JBA JOHNSTON BURKHOLDER ASSOCIATES
consulting structural engineers

STRUCTURAL FIXTURE ANCHORAGE CALCULATIONS

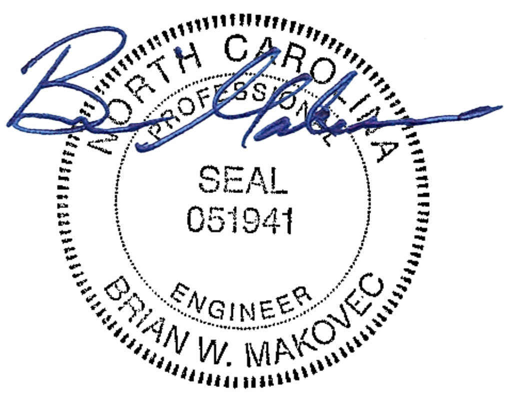
FOR

Cameron, NC

2800 NC Highway 24-87
Store #6958

PREPARED FOR

CITY OF CAMERON, NC



01/03/25

JBA PROJECT #2431906958

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Calculation Index

JBA Johnston Burkholder Associates consulting structural engineers	PROJECT NO: 2431906958	Sheet No: 1	Of: 44
	PROJECT NAME: #6958 - Cameron, NC		
	MADE BY: RBC	DATE: 01/03/25	
	CHECKED BY:	DATE:	

Lateral Seismic Analysis

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Store Latitude/Longitude Coordinates (per Google):

N	35° 14' 38"	35.2439
W	79° 01' 35"	79.0264

	Braced	Down Aisle	
Response Modification Factor, R =	4.0	6.0	ASCE-7, Table 15.4-1
Overstrength Factor, Omega, Ω_o =	2.0		ASCE-7, Table 15.4-1
Deflection Amplification Factor, C_d =	3.5		ASCE-7, Table 15.4-1
Detail Reference Section =	15.5.3		ASCE-7, Table 15.4-1
Risk (Occupancy) Category =	II		IBC, Table 1604.5
Importance Factor, I_p =	1.0		ASCE-7 Sect. 15.5.3
0.2 Second Period Accel., S_s =	0.206 g		IBC Figs. 1613.3.1(1-5), ASCE-7 Figs. 22-1 thru 22-14
1.0 Second Period Accel., S_1 =	0.093 g		IBC Figs. 1613.3.1(1-5), ASCE-7 Figs. 22-1 thru 22-14
(Soil) Site Class =	D		IBC 1613.3.2 -> ASCE-7, Table 20.3-1
F_a =	1.600		IBC Table 1613.3.3(1), ASCE-7 Table 11.4-1
F_v =	2.400		IBC Table 1613.3.3(2), ASCE-7 Table 11.4-2
S_{MS} =	0.330 g		IBC eq. 16-37, ASCE-7 eq. 11.4-1
S_{M1} =	0.223 g		IBC eq. 16-38, ASCE-7 eq. 11.4-2
S_{DS} =	0.220 g		IBC eq. 16-39, ASCE-7 eq. 11.4-3
S_{D1} =	0.150 g		IBC eq. 16-40, ASCE-7 eq. 11.4-4
Seismic Design Category			
--based on S_{DS} =	B		IBC Table 1613.3.5(1), ASCE-7 Table 11.6-1
-- based on S_{D1} =	C		IBC Table 1613.3.5(2), ASCE-7 Table 11.6-2

Shelving Fixture

C_s =	0.055	RMI sect. 2.6.3
C_s, min =	0.010	RMI sect. 2.6.3 and ASCE-7 sect. 15.5.3
Base Shear, $V = C_s I_p W$ =	0.055 W	RMI sect. 2.6.2

Rack Fixture

	Braced	Down Aisle	
Period, T (H_{rack} ≤ 96") =	0.265	1.249	sec. - RMI sect. 2.6.3
Period, T (96" < H_{rack} ≤ 120") =	0.483	1.182	sec. - RMI sect. 2.6.3
Period, T (H_{rack} > 120") =	0.352	1.348	sec. - RMI sect. 2.6.3
Period, T (H_{rack} = 168" w/Base Isolator) =	NA	NA	sec. - RMI sect. 2.6.3
C_s (H_{rack} ≤ 96") =	0.055	0.020	--> min[S_{DS}/R , $S_{D1}/((T)(R))$]
C_s (96" < H_{rack} ≤ 120") =	0.055	0.021	--> min[S_{DS}/R , $S_{D1}/((T)(R))$]
C_s (H_{rack} > 120") =	0.055	0.019	--> min[S_{DS}/R , $S_{D1}/((T)(R))$]
C_s (H_{rack} = 168" w/Base Isolator) =	NA	NA	--> min[S_{DS}/R , $S_{D1}/((T)(R))$]
C_s, min =	0.010	0.010	--> RMI sect. 2.6.3 and ASCE-7 sect. 15.5.3

T_S, (S_{D1}/S_{DS}) = 0.682 sec.

T_L = 8 sec.

Base Shear:

	Braced	Down Aisle		
V (H_{rack} ≤ 96") = $C_s I_p W_s$ =	0.055	0.020	W_s	--> RMI sect. 2.6.2
V (96" < H_{rack} ≤ 120") = $C_s I_p W_s$ =	0.055	0.021	W_s	--> RMI sect. 2.6.2
V (H_{rack} > 120") = $C_s I_p W_s$ =	0.055	0.019	W_s	--> RMI sect. 2.6.2
V (H_{rack}=168"w/Base Iso) = $C_s I_p W_s$ =	NA	NA	W_s	--> RMI sect. 2.6.2

Load Combinations for LRFD Member Design (RMI sect. 2.2):

for RISA Frame analysis

DL = Dead Load

PL = Maximum load from pallets/product stored on racks

EL = Seismic Load - RMI section 2.6.7 - Vert. Distribution

LC #1: 1.4DL + 1.2PL

LC #2: 1.2DL + 1.4PL

LC #7a: $(0.9-0.2S_{DS})DL + (0.9-0.2S_{DS})PL_{app} + \rho(1.0)EL$ <--- PL_{app} = (0.67)PL at each shelf level; ρ = 1.3 at "Braced" frames

0.8560 DL   0.8560 PL_{app} 1.0000 EL

LC #7b: $(0.9-0.2S_{DS})DL + (0.9-0.2S_{DS})PL_{app} + \rho(1.0)EL$ <--- PL_{app} = (1.0)PL at top shelf only; ρ = 1.3 at "Braced" frames

0.8560 DL   0.8560 PL_{app} 1.0000 EL

LC #5: $(1.2+0.2S_{DS})DL + (0.85+0.2S_{DS})\beta PL + \rho(1.0)EL$ <--- ρ = 1.3 at "Braced" frames, β = 0.7

1.2440 DL   0.6258 PL   1.0000 EL

Lateral Seismic Analysis

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Store Latitude/Longitude Coordinates (per Google):

N	35° 14' 38"	35.2439
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	Braced	Down Aisle	
Response Modification Factor, R =	4.0	6.0	ASCE-7, Table 15.4-1
Overstrength Factor, Omega, Ω_o =	2.0		ASCE-7, Table 15.4-1
Deflection Amplification Factor, C_d =	3.5		ASCE-7, Table 15.4-1
Detail Reference Section =	15.5.3		ASCE-7, Table 15.4-1
Occupancy Category =	II		IBC, Table 1604.5
Importance Factor, I_p =	1.5		ASCE-7 Sect. 15.5.3
0.2 Second Period Accel., S_s =	0.206 g		IBC Figs. 1613.3.1(1-5), ASCE-7 Figs. 22-1 thru 22-14
1.0 Second Period Accel., S_1 =	0.093 g		IBC Figs. 1613.3.1(1-5), ASCE-7 Figs. 22-1 thru 22-14
(Soil) Site Class =	D		IBC 1613.3.2 -> ASCE-7, Table 20.3-1
F_a =	1.60		IBC Table 1613.3.3(1), ASCE-7 Table 11.4-1
F_v =	2.40		IBC Table 1613.3.3(2), ASCE-7 Table 11.4-2
S_{MS} =	0.330 g		IBC eq. 16-37, ASCE-7 eq. 11.4-1
S_{M1} =	0.223 g		IBC eq. 16-38, ASCE-7 eq. 11.4-2
S_{DS} =	0.220 g		IBC eq. 16-39, ASCE-7 eq. 11.4-3
S_{D1} =	0.150 g		IBC eq. 16-40, ASCE-7 eq. 11.4-4
Seismic Design Category			
--based on S_{DS} =	B		IBC Table 1613.3.5(1), ASCE-7 Table 11.6-1
-- based on S_{D1} =	C		IBC Table 1613.3.5(2), ASCE-7 Table 11.6-2

Shelving Fixture

C_s =	0.055	RMI sect. 2.6.3
C_s, min =	0.010	RMI sect. 2.6.3 and ASCE-7 sect. 15.5.3
Base Shear, $V = C_sI_pW$ =	0.083 W	RMI sect. 2.6.2

Rack Fixture

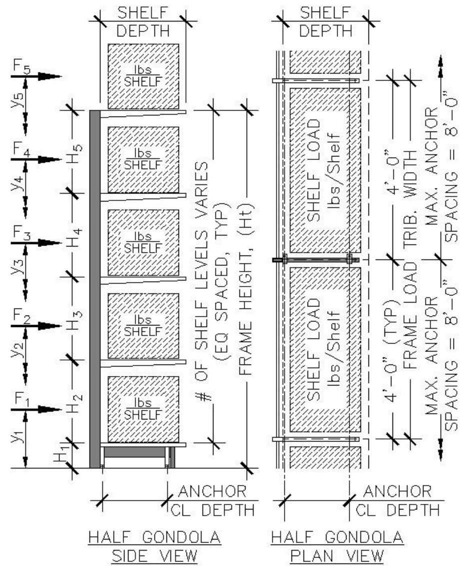
	Braced	Down Aisle	
Period, T (H_{rack} ≤ 96") =	0.265	1.249	sec. - RMI sect. 2.6.3
Period, T (96" < H_{rack} ≤ 120") =	0.483	1.182	sec. - RMI sect. 2.6.3
Period, T (H_{rack} > 120") =	0.352	1.348	sec. - RMI sect. 2.6.3
Period, T (H_{rack} = 168" w/Base Isolator) =	NA	NA	sec. - RMI sect. 2.6.3
C_s (H_{rack} ≤ 96") =	0.055	0.020	--> min[S_{DS}/R , $S_{D1}/((T)(R))$]
C_s (96" < H_{rack} ≤ 120") =	0.055	0.021	--> min[S_{DS}/R , $S_{D1}/((T)(R))$]
C_s (H_{rack} > 120") =	0.055	0.019	--> min[S_{DS}/R , $S_{D1}/((T)(R))$]
C_s (H_{rack} = 168" w/Base Isolator) =	NA	NA	--> min[S_{DS}/R , $S_{D1}/((T)(R))$]
C_s, min =	0.010	0.010	--> RMI sect. 2.6.3 and ASCE-7 sect. 15.5.3

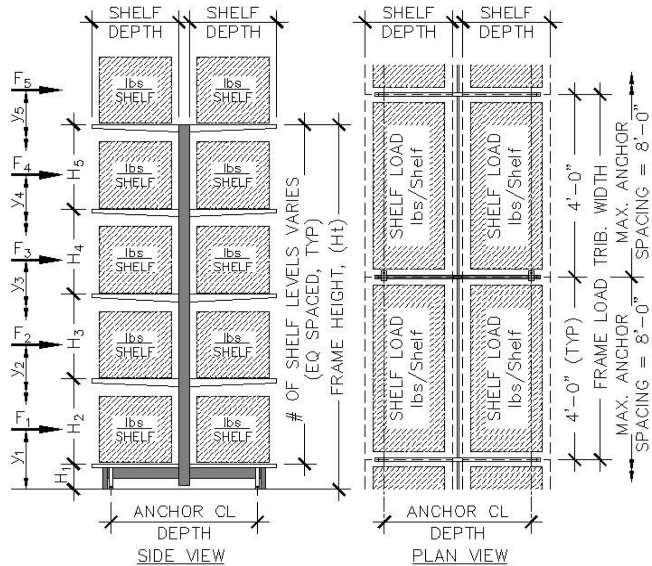
Base Shear:

	Braced	Down Aisle	
V (H_{rack} ≤ 96") = $C_sI_pW_s$ =	0.083	0.030	W_s --> RMI sect. 2.6.2
V (96" < H_{rack} ≤ 120") = $C_sI_pW_s$ =	0.083	0.032	W_s --> RMI sect. 2.6.2
V (H_{rack} > 120") = $C_sI_pW_s$ =	0.083	0.028	W_s --> RMI sect. 2.6.2
V (H_{rack}=168"w/Base Iso) = $C_sI_pW_s$ =	NA	NA	W_s --> RMI sect. 2.6.2

Gondola (Shelving) Anchorage Design - Load Diagrams

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)





Base Shear, RMI, sect. 2.6.2:

$V = (C_s)(I_p)(W_s)$ C_sI_p, C_s based on frame height and I_p = 1.0 or 1.5 with Public Access

$W_s = (0.67(PL_{RF})(PL)) + DL$ PL_{RF} = 1.0,for Cross-Aisle frames

PL = (0.67)PL, for RMI, sect. 2.6.9(1), ASCE 7, 15.5.3.3.2(a)

(1.0)PL, for RMI, sect. 2.6.9(2), ASCE 7, 15.5.3.3.2(b)

Overturning Stability:

Center of Mass (CM) of Product Load (PL) is typically 6" above the shelf or (1/2)(Shelf height, H_i) when shelf height is < 12".

$F_{x = 1..n}$, is set at a Service Load level using $V= (0.7)[C_sI_pW_s]$

Load Case #1: (2/3)PL, each shelf level RMI, sect.2.6.9(1) - ASCE 7, 15.5.3.3.2(a)

ω_x= (0.67)PL	$h_x = y_i$	(0.7V)(ω_x)(h_x) (ω_x)(h_x)	$\sum\omega_x h_x$	Ovrturn'g Mom,M_{OT}	Resist'g Mom, M_{RST}
ω_5	y_5	(ω_5)(y_5)	F_5	(F_5)(y_5)	ω_5(D/2)
ω_4	y_4	(ω_4)(y_4)	F_4	(F_4)(y_4)	ω_4(D/2)
ω_3	y_3	(ω_3)(y_3)	F_3	(F_3)(y_3)	ω_3(D/2)
ω_2	y_2	(ω_2)(y_2)	F_2	(F_2)(y_2)	ω_2(D/2)
ω_1	y_1	(ω_1)(y_1)	F_1	(F_1)(y_1)	ω_1(D/2)
$\omega_u=DL_{frame}$	y_u=Ht/2	(ω_u)(y_u)	F_u	(F_u)(y_u)	ω_u(D/2)
		$\sum(\omega_x)(h_x)$	$\sum(F_u+F_i)$=0.7V	$M_{OT}=\sum(F)(y)$	$M_{RST}=\sum(\omega)(D/2)$

Load Case #2: (1.0)PL, top shelf level only RMI, sect.2.6.9(2) - ASCE 7, 15.5.3.3.2(b)

ω_x= (1.0)PL	$h_x = y_i$	(0.7V)(ω_x)(h_x) (ω_x)(h_x)	$\sum\omega_x h_x$	Ovrturn'g Mom,M_{OT}	Resist'g Mom, M_{RST}
ω_5	y_5	(ω_5)(y_5)	F_5	(F_5)(y_5)	ω_5(D/2)
$\omega_u=DL_{frame}$	y_u=Ht/2	(ω_u)(y_u)	F_u	(F_u)(y_u)	ω_u(D/2)
		$\sum(\omega_x)(h_x)$	$\sum(F_u+F_5)$=0.7V	$M_{OT}=\sum(F)(y)$	$M_{RST}=\sum(\omega)(D/2)$

Design Shelf Loads:

9" Shelf	= 15 lbs/shelf (Pharmacy)
12" Shelf	= 50 lbs/shelf
15"-16" Shelf	= 50 lbs/shelf (incl Apparel)
18"-20" Shelf	= 125 lbs/shelf
	= 50 lbs/shelf (Apparel)
24"+ Shelf	= 150 lbs/shelf
	= 100 lbs/shelf (End Cap)
	= 225 lbs/shelf (Grocery)
30" (HD TV) Shelf	= 75 lbs/shelf

No. of Shelf Levels / Fixture Height (Ht):

(4) Levels at Ht <= 48"
(5) Levels at 48" < Ht <= 90"
(7) Levels at Ht > 90"
(4) Levels at "24V" & "24X" (Full) = 69" & 81" (Top Shelf)
(4) Levels at HD TV = 96" (Top Shelf) (120" tall fixture)
(9) Levels at Pharmacy = 84" ("3RX" fixture)

Factor Of Safety against Overturning at Load Case #1 & #2, $FOS_{OT} = M_{RST}/M_{OT}$:

FOS_{OT} < 1.0; Anchor Bolts required for both Shear & Tension

FOS_{OT} >= 1.0; Anchor Bolts required for Shear only, no net uplift tension at base connection

FOS_{OT} >= 1.5; No Anchor Bolts required (Except for Half Gondola Frames per owner's requirements)

Anchorage Connection Design Load Combinations: RMI, section 2.2 - Strength Design

RMI LC #7: $(0.9-0.2S_{DS})DL + (0.9-0.2S_{DS})(0.67)PL - \Omega_o(EL)$, for Load Case #1

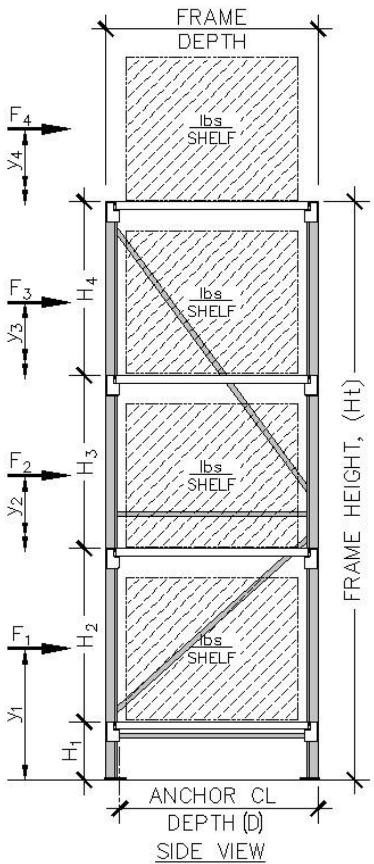
$(0.9-0.2S_{DS})DL + (0.9-0.2S_{DS})PL - \Omega_o(EL)$, for Load Case #2

Shear, $R_{uh} = (\Omega_o)V/2$

Tension, $R_{uv} = [(\Omega_o M_{OT}/0.7)-(0.9-0.2S_{DS})M_{RST}]/(FrameDepth)$

Racking Anchorage Design - Frame Load Diagram

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)



Base Shear, RMI, sect. 2.6.2:

$V = (C_s)(I_p)(W_s)$ C_sI_p, C_s based on frame height and I_p = 1.0 or 1.5 with Public Access

$W_s = (0.67(PL_{RF})(PL)) + DL$

PL_{RF} = 1.0 for Cross-Aisle and Down-Aisle frames

PL = (0.67)PL for RMI, sect. 2.6.9(1), ASCE 7, 15.5.3.3.2(a)

(1.0)PL for RMI, sect. 2.6.9(2), ASCE 7, 15.5.3.3.2(b)

Overturning Stability:

Center of Mass (CM) of Product Load (PL) is typically 20" above the shelf or (1/2)(Shelf height, H_i) when shelf height is < 40" (which is the assumed pallet height).

