (in) =	24.00
Frame Height (in) =	82.750
Max Weight (lb.) =	2,000

			Center of Gravity Location		
Unit	**Part**	**Weight (lbs)**	**X (in)**	**Y (in)**	**Z (in)**
2 - DEFR	Frame+Contents	4,000	24	20	41.375

Seismic Force		
S_{DS} =	1.83	High Seismic
I_p =	1.0	(Importance)
a_p =	1.0	(Cabinets)
R_p =	2.5	(Cabinets)
z/h =	0.0	(Ground Floor)
F_p =	0.293	W
$F_{p,min}$ =	0.55	W
$F_{p,max}$ =	2.93	W
Use F_p =	**0.550**	**W**
Ω =	2.5	Overstrength

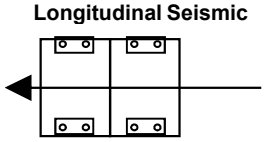
Longitudinal Anchorage Spacing (in) = 24.00
Transverse Anchorage Spacing (in) = 36.00

Longitudinal Overturning

Overturning Moment = 0.55 (41.375 in. x 4000lbs.) = 91,025 lb-in

0.9xResisting Moment = 0.9 [(4000 lbs. - Vert. Comp.) x24 in.]= 54,720 lb-in
Vertical Component (0.2*SDS*Wp) = 1,467 lbs

<u>Ganged DEFR unit Plan</u>



Anchorage Force =	945	lbs/per bolt
Shear Force =	1,375	lbs/per bolt

2 ganged units
Total # of bolts/Unit = 4

Anchorage and Shear Force Increased by Overstrength Factor

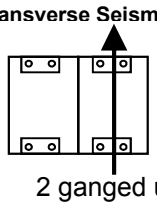
Design Bolts for 945 lbs tension, 1,375 lbs. shear, longitudinal direction

Transverse Overturning

Overturning Moment = 0.55 (41.375 in. x 4000lbs.) = 91,025 lb-in

0.9xResisting Moment = 0.9 [(4000 lbs - Vert. Comp.) x20 in.] = 45,600 lb-in
Vertical Component (0.2*SDS*Wp) = 1,467 lbs

<u>Ganged DEFR unit Plan</u>



2 ganged units

Anchorage Force =	789	lbs/per bolt
Shear Force =	1,375	lbs/per bolt

Total # of bolts/Unit = 4

Anchorage and Shear Force Increased by Overstrength Factor

Design Bolts for 789 lbs tension, 1,375 lbs. shear, transverse direction

Drawing Reference See: <u>SK5 & SK6</u>

Load Case: ***Ganged units on 18in raised computer floor (Ground floor)***

# of Units ganged (min)= 2

Single Unit Dimension	
Width (W) (in) =	40
Depth (D) (in) =	24.00
Frame Height (in) =	82.750
Max Weight (lb.) =	1,000

Raised Floor = 18 in

Unit	Part	Weight (lbs)	Center of Gravity Location X (in)	Y (in)	Z (in)
2 - DEFR	Frame+Contents	2,000	24	20	59.375

Longitudinal Anchorage Spacing (in) = 24

Transverse Anchorage Spacing (in) = 36.00

Seismic Force		
S_{DS} =	1.83	High Seismic
I_p =	1.0	(Importance)
a_p =	1.0	(Cabinets)
R_p =	2.5	(Cabinets)
z/h =	0.0	(Ground Floor)
F_p =	0.293	W
$F_{p,min}$ =	0.55	W
$F_{p,max}$ =	2.93	W
Use F_p =	**0.550**	**W**
Ω =	2.5	Overstrength

Longitudinal Overturning

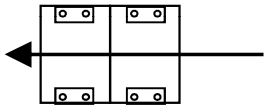
Overturning Moment = 0.55 (59.375 in. x 2000lbs.) = 65,313 lb-in

0.9xResisting Moment = 0.9 [(2000 lbs. - Vert. Comp.) x24 in.]= 27,360 lb-in

Vertical Component (0.2*SDS*Wp) = 733 lbs

Ganged DEFR unit Plan

Longitudinal Seismic Force



2 ganged units

Anchorage Force =	988	lbs/per bolt
Shear Force =	688	lbs/per bolt

Total # of bolts/Unit = 4

Anchorage and Shear Force Increased by Overstrength Factor

Design Bolts for 988 lbs tension, 688 lbs. shear, longitudinal direction

Transverse Overturning

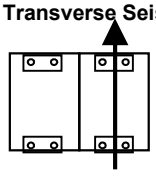
Overturning Moment = 0.55 (59.375in. x 2000lbs.) = 65,313 lb-in

0.9xResisting Moment = 0.9 [(2000 lbs - Vert. Comp.) x20 in.] = 22,800 lb-in

Vertical Component (0.2*SDS*Wp) = 733 lbs

Ganged DEFR unit Plan

Transverse Seismic Force



2 ganged units

Anchorage Force =	738	lbs/per bolt
Shear Force =	688	lbs/per bolt

Total # of bolts/Unit = 4

Anchorage and Shear Force Increased by Overstrength Factor

Design Bolts for 738 lbs tension, 688 lbs. shear, longitudinal direction

Drawing Reference See: SK5 & SK9

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241 Joaquin Ave.
San Leandro, CA 94577
510.991.0977

Crenlo
High Seismic

Job No. : 14273 Date: 06/29/18
By: MAS Page: 27

Load Case: ***Single Unit (≤ 50% of Bldg. Ht.)***
(i.e. 2nd floor of a 4 story building or 4th floor of an 8 story building)

Unit Dimensions	
Depth (D) (in) =	40
Width (W) (in) =	24.00
Frame Height (in) =	82.750
Max Weight (lb.) =	600

			Center of Gravity Location		
Unit	**Part**	**Weight (lbs)**	**X (in)**	**Y (in)**	**Z (in)**
DEFR	Frame+Contents	600	12.000	20	41.375

Seismic Force		
S_{DS} =	1.83	High Seismic
I_p =	1.0	(Importance)
a_p =	1.0	(Cabinets)
R_p =	2.5	(Cabinets)
z/h =	0.5	(50% of bldg ht.)
F_p =	0.587	W
$F_{p,min}$ =	0.55	W
$F_{p,max}$ =	2.93	W
Use F_p =	**0.587**	**W**
Ω =	2.5	Overstrength

Longitudinal Anchorage Spacing (in) = 14.00
Transverse Anchorage Spacing (in) = 36

Longitudinal Overturning

Overturning Moment = 0.59 (41.375 in. x 600lbs.) = 14,564 lb-in

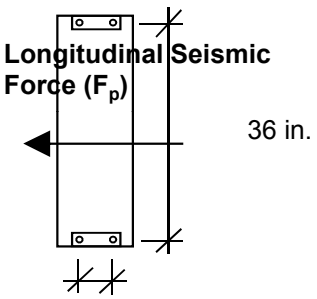
0.9xResisting Moment = 0.9 [(600 lbs. - Vert. Comp.) x (12in.)]= 4,104 lb-in
Vertical Component (0.2*SDS*Wp) = 220 lbs

Total # of Bolts = 4

Anchorage Force =	363	lbs/per bolt
Shear Force =	440	lbs/per bolt

Anchorage and Shear Force Increased by Overstrength Factor

DEFR unit Plan



Design Bolts for 363 lbs tension, 440 lbs. shear, longitudinal direction

Transverse Overturning

Overturning Moment = 0.59 (41.375 in. x 600lbs.) = 14,564 lb-in

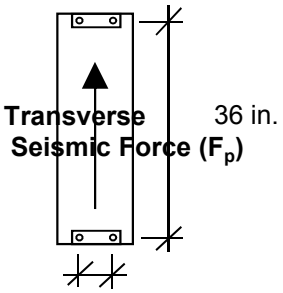
0.9xResisting Moment = 0.9 [(600 lbs. - Vert. Comp.) x (20in)]= 6,840 lb-in
Vertical Component (0.2*SDS*Wp) = 220 lb-in

Total # of Bolts = 4

Anchorage Force =	690	lbs/per bolt
Shear Force =	440	lbs/per bolt

Anchorage and Shear Force Increased by Overstrength Factor

DEFR unit Plan



Design Bolts for 690 lbs tension, 440 lbs. shear, longitudinal direction

****Site Specific Engineering Required****

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241 Joaquin Ave.
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Crenlo
High Seismic

Job No. : 14273 Date: 06/29/18
By: MAS Page: 28

Load Case: ***Single unit on 18in raised computer floor (≤ 50% of Bldg. Ht.)***
(i.e. 2nd floor of a 4 story building or 4th floor of an 8 story building)

Unit Dimensions	
Depth (D) (in) =	40
Width (W) (in) =	24.00
Frame Height (in) =	82.750
Max Weight (lb.) =	400

Raised Floor = 18 in

			Center of Gravity Location		
Unit	**Part**	**Weight (lbs)**	**X (in)**	**Y (in)**	**Z (in)**
DEFR	Frame+Contents	400	12.000	20	59.375

Transverse Anchorage Spacing (in) = 36
Longitudinal Anchorage Spacing (in) = 14.00

Seismic Force		
S_{DS} =	1.83	High Seismic
I_p =	1.0	(Importance)
a_p =	1.0	(Cabinets)
R_p =	2.5	(Cabinets)
z/h =	0.5	(50% of bldg ht.)
F_p =	0.587	W
$F_{p,min}$ =	0.55	W
$F_{p,max}$ =	2.93	W
Use F_p =	**0.587**	**W**
Ω =	2.5	Overstrength