$F_{x = 1..n}$, is set at a Service Load level using $V = (0.7)[C_sI_pW_s]$

Load Case #1: ((2/3)PL at each shelf level, RMI, sect. 2.6.9(1), ASCE 7, 15.5.3.3.2(a))

ω_x= (0.67)PL	$h_x = y_i$	(0.7V)(ω_x)(h_x) (ω_x)(h_x)	$\sum\omega_x h_x$	Ovrturn'g Mom, M_{OT}	Resist'g Mom, M_{RST}
ω_4	y_4	$(\omega_4)(y_4)$	F_{x4}	$(F_{x4})(y_4)$	$\omega_4(D/2)$
ω_3	y_3	$(\omega_3)(y_3)$	F_{x3}	$(F_{x3})(y_3)$	$\omega_3(D/2)$
ω_2	y_2	$(\omega_2)(y_2)$	F_{x2}	$(F_{x2})(y_2)$	$\omega_2(D/2)$
ω_1	y_1	$(\omega_1)(y_1)$	F_{x1}	$(F_{x1})(y_1)$	$\omega_1(D/2)$
$\omega_u=DL_{frame}$	y_u=Ht/2	$(\omega_u)(y_u)$	F_{xu}	$(F_{xu})(y_u)$	$\omega_u(D/2)$
		$\sum(\omega_x)(h_x)$	$\sum(F_{xu}+F_x)=0.7V$	$M_{OT}=\sum(F)(y)$	$M_{RST}=\sum(\omega)(D/2)$

Load Case #2: ((1.0)PL at top shelf level only, RMI, sect. 2.6.9(2), ASCE 7, 15.5.3.3.2(b))

ω_x= (1.0)PL	$h_x = y_i$	(0.7V)(ω_x)(h_x) (ω_x)(h_x)	$\sum\omega_x h_x$	Ovrturn'g Mom, M_{OT}	Resist'g Mom, M_{RST}
ω_4	y_4	$(\omega_4)(y_4)$	F_{x4}	$(F_{x4})(y_4)$	$\omega_4(D/2)$
$\omega_u=DL_{frame}$	y_u=Ht/2	$(\omega_u)(y_u)$	F_{xu}	$(F_{xu})(y_u)$	$\omega_u(D/2)$
		$\sum(\omega_x)(h_x)$	$\sum(F_{xu}+F_{x4})=0.7V$	$M_{OT}=\sum(F)(y)$	$M_{RST}=\sum(\omega)(D/2)$

Factor Of Safety against Overturning at Load Case #1 & #2, $FOS_{OT} = M_{RST}/M_{OT}$:

FOS_{OT} < 1.0; Anchor Bolts required for both Shear & Tension

FOS_{OT} >= 1.0; Anchor Bolts required for Shear only, no net uplift tension at base connection

FOS_{OT} >= 1.5; Anchor Bolts required for Shear only for frames 96" tall and taller at sales floor area and for all frames taller than 48" in storage areas (non sales floor).

Anchorage Connection Design Load Combinations: (RMI, section 2.2 - Strength Design)

RMI LC #6: $(0.9-0.2S_{DS})DL + (0.9-0.2S_{DS})(0.67)PL - \Omega_o(EL)$, for Load Case #1 Shear, $R_{uh} = (\Omega_o)V/2$

$(0.9-0.2S_{DS})DL + (0.9-0.2S_{DS})PL - \Omega_o(EL)$, for Load Case #2 Tension, $R_{uv} = [(\Omega_o M_{OT}/0.7)-(0.9-0.2S_{DS})M_{RST}]/(FrameDepth)$

Rack Frame Member Design Load Combinations: (RMI, section 2.2 - Strength Design)

RMI LC #1: 1.4DL + 1.2PL Redundancy factor, ρ = 1.0 <- SDC "A"/"B"/"C", RMI, sect. 2.6.2.1

RMI LC #2: 1.2DL + 1.4PL 1.3 <- SDC "D"/"E"/"F", RMI, sect. 2.6.2.1

RMI LC #5: $(1.2+0.2S_{DS})DL + (0.85+0.2S_{DS})(0.67)\beta PL + \rho EL$, for Load Case #1 β = 0.7 RMI, sect. 2.1

$(1.2+0.2S_{DS})DL + (0.85+0.2S_{DS})\beta PL + \rho EL$, for Load Case #2

RMI LC #7: $(0.9-0.2S_{DS})DL + (0.9-0.2S_{DS})(0.67)PL - \rho EL$, for Load Case #1

$(0.9-0.2S_{DS})DL + (0.9-0.2S_{DS})PL - \rho EL$, for Load Case #2

Rack Framing Member Design: (RMI, section 6.3)

Per RMI/ANSI/MH16.1, effective lengths may be determined by rational methods consistent with AISI or AISC. AISC Design by Second-Order Analysis, Section C2.2a is used. Notional loads are applied to gravity load cases and K=1.0 is used since the ratio of second-order drift to first-order drift (P-δ) / (P-Δ) < 1.1.

PROJECT NO:	SHEET NO:	OF:
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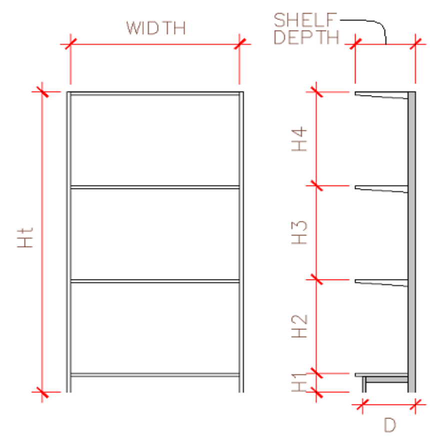
PROJECT NAME: #6958 - Cameron, NC	
MADE BY: RBC	DATE: 01/03/25
CHECKED BY:	DATE:

Shelving / Single Sided 48" Tall "R" 4 Level 18R

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor =	1.5		
Supported on Elevated Floor (Y/N):	No		
Total Load per shelf =	125 lbs		
# of Levels =	Wall 4 Level		
Uniform Weight per level =	20.83 psf/shelf		
Weight of Unit =	100 lbs		
Anchorage spacing/Trib width =	8 ft	*(Frames are assumed to be 4'-0" oc)*	
Shelf depth =	18 in		Shelf Load / Level
h_9 =	0 in		
h_8 =	0 in		
h_7 =	0 in		
h_6 =	0 in		
h_5 =	0 in		
h_4 =	14 in		250 lbs
h_3 =	14 in		250 lbs
h_2 =	14 in		250 lbs
h_1 =	6 in		250 lbs
Total Shelf Height, H_t =	48 in		
Unit Height, H_u =	48 in		
Unit Base Depth, D =	11 in		



Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1* [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]
Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ = 548.9 lbs
Base Shear, $V = C_sI_pW_s$ = 45.3 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)
(Service Loads, E = 0.7)

	F_9 =	0.0 lbs	@ 0 in (CM)
Note:	F_8 =	0.0 lbs	@ 0 in (CM)
(CM) = Product Center of	F_7 =	0.0 lbs	@ 0 in (CM)
Mass typically 6 inches	F_6 =	0.0 lbs	@ 0 in (CM)
above the top of shelf at	F_5 =	0.0 lbs	@ 0 in (CM)
each level.	F_4 =	11.7 lbs	@ 54 in (CM)
	F_3 =	8.7 lbs	@ 40 in (CM)
	F_2 =	5.6 lbs	@ 26 in (CM)
	F_1 =	2.6 lbs	@ 12 in (CM)
	F_u =	3.1 lbs	@ 24 in (CM)
	Σf_i =	45.3 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 1230 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 4217 in-lbs
Factor of Safety
FOS = 3.427
NO UPLIFT - NO ANCHORS REQUIRED

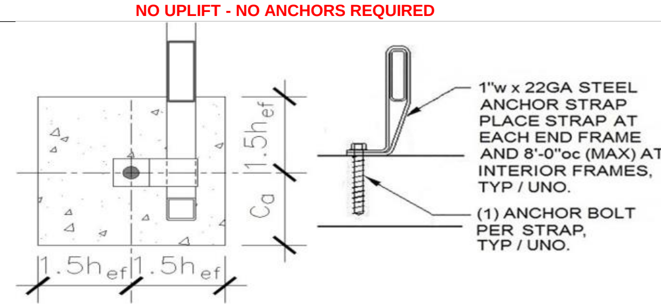
Load Case 2* [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]
Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((1)PL)+DL$ = 267.5 lbs
Base Shear, $V = C_sI_pW_s$ = 22.1 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)
(Service Loads)

F_9 =	0.0 lbs	
F_8 =	0.0 lbs	
F_7 =	0.0 lbs	
F_6 =	0.0 lbs	
F_5 =	0.0 lbs	
F_4 =	13.1 lbs	@ 54in (CM)
F_3 =	0.0 lbs	
F_2 =	0.0 lbs	
F_1 =	0.0 lbs	
F_u =	2.3 lbs	@ 24in (CM)
Σf_i =	22.1 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 764 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 1925 in-lbs
Factor of Safety
FOS = 2.519
NO UPLIFT - NO ANCHORS REQUIRED

Base Reactions:

Reactions (Service Loads):	LC #1		LC #2	
R_h =	16 lbs		8 lbs	
R_v =	0 lbs	(No Uplift)	0 lbs	(No Uplift)
Overturning FOS =	3.427	>= 1.5	2.519	>= 1.5
Sliding Restraint force, R_{RST} / FOS =	97lbs / 6.093 >= 1.5 OK		51lbs / 6.578 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	45 lbs		22 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	923 lbs		366 lbs	



Anchor Design (using "Cracked Concrete" Properties)
Try: 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.

Embedment =	2 in		
f'_c =	3500 psi		
e_n' =	0 in	<--- Eccen. Of Anchor	
h_{ef} =	1.33 in	$1.5(h_{ef})$ =	1.995 in
c_a =	5 in	$1.5(c_a)$ =	7.500 in
Conc. thickness, t =	4 in		
# of Anchors, n =	1	- anchors per connection	
S_X =	0 in		
A_{se} =	0.094 in^2		

Tension Allowables

Steel Strength, ϕN_{sa} =	5675 lbs	<--ACI 318-14 Eq 17.4.1.2
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	752 lbs	<--ACI 318-14 Eq 17.4.2.1a
Pullout Strength, $(0.75)\phi N_{pn}$ =	519 lbs	<--ACI 318-14 Eq 17.4.3.1

	LC #1		LC #2	
Factored Tension Load (N_u) =	0 lbs		0 lbs	
max tension stress ratio (TSR) =	0.000	OK	0.000	OK

Shear Allowables

Steel Strength, ϕV_{sa} =	1449 lbs	<--ACI 318-14 Eq 17.5.1.2b
Concrete breakout, ϕV_{cbg} =	2334 lbs	<--ACI 318-14 Eq 17.5.2.1a
Concrete pryout, ϕV_{cpg} =	1080 lbs	<--ACI 318-14 Eq 17.5.3.1a

	LC #1		LC #2	
Factored Shear Load (V_u) =	45 lbs		22 lbs	
Max shear stress ratio (VSR) =	0.042	OK	0.020	OK
Combined shear and tension stress ratio (TSR + VSR) =	0.042	< 1.2 OK - LC#1 (controls)		

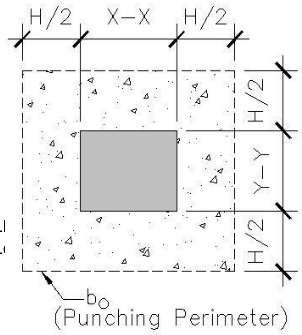
USE: NO UPLIFT - USE (1) 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed. ICC REPORT #ESR-3889

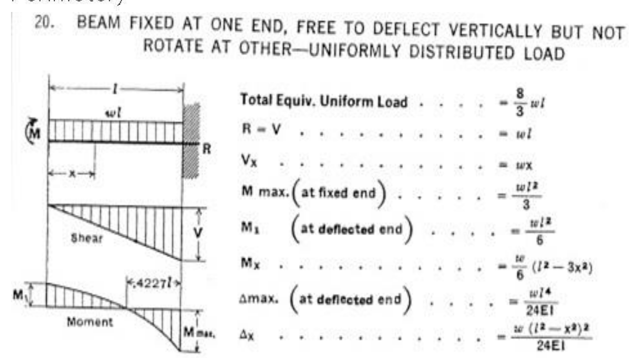
Shelving / Single Sided 48" Tall "R" 4 Level 18R

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	923	lbs	
Slab Concrete f'_c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	2	in.	
Rack Post Y-Y =	2	in.	
b_o =	24.00	in.	
β =	1.00		
V_n =	22718	lbs	Table 14.5.5.1l
V_n max =	15145	lbs	Table 14.5.5.1(
ϕV_n =	9087.10	lbs	
$V_u/\phi V_n$ =	0.102	< 1.0 O.K.	



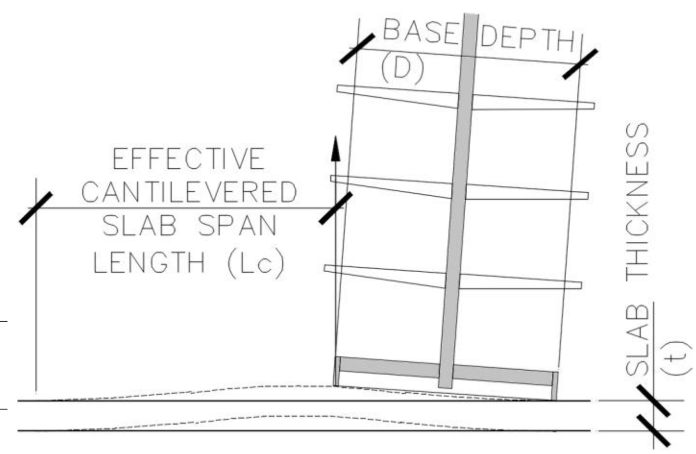


Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf	
Max. Vertical Load (Service) (P) =	672	lbs	
Area reqd. for bearing (A_{reqd}) =	0.45	ft^2	
"b" distance =	8.03	in	
Slab thickness (t) =	4.00	in	
$S = (1")(t)^2/6$ =	2.67	in^3/in	
ϕM_{nt} (tension allowable) = $\phi_t(7.5)[(f'_c)^{1/2}](S)$ =	710	in-lb/in	
Factored uniform bearing, $w_u = P_u / A_{reqd}$ =	14	lb/in/in	
$M_u = w_u L^2/3 = (w_u)[(b-(2"))/2)^2] / 3$ =	43.38	in-lb/in - Defl. End M1 = 22 in-lb/in	
$M_u/\phi M_{nt}$ =	0.061	< 1.0 O.K.	

Shelving Fixture FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	11	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, f_r = 7.5*SQRT(f'c) =	443.7	psi
Concrete Slab Section Modulus, $S = b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, $M_{all}/FS = S*f_r/1.5$ =	1183.2	ft*lbs/ft
Effective Cantilever Span Length (L_c) at M_{all} =	6.9	ft
Total Length of Slab (l_c + Width of Single Rack) =	7.8	ft
Trib. Width of Slab = Trib width of Rack =	8.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	3118	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)} = P_{conc} * L_c/2$ =	145876	in*lbs
Load Combination #1: M_{OT} =	1230	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	150092	in*lbs
Total Overturning FOS =	121.984	OK
Load Combination #2: M_{OT} =	764	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	147801	in*lbs
Total Overturning FOS =	193.394	OK

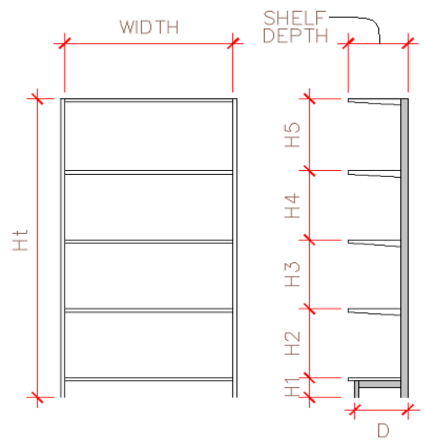


JOHNSTON BURKHOLDER ASSOCIATES consulting structural engineers 930 CENTRAL · KANSAS CITY, MO 64105 816.421.4200 · WWW.JBAENGR.COM	PROJECT NO: 2431906958	SHEET NO: 7	OF: 44
	PROJECT NAME: #6958 - Cameron, NC		
	MADE BY: RBC	DATE: 01/03/25	
	CHECKED BY:	DATE:	

Shelving / Single Sided 54" Tall "S" 5 Level 18S

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor =	1.5		
Supported on Elevated Floor (Y/N):	No		
Total Load per shelf =	125 lbs		
# of Levels =	Wall 5 Level		
Uniform Weight per level =	20.83 psf/shelf		
Weight of Unit =	100 lbs		
Anchorage spacing/Trib width =	8 ft	*(Frames are assumed to be 4'-0" oc)*	
Shelf depth =	18 in		Shelf Load / Level
h_9 =	0 in		
h_8 =	0 in		
h_7 =	0 in		
h_6 =	0 in		
h_5 =	12 in		250 lbs
h_4 =	12 in		250 lbs
h_3 =	12 in		250 lbs
h_2 =	12 in		250 lbs
h_1 =	6 in		250 lbs
Total Shelf Height, H_t =	54 in		
Unit Height, H_u =	54 in		
Unit Base Depth, D =	11 in		



Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1* [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ = 661.1 lbs
Base Shear, $V = C_sI_pW_s$ = 54.5 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

(Service Loads, E = 0.7)

	F_9 =	0.0 lbs	@ 0 in (CM)
	F_8 =	0.0 lbs	@ 0 in (CM)
	F_7 =	0.0 lbs	@ 0 in (CM)
	F_6 =	0.0 lbs	@ 0 in (CM)
	F_5 =	11.7 lbs	@ 60 in (CM)
	F_4 =	9.3 lbs	@ 48 in (CM)
	F_3 =	7.0 lbs	@ 36 in (CM)
	F_2 =	4.7 lbs	@ 24 in (CM)
	F_1 =	2.3 lbs	@ 12 in (CM)
	F_u =	3.1 lbs	@ 27 in (CM)
	Σf_i =	54.5 lbs	(@ Factored Loads)

Note:
(CM) = Product Center of Mass typically 6 inches above the top of shelf at each level.

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 1627 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 5133 in-lbs
Factor of Safety
FOS = 3.156
NO UPLIFT - NO ANCHORS REQUIRED

Load Case 2* [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((1)PL)+DL$ = 267.5 lbs
Base Shear, $V = C_sI_pW_s$ = 22.1 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

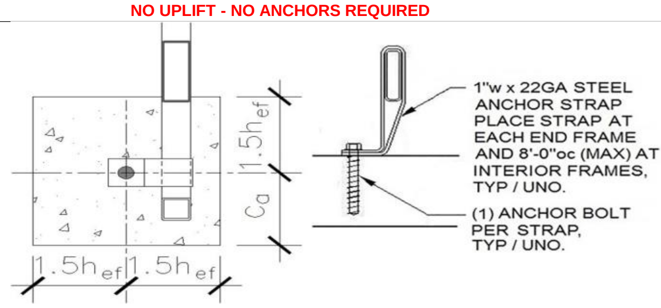
(Service Loads)

F_9 =	0.0 lbs	
F_8 =	0.0 lbs	
F_7 =	0.0 lbs	
F_6 =	0.0 lbs	
F_5 =	13.1 lbs	@ 60in (CM)
F_4 =	0.0 lbs	
F_3 =	0.0 lbs	
F_2 =	0.0 lbs	
F_1 =	0.0 lbs	
F_u =	2.4 lbs	@ 27in (CM)
Σf_i =	22.1 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 849 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 1925 in-lbs
Factor of Safety
FOS = 2.267
NO UPLIFT - NO ANCHORS REQUIRED

Base Reactions:

Reactions (Service Loads):	LC #1		LC #2	
R_h =	19 lbs		8 lbs	
R_v =	0 lbs	(No Uplift)	0 lbs	(No Uplift)
Overturning FOS =	3.156	>= 1.5	2.267	>= 1.5
Sliding Restraint force, R_{RST} / FOS =	120lbs / 6.265 >= 1.5 OK		53lbs / 6.827 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	55 lbs		22 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	1155 lbs		382 lbs	



Anchor Design (using "Cracked Concrete" Properties)

Try: 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.

Embedment =	2 in		
f'_c =	3500 psi		
e_n' =	0 in	<--- Eccen. Of Anchor	
h_{ef} =	1.33 in	$1.5(h_{ef})$ =	1.995 in
c_a =	5 in	$1.5(c_a)$ =	7.500 in
Conc. thickness, t =	4 in		
# of Anchors, n =	1	- anchors per connection	
S_X =	0 in		
A_{se} =	0.094 in^2		

Tension Allowables

Steel Strength, ϕN_{sa} =	5675 lbs	<--ACI 318-14 Eq 17.4.1.2
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	752 lbs	<--ACI 318-14 Eq 17.4.2.1a
Pullout Strength, $(0.75)\phi N_{pn}$ =	519 lbs	<--ACI 318-14 Eq 17.4.3.1

	LC #1		LC #2	
Factored Tension Load (N_u) =	0 lbs		0 lbs	
max tension stress ratio (TSR) =	0.000	OK	0.000	OK

Shear Allowables

Steel Strength, ϕV_{sa} =	1449 lbs	<--ACI 318-14 Eq 17.5.1.2b
Concrete breakout, ϕV_{cbg} =	2334 lbs	<--ACI 318-14 Eq 17.5.2.1a
Concrete pryout, ϕV_{cpg} =	1080 lbs	<--ACI 318-14 Eq 17.5.3.1a

	LC #1		LC #2	
Factored Shear Load (V_u) =	55 lbs		22 lbs	
Max shear stress ratio (VSR) =	0.051	OK	0.020	OK
Combined shear and tension stress ratio (TSR + VSR) =	0.051	< 1.2 OK - LC#1 (controls)		

USE: NO UPLIFT - USE (1) 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed. ICC REPORT #ESR-3889

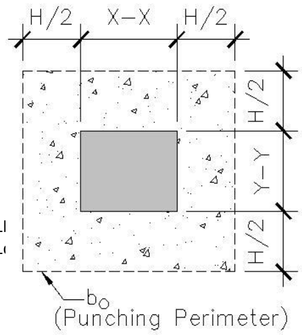
JBA Johnston Burkholder Associates	PROJECT NO: 2431906958	SHEET NO: 8	OF: 44
consulting structural engineers	PROJECT NAME: #6958 - Cameron, NC		
930 Central · Kansas City, MO 64105	MADE BY: RBC	DATE: 01/03/25	
816.421.4200 · www.jbaengr.com	CHECKED BY:	DATE:	

Shelving / Single Sided   54" Tall "S" 5 Level   18S

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

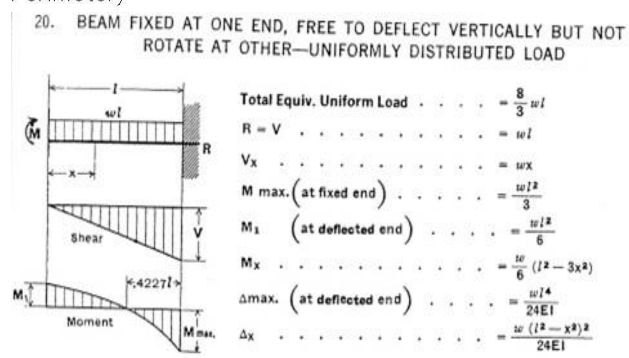
Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	1155	lbs	
Slab Concrete f'_c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	2	in.	
Rack Post Y-Y =	2	in.	
b_o =	24.00	in.	
β =	1.00		
V_n =	22718	lbs	Table 14.5.5.1
V_n max =	15145	lbs	Table 14.5.5.1
ϕV_n =	9087.10	lbs	
$V_u/\phi V_n$ =	0.127	< 1.0 O.K.	



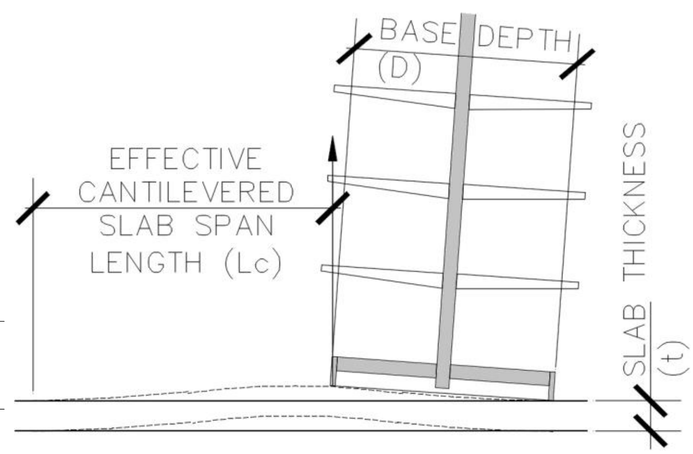
Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf
Max. Vertical Load (Service) (P) =	833	lbs
Area reqd. for bearing (A_{reqd}) =	0.56	ft^2
"b" distance =	8.94	in
Slab thickness (t) =	4.00	in
$S = (1")(t)^2/6$ =	2.67	in^3/in
ϕM_{nt} (tension allowable) = $\phi_t(7.5)[(f'_c)^{1/2}](S)$ =	710	in-lb/in
Factored uniform bearing, $w_u = P_u / A_{reqd}$ =	14	lb/in/in
$M_u = w_u L^2/3 = (w_u)[(b-(2"))/2)^2] / 3$ =	58.01	in-lb/in - Defl. End M1 = 30 in-lb/in
$M_u/\phi M_{nt}$ =	0.082	< 1.0 O.K.



Shelving Fixture FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	11	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, $f_r = 7.5*SQRT(f'c)$ =	443.7	psi
Concrete Slab Section Modulus, $S = b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, $M_{all}/FS = S*f_r/1.5$ =	1183.2	ft*lbs/ft
Effective Cantilever Span Length (L_c) at M_{all} =	6.9	ft
Total Length of Slab (l_c + Width of Single Rack) =	7.8	ft
Trib. Width of Slab = Trib width of Rack =	8.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	3118	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)} = P_{conc} * L_c/2$ =	145876	in*lbs
Load Combination #1: M_{OT} =	1627	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	151009	in*lbs
Total Overturning FOS =	92.839	OK
Load Combination #2: M_{OT} =	849	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	147801	in*lbs
Total Overturning FOS =	174.063	OK



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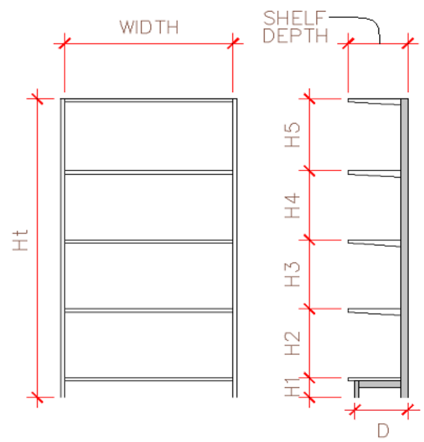
PROJECT NO:	SHEET NO:	OF:
2431906958	9	44
PROJECT NAME: #6958 - Cameron, NC		
MADE BY: RBC	DATE: 01/03/25	
CHECKED BY:	DATE:	

Shelving / Single Sided   78" Tall "V" 5 Level   18V

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor =	1.5		
Supported on Elevated Floor (Y/N):	No		
Total Load per shelf =	125 lbs		
# of Levels =	Wall 5 Level		
Uniform Weight per level =	20.83 psf/shelf		
Weight of Unit =	100 lbs		
Anchorage spacing/Trib width =	8 ft	*(Frames are assumed to be 4'-0" oc)*	
Shelf depth =	18 in		Shelf Load / Level
h_9 =	0 in		
h_8 =	0 in		
h_7 =	0 in		
h_6 =	0 in		
h_5 =	18 in		250 lbs
h_4 =	18 in		250 lbs
h_3 =	18 in		250 lbs
h_2 =	18 in		250 lbs
h_1 =	6 in		250 lbs
Total Shelf Height, H_t =	78 in		
Unit Height, H_u =	78 in		
Unit Base Depth, D =	11 in		



Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1* [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ =	0.083	W_s (Cross-Aisle)	
$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ =	661.1 lbs		
Base Shear, $V = C_sI_pW_s$ =	54.5 lbs		
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)			
(Service Loads, E = 0.7) F_9 =	0.0 lbs	@ 0 in (CM)	
Note: F_8 =	0.0 lbs	@ 0 in (CM)	
(CM) = Product Center of F_7 =	0.0 lbs	@ 0 in (CM)	
Mass typically 6 inches F_6 =	0.0 lbs	@ 0 in (CM)	
above the top of shelf at F_5 =	12.2 lbs	@ 84 in (CM)	
each level. F_4 =	9.6 lbs	@ 66 in (CM)	
F_3 =	7.0 lbs	@ 48 in (CM)	
F_2 =	4.4 lbs	@ 30 in (CM)	
F_1 =	1.7 lbs	@ 12 in (CM)	
F_u =	3.4 lbs	@ 39 in (CM)	
Σf_i =	54.5 lbs	(@ Factored Loads)	
Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$			
M_{OT} =	2272 in-lbs		
Calculate Resisting Moment (Service), M_{RST}			
M_{RST} =	5133 in-lbs		
Factor of Safety FOS =	2.259		

NO UPLIFT - NO ANCHORS REQUIRED

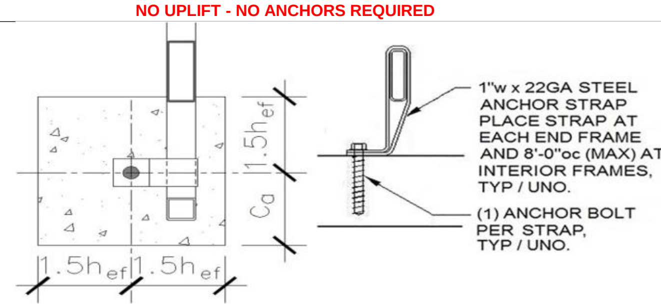
Load Case 2* [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ =	0.083	W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((1)PL)+DL$ =	267.5 lbs	
Base Shear, $V = C_sI_pW_s$ =	22.1 lbs	
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)		
(Service Loads) F_9 =	0.0 lbs	
F_8 =	0.0 lbs	
F_7 =	0.0 lbs	
F_6 =	0.0 lbs	
F_5 =	13.0 lbs	@ 84in (CM)
F_4 =	0.0 lbs	
F_3 =	0.0 lbs	
F_2 =	0.0 lbs	
F_1 =	0.0 lbs	
F_u =	2.4 lbs	@ 39in (CM)
Σf_i =	22.1 lbs	(@ Factored Loads)
Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$		
M_{OT} =	1189 in-lbs	
Calculate Resisting Moment (Service), M_{RST}		
M_{RST} =	1925 in-lbs	
Factor of Safety FOS =	1.619	

NO UPLIFT - NO ANCHORS REQUIRED

Base Reactions:

Reactions (Service Loads):	LC #1		LC #2	
R_h =	19 lbs		8 lbs	
R_v =	0 lbs	(No Uplift)	0 lbs	(No Uplift)
Overturning FOS =	2.259	>= 1.5	1.619	>= 1.5
Sliding Restraint force, R_{RST} / FOS =	134lbs / 7.034 >= 1.5 OK		60lbs / 7.827 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	55 lbs		22 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	1280 lbs		448 lbs	



Anchor Design (using "Cracked Concrete" Properties)
Try: 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.

Embedment =	2 in		
f'_c =	3500 psi		
e_n' =	0 in	<--- Eccen. Of Anchor	
h_{ef} =	1.33 in	$1.5(h_{ef})$ =	1.995 in
c_a =	5 in	$1.5(c_a)$ =	7.500 in
Conc. thickness, t =	4 in		
# of Anchors, n =	1	- anchors per connection	
S_X =	0 in		
A_{se} =	0.094 in^2		

Tension Allowables

Steel Strength, ϕN_{sa} =	5675 lbs	<--ACI 318-14 Eq 17.4.1.2
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	752 lbs	<--ACI 318-14 Eq 17.4.2.1a
Pullout Strength, $(0.75)\phi N_{pn}$ =	519 lbs	<--ACI 318-14 Eq 17.4.3.1

	LC #1		LC #2	
Factored Tension Load (N_u) =	0 lbs		0 lbs	
max tension stress ratio (TSR) =	0.000	OK	0.000	OK

Shear Allowables

Steel Strength, ϕV_{sa} =	1449 lbs	<--ACI 318-14 Eq 17.5.1.2b
Concrete breakout, ϕV_{cbg} =	2334 lbs	<--ACI 318-14 Eq 17.5.2.1a
Concrete pryout, ϕV_{cpg} =	1080 lbs	<--ACI 318-14 Eq 17.5.3.1a

	LC #1		LC #2	
Factored Shear Load (V_u) =	55 lbs		22 lbs	
Max shear stress ratio (VSR) =	0.051	OK	0.020	OK
Combined shear and tension stress ratio (TSR + VSR) =	0.051	< 1.2 OK - LC#1 (controls)		

USE: NO UPLIFT - USE (1) 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed. ICC REPORT #ESR-3889

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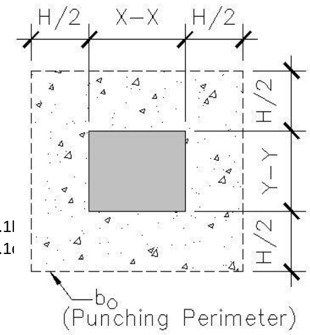
PROJECT NO:	SHEET NO:	OF:
2431906958	10	44
PROJECT NAME: #6958 - Cameron, NC		
MADE BY: RBC	DATE: 01/03/25	
CHECKED BY:	DATE:	

Shelving / Single Sided 78" Tall "V" 5 Level 18V

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

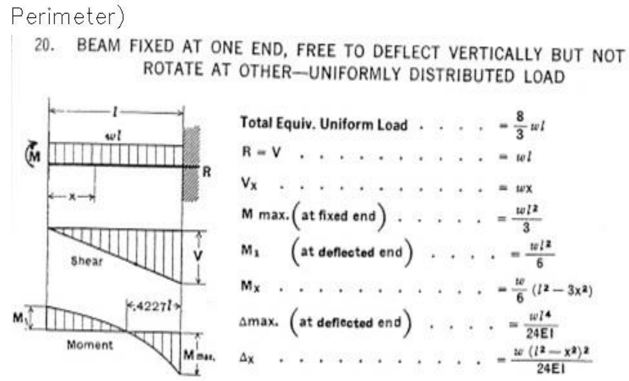
Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	1280	lbs	
Slab Concrete f'_c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	2	in.	
Rack Post Y-Y =	2	in.	
b_o =	24.00	in.	
β =	1.00		
V_n =	22718	lbs	Table 14.5.5.1l
V_n max =	15145	lbs	Table 14.5.5.1(
ϕV_n =	9087.10	lbs	
$V_u/\phi V_n$ =	0.141	< 1.0 O.K.	



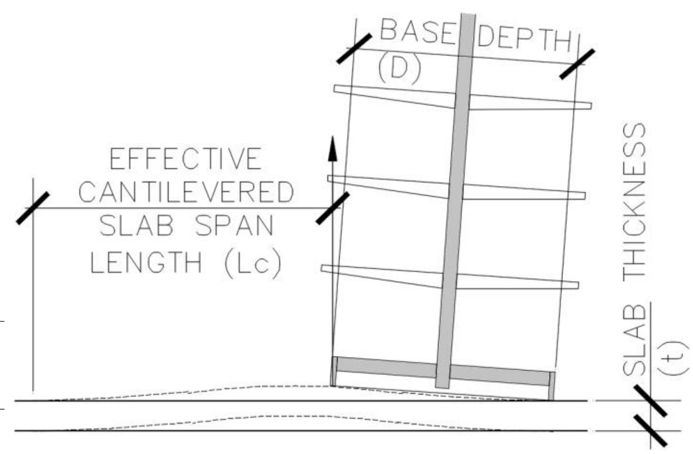
Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf
Max. Vertical Load (Service) (P) =	877	lbs
Area reqd. for bearing (A_{reqd}) =	0.58	ft^2
"b" distance =	9.18	in
Slab thickness (t) =	4.00	in
$S = (1")(t)^2/6$ =	2.67	in^3/in
ϕM_{nt} (tension allowable) = $\phi_t(7.5)[(f'_c)^{1/2}](S)$ =	710	in-lb/in
Factored uniform bearing, $w_u = P_u / A_{reqd}$ =	15	lb/in/in
$M_u = w_u L^2/3 = (w_u)[(b-(2"))/2)^2] / 3$ =	65.23	in-lb/in - Defl. End M1 = 33 in-lb/in
$M_u/\phi M_{nt}$ =	0.092	< 1.0 O.K.



Shelving Fixture FOS Overturning with Resistance from Effective Weight of Slab on Grade:

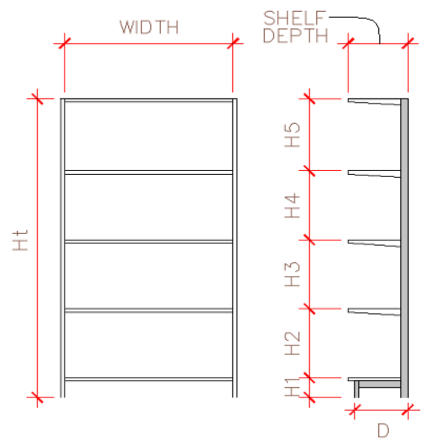
Width of Single Rack =	11	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, f_r = 7.5*SQRT(f'c) =	443.7	psi
Concrete Slab Section Modulus, $S = b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, $M_{all}/FS = S*f_r/1.5$ =	1183.2	ft*lbs/ft
Effective Cantilever Span Length (L_c) at M_{all} =	6.9	ft
Total Length of Slab (l_c + Width of Single Rack) =	7.8	ft
Trib. Width of Slab = Trib width of Rack =	8.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	3118	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)} = P_{conc} * L_c/2$ =	145876	in*lbs
Load Combination #1: M_{OT} =	2272	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	151009	in*lbs
Total Overturning FOS =	66.462	OK
Load Combination #2: M_{OT} =	1189	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	147801	in*lbs
Total Overturning FOS =	124.332	OK



Shelving / Single Sided 84" Tall "3" 5 Level 18-3

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor =	1.5		
Supported on Elevated Floor (Y/N):	No		
Total Load per shelf =	50 lbs		
# of Levels =	Wall 5 Level		
Uniform Weight per level =	8.33 psf/shelf		
Weight of Unit =	100 lbs		
Anchorage spacing/Trib width =	4 ft	*(Frames are assumed to be 4'-0" oc)*	
Shelf depth =	18 in		Shelf Load / Level
h_9 =	0 in		
h_8 =	0 in		
h_7 =	0 in		
h_6 =	0 in		
h_5 =	20 in		50 lbs
h_4 =	19 in		50 lbs
h_3 =	20 in		50 lbs
h_2 =	19 in		50 lbs
h_1 =	6 in		50 lbs
Total Shelf Height, H_t =	84 in		
Unit Height, H_u =	84 in		
Unit Base Depth, D =	11 in		



Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1* [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ = 212.2 lbs
Base Shear, $V = C_sI_pW_s$ = 17.5 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)
(Service Loads, E = 0.7)

	F_9 =	0.0 lbs	@ 0 in (CM)
Note:	F_8 =	0.0 lbs	@ 0 in (CM)
(CM) = Product Center of	F_7 =	0.0 lbs	@ 0 in (CM)
Mass typically 6 inches	F_6 =	0.0 lbs	@ 0 in (CM)
above the top of shelf at	F_5 =	2.9 lbs	@ 90 in (CM)
each level.	F_4 =	2.3 lbs	@ 70 in (CM)
	F_3 =	1.6 lbs	@ 51 in (CM)
	F_2 =	1.0 lbs	@ 31 in (CM)
	F_1 =	0.4 lbs	@ 12 in (CM)
	F_u =	4.1 lbs	@ 42 in (CM)
	Σf_i =	17.5 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 710 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 1467 in-lbs
Factor of Safety
FOS = 2.066
NO UPLIFT - NO ANCHORS REQUIRED

Load Case 2* [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

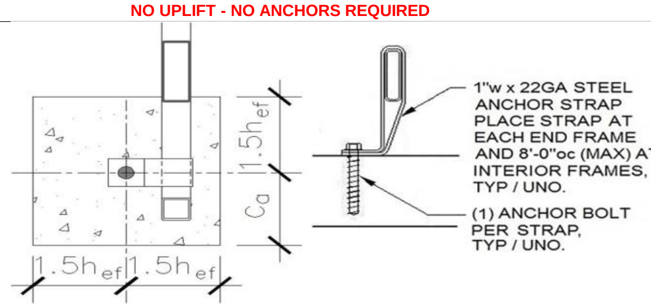
Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((1)PL)+DL$ = 133.5 lbs
Base Shear, $V = C_sI_pW_s$ = 11.0 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)
(Service Loads)

F_9 =	0.0 lbs	
F_8 =	0.0 lbs	
F_7 =	0.0 lbs	
F_6 =	0.0 lbs	
F_5 =	4.0 lbs	@ 90in (CM)
F_4 =	0.0 lbs	
F_3 =	0.0 lbs	
F_2 =	0.0 lbs	
F_1 =	0.0 lbs	
F_u =	3.7 lbs	@ 42in (CM)
Σf_i =	11.0 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 515 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 825 in-lbs
Factor of Safety
FOS = 1.601
NO UPLIFT - NO ANCHORS REQUIRED

Base Reactions:

Reactions (Service Loads):	LC #1		LC #2	
R_h =	6 lbs		4 lbs	
R_v =	0 lbs	(No Uplift)	0 lbs	(No Uplift)
Overturning FOS =	2.066	>= 1.5	1.601	>= 1.5
Sliding Restraint force, R_{RST} / FOS =	43lbs / 6.962 >= 1.5 OK		28lbs / 7.367 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	18 lbs		11 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	355 lbs		193 lbs	



Anchor Design (using "Cracked Concrete" Properties)

Try: 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.