Longitudinal Overturning

Overturning Moment = 0.59 (59.375 in. x 400lbs.) = 13,933 lb-in

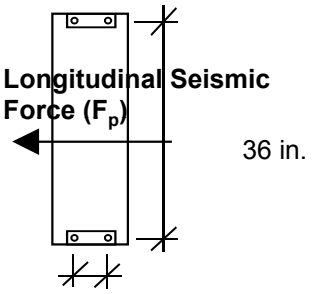
0.9xResisting Moment = 0.9 [(400 lbs. - Vert. Comp.) x (12in)]= 2,736 lb-in
Vertical Component (0.2*SDS*Wp) = 147 lbs

Total # of Bolts = 4

Anchorage Force =	389	lbs/per bolt
Shear Force =	293	lbs/per bolt

Anchorage and Shear Force Increased by Overstrength Factor

DEFR unit Plan



Design Bolts for 389 lbs tension, 293 lbs. shear, longitudinal direction

Transverse Overturning

Overturning Moment = 0.59 (59.375 in. x 400lbs.) = 13,933 lb-in

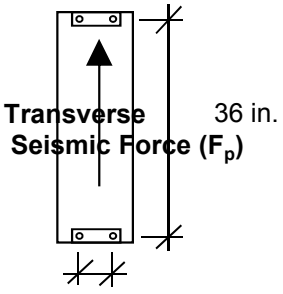
0.9xResisting Moment = 0.9 [(400 lbs. - Vert. Comp.) x (20in.)]= 4,560 lb-in
Vertical Component (0.2*SDS*Wp*20in) = 147 lb-in

Total # of Bolts = 4

Anchorage Force =	837	lbs/per bolt
Shear Force =	293	lbs/per bolt

Anchorage and Shear Force Increased by Overstrength Factor

DEFR unit Plan



Design Bolts for 837 lbs tension, 293 lbs. shear, longitudinal direction

****Site Specific Engineering May Result in Higher Loads****

Load Case: <u>Ganged Unit (≤ 50% of Bldg. Ht.)</u>

# of Units ganged (min)= 2

Single Unit Dimension					
Depth (D) (in) =	40	add	0	in	Edge length
Width (W) (in) =	24.00				
Frame Height (in) =	82.750				
Max Weight (lb.) =	1,000				

			Center of Gravity Location		
Unit	**Part**	**Weight (lbs)**	**X (in)**	**Y (in)**	**Z (in)**
2 - DEFR	Frame+Contents	2,000	24	20	41.375

Seismic Force		
S_{DS} =	1.83	High Seismic
I_p =	1.0	(Importance)
a_p =	1.0	(Cabinets)
R_p =	2.5	(Cabinets)
z/h =	0.5	(50% of bldg ht.)
F_p =	0.587	W
$F_{p,min}$ =	0.55	W
$F_{p,max}$ =	2.93	W
Use F_p =	**0.587**	**W**
Ω =	2.5	Overstrength

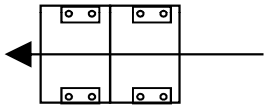
Longitudinal Anchorage Spacing (in) = 24
Transverse Anchorage Spacing (in) = 36.00

Longitudinal Overturning

Overturning Moment = 0.59 (41.375 in. x 2000lbs.) = 48,547 lb-in

0.9xResisting Moment = 0.9 [(2000 lbs. - Vert. Comp.) x24 in.]= 27,360 lb-in
Vertical Component (0.2*SDS*Wp) = 733 lbs

Ganged DEFR unit Plan
Longitudinal Seismic Force



2 ganged units

Anchorage Force =	552	lbs
Shear Force =	733	lbs/per bolt

Total # of bolts/Unit = 4

Anchorage and Shear Force Increased by Overstrength Factor

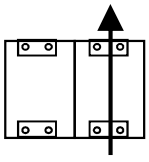
Design Bolts for 552 lbs tension, 733 lbs. shear, longitudinal direction

Transverse Overturning

Overturning Moment = 0.59 (41.375 in. x 2000lbs.) = 48,547 lb-in

0.9xResisting Moment = 0.9 [(2000 lbs - Vert. Comp.) x20 in.] = 22,800 lb-in
Vertical Component (0.2*SDS*Wp) = 733 lbs

Ganged DEFR unit Plan
Transverse Seismic Force



2 ganged units

Anchorage Force =	447	lbs/per bolt
Shear Force =	733	lbs/per bolt

Total # of bolts/Unit = 4

Anchorage and Shear Force Increased by Overstrength Factor

Design Bolts for 447 lbs tension, 733 lbs. shear, longitudinal direction

Drawing Reference See: <u>SK5 & SK7</u>

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510.991.0977

Crenlo
High Seismic

Job No. : 14273 Date: 06/29/18
By: MAS Page: 30

Load Case: ***<u>Ganged unit on 18in raised computer floor (≤ 50% of Bldg. Ht.)</u>***

# of Units ganged (min)= 2

Single Unit Dimension	
Depth (D) (in) =	40
Width (W) (in) =	24.00
Frame Height (in) =	82.750
Max Weight (lb.) =	1,000

Raised Floor = 18 in

Unit	Part	Weight (lbs)	Center of Gravity Location X (in)	Y (in)	Z (in)
2 - DEFR	Frame+Contents	2,000	24	20	59.375

Longitudinal Anchorage Spacing (in) = 24
Transverse Anchorage Spacing (in) = 36.00

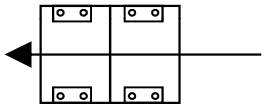
Seismic Force		
S_{DS} =	1.83	High Seismic
I_p =	1.0	(Importance)
a_p =	1.0	(Cabinets)
R_p =	2.5	(Cabinets)
z/h =	0.5	(50% of bldg ht.)
F_p =	0.587	W
$F_{p,min}$ =	0.55	W
$F_{p,max}$ =	2.93	W
Use F_p =	**0.587**	**W**
Ω =	2.5	Overstrength

Longitudinal Overturning

Overturning Moment = 0.59 (59.375 in. x 2000lbs.) = 69,667 lb-in

0.9xResisting Moment = 0.9 (2000 lbs. x24 in.)= 27,360 lb-in
Vert. Comp. (0.2*SDS*Wp)= 733 lbs

<u>Ganged DEFR unit Plan</u>
Longitudinal Seismic Force



2 ganged units

Anchorage Force =	1,102	lbs/per bolt
Shear Force =	733	lbs/per bolt

Total # of bolts/Unit = 4

Anchorage and Shear Force Increased by Overstrength Factor

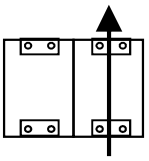
Design Bolts for 1,102 lbs tension, 733 lbs. shear, longitudinal direction

Transverse Overturning

Overturning Moment = 0.59 (59.375in. x 2000lbs.) = 69,667 lb-in

0.9xResisting Moment = 0.9 [(2000 lbs - Vert. Comp.) x20 in.] = 22,800 lb-in
Vertical Component (0.2*SDS*Wp) = 733 lb-in

<u>Ganged DEFR unit Plan</u>
Transverse Seismic Force



2 ganged units

Anchorage Force =	814	lbs/per bolt
Shear Force =	733	lbs/per bolt

Total # of bolts/Unit = 4

Anchorage and Shear Force Increased by Overstrength Factor

Design Bolts for 814 lbs tension, 733 lbs. shear, longitudinal direction

Drawing Reference See: <u>SK5 & SK8</u>

RMJ

Structural Engineers

Robinson
Meier
Juilly & Associates

Principals
Peter Robinson, S.E.
Jayson E. Haines, S.E.

Drawing Details

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San Leandro CA 94577
(510)991-0977

GENERAL NOTES

DESIGN

Design conforms to the International Building Code, 2012 Edition, & the California Building Code, 2013 Edition.

Design live loads:
Importance Factor 1.0
Seismic Design Category (SDC).... VARIES
Maximum Value of Ss..... 2.75

Typical Details: and notes on these sheets shall apply unless specifically shown or noted otherwise. Construction details not fully shown or noted shall be similar to details for similar conditions. All work and construction shall comply with all applicable building codes, regulations, and safety requirements.

Discrepancies: The Contractor shall inform the Architect in writing, during the bidding period, of any discrepancies or omissions noted on the drawings or in the specifications, or of any variations needed in order to conform to codes, rules, and regulations. Upon receipt of such information, the Architect will send written instructions to all concerned. Any such discrepancy, omission, or variation not reported shall be the responsibility of the Contractor, and work shall be performed in a manner as directed by the Architect.

EXISTING CONSTRUCTION

The Contractor shall verify all existing conditions and shall notify the Architect of all exceptions before proceeding with the work. The removal, cutting, drilling, etc. of existing work shall be performed with great care and small tools in order not to jeopardize the structural integrity of the building.
If existing structural members, not indicated for removal, interfere with the new work, the Structural Engineer shall be notified immediately, and approval obtained, before removal of the existing members.

FASTENERS

Wedge Anchors: Hilti Kwik Bolt Wedge Anchor, types as indicated per ICBO evaluation report No. 1917 or by manufacture having current ICBO evaluation report with values in shear and tension) equal or greater.