Embedment =	2 in		
f'_c =	3500 psi		
e_n' =	0 in	<--- Eccen. Of Anchor	
h_{ef} =	1.33 in	$1.5(h_{ef})$ =	1.995 in
c_a =	5 in	$1.5(c_a)$ =	7.500 in
Conc. thickness, t =	4 in		
# of Anchors, n =	1	- anchors per connection	
S_X =	0 in		
A_{se} =	0.094 in^2		

Tension Allowables

Steel Strength, ϕN_{sa} =	5675 lbs	<--ACI 318-14 Eq 17.4.1.2		
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	752 lbs	<--ACI 318-14 Eq 17.4.2.1a		
Pullout Strength, $(0.75)\phi N_{pn}$ =	519 lbs	<--ACI 318-14 Eq 17.4.3.1		
	LC #1		LC #2	
Factored Tension Load (N_u) =	0 lbs		0 lbs	
max tension stress ratio (TSR) =	0.000	OK	0.000	OK

Shear Allowables

Steel Strength, ϕV_{sa} =	1449 lbs	<--ACI 318-14 Eq 17.5.1.2b		
Concrete breakout, ϕV_{cbg} =	2334 lbs	<--ACI 318-14 Eq 17.5.2.1a		
Concrete pryout, ϕV_{cpg} =	1080 lbs	<--ACI 318-14 Eq 17.5.3.1a		
	LC #1		LC #2	
Factored Shear Load (V_u) =	18 lbs		11 lbs	
Max shear stress ratio (VSR) =	0.016	OK	0.010	OK
Combined shear and tension stress ratio (TSR + VSR) =	0.016	< 1.2 OK - LC#1 (controls)		

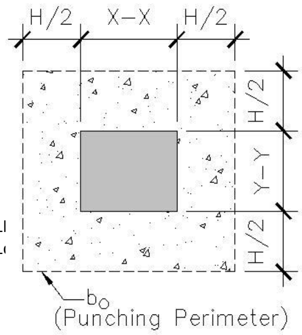
USE: NO UPLIFT - USE (1) 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed. ICC REPORT #ESR-3889

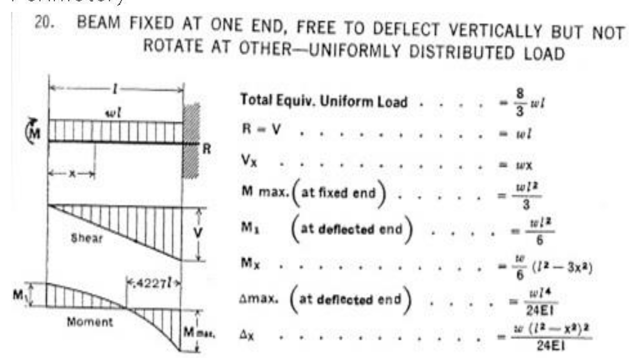
Shelving / Single Sided 84" Tall "3" 5 Level 18-3

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	355	lbs	
Slab Concrete f'_c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	2	in.	
Rack Post Y-Y =	2	in.	
b_o =	24.00	in.	
β =	1.00		
V_n =	22718	lbs	Table 14.5.5.1
V_n max =	15145	lbs	Table 14.5.5.1
ϕV_n =	9087.10	lbs	
$V_u/\phi V_n$ =	0.039	< 1.0 O.K.	





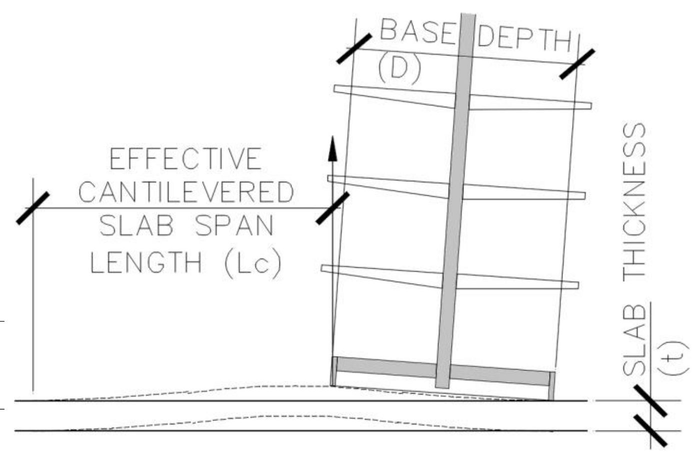
Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf
Max. Vertical Load (Service) (P) =	234	lbs
Area reqd. for bearing (A_{reqd}) =	0.16	ft^2
"b" distance =	4.74	in
Slab thickness (t) =	4.00	in
$S = (1")(t)^2/6$ =	2.67	in^3/in
ϕM_{nt} (tension allowable) = $\phi_t(7.5)[(f'_c)^{1/2}](S)$ =	710	in-lb/in
Factored uniform bearing, $w_u = P_u / A_{reqd}$ =	16	lb/in/in
$M_u = w_u L^2/3 = (w_u)[(b-(2"))/2)^2] / 3$ =	9.88	in-lb/in - Defl. End M1 = 5 in-lb/in
$M_u/\phi M_{nt}$ =	0.014	< 1.0 O.K.

Shelving Fixture FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	11	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, $f_r = 7.5 \cdot SQRT(f'c)$ =	443.7	psi
Concrete Slab Section Modulus, $S = b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, $M_{all}/FS = S \cdot f_r/1.5$ =	1183.2	ft*lbs/ft
Effective Cantilever Span Length (L_c) at M_{all} =	6.9	ft
Total Length of Slab (l_c + Width of Single Rack) =	7.8	ft
Trib. Width of Slab = Trib width of Rack =	4.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	1559	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)} = P_{conc} \cdot L_c/2$ =	72938	in*lbs

Load Combination #1:	M_{OT} =	710	in*lbs
	$M_{RST(Rack)} + M_{RST(slab)}$ =	74404	in*lbs
	Total Overturning FOS =	104.822	OK
Load Combination #2:	M_{OT} =	515	in*lbs
	$M_{RST(Rack)} + M_{RST(slab)}$ =	73763	in*lbs
	Total Overturning FOS =	143.169	OK



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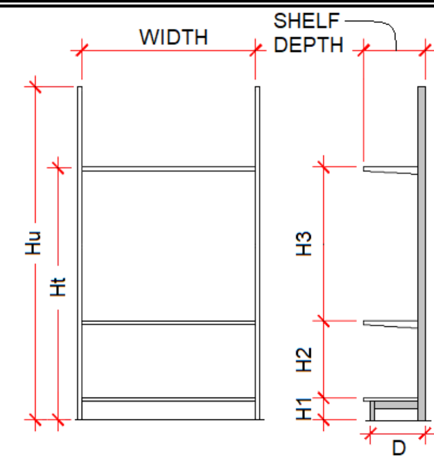
PROJECT NO:	SHEET NO:	OF:
2431906958	13	44
PROJECT NAME: #6958 - Cameron, NC		
MADE BY: RBC	DATE: 01/03/25	
CHECKED BY:	DATE:	

Shelving / Single Sided   120" Tall "FW" 3 Level   18FW

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor =	1.5		
Supported on Elevated Floor (Y/N):	No		
Total Load per shelf =	50 lbs		
# of Levels =	Wall 3 Level - FW		
Uniform Weight per level =	8.33 psf/shelf		
Weight of Unit =	100 lbs		
Anchorage spacing/Trib width =	4 ft	*(Frames are assumed to be 4'-0" oc)*	
Shelf depth =	18 in		Shelf Load / Level
h_9 =	0 in		
h_8 =	0 in		
h_7 =	0 in		
h_6 =	0 in		
h_5 =	0 in		
h_4 =	0 in		
h_3 =	66 in		50 lbs
h_2 =	12 in		50 lbs
h_1 =	6 in		50 lbs
Total Shelf Height, H_t =	84 in		
Unit Height, H_u =	120 in		
Unit Base Depth, D =	11 in		



Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1* [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ = 167.3 lbs
Base Shear, $V = C_sI_pW_s$ = 13.8 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

(Service Loads, E = 0.7)			
	F_9 =	0.0 lbs	@ 0 in (CM)
Note:	F_8 =	0.0 lbs	@ 0 in (CM)
(CM) = Product Center of	F_7 =	0.0 lbs	@ 0 in (CM)
Mass typically 6 inches	F_6 =	0.0 lbs	@ 0 in (CM)
above the top of shelf at	F_5 =	0.0 lbs	@ 0 in (CM)
each level.	F_4 =	0.0 lbs	@ 0 in (CM)
	F_3 =	2.9 lbs	@ 90 in (CM)
	F_2 =	0.8 lbs	@ 24 in (CM)
	F_1 =	0.4 lbs	@ 12 in (CM)
	F_u =	5.7 lbs	@ 60 in (CM)
	Σf_i =	13.8 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_ih_i$
M_{OT} = 620 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 1100 in-lbs
Factor of Safety
FOS = 1.775

NO UPLIFT - NO ANCHORS REQUIRED

Load Case 2* [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((1)PL)+DL$ = 133.5 lbs
Base Shear, $V = C_sI_pW_s$ = 11.0 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

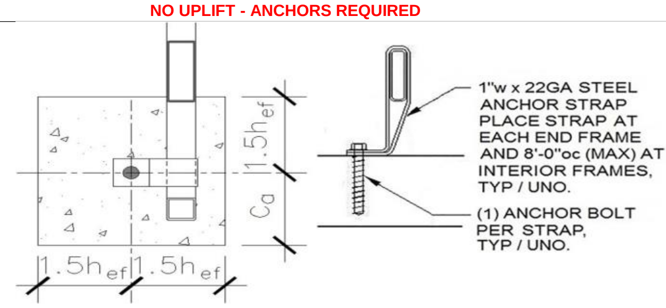
(Service Loads)			
	F_9 =	0.0 lbs	
	F_8 =	0.0 lbs	
	F_7 =	0.0 lbs	
	F_6 =	0.0 lbs	
	F_5 =	0.0 lbs	
	F_4 =	0.0 lbs	
	F_3 =	3.3 lbs	@ 90in (CM)
	F_2 =	0.0 lbs	
	F_1 =	0.0 lbs	
	F_u =	4.4 lbs	@ 60in (CM)
	Σf_i =	11.0 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_ih_i$
M_{OT} = 562 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 825 in-lbs
Factor of Safety
FOS = 1.469

NO UPLIFT - ANCHORS REQUIRED

Base Reactions:

Reactions (Service Loads):	LC #1		LC #2	
R_h =	5 lbs		4 lbs	
R_v =	0 lbs	(No Uplift)	0 lbs	(No Uplift)
Overturning FOS =	1.775	>= 1.5	1.469	<1.5--ABs Reqd
Sliding Restraint force, R_{RST} / FOS =	35lbs / 7.244 >= 1.5 OK		29lbs / 7.641 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	14 lbs		11 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	276 lbs		202 lbs	



Anchor Design (using "Cracked Concrete" Properties)

Try: 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.

Embedment =	2 in		
f'_c =	3500 psi		
e_n' =	0 in	<--- Eccen. Of Anchor	
h_{ef} =	1.33 in	$1.5(h_{ef})$ =	1.995 in
c_a =	5 in	$1.5(c_a)$ =	7.500 in
Conc. thickness, t =	4 in		
# of Anchors, n =	1	- anchors per connection	
S_X =	0 in		
A_{se} =	0.094 in^2		

Tension Allowables

Steel Strength, ϕN_{sa} =	5675 lbs	<--ACI 318-14 Eq 17.4.1.2		
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	752 lbs	<--ACI 318-14 Eq 17.4.2.1a		
Pullout Strength, $(0.75)\phi N_{pn}$ =	519 lbs	<--ACI 318-14 Eq 17.4.3.1		
	LC #1		LC #2	
Factored Tension Load (N_u) =	0 lbs		0 lbs	
max tension stress ratio (TSR) =	0.000	OK	0.000	OK

Shear Allowables

Steel Strength, ϕV_{sa} =	1449 lbs	<--ACI 318-14 Eq 17.5.1.2b		
Concrete breakout, ϕV_{cbg} =	2334 lbs	<--ACI 318-14 Eq 17.5.2.1a		
Concrete pryout, ϕV_{cpg} =	1080 lbs	<--ACI 318-14 Eq 17.5.3.1a		
	LC #1		LC #2	
Factored Shear Load (V_u) =	14 lbs		11 lbs	
Max shear stress ratio (VSR) =	0.013	OK	0.010	OK
Combined shear and tension stress ratio (TSR + VSR) =	0.013	< 1.2 OK - LC#1 (controls)		

USE: (1) 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed. ICC REPORT #ESR-3889

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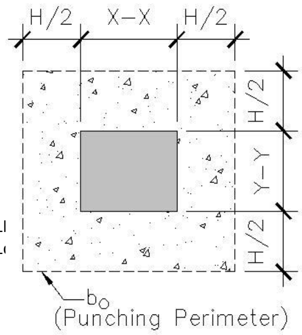
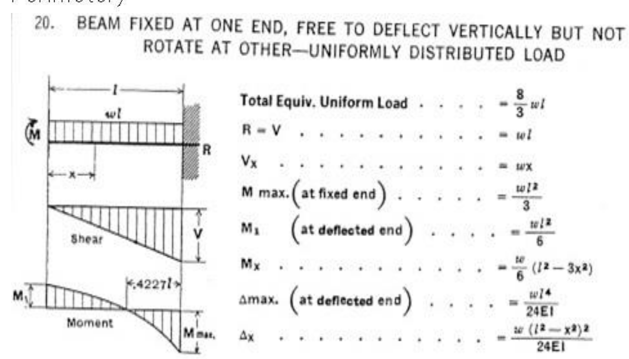
Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	276	lbs	
Slab Concrete f'_c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	2	in.	
Rack Post Y-Y =	2	in.	
b_o =	24.00	in.	
β =	1.00		
V_n =	22718	lbs	Table 14.5.5.1l
V_n max =	15145	lbs	Table 14.5.5.1(
ϕV_n =	9087.10	lbs	
$V_u/\phi V_n$ =	0.030	< 1.0 O.K.	



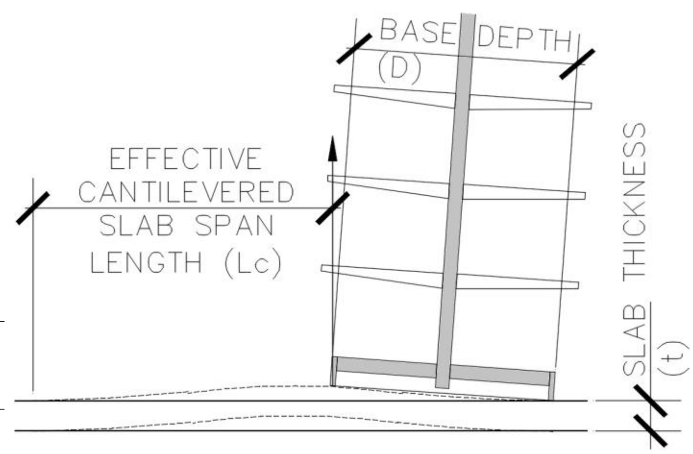


Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf
Max. Vertical Load (Service) (P) =	174	lbs
Area reqd. for bearing (A_{reqd}) =	0.12	ft^2
"b" distance =	4.09	in
Slab thickness (t) =	4.00	in
$S = (1")(t)^2/6$ =	2.67	in^3/in
ϕM_{nt} (tension allowable) = $\phi_t(7.5)[(f'_c)^{1/2}](S)$ =	710	in-lb/in
Factored uniform bearing, $w_u = P_u / A_{reqd}$ =	17	lb/in/in
$M_u = w_u L^2/3 = (w_u)[(b-(2"))/2)^2] / 3$ =	6.00	in-lb/in - Defl. End M1 = 3 in-lb/in
$M_u/\phi M_{nt}$ =	0.008	< 1.0 O.K.

Shelving Fixture FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	11	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, $f_r = 7.5*SQRT(f'c)$ =	443.7	psi
Concrete Slab Section Modulus, $S = b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, $M_{all}/FS = S*f_r/1.5$ =	1183.2	ft*lbs/ft
Effective Cantilever Span Length (L_c) at M_{all} =	6.9	ft
Total Length of Slab (l_c + Width of Single Rack) =	7.8	ft
Trib. Width of Slab = Trib width of Rack =	4.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	1559	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)} = P_{conc} * L_c/2$ =	72938	in*lbs
Load Combination #1: M_{OT} =	620	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	74038	in*lbs
Total Overturning FOS =	119.469	OK
Load Combination #2: M_{OT} =	562	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	73763	in*lbs
Total Overturning FOS =	131.320	OK



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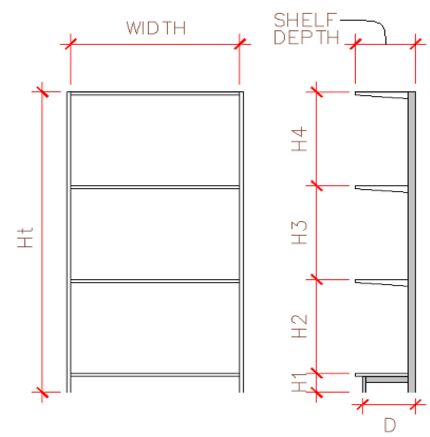
PROJECT NO:	SHEET NO:	OF:
2431906958	15	44
PROJECT NAME: #6958 - Cameron, NC		
MADE BY: RBC	DATE: 01/03/25	
CHECKED BY:	DATE:	

Shelving / Single Sided 48" Tall "R" 4 Level 24R

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor =	1.5		
Supported on Elevated Floor (Y/N):	No		
Total Load per shelf =	150 lbs		
# of Levels =	Wall 4 Level		
Uniform Weight per level =	18.75 psf/shelf		
Weight of Unit =	100 lbs		
Anchorage spacing/Trib width =	8 ft	*(Frames are assumed to be 4'-0" oc)*	
Shelf depth =	24 in		Shelf Load / Level
h_9 =	0 in		
h_8 =	0 in		
h_7 =	0 in		
h_6 =	0 in		
h_5 =	0 in		
h_4 =	14 in		300 lbs
h_3 =	14 in		300 lbs
h_2 =	14 in		300 lbs
h_1 =	6 in		300 lbs
Total Shelf Height, H_t =	48 in		
Unit Height, H_u =	48 in		
Unit Base Depth, D =	15 in		



Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1* [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ = 638.7 lbs
Base Shear, $V = C_sI_pW_s$ = 52.7 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)
(Service Loads, E = 0.7)

Note:
(CM) = Product Center of Mass typically 6 inches above the top of shelf at each level.