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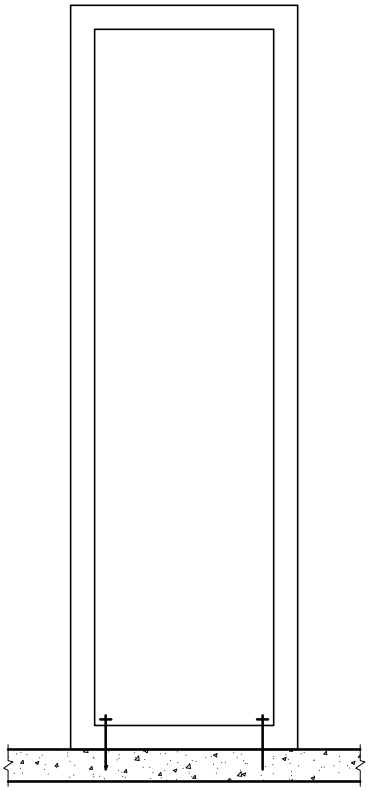
241 Joaquin Avenue
San Leandro, CA 94577
Tel: 510.991.0977

CRENLO DEFR GUARDIAN	Job No. 14273
LOW, MODERATE, AND HIGH SEISMIC REGIONS	Sheet No. SK1
Signed by JEH Date 6/29/18	

DESIGN SCENARIOS AND CONDITIONS

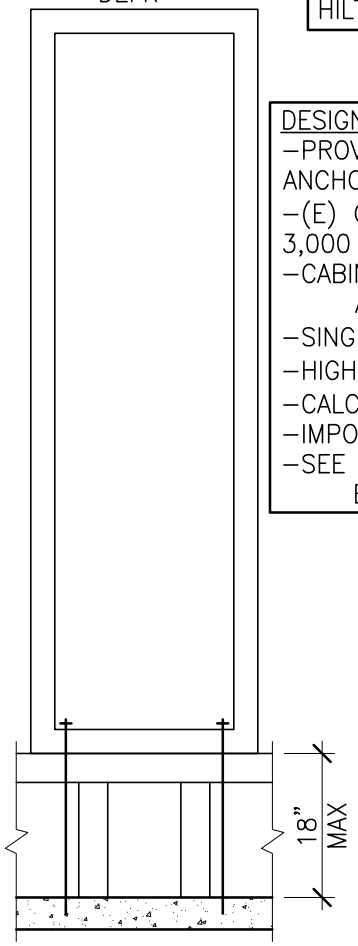
FASTENER SELECTION
HILTI KB–TZ $^{1}/_{2}$" ø BOLT

DEFR



CONC. SLAB OR CONC. OVER METAL DECK (DIRECT FRAME TO FLOOR) REFER TO DRAWINGS SK3, SK4, SK5, SK6, SK9

DEFR



RAISED COMP. FLOOR (ANCHOR FRAME TO SUB–FLOOR) REFER TO DRAWINGS SK3, SK4, SK5, SK7, SK8

DESIGN CRITERIA
- –PROVIDE SPECIAL INSPECTION FOR EXPANSION ANCHOR
- –(E) CONC. MIN COMPRESSIVE STRENGTH 3,000 psi
- –CABINETS LOCATED AT GROUND FLOOR or AT <50% OF BUILDING HEIGHT
- –SINGLE & GANGED UNITS (3 OR MORE)
- –HIGH or LOW/MODERATE SEISMIC REGIONS
- –CALCULATION PER IBC 2012/CBC 2013
- –IMPORTANCE FACTOR 1.0
- –SEE TABLE 1 FOR ALLOWABLE WEIGHT OF ENCLOSURE AND CONTENTS

ALLOWABLE CABINET TOTAL WEIGHT (CABINET AND CONTENTS) TABLE 1

MAX CABINET WT. WITH CONTENTS	LOW & MODERATE SEISMIC				HIGH SEISMIC			
	GROUND		UPPER		GROUND		UPPER	
	ON FLOOR	RAISED	ON FLOOR	RAISED	ON FLOOR	RAISED	ON FLOOR	RAISED
SINGLE UNIT	1,600	1,000	1,200	1,000	700	400	600	400
GANGED UNIT	1,600	1,200	1,200	1,200	1,200	1,200	1,000	1,000

SS[1] – SITE SPECIFIC ENGINEERING REQUIRED

REGISTERED PROFESSIONAL ENGINEER
JAYSON E. HAINES
No. 4801
Exp. 12/31/2019
STRUCTURAL
STATE OF CALIFORNIA

RMJ
Robinson Meier Juilly & Associates
www.rmjse.com
Structural Engineers
241 Joaquin Avenue
San Leandro, CA 94577
Tel: 510.991.0977

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Job No. 14273

LOW, MODERATE, AND HIGH SEISMIC REGIONS

Sheet No. SK2

Signed by

Date 6/29/18

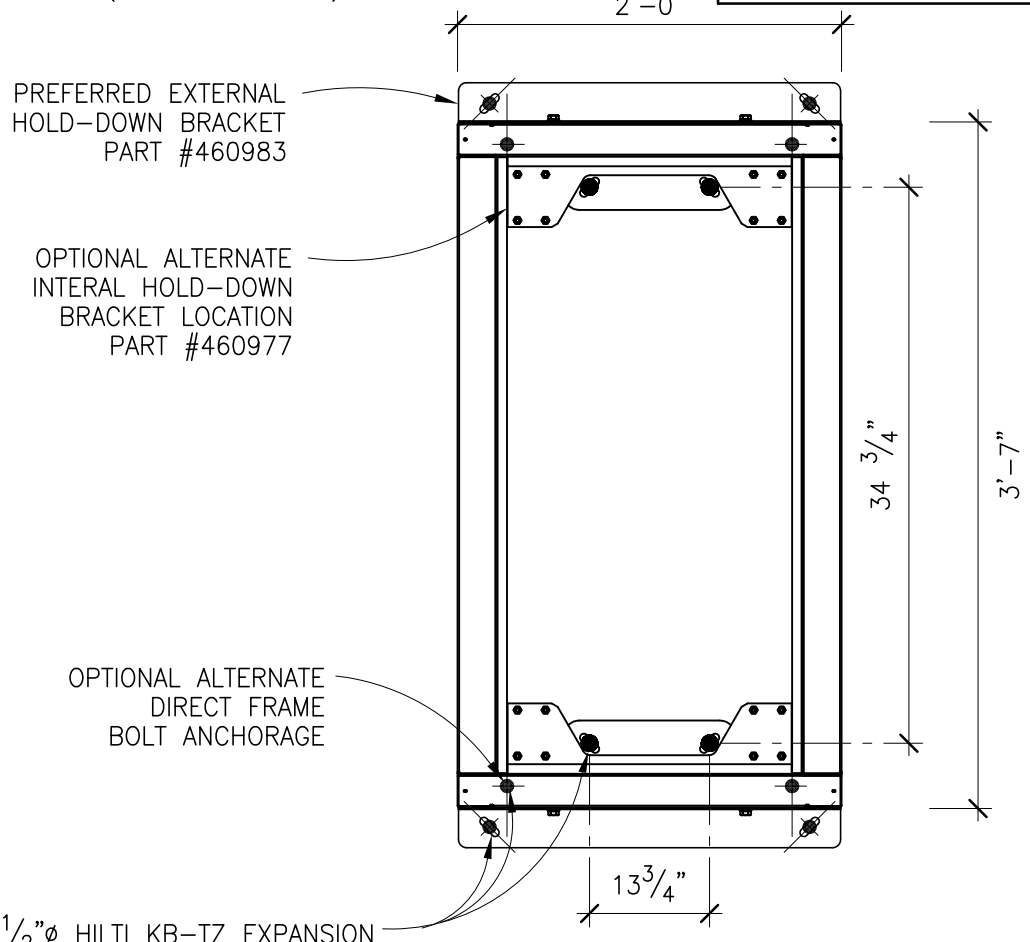
NOTES:
*POSITION BOLTS IN OUTER OR UPPER HALF OF SLOTTED BOLT HOLES WHERE APPLICABLE
*SEE MANUFACTURE DRAWINGS FOR EXACT DIMENSIONS AND SIZE OF DEFR UNITS

CONDITION SCHEDULE

CONDITION	SEE
CONCRETE SLAB	SK6
CONCRETE FILL OVER METAL DECK	SK7
RAISED COMP. FLOOR CONC. FILL METAL DECK	SK8
RAISED COMP. FLOOR CONC. SLAB	SK9

INSTALLATION FOR THE FOLLOWING CONDITIONS:

1. ALL (EXCEPT SUBBASE)



SINGLE DEFR UNIT BOTTOM PLAN VIEW

PLAN 1 / SK3
1"=1'-0"

REGISTERED PROFESSIONAL ENGINEER
JAYSON E. HAINES
No. 4801
Exp. 12/31/2019
STRUCTURAL
STATE OF CALIFORNIA

RMJ
Robinson Meier Juilly & Associates
www.rmjse.com
Structural Engineers
241 Joaquin Avenue
San Leandro, CA 94577
Tel: 510.991.0977

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LOW, MODERATE, AND HIGH SEISMIC REGIONS