F_9 =	0.0 lbs	@ 0 in (CM)
F_8 =	0.0 lbs	@ 0 in (CM)
F_7 =	0.0 lbs	@ 0 in (CM)
F_6 =	0.0 lbs	@ 0 in (CM)
F_5 =	0.0 lbs	@ 0 in (CM)
F_4 =	13.8 lbs	@ 54 in (CM)
F_3 =	10.2 lbs	@ 40 in (CM)
F_2 =	6.7 lbs	@ 26 in (CM)
F_1 =	3.1 lbs	@ 12 in (CM)
F_u =	3.1 lbs	@ 24 in (CM)
Σf_i =	52.7 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 1441 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 6750 in-lbs
Factor of Safety
FOS = 4.685
NO UPLIFT - NO ANCHORS REQUIRED

Load Case 2* [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

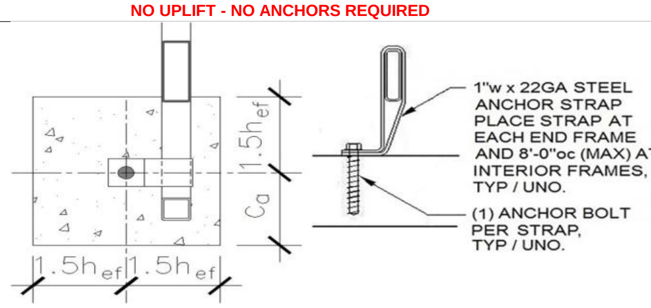
Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((1)PL)+DL$ = 301.0 lbs
Base Shear, $V = C_sI_pW_s$ = 24.8 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)
(Service Loads)

F_9 =	0.0 lbs	
F_8 =	0.0 lbs	
F_7 =	0.0 lbs	
F_6 =	0.0 lbs	
F_5 =	0.0 lbs	
F_4 =	15.1 lbs	@ 54in (CM)
F_3 =	0.0 lbs	
F_2 =	0.0 lbs	
F_1 =	0.0 lbs	
F_u =	2.2 lbs	@ 24in (CM)
Σf_i =	24.8 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 871 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 3000 in-lbs
Factor of Safety
FOS = 3.443
NO UPLIFT - NO ANCHORS REQUIRED

Base Reactions:

Reactions (Service Loads):	LC #1		LC #2	
R_h =	18 lbs		9 lbs	
R_v =	0 lbs	(No Uplift)	0 lbs	(No Uplift)
Overturning FOS =	4.685	>= 1.5	3.443	>= 1.5
Sliding Restraint force, R_{RST} / FOS =	104lbs / 5.631 >= 1.5 OK		52lbs / 6 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	53 lbs		25 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	1013 lbs		373 lbs	



Anchor Design (using "Cracked Concrete" Properties)
Try: 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.

Embedment =	2 in		
f'_c =	3500 psi		
e_n' =	0 in	<--- Eccen. Of Anchor	
h_{ef} =	1.33 in	$1.5(h_{ef})$ =	1.995 in
c_a =	5 in	$1.5(c_a)$ =	7.500 in
Conc. thickness, t =	4 in		
# of Anchors, n =	1	- anchors per connection	
S_X =	0 in		
A_{se} =	0.094 in^2		

Tension Allowables

Steel Strength, ϕN_{sa} =	5675 lbs	<--ACI 318-14 Eq 17.4.1.2		
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	752 lbs	<--ACI 318-14 Eq 17.4.2.1a		
Pullout Strength, $(0.75)\phi N_{pn}$ =	519 lbs	<--ACI 318-14 Eq 17.4.3.1		
	LC #1		LC #2	
Factored Tension Load (N_u) =	0 lbs		0 lbs	
max tension stress ratio (TSR) =	0.000	OK	0.000	OK

Shear Allowables

Steel Strength, ϕV_{sa} =	1449 lbs	<--ACI 318-14 Eq 17.5.1.2b		
Concrete breakout, ϕV_{cbg} =	2334 lbs	<--ACI 318-14 Eq 17.5.2.1a		
Concrete pryout, ϕV_{cpg} =	1080 lbs	<--ACI 318-14 Eq 17.5.3.1a		
	LC #1		LC #2	
Factored Shear Load (V_u) =	53 lbs		25 lbs	
Max shear stress ratio (VSR) =	0.049	OK	0.023	OK
Combined shear and tension stress ratio (TSR + VSR) =	0.049	< 1.2 OK - LC#1 (controls)		

USE: NO UPLIFT - USE (1) 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed. ICC REPORT #ESR-3889

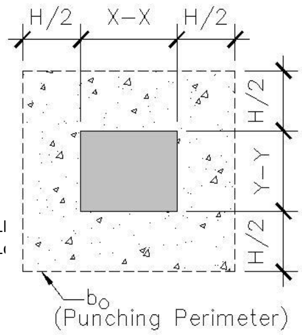
JBA Johnston Burkholder Associates consulting structural engineers 930 Central · Kansas City, MO 64105 816.421.4200 · www.jbaengr.com	PROJECT NO: 2431906958	SHEET NO: 16	OF: 44
	PROJECT NAME: #6958 - Cameron, NC		
	MADE BY: RBC	DATE: 01/03/25	
	CHECKED BY:	DATE:	

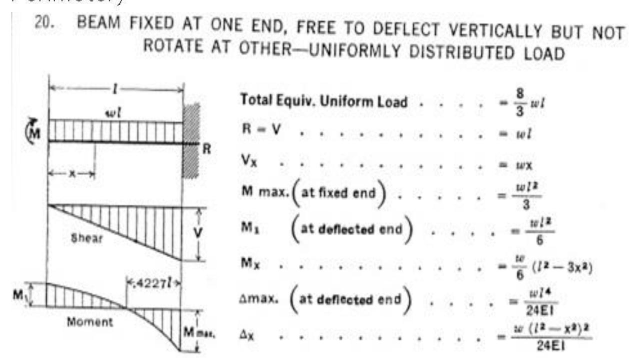
Shelving / Single Sided 48" Tall "R" 4 Level 24R

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	1013	lbs	
Slab Concrete f'_c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	2	in.	
Rack Post Y-Y =	2	in.	
b_o =	24.00	in.	
β =	1.00		
V_n =	22718	lbs	Table 14.5.5.1
V_n max =	15145	lbs	Table 14.5.5.1
ϕV_n =	9087.10	lbs	
$V_u/\phi V_n$ =	0.111	< 1.0 O.K.	



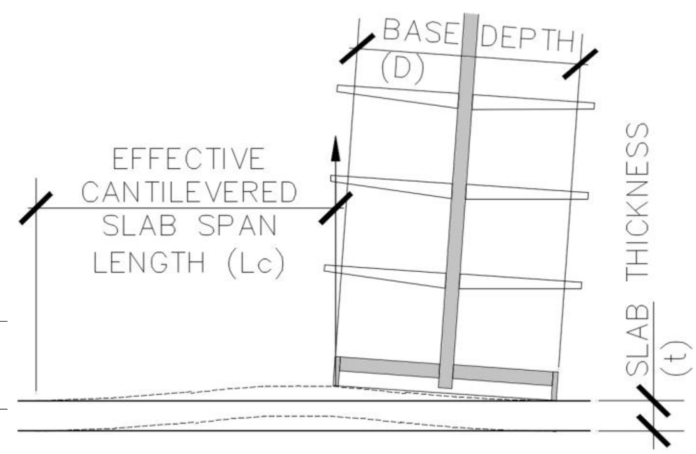


Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf
Max. Vertical Load (Service) (P) =	767	lbs
Area reqd. for bearing (A_{reqd}) =	0.51	ft^2
"b" distance =	8.58	in
Slab thickness (t) =	4.00	in
$S = (1")(t)^2/6$ =	2.67	in^3/in
ϕM_{nt} (tension allowable) = $\phi_t(7.5)[(f'_c)^{1/2}](S)$ =	710	in-lb/in
Factored uniform bearing, $w_u = P_u / A_{reqd}$ =	14	lb/in/in
$M_u = w_u L^2/3 = (w_u)[(b-(2"))/2)^2] / 3$ =	49.65	in-lb/in - Defl. End M1 = 25 in-lb/in
$M_u/\phi M_{nt}$ =	0.070	< 1.0 O.K.

Shelving Fixture FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	15	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, $f_r = 7.5*SQRT(f'c)$ =	443.7	psi
Concrete Slab Section Modulus, $S = b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, $M_{all}/FS = S*f_r/1.5$ =	1183.2	ft*lbs/ft
Effective Cantilever Span Length (L_c) at M_{all} =	6.9	ft
Total Length of Slab (l_c + Width of Single Rack) =	8.1	ft
Trib. Width of Slab = Trib width of Rack =	8.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	3252	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)} = P_{conc} * L_c/2$ =	158616	in*lbs
Load Combination #1: M_{OT} =	1441	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	165366	in*lbs
Total Overturning FOS =	114.778	OK
Load Combination #2: M_{OT} =	871	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	161616	in*lbs
Total Overturning FOS =	185.471	OK



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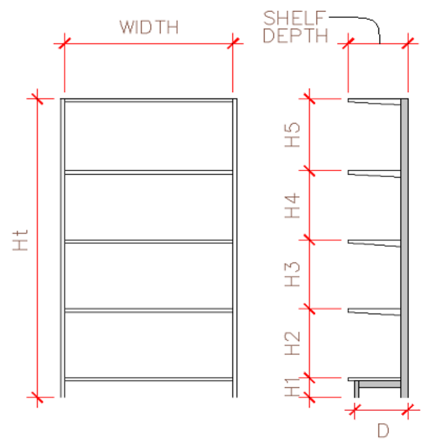
PROJECT NO:	SHEET NO:	OF:
2431906958	17	44
PROJECT NAME: #6958 - Cameron, NC		
MADE BY: RBC	DATE: 01/03/25	
CHECKED BY:	DATE:	

Shelving / Single Sided — 60" Tall "T" 5 Level — 24T

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor =	1.5		
Supported on Elevated Floor (Y/N):	No		
Total Load per shelf =	150 lbs		
# of Levels =	Wall 5 Level		
Uniform Weight per level =	18.75 psf/shelf		
Weight of Unit =	100 lbs		
Anchorage spacing/Trib width =	8 ft	*(Frames are assumed to be 4'-0" oc)*	
Shelf depth =	24 in		Shelf Load / Level
h_9 =	0 in		
h_8 =	0 in		
h_7 =	0 in		
h_6 =	0 in		
h_5 =	13.5 in		300 lbs
h_4 =	13.5 in		300 lbs
h_3 =	13.5 in		300 lbs
h_2 =	13.5 in		300 lbs
h_1 =	6 in		300 lbs
Total Shelf Height, H_t =	60 in		
Unit Height, H_u =	60 in		
Unit Base Depth, D =	15 in		



Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1* [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ =	0.083	W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ =	773.4 lbs	
Base Shear, $V = C_s I_p W_s$ =	63.8 lbs	

Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)
(Service Loads, E = 0.7)

F_9 =	0.0 lbs	@ 0 in (CM)
F_8 =	0.0 lbs	@ 0 in (CM)
F_7 =	0.0 lbs	@ 0 in (CM)
F_6 =	0.0 lbs	@ 0 in (CM)
F_5 =	14.0 lbs	@ 66 in (CM)
F_4 =	11.2 lbs	@ 52.5 in (CM)
F_3 =	8.3 lbs	@ 39 in (CM)
F_2 =	5.4 lbs	@ 25.5 in (CM)
F_1 =	2.6 lbs	@ 12 in (CM)
F_u =	3.2 lbs	@ 30 in (CM)
Σf_i =	63.8 lbs	(@ Factored Loads)

Note:
(CM) = Product Center of Mass typically 6 inches above the top of shelf at each level.

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 2101 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 8250 in-lbs
Factor of Safety
FOS = 3.927
NO UPLIFT - NO ANCHORS REQUIRED

Load Case 2* [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ =	0.083	W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((1)PL)+DL$ =	301.0 lbs	
Base Shear, $V = C_s I_p W_s$ =	24.8 lbs	

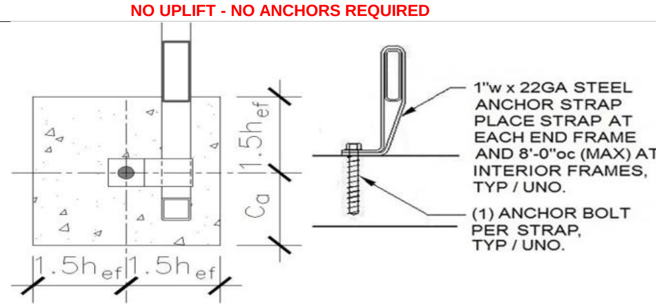
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)
(Service Loads)

F_9 =	0.0 lbs	
F_8 =	0.0 lbs	
F_7 =	0.0 lbs	
F_6 =	0.0 lbs	
F_5 =	15.1 lbs	@ 66in (CM)
F_4 =	0.0 lbs	
F_3 =	0.0 lbs	
F_2 =	0.0 lbs	
F_1 =	0.0 lbs	
F_u =	2.3 lbs	@ 30in (CM)
Σf_i =	24.8 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 1065 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 3000 in-lbs
Factor of Safety
FOS = 2.817
NO UPLIFT - NO ANCHORS REQUIRED

Base Reactions:

Reactions (Service Loads):	LC #1		LC #2	
R_h =	22 lbs		9 lbs	
R_v =	0 lbs	(No Uplift)	0 lbs	(No Uplift)
Overturning FOS =	3.927	>= 1.5	2.817	>= 1.5
Sliding Restraint force, R_{RST} / FOS =	132lbs / 5.897 >= 1.5 OK		55lbs / 6.371 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	64 lbs		25 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	1294 lbs		400 lbs	



Anchor Design (using "Cracked Concrete" Properties)
Try: 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.

Embedment =	2 in		
f'_c =	3500 psi		
e_n' =	0 in	<--- Eccen. Of Anchor	
h_{ef} =	1.33 in	$1.5(h_{ef})$ =	1.995 in
c_a =	5 in	$1.5(c_a)$ =	7.500 in
Conc. thickness, t =	4 in		
# of Anchors, n =	1	- anchors per connection	
S_X =	0 in		
A_{se} =	0.094 in^2		

Tension Allowables

Steel Strength, ϕN_{sa} =	5675 lbs	<--ACI 318-14 Eq 17.4.1.2
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	752 lbs	<--ACI 318-14 Eq 17.4.2.1a
Pullout Strength, $(0.75)\phi N_{pn}$ =	519 lbs	<--ACI 318-14 Eq 17.4.3.1

	LC #1		LC #2	
Factored Tension Load (N_u) =	0 lbs		0 lbs	
max tension stress ratio (TSR) =	0.000	OK	0.000	OK

Shear Allowables

Steel Strength, ϕV_{sa} =	1449 lbs	<--ACI 318-14 Eq 17.5.1.2b
Concrete breakout, ϕV_{cbg} =	2334 lbs	<--ACI 318-14 Eq 17.5.2.1a
Concrete pryout, ϕV_{cpg} =	1080 lbs	<--ACI 318-14 Eq 17.5.3.1a

	LC #1		LC #2	
Factored Shear Load (V_u) =	64 lbs		25 lbs	
Max shear stress ratio (VSR) =	0.059	OK	0.023	OK
Combined shear and tension stress ratio (TSR + VSR) =	0.059	< 1.2 OK - LC#1 (controls)		

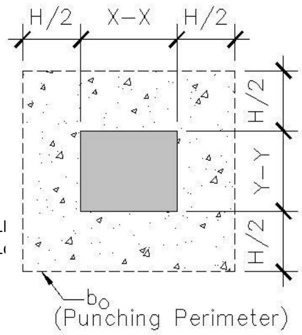
USE: NO UPLIFT - USE (1) 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed. ICC REPORT #ESR-3889

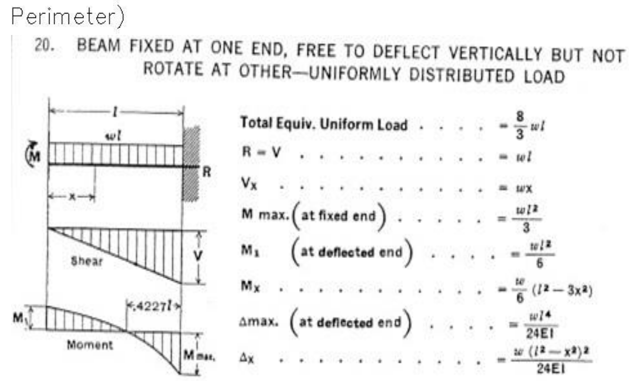
Shelving / Single Sided 60" Tall "T" 5 Level 24T

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	1294	lbs	
Slab Concrete f'_c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	2	in.	
Rack Post Y-Y =	2	in.	
b_o =	24.00	in.	
β =	1.00		
V_n =	22718	lbs	Table 14.5.5.1
V_n max =	15145	lbs	Table 14.5.5.1
ϕV_n =	9087.10	lbs	
$V_u/\phi V_n$ =	0.142	< 1.0 O.K.	



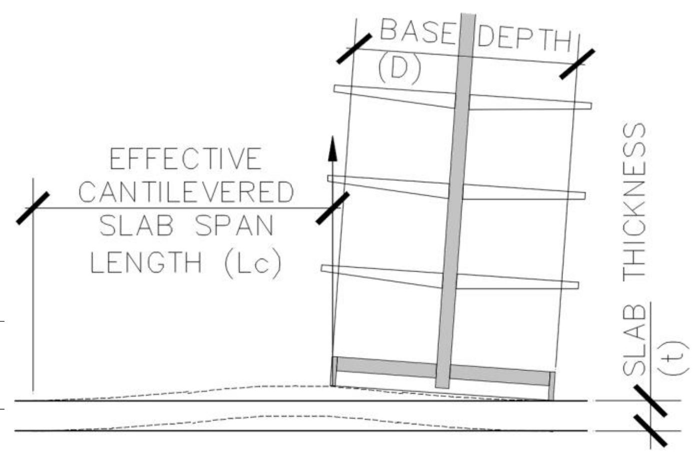


Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf
Max. Vertical Load (Service) (P) =	961	lbs
Area reqd. for bearing (A_{reqd}) =	0.64	ft^2
"b" distance =	9.60	in
Slab thickness (t) =	4.00	in
$S = (1")(t)^2/6$ =	2.67	in^3/in
ϕM_{nt} (tension allowable) = $\phi_t(7.5)[(f'_c)^{1/2}](S)$ =	710	in-lb/in
Factored uniform bearing, $w_u = P_u / A_{reqd}$ =	14	lb/in/in
$M_u = w_u L^2/3 = (w_u)[(b-(2"))/2)^2] / 3$ =	67.60	in-lb/in - Defl. End M1 = 34 in-lb/in
$M_u/\phi M_{nt}$ =	0.095	< 1.0 O.K.