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Job No. 14273

Sheet No. SK3

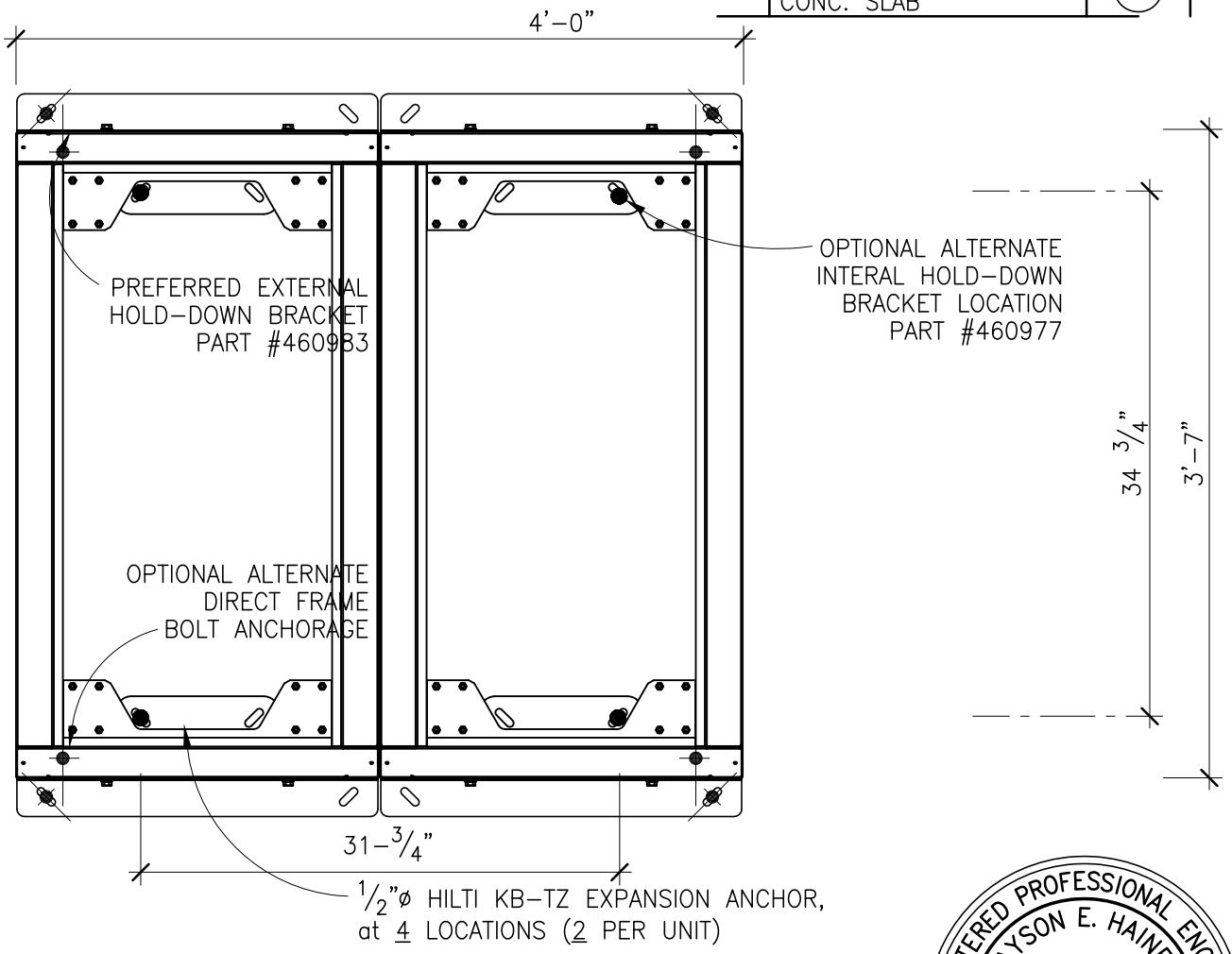
NOTES:
*POSITION BOLTS IN OUTER OR UPPER HALF OF SLOTTED BOLT HOLES WHERE APPLICABLE
*SEE MANUFACTURE DRAWINGS FOR EXACT DIMENSIONS AND SIZE OF DEFR UNITS

INSTALLATION FOR THE FOLLOWING CONDITIONS:

1. ALL (EXCEPT SUBBASE)

CONDITION SCHEDULE

CONDITION	SEE
CONCRETE SLAB	SK6
CONCRETE FILL OVER METAL DECK	SK7
RAISED COMP. FLOOR CONC. FILL METAL DECK	SK8
RAISED COMP. FLOOR CONC. SLAB	SK9



GANG DEFR UNITS BOTTOM PLAN VIEW
(2 UNITS OR MORE GANGED TOGETHER)

PLAN 1" = 1'-0" — 1 / SK4

REGISTERED PROFESSIONAL ENGINEER
JAYSON E. HAINES
No. 4801
Exp. 12/31/2019
STRUCTURAL
STATE OF CALIFORNIA

RMJ
Robinson Meier Juilly & Associates
www.rmjse.com
Structural Engineers
241 Joaquin Avenue
San Leandro, CA 94577
Tel: 510.991.0977

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Sheet No. SK4

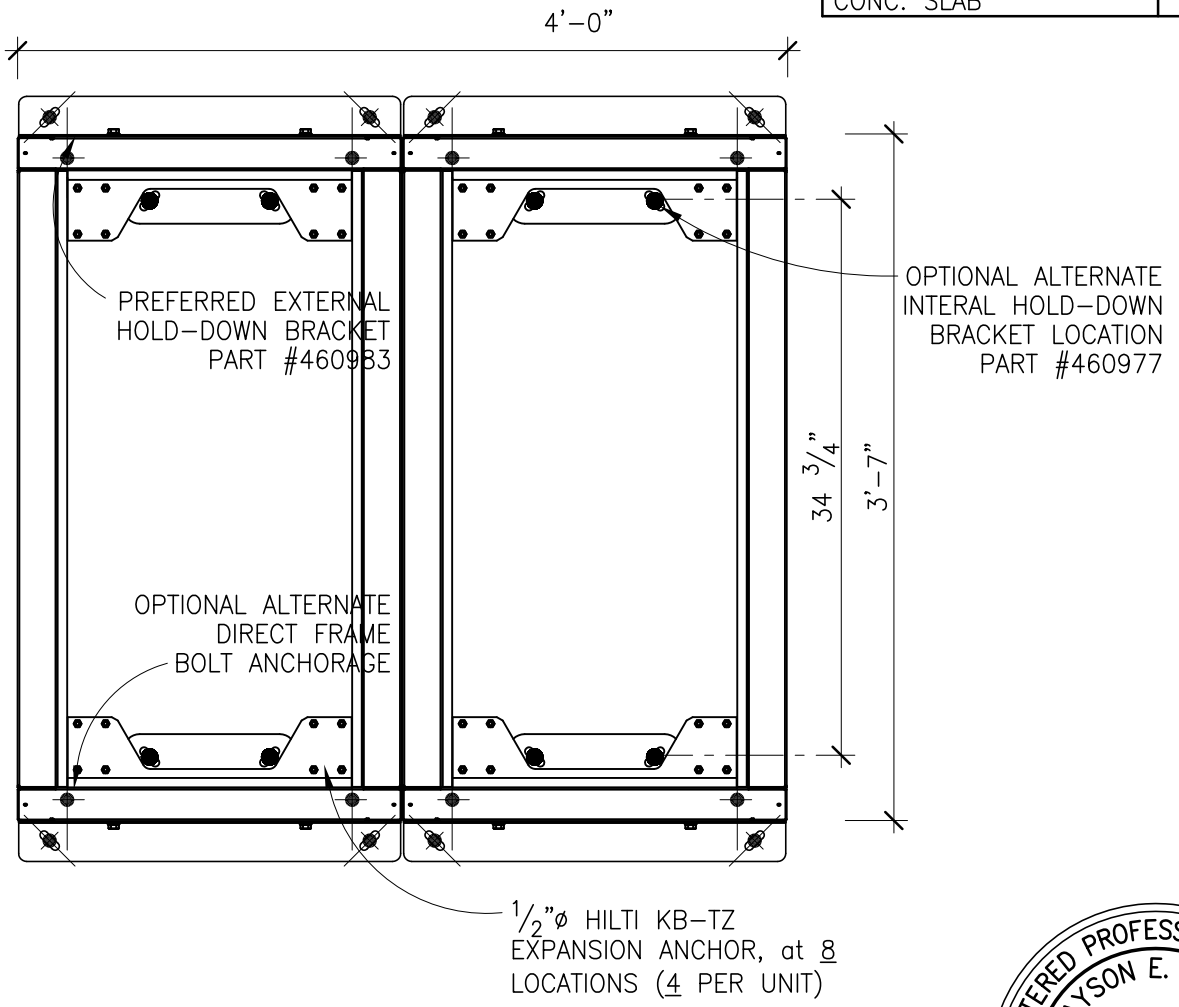
NOTES:
*POSITION BOLTS IN OUTER OR UPPER HALF OF SLOTTED BOLT HOLES WHERE APPLICABLE
*SEE MANUFACTURE DRAWINGS FOR EXACT DIMENSIONS AND SIZE OF DEFR UNITS

INSTALLATION FOR THE FOLLOWING CONDITIONS:

1. ALL (EXCEPT SUBBASE)

CONDITION SCHEDULE

CONDITION	SEE
CONCRETE SLAB	SK6
CONCRETE FILL OVER METAL DECK	SK7
RAISED COMP. FLOOR CONC. FILL METAL DECK	SK8
RAISED COMP. FLOOR CONC. SLAB	SK9



GANG DEFR UNITS BOTTOM PLAN VIEW
(2 UNITS OR MORE GANGED TOGETHER)

PLAN 1/SK5
1"=1'-0"

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JAYSON E. HAINES
No. 4801
Exp. 12/31/2019
STRUCTURAL
STATE OF CALIFORNIA

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Tel: 510.991.0977

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LOW, MODERATE, AND HIGH SEISMIC REGIONS

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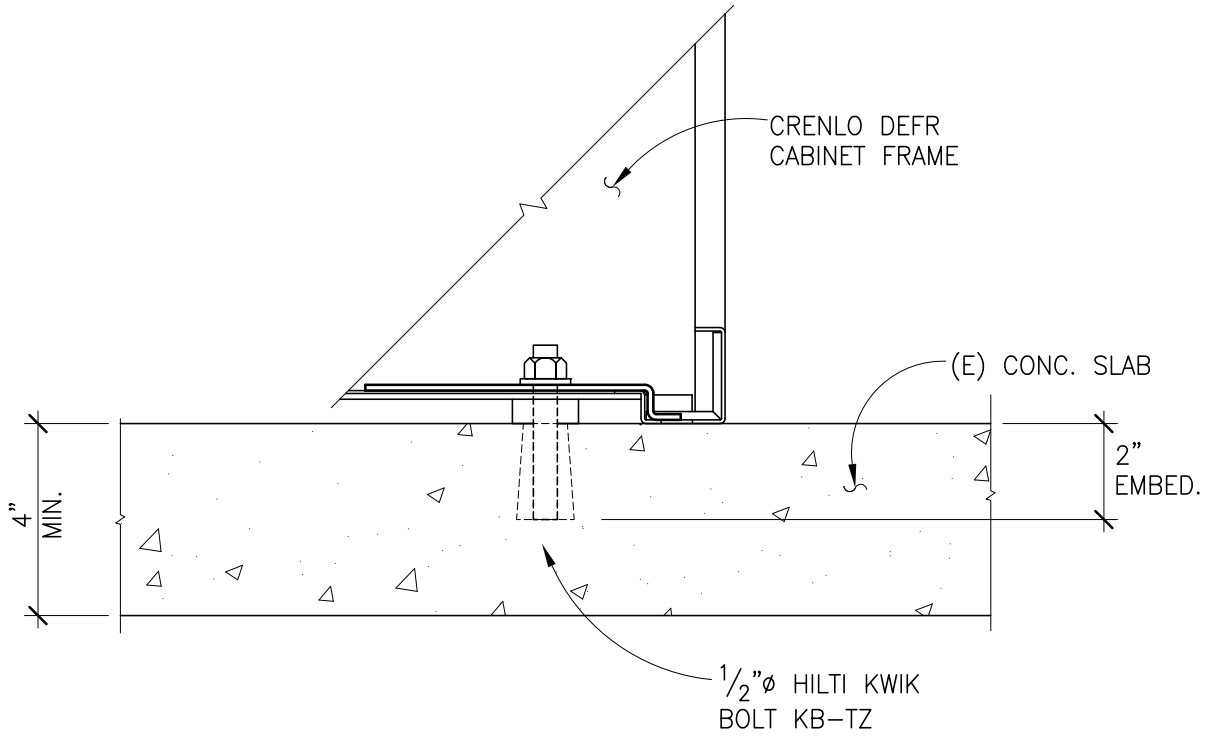
Sheet No. SK5



CONCRETE SLAB INSTALLATION

DETAIL 1 / SK6

3"=1'-0"

REGISTERED PROFESSIONAL ENGINEER
JAYSON E. HAINES
No. 4801
Exp. 12/31/2019
STRUCTURAL
STATE OF CALIFORNIA

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www.rmjse.com

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241 Joaquin Avenue
San Leandro, CA 94577
Tel: 510.991.0977

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LOW, MODERATE, AND HIGH SEISMIC REGIONS

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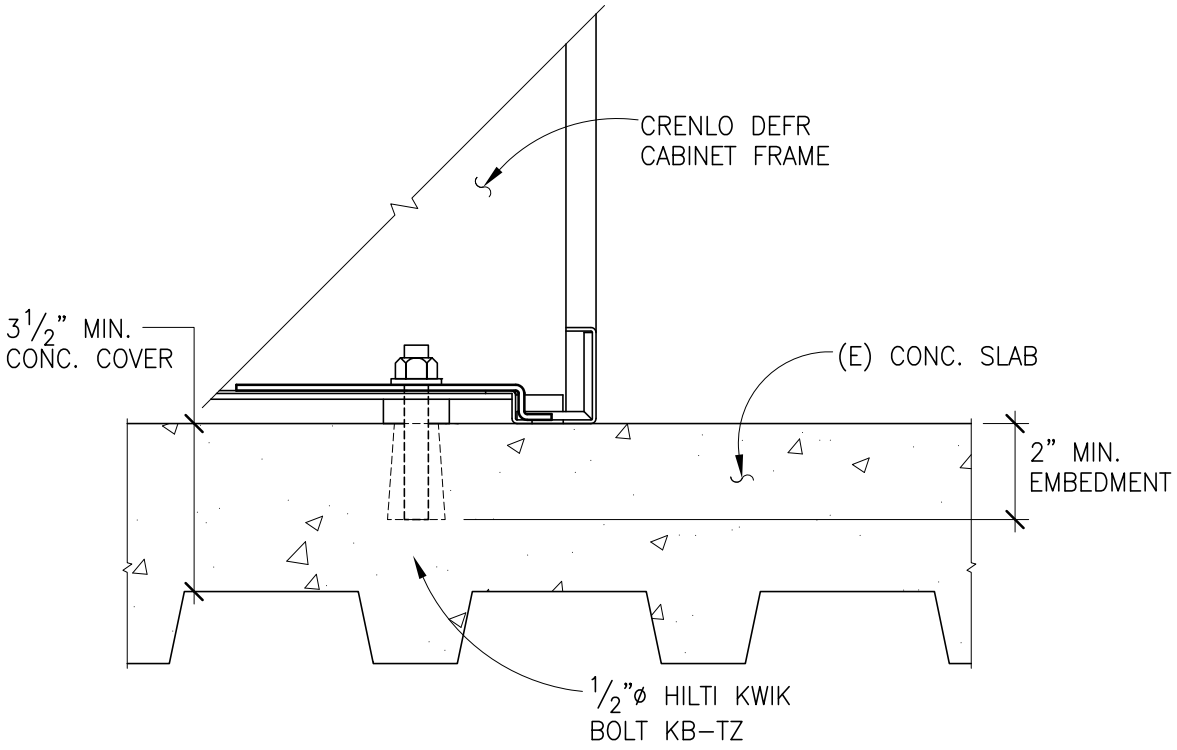
Job No. 14273

Sheet No. SK6



CONCRETE FILL OVER METAL DECK INSTALLATION

DETAIL 1/SK7

3"=1'-0"

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JAYSON E. HAINES
No. 4801
Exp. 12/31/2019
STRUCTURAL
STATE OF CALIFORNIA

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241 Joaquin Avenue
San Leandro, CA 94577
Tel: 510.991.0977

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LOW, MODERATE, AND HIGH SEISMIC REGIONS

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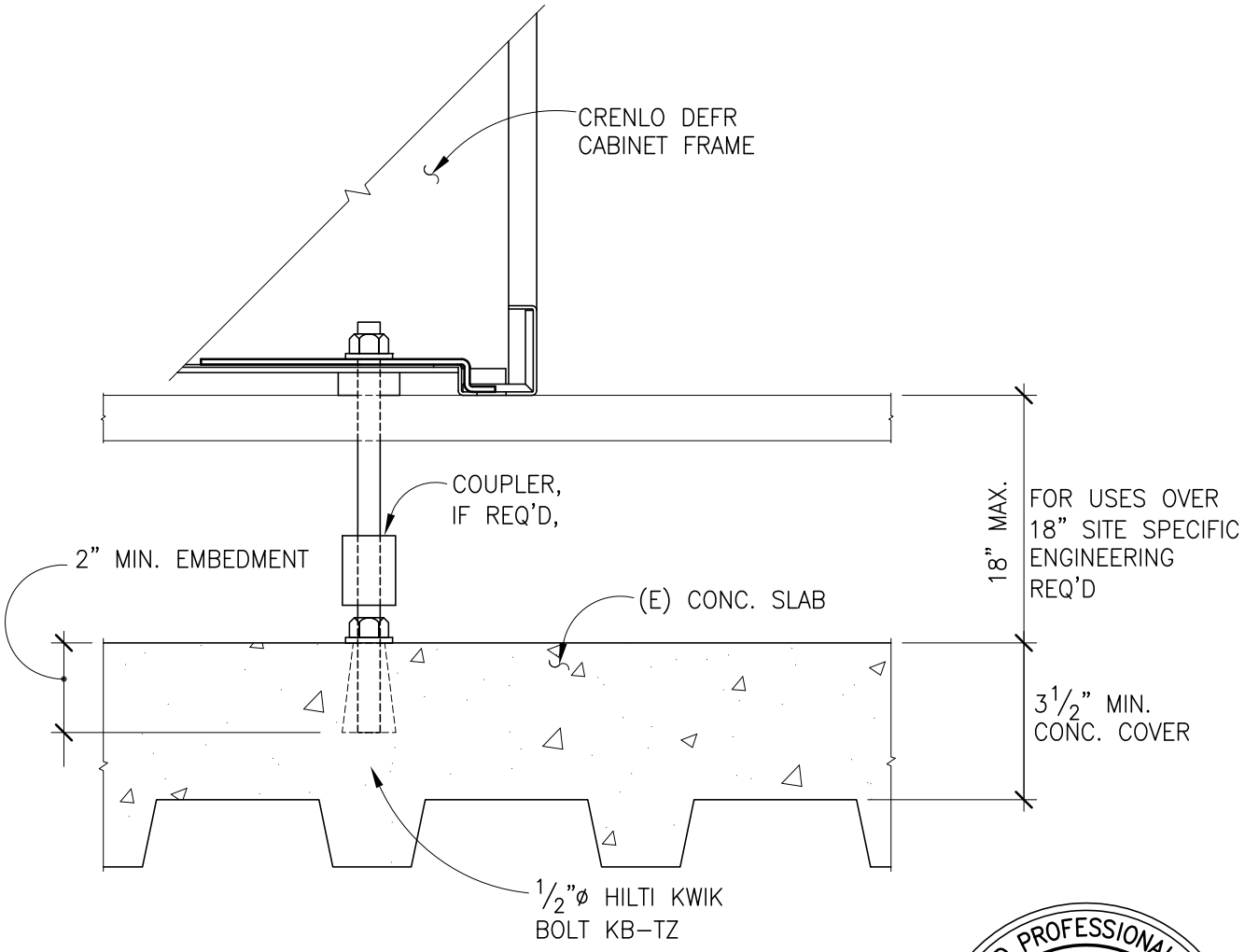
Job No.
14273