Shelving Fixture FOS Overturning with Resistance from Effective Weight of Slab on Grade:

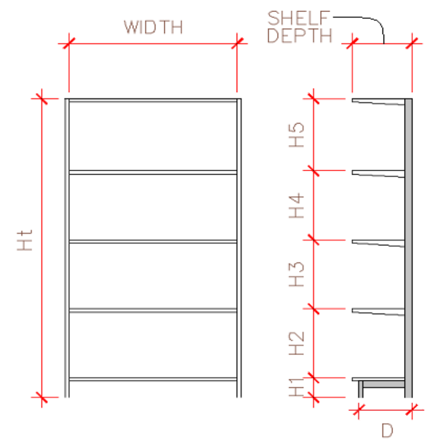
Width of Single Rack =	15	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, $f_r = 7.5*SQRT(f'c)$ =	443.7	psi
Concrete Slab Section Modulus, $S = b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, $M_{all}/FS = S*f_r/1.5$ =	1183.2	ft*lbs/ft
Effective Cantilever Span Length (L_c) at M_{all} =	6.9	ft
Total Length of Slab (l_c + Width of Single Rack) =	8.1	ft
Trib. Width of Slab = Trib width of Rack =	8.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	3252	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)} = P_{conc} * L_c/2$ =	158616	in*lbs
Load Combination #1: M_{OT} =	2101	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	166866	in*lbs
Total Overturning FOS =	79.425	OK
Load Combination #2: M_{OT} =	1065	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	161616	in*lbs
Total Overturning FOS =	151.763	OK



Shelving / Single Sided 78" Tall "V" 5 Level 24V

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor =	1.5		
Supported on Elevated Floor (Y/N):	No		
Total Load per shelf =	150 lbs		
# of Levels =	Wall 5 Level		
Uniform Weight per level =	18.75 psf/shelf		
Weight of Unit =	100 lbs		
Anchorage spacing/Trib width =	8 ft	*(Frames are assumed to be 4'-0" oc)*	
Shelf depth =	24 in		Shelf Load / Level
h_9 =	0 in		
h_8 =	0 in		
h_7 =	0 in		
h_6 =	0 in		
h_5 =	18 in		300 lbs
h_4 =	18 in		300 lbs
h_3 =	18 in		300 lbs
h_2 =	18 in		300 lbs
h_1 =	6 in		300 lbs
Total Shelf Height, H_t =	78 in		
Unit Height, H_u =	78 in		
Unit Base Depth, D =	15 in		



Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1* [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ = 773.4 lbs
Base Shear, $V = C_s I_p W_s$ = 63.8 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

(Service Loads, E = 0.7)

Note:
(CM) = Product Center of Mass typically 6 inches above the top of shelf at each level.

F_9 =	0.0 lbs	@ 0 in (CM)
F_8 =	0.0 lbs	@ 0 in (CM)
F_7 =	0.0 lbs	@ 0 in (CM)
F_6 =	0.0 lbs	@ 0 in (CM)
F_5 =	14.5 lbs	@ 84 in (CM)
F_4 =	11.4 lbs	@ 66 in (CM)
F_3 =	8.3 lbs	@ 48 in (CM)
F_2 =	5.2 lbs	@ 30 in (CM)
F_1 =	2.1 lbs	@ 12 in (CM)
F_u =	3.3 lbs	@ 39 in (CM)
Σf_i =	63.8 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 2671 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 8250 in-lbs
Factor of Safety
FOS = 3.088
NO UPLIFT - NO ANCHORS REQUIRED

Load Case 2* [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((1)PL)+DL$ = 301.0 lbs
Base Shear, $V = C_s I_p W_s$ = 24.8 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

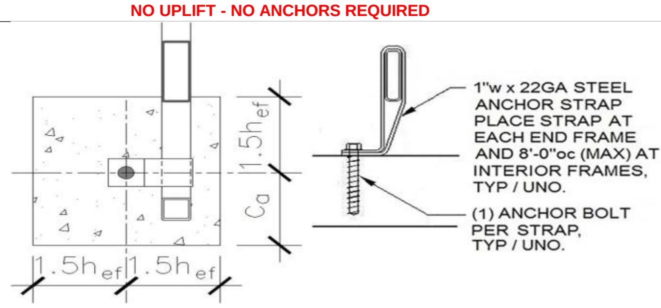
(Service Loads)

F_9 =	0.0 lbs	
F_8 =	0.0 lbs	
F_7 =	0.0 lbs	
F_6 =	0.0 lbs	
F_5 =	15.1 lbs	@ 84in (CM)
F_4 =	0.0 lbs	
F_3 =	0.0 lbs	
F_2 =	0.0 lbs	
F_1 =	0.0 lbs	
F_u =	2.3 lbs	@ 39in (CM)
Σf_i =	24.8 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 1355 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 3000 in-lbs
Factor of Safety
FOS = 2.214
NO UPLIFT - NO ANCHORS REQUIRED

Base Reactions:

Reactions (Service Loads):	LC #1		LC #2	
R_h =	22 lbs		9 lbs	
R_v =	0 lbs	(No Uplift)	0 lbs	(No Uplift)
Overturning FOS =	3.088	>= 1.5	2.214	>= 1.5
Sliding Restraint force, R_{RST} / FOS =	141lbs / 6.323 >= 1.5 OK		60lbs / 6.928 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	64 lbs		25 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	1375 lbs		441 lbs	



Anchor Design (using "Cracked Concrete" Properties)

Try: 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.

Embedment =	2 in		
f'_c =	3500 psi		
e_n' =	0 in	<--- Eccen. Of Anchor	
h_{ef} =	1.33 in	$1.5(h_{ef})$ =	1.995 in
c_a =	5 in	$1.5(c_a)$ =	7.500 in
Conc. thickness, t =	4 in		
# of Anchors, n =	1	- anchors per connection	
S_X =	0 in		
A_{se} =	0.094 in^2		

Tension Allowables

Steel Strength, ϕN_{sa} =	5675 lbs	<--ACI 318-14 Eq 17.4.1.2
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	752 lbs	<--ACI 318-14 Eq 17.4.2.1a
Pullout Strength, $(0.75)\phi N_{pn}$ =	519 lbs	<--ACI 318-14 Eq 17.4.3.1

	LC #1		LC #2	
Factored Tension Load (N_u) =	0 lbs		0 lbs	
max tension stress ratio (TSR) =	0.000	OK	0.000	OK

Shear Allowables

Steel Strength, ϕV_{sa} =	1449 lbs	<--ACI 318-14 Eq 17.5.1.2b
Concrete breakout, ϕV_{cbg} =	2334 lbs	<--ACI 318-14 Eq 17.5.2.1a
Concrete pryout, ϕV_{cpg} =	1080 lbs	<--ACI 318-14 Eq 17.5.3.1a

	LC #1		LC #2	
Factored Shear Load (V_u) =	64 lbs		25 lbs	
Max shear stress ratio (VSR) =	0.059	OK	0.023	OK
Combined shear and tension stress ratio (TSR + VSR) =	0.059	< 1.2 OK - LC#1 (controls)		

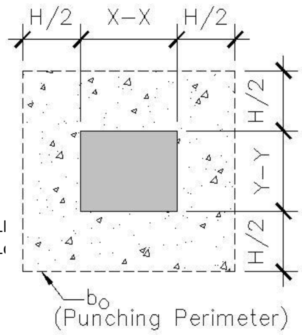
USE: NO UPLIFT - USE (1) 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed. ICC REPORT #ESR-3889

Shelving / Single Sided 78" Tall "V" 5 Level 24V

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

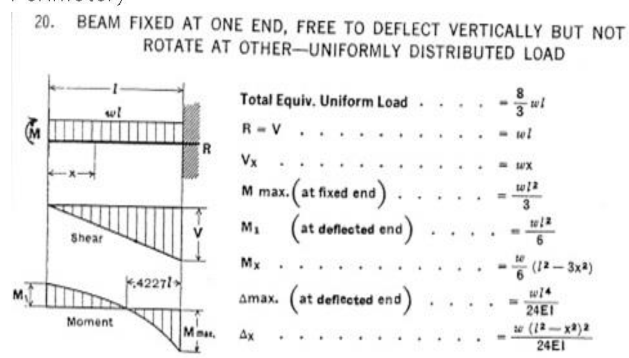
Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	1375	lbs
Slab Concrete f'_c =	3500	psi
Slab thickness (t) =	4	in.
Rack Post X-X =	2	in.
Rack Post Y-Y =	2	in.
b_o =	24.00	in.
β =	1.00	
V_n =	22718	lbs Table 14.5.5.1
V_n max =	15145	lbs Table 14.5.5.1
ϕV_n =	9087.10	lbs
$V_u/\phi V_n$ =	0.151	< 1.0 O.K.



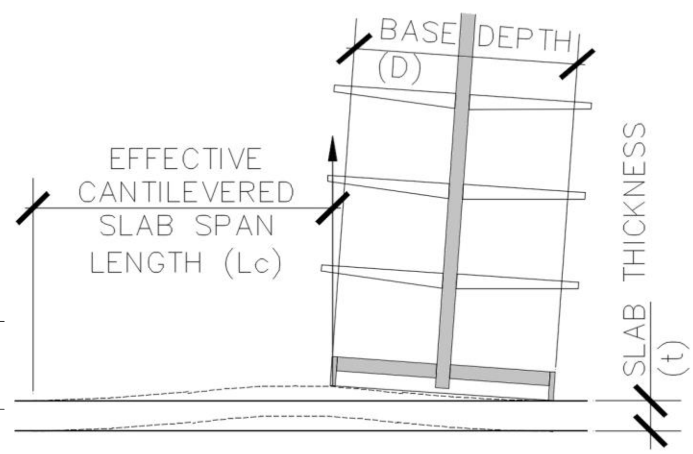
Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf
Max. Vertical Load (Service) (P) =	990	lbs
Area reqd. for bearing (A_{reqd}) =	0.66	ft^2
"b" distance =	9.75	in
Slab thickness (t) =	4.00	in
$S = (1")(t)^2/6$ =	2.67	in^3/in
ϕM_{nt} (tension allowable) = $\phi_t(7.5)[(f'_c)^{1/2}](S)$ =	710	in-lb/in
Factored uniform bearing, $w_u = P_u / A_{reqd}$ =	14	lb/in/in
$M_u = w_u L^2/3 = (w_u)[(b-(2"))/2)^2] / 3$ =	72.39	in-lb/in - Defl. End M1 = 37 in-lb/in
$M_u/\phi M_{nt}$ =	0.102	< 1.0 O.K.



Shelving Fixture FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	15	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, $f_r = 7.5*SQRT(f'c)$ =	443.7	psi
Concrete Slab Section Modulus, $S = b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, $M_{all}/FS = S*f_r/1.5$ =	1183.2	ft*lbs/ft
Effective Cantilever Span Length (L_c) at M_{all} =	6.9	ft
Total Length of Slab (l_c + Width of Single Rack) =	8.1	ft
Trib. Width of Slab = Trib width of Rack =	8.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	3252	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)} = P_{conc} * L_c/2$ =	158616	in*lbs
Load Combination #1: M_{OT} =	2671	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	166866	in*lbs
Total Overturning FOS =	62.462	OK
Load Combination #2: M_{OT} =	1355	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	161616	in*lbs
Total Overturning FOS =	119.246	OK



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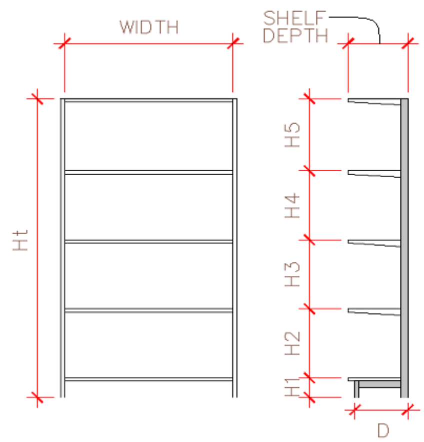
PROJECT NO:	SHEET NO:	OF:
2431906958	21	44
PROJECT NAME: #6958 - Cameron, NC		
MADE BY: RBC	DATE: 01/03/25	
CHECKED BY:	DATE:	

Shelving / Single Sided 90" Tall "X" 5 Level 24X

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor =	1.5	
Supported on Elevated Floor (Y/N):	No	
Total Load per shelf =	150 lbs	
# of Levels =	Wall 5 Level	
Uniform Weight per level =	18.75 psf/shelf	
Weight of Unit =	100 lbs	
Anchorage spacing/Trib width =	8 ft	*(Frames are assumed to be 4'-0" oc)*
Shelf depth =	24 in	Shelf Load / Level
h_9 =	0 in	
h_8 =	0 in	
h_7 =	0 in	
h_6 =	0 in	
h_5 =	21 in	300 lbs
h_4 =	21 in	300 lbs
h_3 =	21 in	300 lbs
h_2 =	21 in	300 lbs
h_1 =	6 in	300 lbs
Total Shelf Height, H_t =	90 in	
Unit Height, H_u =	90 in	
Unit Base Depth, D =	15 in	



Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1* [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ =	0.083	W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ =	773.4 lbs	
Base Shear, $V = C_sI_pW_s$ =	63.8 lbs	

Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

Note: (CM) = Product Center of Mass typically 6 inches above the top of shelf at each level.

(Service Loads, E = 0.7)		
F_9 =	0.0 lbs	@ 0 in (CM)
F_8 =	0.0 lbs	@ 0 in (CM)
F_7 =	0.0 lbs	@ 0 in (CM)
F_6 =	0.0 lbs	@ 0 in (CM)
F_5 =	14.7 lbs	@ 96 in (CM)
F_4 =	11.5 lbs	@ 75 in (CM)
F_3 =	8.2 lbs	@ 54 in (CM)
F_2 =	5.0 lbs	@ 33 in (CM)
F_1 =	1.8 lbs	@ 12 in (CM)
F_u =	3.4 lbs	@ 45 in (CM)
Σf_i =	63.8 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 3055 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 8250 in-lbs
Factor of Safety
FOS = 2.701
NO UPLIFT - NO ANCHORS REQUIRED

Load Case 2* [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ =	0.083	W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((1)PL)+DL$ =	301.0 lbs	
Base Shear, $V = C_sI_pW_s$ =	24.8 lbs	

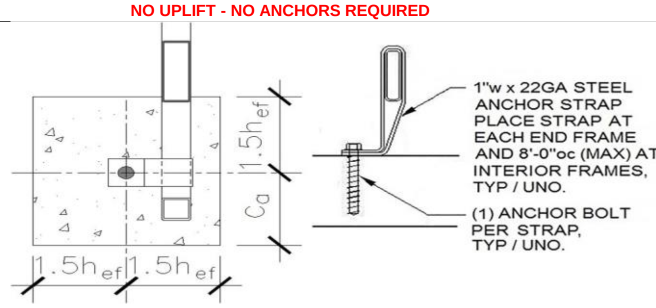
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

(Service Loads)		
F_9 =	0.0 lbs	
F_8 =	0.0 lbs	
F_7 =	0.0 lbs	
F_6 =	0.0 lbs	
F_5 =	15.0 lbs	@ 96in (CM)
F_4 =	0.0 lbs	
F_3 =	0.0 lbs	
F_2 =	0.0 lbs	
F_1 =	0.0 lbs	
F_u =	2.3 lbs	@ 45in (CM)
Σf_i =	24.8 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 1549 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 3000 in-lbs
Factor of Safety
FOS = 1.937
NO UPLIFT - NO ANCHORS REQUIRED

Base Reactions:

Reactions (Service Loads):	LC #1		LC #2	
R_h =	22 lbs		9 lbs	
R_v =	0 lbs	(No Uplift)	0 lbs	(No Uplift)
Overturning FOS =	2.701	>= 1.5	1.937	>= 1.5
Sliding Restraint force, R_{RST} / FOS =	148lbs / 6.609 >= 1.5 OK		63lbs / 7.299 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	64 lbs		25 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	1429 lbs		469 lbs	



Anchor Design (using "Cracked Concrete" Properties)

Try: 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.

Embedment =	2 in	
f'_c =	3500 psi	
e_n' =	0 in	<--- Eccen. Of Anchor
h_{ef} =	1.33 in	$1.5(h_{ef})$ = 1.995 in
c_a =	5 in	$1.5(c_a)$ = 7.500 in
Conc. thickness, t =	4 in	
# of Anchors, n =	1	- anchors per connection
S_X =	0 in	
A_{se} =	0.094 in^2	

Tension Allowables

Steel Strength, ϕN_{sa} =	5675 lbs	<--ACI 318-14 Eq 17.4.1.2		
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	752 lbs	<--ACI 318-14 Eq 17.4.2.1a		
Pullout Strength, $(0.75)\phi N_{pn}$ =	519 lbs	<--ACI 318-14 Eq 17.4.3.1		
	LC #1		LC #2	
Factored Tension Load (N_u) =	0 lbs		0 lbs	
max tension stress ratio (TSR) =	0.000	OK	0.000	OK

Shear Allowables

Steel Strength, ϕV_{sa} =	1449 lbs	<--ACI 318-14 Eq 17.5.1.2b		
Concrete breakout, ϕV_{cbg} =	2334 lbs	<--ACI 318-14 Eq 17.5.2.1a		
Concrete pryout, ϕV_{cpg} =	1080 lbs	<--ACI 318-14 Eq 17.5.3.1a		
	LC #1		LC #2	
Factored Shear Load (V_u) =	64 lbs		25 lbs	
Max shear stress ratio (VSR) =	0.059	OK	0.023	OK
Combined shear and tension stress ratio (TSR + VSR) =	0.059	< 1.2 OK - LC#1 (controls)		

USE: NO UPLIFT - USE (1) 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed. ICC REPORT #ESR-3889

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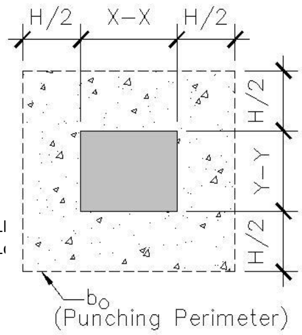
Shelving / Single Sided 90" Tall "X" 5 Level 24X

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

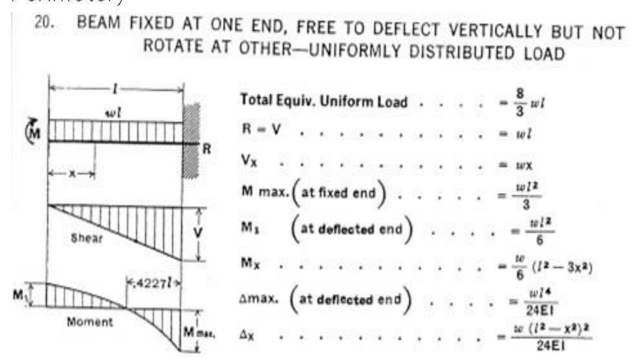
Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	1429	lbs	
Slab Concrete f'_c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	2	in.	
Rack Post Y-Y =	2	in.	
b_o =	24.00	in.	
β =	1.00		
V_n =	22718	lbs	Table 14.5.5.1l
V_n max =	15145	lbs	Table 14.5.5.1(
ϕV_n =	9087.10	lbs	
$V_u/\phi V_n$ =	0.157	< 1.0 O.K.	



Slab tension based on Soil bearing area check:

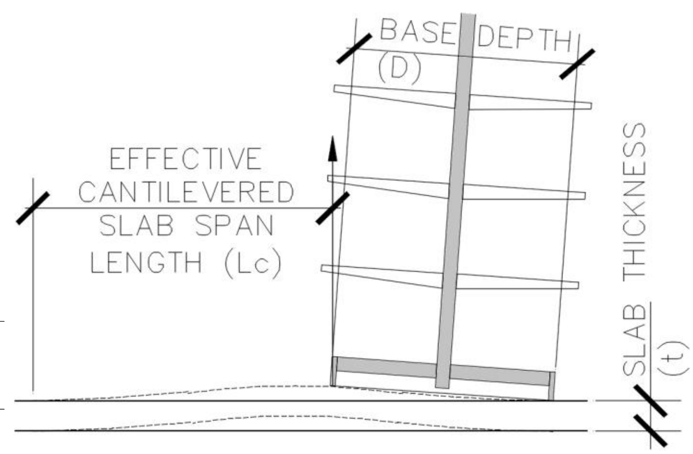
Allowable soil bearing =	1500	psf
Max. Vertical Load (Service) (P) =	1009	lbs
Area reqd. for bearing (A_{reqd}) =	0.67	ft^2
"b" distance =	9.84	in
Slab thickness (t) =	4.00	in
$S = (1")(t)^2/6$ =	2.67	in^3/in
ϕM_{nt} (tension allowable) = $\phi_t(7.5)[(f'_c)^{1/2}](S)$ =	710	in-lb/in
Factored uniform bearing, $w_u = P_u / A_{reqd}$ =	15	lb/in/in
$M_u = w_u L^2/3 = (w_u)[(b-(2"))/2)^2] / 3$ =	75.60	in-lb/in - Defl. End M1 = 38 in-lb/in
$M_u/\phi M_{nt}$ =	0.106	< 1.0 O.K.



Shelving Fixture FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	15	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, $f_r = 7.5*SQRT(f'c)$ =	443.7	psi
Concrete Slab Section Modulus, $S = b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, $M_{all}/FS = S*f_r/1.5$ =	1183.2	ft*lbs/ft
Effective Cantilever Span Length (L_c) at M_{all} =	6.9	ft
Total Length of Slab (l_c + Width of Single Rack) =	8.1	ft
Trib. Width of Slab = Trib width of Rack =	8.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	3252	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)} = P_{conc} * L_c/2$ =	158616	in*lbs

Load Combination #1:	M_{OT} =	3055	in*lbs
	$M_{RST(Rack)} + M_{RST(slab)}$ =	166866	in*lbs
	Total Overturning FOS =	54.629	OK
Load Combination #2:	M_{OT} =	1549	in*lbs
	$M_{RST(Rack)} + M_{RST(slab)}$ =	161616	in*lbs
	Total Overturning FOS =	104.340	OK

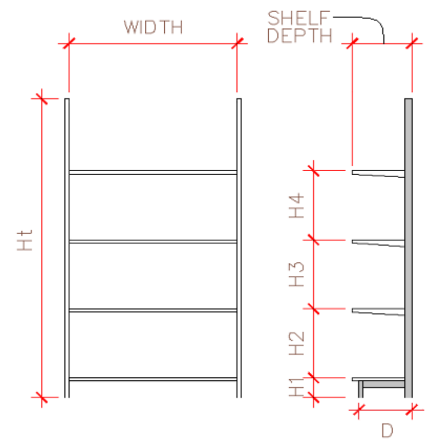


JOHNSTON BURKHOLDER ASSOCIATES consulting structural engineers 930 CENTRAL · KANSAS CITY, MO 64105 816.421.4200 · WWW.JBAENGR.COM	PROJECT NO: 2431906958	SHEET NO: 23	OF: 44
	PROJECT NAME: #6958 - Cameron, NC		
	MADE BY: RBC	DATE: 01/03/25	
	CHECKED BY:	DATE:	

Shelving / Single Sided 120" Tall "YZ" 4 Level 30YZ

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor =	1.5		
Supported on Elevated Floor (Y/N):	No		
Total Load per shelf =	75 lbs		
# of Levels =	Wall 4 Level - HD TV		
Uniform Weight per level =	7.50 psf/shelf		
Weight of Unit =	100 lbs		
Anchorage spacing/Trib width =	8 ft	(*Frames are assumed to be 4'-0" oc*)	
Shelf depth =	30 in		Shelf Load / Level
h_9 =	0 in		
h_8 =	0 in		
h_7 =	0 in		
h_6 =	0 in		
h_5 =	0 in		
h_4 =	30 in		150 lbs
h_3 =	30 in		150 lbs
h_2 =	30 in		150 lbs
h_1 =	6 in		150 lbs
Total Shelf Height, H_t =	96 in		
Unit Height, H_u =	120 in		
Unit Base Depth, D =	21 in		



Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1* [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ =	0.083	W_s (Cross-Aisle)	
$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ =	369.3 lbs		
Base Shear, $V = C_sI_pW_s$ =	30.5 lbs		
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)			
(Service Loads, E = 0.7)	F_9 =	0.0 lbs	@ 0 in (CM)
Note:	F_8 =	0.0 lbs	@ 0 in (CM)
(CM) = Product Center of	F_7 =	0.0 lbs	@ 0 in (CM)
Mass typically 6 inches	F_6 =	0.0 lbs	@ 0 in (CM)
above the top of shelf at	F_5 =	0.0 lbs	@ 0 in (CM)
each level.	F_4 =	7.6 lbs	@ 102 in (CM)
	F_3 =	5.3 lbs	@ 72 in (CM)
	F_2 =	3.1 lbs	@ 42 in (CM)
	F_1 =	0.9 lbs	@ 12 in (CM)
	F_u =	4.4 lbs	@ 60 in (CM)
	Σf_i =	30.5 lbs	(@ Factored Loads)
Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_ih_i$			
	M_{OT} =	1563 in-lbs	
Calculate Resisting Moment (Service), M_{RST}			
	M_{RST} =	5250 in-lbs	
Factor of Safety			
	FOS =	3.360	

NO UPLIFT - NO ANCHORS REQUIRED

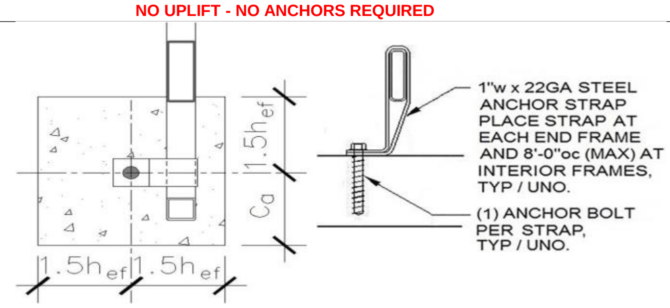
Load Case 2* [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ =	0.083	W_s (Cross-Aisle)	
$W_s = (0.67)(PL_{RF})((1)PL)+DL$ =	200.5 lbs		
Base Shear, $V = C_sI_pW_s$ =	16.5 lbs		
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)			
(Service Loads)	F_9 =	0.0 lbs	
	F_8 =	0.0 lbs	
	F_7 =	0.0 lbs	
	F_6 =	0.0 lbs	
	F_5 =	0.0 lbs	
	F_4 =	8.3 lbs	@ 102in (CM)
	F_3 =	0.0 lbs	
	F_2 =	0.0 lbs	
	F_1 =	0.0 lbs	
	F_u =	3.3 lbs	@ 60in (CM)
	Σf_i =	16.5 lbs	(@ Factored Loads)
Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_ih_i$			
	M_{OT} =	1044 in-lbs	
Calculate Resisting Moment (Service), M_{RST}			
	M_{RST} =	2625 in-lbs	
Factor of Safety			
	FOS =	2.514	

NO UPLIFT - NO ANCHORS REQUIRED

Base Reactions:

Reactions (Service Loads):	LC #1		LC #2	
R_h =	11 lbs		6 lbs	
R_v =	0 lbs	(No Uplift)	0 lbs	(No Uplift)
Overturning FOS =	3.360	>= 1.5	2.514	>= 1.5
Sliding Restraint force, R_{RST} / FOS =	65lbs / 6.073 >= 1.5 OK		37lbs / 6.476 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	30 lbs		17 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	594 lbs		262 lbs	



Anchor Design (using "Cracked Concrete" Properties)

Try: 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.

Embedment =	2 in		
f'_c =	3500 psi		
e_n' =	0 in	<--- Eccen. Of Anchor	
h_{ef} =	1.33 in	$1.5(h_{ef})$ =	1.995 in
c_a =	5 in	$1.5(c_a)$ =	7.500 in
Conc. thickness, t =	4 in		
# of Anchors, n =	1	- anchors per connection	
S_X =	0 in		
A_{se} =	0.094 in^2		

Tension Allowables

Steel Strength, ϕN_{sa} =	5675 lbs	<--ACI 318-14 Eq 17.4.1.2			
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	752 lbs	<--ACI 318-14 Eq 17.4.2.1a			
Pullout Strength, $(0.75)\phi N_{pn}$ =	519 lbs	<--ACI 318-14 Eq 17.4.3.1			
	LC #1		LC #2		
Factored Tension Load (N_u) =	0 lbs		0 lbs		
max tension stress ratio (TSR) =	0.000	OK	0.000	OK	

Shear Allowables

Steel Strength, ϕV_{sa} =	1449 lbs	<--ACI 318-14 Eq 17.5.1.2b		
Concrete breakout, ϕV_{cbg} =	2334 lbs	<--ACI 318-14 Eq 17.5.2.1a		
Concrete pryout, ϕV_{cpg} =	1080 lbs	<--ACI 318-14 Eq 17.5.3.1a		
	LC #1		LC #2	
Factored Shear Load (V_u) =	30 lbs		17 lbs	
Max shear stress ratio (VSR) =	0.028	OK	0.015	OK
Combined shear and tension stress ratio (TSR + VSR) =	0.028	< 1.2 OK - LC#1 (controls)		

USE: (1) 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed. ICC REPORT #ESR-3889

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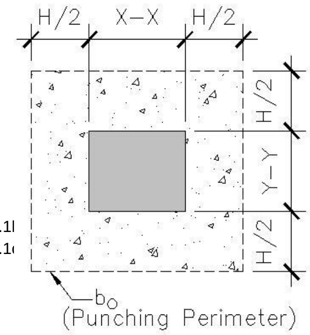
PROJECT NO:	SHEET NO:	OF:
2431906958	24	44
PROJECT NAME: #6958 - Cameron, NC		
MADE BY: RBC	DATE: 01/03/25	
CHECKED BY:	DATE:	

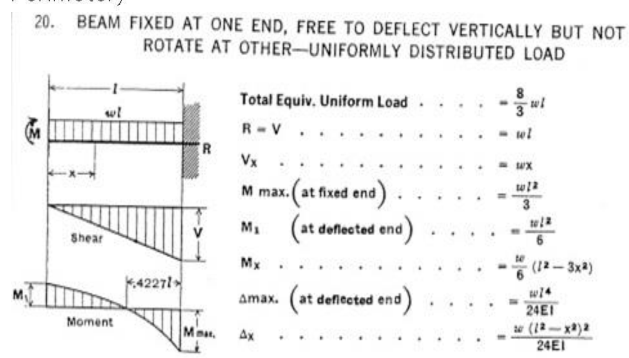
Shelving / Single Sided 120" Tall "YZ" 4 Level 30YZ

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	594	lbs	
Slab Concrete f'_c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	2	in.	
Rack Post Y-Y =	2	in.	
b_o =	24.00	in.	
β =	1.00		
V_n =	22718	lbs	Table 14.5.5.1l
V_n max =	15145	lbs	Table 14.5.5.1(
ϕV_n =	9087.10	lbs	
$V_u/\phi V_n$ =	0.065	< 1.0 O.K.	





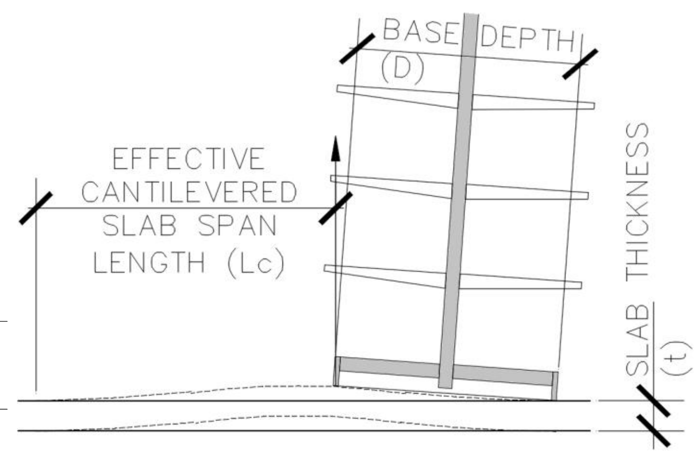
Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf
Max. Vertical Load (Service) (P) =	429	lbs
Area reqd. for bearing (A_{reqd}) =	0.29	ft^2
"b" distance =	6.42	in
Slab thickness (t) =	4.00	in
$S = (1")(t)^2/6$ =	2.67	in^3/in
ϕM_{nt} (tension allowable) = $\phi_t(7.5)[(f'_c)^{1/2}](S)$ =	710	in-lb/in
Factored uniform bearing, $w_u = P_u / A_{reqd}$ =	14	lb/in/in
$M_u = w_u L^2/3 = (w_u)[(b-(2"))/2)^2] / 3$ =	23.45	in-lb/in - Defl. End M1 = 12 in-lb/in
$M_u/\phi M_{nt}$ =	0.033	< 1.0 O.K.

Shelving Fixture FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	21	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, $f_r = 7.5*SQRT(f'c)$ =	443.7	psi
Concrete Slab Section Modulus, $S = b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, $M_{all}/FS = S*f_r/1.5$ =	1183.2	ft*lbs/ft
Effective Cantilever Span Length (L_c) at M_{all} =	6.9	ft
Total Length of Slab (l_c + Width of Single Rack) =	8.6	ft
Trib. Width of Slab = Trib width of Rack =	8.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	3452	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)} = P_{conc} * L_c/2$ =	178727	in*lbs

Load Combination #1:	M_{OT} =	1563	in*lbs
	$M_{RST(Rack)} + M_{RST(slab)}$ =	183977	in*lbs
	Total Overturning FOS =	117.733	OK
Load Combination #2:	M_{OT} =	1044	in*lbs
	$M_{RST(Rack)} + M_{RST(slab)}$ =	181352	in*lbs
	Total Overturning FOS =	173.700	OK



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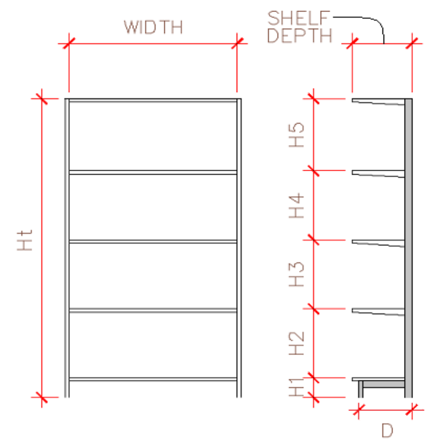
PROJECT NO:	SHEET NO:	OF:
2431906958	25	44
PROJECT NAME: #6958 - Cameron, NC		
MADE BY: RBC	DATE: 01/03/25	
CHECKED BY:	DATE:	

Shelving / Single Sided | 78" Tall "V" 5 Level | 36V

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor =	1.5	
Supported on Elevated Floor (Y/N):	No	
Total Load per shelf =	150 lbs	
# of Levels =	Wall 5 Level	
Uniform Weight per level =	12.50 psf/shelf	
Weight of Unit =	100 lbs	
Anchorage spacing/Trib width =	8 ft	*(Frames are assumed to be 4'-0" oc)*
Shelf depth =	36 in	Shelf Load / Level
h_9 =	0 in	
h_8 =	0 in	
h_7 =	0 in	
h_6 =	0 in	
h_5 =	18 in	300 lbs
h_4 =	18 in	300 lbs
h_3 =	18 in	300 lbs
h_2 =	18 in	300 lbs
h_1 =	6 in	300 lbs
Total Shelf Height, H_t =	78 in	
Unit Height, H_u =	78 in	
Unit Base Depth, D =	27 in	



Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1* [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]
Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ = 773.4 lbs
Base Shear, $V = C_sI_pW_s$ = 63.8 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)
(Service Loads, E = 0.7)

	F_9 =	0.0 lbs	@ 0 in (CM)
Note:	F_8 =	0.0 lbs	@ 0 in (CM)
(CM) = Product Center of	F_7 =	0.0 lbs	@ 0 in (CM)
Mass typically 6 inches	F_6 =	0.0 lbs	@ 0 in (CM)
above the top of shelf at	F_5 =	14.5 lbs	@ 84 in (CM)
each level.	F_4 =	11.4 lbs	@ 66 in (CM)
	F_3 =	8.3 lbs	@ 48 in (CM)
	F_2 =	5.2 lbs	@ 30 in (CM)
	F_1 =	2.1 lbs	@ 12 in (CM)
	F_u =	3.3 lbs	@ 39 in (CM)
	Σf_i =	63.8 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_ih_i$
M_{OT} = 2671 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 14850 in-lbs
Factor of Safety
FOS = 5.559
NO UPLIFT - NO ANCHORS REQUIRED

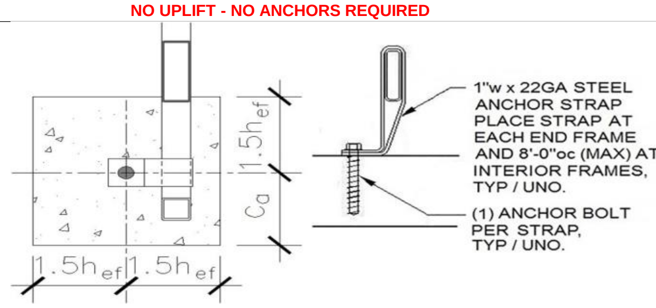
Load Case 2* [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]
Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((1)PL)+DL$ = 301.0 lbs
Base Shear, $V = C_sI_pW_s$ = 24.8 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)
(Service Loads)

F_9 =	0.0 lbs	
F_8 =	0.0 lbs	
F_7 =	0.0 lbs	
F_6 =	0.0 lbs	
F_5 =	15.1 lbs	@ 84in (CM)
F_4 =	0.0 lbs	
F_3 =	0.0 lbs	
F_2 =	0.0 lbs	
F_1 =	0.0 lbs	
F_u =	2.3 lbs	@ 39in (CM)
Σf_i =	24.8 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_ih_i$
M_{OT} = 1355 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 5400 in-lbs
Factor of Safety
FOS = 3.984
NO UPLIFT - NO ANCHORS REQUIRED

Base Reactions:

Reactions (Service Loads):	LC #1		LC #2	
R_h =	22 lbs		9 lbs	
R_v =	0 lbs	(No Uplift)	0 lbs	(No Uplift)
Overturning FOS =	5.559	>= 1.5	3.984	>= 1.5
Sliding Restraint force, R_{RST} / FOS =	121lbs / 5.437 >= 1.5 OK		50lbs / 5.773 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	64 lbs		25 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	1206 lbs		356 lbs	



Anchor Design (using "Cracked Concrete" Properties)
Try: 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.