Sheet No.
SK7



RAISED COMPUTER OVER CONC. FILLED METAL DECK INSTALLATION

DETAIL 1/SK8

3"=1'-0"

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JAYSON E. HAINES
No. 4801
Exp. 12/31/2019
STRUCTURAL
STATE OF CALIFORNIA

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www.rmjse.com

Structural Engineers
241 Joaquin Avenue
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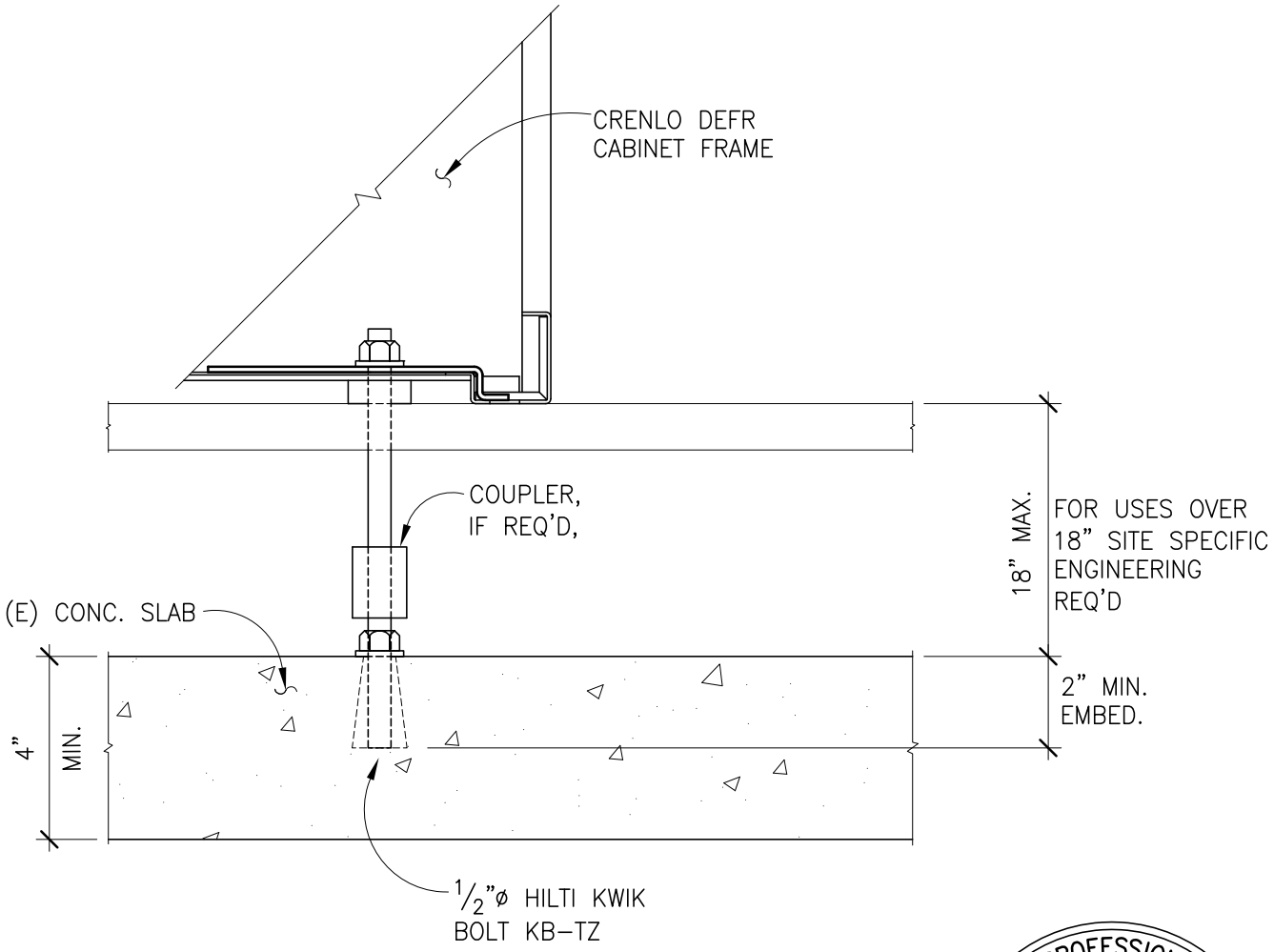
LOW, MODERATE, AND HIGH SEISMIC REGIONS	Sheet No. SK8
Signed by JEH Date 6/29/18	



RAISED COMPUTER OVER CONC. SLAB INSTALLATION

DETAIL 1/SK9

3"=1'-0"

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JAYSON E. HAINES
No. 4801
Exp. 12/31/2019
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STATE OF CALIFORNIA

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www.rmjse.com

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San Leandro, CA 94577
Tel: 510.991.0977

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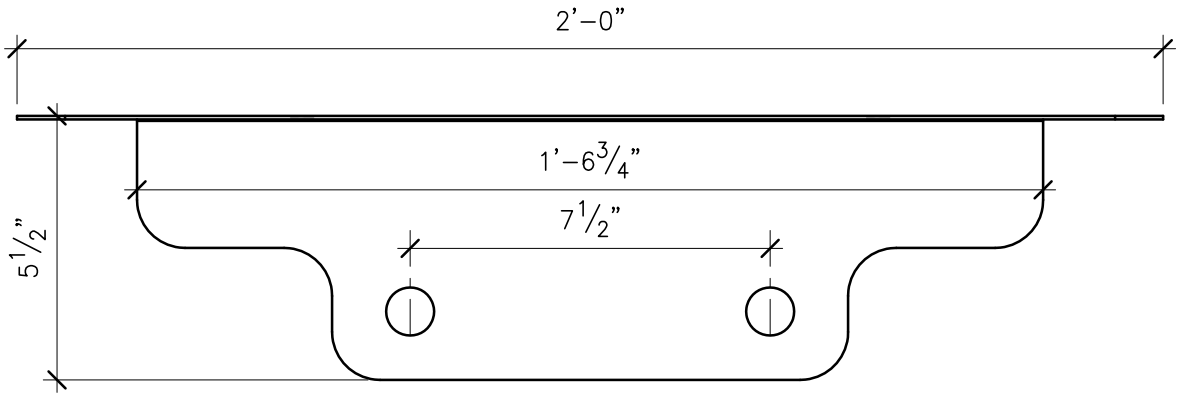
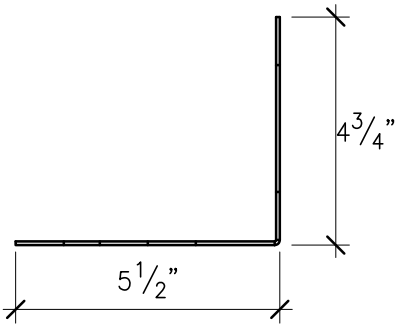
LOW, MODERATE, AND HIGH SEISMIC REGIONS	Sheet No. SK9
Signed by	Date 6/29/18



INTERNAL SEISMIC BRACKET
(#460977)
PLAN



DETAIL 1 / SK10

3"=1'–0"

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JAYSON E. HAINES
No. 4801
Exp. 12/31/2019
STRUCTURAL
STATE OF CALIFORNIA

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Robinson
Meier
Juilly & Associates
www.rmjse.com

Structural Engineers
241 Joaquin Avenue
San Leandro, CA 94577
Tel: 510.991.0977

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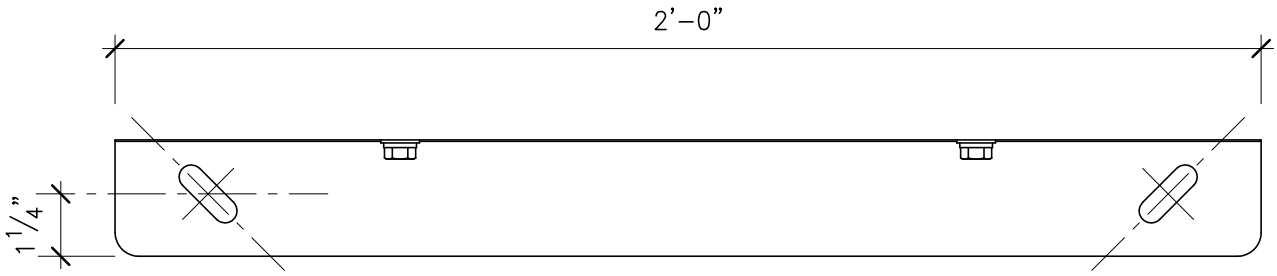
DEFR GUARDIAN

LOW, MODERATE, AND HIGH SEISMIC REGIONS

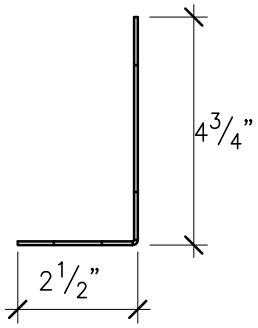
Signed by JEH Date 6/29/18

Job No. 14273

Sheet No. SK10



EXTERNAL SEISMIC BRACKET
(#460983)
PLAN



DETAIL 1 / SK11
3"=1'–0"

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JAYSON E. HAINES
No. 4801
Exp. 12/31/2019
STRUCTURAL
STATE OF CALIFORNIA

RMJ
Robinson
Meier
Juilly & Associates
www.rmjse.com

Structural Engineers
241 Joaquin Avenue
San Leandro, CA 94577
Tel: 510.991.0977

CRENLO
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LOW, MODERATE, AND HIGH
SEISMIC REGIONS

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Date 6/29/18

Job No.
14273

Sheet No.
SK11

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Structural Engineers

Robinson
Meier
Juilly & Associates

Principals
Peter Robinson, S.E.
Jayson E. Haines, S.E.

Appendix
(Hilti Output Files)

241 Joaquin Avenue
San Leandro CA 94577
(510)991-0977

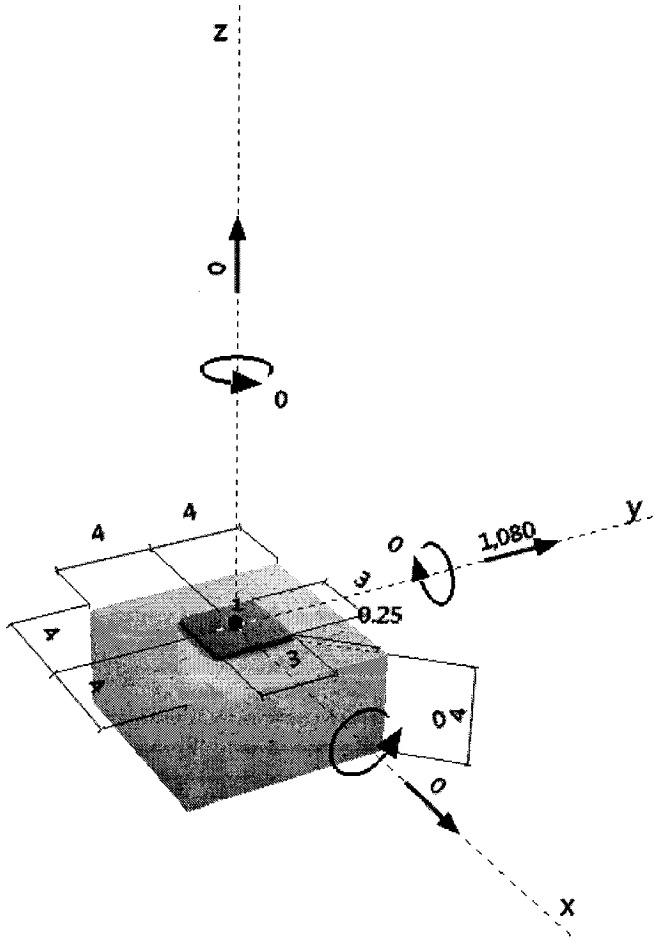
Company:	RMJ	Page:	1
Specifier:	Mario	Project:	Creno-DEFRS
Address:	241 Joaquin Ave.	Sub-Project I Pos. No.:	14273
Phone I Fax:	510.991.0977 |	Date:	4/6/2015
E-Mail:	msigala@rmjse.com		

Specifier's comments: DEFRS: SINGLE ANCHOR, Maximum Shear 1,080# 100% Capacity

1 Input data

Anchor type and diameter:	**Kwik Bolt TZ - CS 1/2 (2)**
Effective embedment depth:	$h_{ef,act}$ = 2.000 in., h_{nom} = 2.375 in.
Material:	Carbon Steel
Evaluation Service Report:	ESR-1917
Issued I Valid:	5/1/2013 | 5/1/2015
Proof:	Design method ACI 318-11 / Mech.
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.250 in.
Anchor plate:	l_x x l_y x t = 3.000 in. x 3.000 in. x 0.250 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 4.000 in.
Installation:	hammer drilled hole, Installation condition: Dry
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	Tension load: yes (D.3.3.4.3 (d)) Shear load: yes (D.3.3.5.3 (c))

Geometry [in.] & Loading [lb, in.lb]



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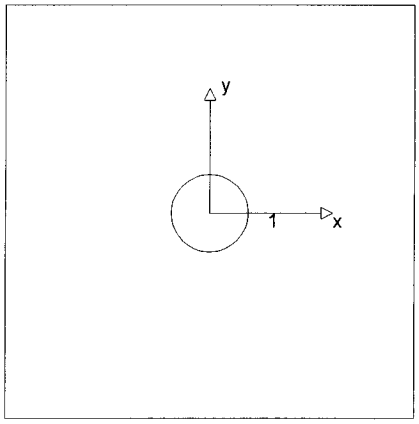
E-Mail: msigala@rmjse.com

2 Load case/Resulting anchor forces

Load case: Design loads



Anchor reactions [lb]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	0	1080	0	1080

max. concrete compressive strain: - [‰]
max. concrete compressive stress: - [psi]
resulting tension force in (x/y)=(0.000/0.000): 0 [lb]
resulting compression force in (x/y)=(0.000/0.000): 0 [lb]

3 Tension load

	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization $\beta_N = N_{ua}/\phi N_n$	Status
Steel Strength*	N/A	N/A	N/A	N/A
Pullout Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Strength**	N/A	N/A	N/A	N/A

* anchor having the highest loading **anchor group (anchors in tension)

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Phone I Fax:	510.991.0977 |	Date:	4/6/2015
E-Mail:	msigala@rmjse.com		

4 Shear load

	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization $\beta_V = V_{ua}/\phi V_n$	Status
Steel Strength*	1080	3572	31	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength**	1080	1844	59	OK
Concrete edge failure in direction y+**	1080	1090	100	OK

* anchor having the highest loading **anchor group (relevant anchors)

4.1 Steel Strength

$V_{sa,eq}$ = ESR value refer to ICC-ES ESR-1917

$\phi V_{steel} \geq V_{ua}$ ACI 318-11 Table D.4.1.1

Variables

n	$A_{se,V}$ [in.^{2}]	f_{uta} [psi]
1	0.10	106000

Calculations

$V_{sa,eq}$ [lb]
5495

Results

$V_{sa,eq}$ [lb]	ϕ_{steel}	ϕV_{sa} [lb]	V_{ua} [lb]
5495	0.650	3572	1080

4.2 Pryout Strength

$V_{cp} = k_{cp}\left[\left(\frac{A_{Nc}}{A_{Nc0}}\right)\psi_{ed,N}\,\psi_{c,N}\,\psi_{cp,N}\,N_b\right]$ ACI 318-11 Eq. (D-40)

$\phi V_{cp} \geq V_{ua}$ ACI 318-11 Table D.4.1.1

A_{Nc} see ACI 318-11, Part D.5.2.1, Fig. RD.5.2.1(b)

$A_{Nc0} = 9\,h_{ef}^2$ ACI 318-11 Eq. (D-5)

$\psi_{ec,N} = \left(\frac{1}{1+\frac{2\,e_N}{3\,h_{ef}}}\right) \leq 1.0$ ACI 318-11 Eq. (D-8)

$\psi_{ed,N} = 0.7 + 0.3\left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ ACI 318-11 Eq. (D-10)

$\psi_{cp,N} = MAX\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-11 Eq. (D-12)

$N_b = k_c\,\lambda_a\,\sqrt{f'_c}\,h_{ef}^{1.5}$ ACI 318-11 Eq. (D-6)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
1	2.000	0.000	0.000	4.000

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
1.000	5.500	17	1.000	3000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
36.00	36.00	1.000	1.000	1.000	1.000	2634

Results

V_{cp} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cp} [lb]	V_{ua} [lb]
2634	0.700	1.000	1.000	1844	1080

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E-Mail:	msigala@rmjse.com		

4.3 Concrete edge failure in direction y+

$V_{cb} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ed,V}\, \psi_{c,V}\, \psi_{h,V}\, \psi_{parallel,V}\, V_b$ — ACI 318-11 Eq. (D-30)

$\phi\, V_{cb} \geq V_{ua}$ — ACI 318-11 Table D.4.1.1

A_{Vc} see ACI 318-11, Part D.6.2.1, Fig. RD.6.2.1(b)

$A_{Vc0} = 4.5\, c_{a1}^2$ — ACI 318-11 Eq. (D-32)

$\psi_{ec,V} = \left(\frac{1}{1 + \frac{2e_v}{3c_{a1}}}\right) \leq 1.0$ — ACI 318-11 Eq. (D-36)

$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$ — ACI 318-11 Eq. (D-38)

$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$ — ACI 318-11 Eq. (D-39)

$V_b = \left(7\left(\frac{l_e}{d_a}\right)^{0.2}\sqrt{d_a}\right) \lambda_a \sqrt{f'_c}\, c_{a1}^{1.5}$ — ACI 318-11 Eq. (D-33)

Variables

c_{a1} [in.]	c_{a2} [in.]	e_{cV} [in.]	$\psi_{c,V}$	h_a [in.]
2.667	4.000	0.000	1.000	4.000

l_e [in.]	λ_a	d_a [in.]	f'_c [psi]	$\psi_{parallel,V}$
2.000	1.000	0.500	3000	1.000

Calculations

A_{Vc} [in.^{2}]	A_{Vc0} [in.^{2}]	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [lb]
32.00	32.00	1.000	1.000	1.000	1558

Results

V_{cb} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi\, V_{cb}$ [lb]	V_{ua} [lb]
1558	0.700	1.000	1.000	1090	1080

5 Warnings

- Load re-distributions on the anchors due to elastic deformations of the anchor plate are not considered. The anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the loading! Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Condition A applies when supplementary reinforcement is used. The Φ factor is increased for non-steel Design Strengths except Pullout Strength and Pryout strength. Condition B applies when supplementary reinforcement is not used and for Pullout Strength and Pryout Strength. Refer to your local standard.
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- Checking the transfer of loads into the base material and the shear resistance are required in accordance with ACI 318 or the relevant standard!
- An anchor design approach for structures assigned to Seismic Design Category C, D, E or F is given in ACI 318-11 Appendix D, Part D.3.3.4.3 (a) that requires the governing design strength of an anchor or group of anchors be limited by ductile steel failure. If this is NOT the case, the connection design (tension) shall satisfy the provisions of Part D.3.3.4.3 (b), Part D.3.3.4.3 (c), or Part D.3.3.4.3 (d). The connection design (shear) shall satisfy the provisions of Part D.3.3.5.3 (a), Part D.3.3.5.3 (b), or Part D.3.3.5.3 (c).
- Part D.3.3.4.3 (b) / part D.3.3.5.3 (a) requires that the attachment the anchors are connecting to the structure be designed to undergo ductile yielding at a load level corresponding to anchor forces no greater than the controlling design strength. Part D.3.3.4.3 (c) / part D.3.3.5.3 (b) waives the ductility requirements and requires that the anchors shall be designed for the maximum tension / shear that can be transmitted to the anchors by a non-yielding attachment. Part D.3.3.4.3 (d) / part D.3.3.5.3 (c) waives the ductility requirements and requires the design strength of the anchors to equal or exceed the maximum tension / shear obtained from design load combinations that include E, with E increased by Ω_0.
- Hilti post-installed anchors shall be installed in accordance with the Hilti Manufacturer's Printed Installation Instructions (MPII). Reference ACI 318-11, Part D.9.1

Fastening meets the design criteria!

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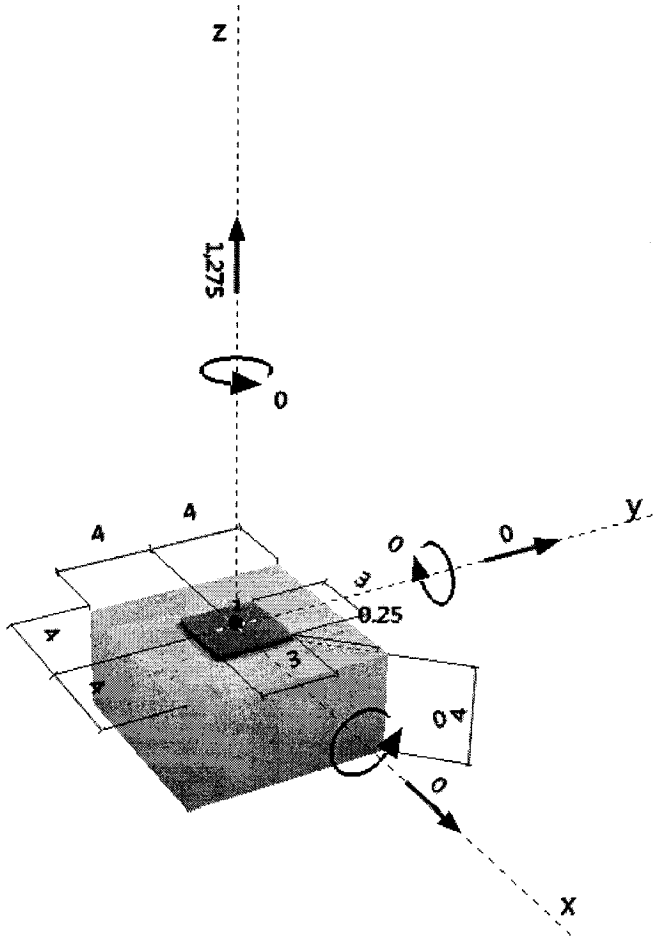
E-Mail:	msigala@rmjse.com		

Specifier's comments: DEFRS: SINGLE ANCHOR, Maximum Tension 1,275# 100% Capacity

1 Input data

Anchor type and diameter:	**Kwik Bolt TZ - CS 1/2 (2)**
Effective embedment depth:	$h_{ef,act}$ = 2.000 in., h_{nom} = 2.375 in.
Material:	Carbon Steel
Evaluation Service Report:	ESR-1917
Issued I Valid:	5/1/2013 | 5/1/2015
Proof:	Design method ACI 318-11 / Mech.
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.250 in.
Anchor plate:	l_x x l_y x t = 3.000 in. x 3.000 in. x 0.250 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 4.000 in.
Installation:	hammer drilled hole, Installation condition: Dry
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	Tension load: yes (D.3.3.4.3 (d)) Shear load: yes (D.3.3.5.3 (c))

Geometry [in.] & Loading [lb, in.lb]



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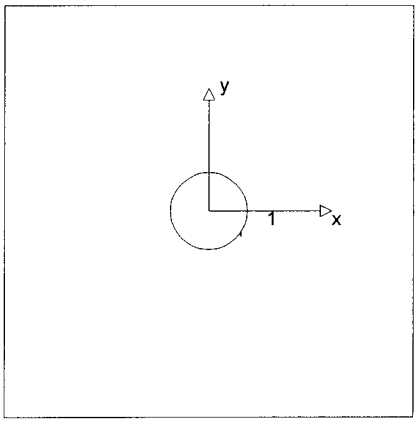
2 Load case/Resulting anchor forces

Load case: Design loads



Anchor reactions [lb]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	1275	0	0	0

max. concrete compressive strain: - [‰]
max. concrete compressive stress: - [psi]
resulting tension force in (x/y)=(0.000/0.000): 1275 [lb]
resulting compression force in (x/y)=(0.000/0.000): 0 [lb]

3 Tension load

	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization $\beta_N = N_{ua}/\phi N_n$	Status
Steel Strength*	1275	8029	16	OK
Pullout Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Strength**	1275	1284	100	OK

* anchor having the highest loading **anchor group (anchors in tension)

3.1 Steel Strength

N_{sa} = ESR value refer to ICC-ES ESR-1917
$\phi N_{steel} \geq N_{ua}$ ACI 318-11 Table D.4.1.1

Variables

n	$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
1	0.10	106000

Calculations

N_{sa} [lb]
10705

Results

N_{sa} [lb]	ϕ_{steel}	ϕN_{sa} [lb]	N_{ua} [lb]
10705	0.750	8029	1275

Company: RMJ
Specifier: Mario
Address: 241 Joaquin Ave.
Phone I Fax: 510.991.0977 |
E-Mail: msigala@rmjse.com

3.2 Concrete Breakout Strength

$N_{cb} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ed,N}\, \psi_{c,N}\, \psi_{cp,N}\, N_b$ — ACI 318-11 Eq. (D-3)

$\phi\, N_{cb} \geq N_{ua}$ — ACI 318-11 Table D.4.1.1

A_{Nc} see ACI 318-11, Part D.5.2.1, Fig. RD.5.2.1(b)

$A_{Nc0} = 9\, h_{ef}^2$ — ACI 318-11 Eq. (D-5)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\, e_N}{3\, h_{ef}}}\right) \leq 1.0$ — ACI 318-11 Eq. (D-8)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}}\right) \leq 1.0$ — ACI 318-11 Eq. (D-10)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}}\right) \leq 1.0$ — ACI 318-11 Eq. (D-12)

$N_b = k_c\, \lambda_a\, \sqrt{f'_c}\, h_{ef}^{1.5}$ — ACI 318-11 Eq. (D-6)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
2.000	0.000	0.000	4.000	1.000

c_{ac} [in.]	k_c	λ_a	f'_c [psi]
5.500	17	1.000	3000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
36.00	36.00	1.000	1.000	1.000	1.000	2634

Results

N_{cb} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi\, N_{cb}$ [lb]	N_{ua} [lb]
2634	0.650	0.750	1.000	1284	1275

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E-Mail:	msigala@rmjse.com		

4 Shear load

	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization $\beta_V = V_{ua}/\phi V_n$	Status
Steel Strength*	N/A	N/A	N/A	N/A
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength*	N/A	N/A	N/A	N/A
Concrete edge failure in direction **	N/A	N/A	N/A	N/A

* anchor having the highest loading **anchor group (relevant anchors)

5 Warnings

- Load re-distributions on the anchors due to elastic deformations of the anchor plate are not considered. The anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the loading! Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Condition A applies when supplementary reinforcement is used. The Φ factor is increased for non-steel Design Strengths except Pullout Strength and Pryout strength. Condition B applies when supplementary reinforcement is not used and for Pullout Strength and Pryout Strength. Refer to your local standard.
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- Checking the transfer of loads into the base material and the shear resistance are required in accordance with ACI 318 or the relevant standard!
- An anchor design approach for structures assigned to Seismic Design Category C, D, E or F is given in ACI 318-11 Appendix D, Part D.3.3.4.3 (a) that requires the governing design strength of an anchor or group of anchors be limited by ductile steel failure. If this is NOT the case, the connection design (tension) shall satisfy the provisions of Part D.3.3.4.3 (b), Part D.3.3.4.3 (c), or Part D.3.3.4.3 (d). The connection design (shear) shall satisfy the provisions of Part D.3.3.5.3 (a), Part D.3.3.5.3 (b), or Part D.3.3.5.3 (c).
- Part D.3.3.4.3 (b) / part D.3.3.5.3 (a) requires that the attachment the anchors are connecting to the structure be designed to undergo ductile yielding at a load level corresponding to anchor forces no greater than the controlling design strength. Part D.3.3.4.3 (c) / part D.3.3.5.3 (b) waives the ductility requirements and requires that the anchors shall be designed for the maximum tension / shear that can be transmitted to the anchors by a non-yielding attachment. Part D.3.3.4.3 (d) / part D.3.3.5.3 (c) waives the ductility requirements and requires the design strength of the anchors to equal or exceed the maximum tension / shear obtained from design load combinations that include E, with E increased by Ω_0.
- Hilti post-installed anchors shall be installed in accordance with the Hilti Manufacturer's Printed Installation Instructions (MPII). Reference ACI 318-11, Part D.9.1

Fastening meets the design criteria!