Embedment =	2 in	
f'_c =	3500 psi	
e_n' =	0 in	<--- Eccen. Of Anchor
h_{ef} =	1.33 in	$1.5(h_{ef})$ = 1.995 in
c_a =	5 in	$1.5(c_a)$ = 7.500 in
Conc. thickness, t =	4 in	
# of Anchors, n =	1	- anchors per connection
S_X =	0 in	
A_{se} =	0.094 in^2	

Tension Allowables

Steel Strength, ϕN_{sa} =	5675 lbs	<--ACI 318-14 Eq 17.4.1.2
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	752 lbs	<--ACI 318-14 Eq 17.4.2.1a
Pullout Strength, $(0.75)\phi N_{pn}$ =	519 lbs	<--ACI 318-14 Eq 17.4.3.1

	LC #1		LC #2	
Factored Tension Load (N_u) =	0 lbs		0 lbs	
max tension stress ratio (TSR) =	0.000	OK	0.000	OK

Shear Allowables

Steel Strength, ϕV_{sa} =	1449 lbs	<--ACI 318-14 Eq 17.5.1.2b
Concrete breakout, ϕV_{cbg} =	2334 lbs	<--ACI 318-14 Eq 17.5.2.1a
Concrete pryout, ϕV_{cpg} =	1080 lbs	<--ACI 318-14 Eq 17.5.3.1a

	LC #1		LC #2	
Factored Shear Load (V_u) =	64 lbs		25 lbs	
Max shear stress ratio (VSR) =	0.059	OK	0.023	OK
Combined shear and tension stress ratio (TSR + VSR) =	0.059	< 1.2 OK - LC#1 (controls)		

USE: NO UPLIFT - USE (1) 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed. ICC REPORT #ESR-3889

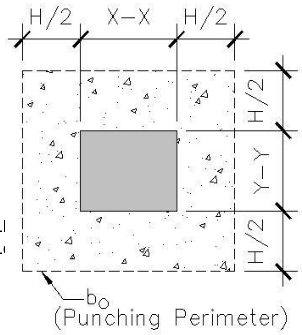
JOHNSTON BURKHOLDER ASSOCIATES consulting structural engineers 930 CENTRAL · KANSAS CITY, MO 64105 816.421.4200 · WWW.JBAENGR.COM	PROJECT NO: 2431906958	SHEET NO: 26	OF: 44
	PROJECT NAME: #6958 - Cameron, NC		
	MADE BY: RBC	DATE: 01/03/25	
	CHECKED BY:	DATE:	

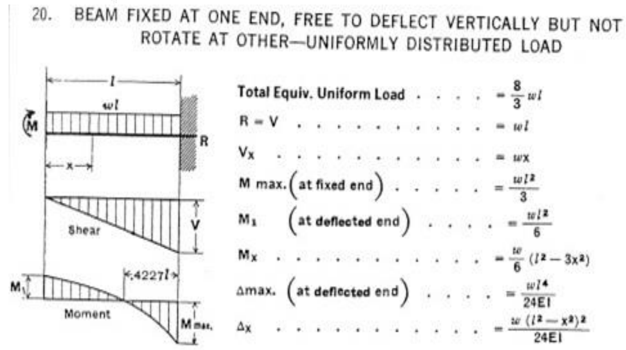
Shelving / Single Sided 78" Tall "V" 5 Level 36V

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	1206	lbs	
Slab Concrete f'_c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	2	in.	
Rack Post Y-Y =	2	in.	
b_o =	24.00	in.	
β =	1.00		
V_n =	22718	lbs	Table 14.5.5.1l
V_n max =	15145	lbs	Table 14.5.5.1(
ϕV_n =	9087.10	lbs	
$V_u/\phi V_n$ =	0.133	< 1.0 O.K.	



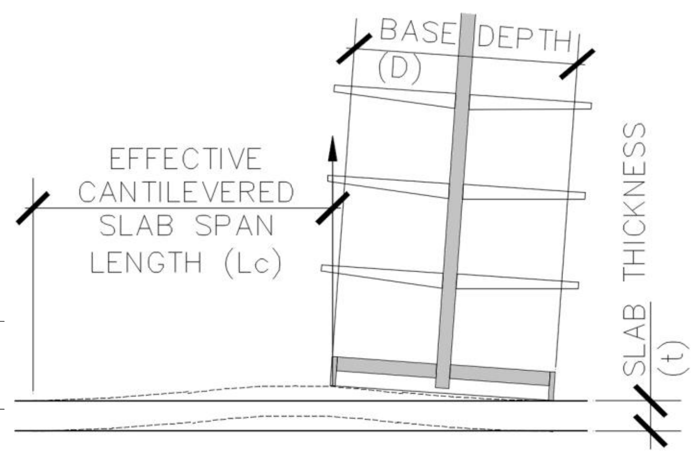


Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf
Max. Vertical Load (Service) (P) =	930	lbs
Area reqd. for bearing (A_{reqd}) =	0.62	ft^2
"b" distance =	9.45	in
Slab thickness (t) =	4.00	in
$S = (1")(t)^2/6$ =	2.67	in^3/in
ϕM_{nt} (tension allowable) = $\phi_t(7.5)[(f'_c)^{1/2}](S)$ =	710	in-lb/in
Factored uniform bearing, $w_u = P_u / A_{reqd}$ =	14	lb/in/in
$M_u = w_u L^2/3 = (w_u)[(b-(2"))/2)^2] / 3$ =	62.46	in-lb/in - Defl. End M1 = 32 in-lb/in
$M_u/\phi M_{nt}$ =	0.088	< 1.0 O.K.

Shelving Fixture FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	27	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, f_r = 7.5*SQRT(f'c) =	443.7	psi
Concrete Slab Section Modulus, $S = b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, $M_{all}/FS = S*f_r/1.5$ =	1183.2	ft*lbs/ft
Effective Cantilever Span Length (L_c) at M_{all} =	6.9	ft
Total Length of Slab (l_c + Width of Single Rack) =	9.1	ft
Trib. Width of Slab = Trib width of Rack =	8.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	3652	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)} = P_{conc} * L_c/2$ =	200038	in*lbs
Load Combination #1: M_{OT} =	2671	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	214888	in*lbs
Total Overturning FOS =	80.438	OK
Load Combination #2: M_{OT} =	1355	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	205438	in*lbs
Total Overturning FOS =	151.579	OK

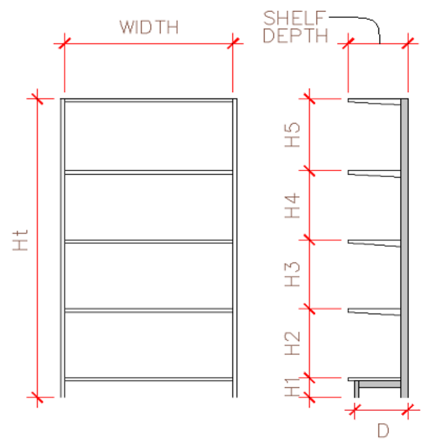


JOHNSTON BURKHOLDER ASSOCIATES consulting structural engineers 930 CENTRAL · KANSAS CITY, MO 64105 816.421.4200 · WWW.JBAENGR.COM	PROJECT NO: 2431906958	SHEET NO: 27	OF: 44
	PROJECT NAME: #6958 - Cameron, NC		
	MADE BY: RBC	DATE: 01/03/25	
	CHECKED BY:	DATE:	

Shelving / Single Sided | 90" Tall "EC" 5 Level | 2490 EC

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor =	1.5		
Supported on Elevated Floor (Y/N):	No		
Total Load per shelf =	100 lbs		
# of Levels =	Wall 5 Level		
Uniform Weight per level =	12.50 psf/shelf		
Weight of Unit =	100 lbs		
Anchorage spacing/Trib width =	2 ft	*(Frames are assumed to be 4'-0" oc)*	
Shelf depth =	24 in		Shelf Load / Level
h_9 =	0 in		
h_8 =	0 in		
h_7 =	0 in		
h_6 =	0 in		
h_5 =	21 in		50 lbs
h_4 =	21 in		50 lbs
h_3 =	21 in		50 lbs
h_2 =	21 in		50 lbs
h_1 =	6 in		50 lbs
Total Shelf Height, H_t =	90 in		
Unit Height, H_u =	90 in		
Unit Base Depth, D =	15 in		



Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1* [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ = 212.2 lbs
Base Shear, $V = C_sI_pW_s$ = 17.5 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

(Service Loads, E = 0.7)

	F_9 =	0.0 lbs	@ 0 in (CM)
Note:	F_8 =	0.0 lbs	@ 0 in (CM)
(CM) = Product Center of	F_7 =	0.0 lbs	@ 0 in (CM)
Mass typically 6 inches	F_6 =	0.0 lbs	@ 0 in (CM)
above the top of shelf at	F_5 =	2.9 lbs	@ 96 in (CM)
each level.	F_4 =	2.3 lbs	@ 75 in (CM)
	F_3 =	1.6 lbs	@ 54 in (CM)
	F_2 =	1.0 lbs	@ 33 in (CM)
	F_1 =	0.4 lbs	@ 12 in (CM)
	F_u =	4.1 lbs	@ 45 in (CM)
	Σf_i =	17.5 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_ih_i$
M_{OT} = 759 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 2000 in-lbs
Factor of Safety
FOS = 2.636
NO UPLIFT - NO ANCHORS REQUIRED

Load Case 2* [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((1)PL)+DL$ = 133.5 lbs
Base Shear, $V = C_sI_pW_s$ = 11.0 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

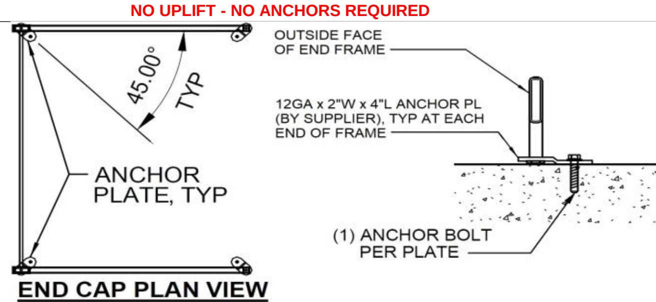
(Service Loads)

F_9 =	0.0 lbs	
F_8 =	0.0 lbs	
F_7 =	0.0 lbs	
F_6 =	0.0 lbs	
F_5 =	4.0 lbs	@ 96in (CM)
F_4 =	0.0 lbs	
F_3 =	0.0 lbs	
F_2 =	0.0 lbs	
F_1 =	0.0 lbs	
F_u =	3.7 lbs	@ 45in (CM)
Σf_i =	11.0 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_ih_i$
M_{OT} = 550 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 1125 in-lbs
Factor of Safety
FOS = 2.046
NO UPLIFT - NO ANCHORS REQUIRED

Base Reactions:

Reactions (Service Loads):	LC #1		LC #2	
R_h =	6 lbs		4 lbs	
R_v =	0 lbs	(No Uplift)	0 lbs	(No Uplift)
Overturning FOS =	2.636	>= 1.5	2.046	>= 1.5
Sliding Restraint force, R_{RST} / FOS =	39lbs / 6.393 >= 1.5 OK		26lbs / 6.706 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	18 lbs		11 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	326 lbs		171 lbs	



END CAP PLAN VIEW

Anchor Design (using "Cracked Concrete" Properties)

Try: 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.

Embedment =	2 in		
f'_c =	3500 psi		
e_n' =	0 in	<--- Eccen. Of Anchor	
h_{ef} =	1.33 in	$1.5(h_{ef})$ =	1.995 in
c_a =	5 in	$1.5(c_a)$ =	7.500 in
Conc. thickness, t =	4 in		
# of Anchors, n =	1	- anchors per connection	
S_X =	0 in		
A_{se} =	0.094 in^2		

Tension Allowables

Steel Strength, ϕN_{sa} =	5675 lbs	<--ACI 318-14 Eq 17.4.1.2
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	752 lbs	<--ACI 318-14 Eq 17.4.2.1a
Pullout Strength, $(0.75)\phi N_{pn}$ =	519 lbs	<--ACI 318-14 Eq 17.4.3.1

	LC #1		LC #2	
Factored Tension Load (N_u) =	0 lbs		0 lbs	
max tension stress ratio (TSR) =	0.000	OK	0.000	OK

Shear Allowables

Steel Strength, ϕV_{sa} =	1449 lbs	<--ACI 318-14 Eq 17.5.1.2b
Concrete breakout, ϕV_{cbg} =	2334 lbs	<--ACI 318-14 Eq 17.5.2.1a
Concrete pryout, ϕV_{cpg} =	1080 lbs	<--ACI 318-14 Eq 17.5.3.1a

	LC #1		LC #2	
Factored Shear Load (V_u) =	18 lbs		11 lbs	
Max shear stress ratio (VSR) =	0.016	OK	0.010	OK
Combined shear and tension stress ratio (TSR + VSR) =	0.016	< 1.2 OK - LC#1 (controls)		

USE: NO UPLIFT - USE (1) 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed. ICC REPORT #ESR-3889

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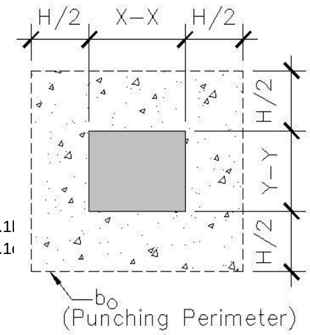
Shelving / Single Sided 90" Tall "EC" 5 Level 2490 EC

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

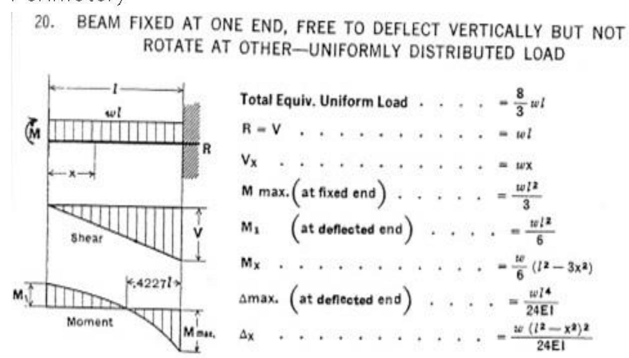
Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	326	lbs	
Slab Concrete f'_c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	2	in.	
Rack Post Y-Y =	2	in.	
b_o =	24.00	in.	
β =	1.00		
V_n =	22718	lbs	Table 14.5.5.1l
V_n max =	15145	lbs	Table 14.5.5.1(
ϕV_n =	9087.10	lbs	
$V_u/\phi V_n$ =	0.036	< 1.0 O.K.	



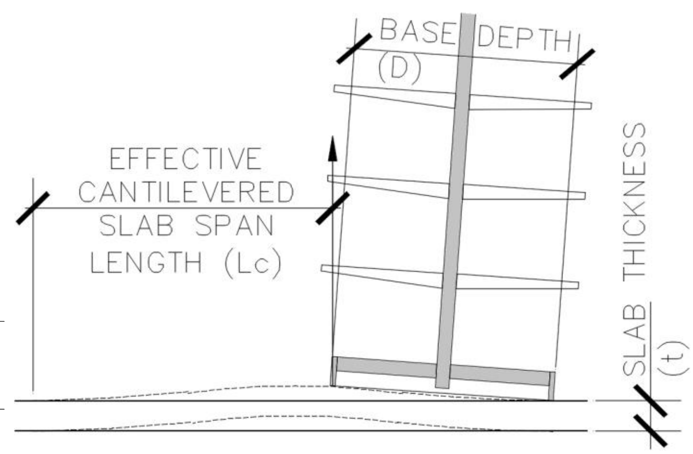
Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf
Max. Vertical Load (Service) (P) =	223	lbs
Area reqd. for bearing (A_{reqd}) =	0.15	ft^2
"b" distance =	4.63	in
Slab thickness (t) =	4.00	in
$S = (1")(t)^2/6$ =	2.67	in^3/in
ϕM_{nt} (tension allowable) = $\phi_t(7.5)[(f'_c)^{1/2}](S)$ =	710	in-lb/in
Factored uniform bearing, $w_u = P_u / A_{reqd}$ =	15	lb/in/in
$M_u = w_u L^2/3 = (w_u)[(b-(2"))/2)^2] / 3$ =	8.76	in-lb/in - Defl. End M1 = 5 in-lb/in
$M_u/\phi M_{nt}$ =	0.012	< 1.0 O.K.



Shelving Fixture FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	15	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, $f_r = 7.5*SQRT(f'c)$ =	443.7	psi
Concrete Slab Section Modulus, $S = b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, $M_{all}/FS = S*f_r/1.5$ =	1183.2	ft*lbs/ft
Effective Cantilever Span Length (L_c) at M_{all} =	6.9	ft
Total Length of Slab (l_c + Width of Single Rack) =	8.1	ft
Trib. Width of Slab = Trib width of Rack =	2.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	813	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)} = P_{conc} * L_c/2$ =	39654	in*lbs
Load Combination #1: M_{OT} =	759	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	41654	in*lbs
Total Overturning FOS =	54.891	OK
Load Combination #2: M_{OT} =	550	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	40779	in*lbs
Total Overturning FOS =	74.161	OK



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PROJECT NO:	SHEET NO:	OF:
2431906958	29	44

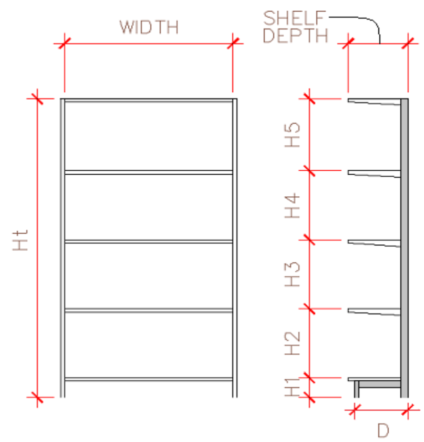
PROJECT NAME: #6958 - Cameron, NC

MADE BY:	DATE:
RBC	01/03/25
CHECKED BY:	DATE:

Shelving / Single Sided — 78" Tall "EC" 5 Level — 3678 EC

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor =	1.5	
Supported on Elevated Floor (Y/N):	No	
Total Load per shelf =	100 lbs	
# of Levels =	Wall 5 Level	
Uniform Weight per level =	8.33 psf/shelf	
Weight of Unit =	100 lbs	
Anchorage spacing/Trib width =	2 ft	(*Frames are assumed to be 4'-0" oc*)
Shelf depth =	36 in	Shelf Load / Level
h_9 =	0 in	
h_8 =	0 in	
h_7 =	0 in	
h_6 =	0 in	
h_5 =	18 in	50 lbs
h_4 =	18 in	50 lbs
h_3 =	18 in	50 lbs
h_2 =	18 in	50 lbs
h_1 =	6 in	50 lbs
Total Shelf Height, H_t =	78 in	
Unit Height, H_u =	78 in	
Unit Base Depth, D =	27 in	



Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1* [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ = 212.2 lbs
Base Shear, $V = C_sI_pW_s$ = 17.5 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)
(Service Loads, E = 0.7)

Note:
(CM) = Product Center of Mass typically 6 inches above the top of shelf at each level.

F_9 =	0.0 lbs	@ 0 in (CM)
F_8 =	0.0 lbs	@ 0 in (CM)
F_7 =	0.0 lbs	@ 0 in (CM)
F_6 =	0.0 lbs	@ 0 in (CM)
F_5 =	2.9 lbs	@ 84 in (CM)
F_4 =	2.3 lbs	@ 66 in (CM)
F_3 =	1.7 lbs	@ 48 in (CM)
F_2 =	1.0 lbs	@ 30 in (CM)
F_1 =	0.4 lbs	@ 12 in (CM)
F_u =	4.0 lbs	@ 39 in (CM)
Σf_i =	17.5 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 664 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 3600 in-lbs
Factor of Safety
FOS = 5.424
NO UPLIFT - NO ANCHORS REQUIRED

Load Case 2* [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

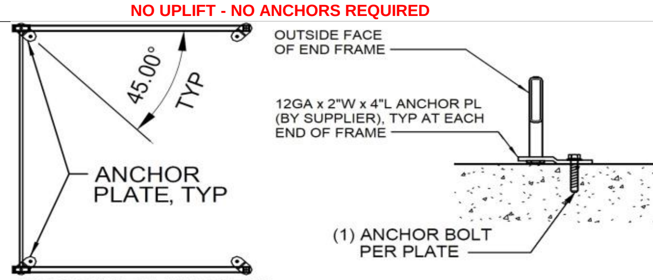
Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((1)PL)+DL$ = 133.5 lbs
Base Shear, $V = C_sI_pW_s$ = 11.0 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)
(Service Loads)

F_9 =	0.0 lbs	
F_8 =	0.0 lbs	
F_7 =	0.0 lbs	
F_6 =	0.0 lbs	
F_5 =	4.0 lbs	@ 84in (CM)
F_4 =	0.0 lbs	
F_3 =	0.0 lbs	
F_2 =	0.0 lbs	
F_1 =	0.0 lbs	
F_u =	3.7 lbs	@ 39in (CM)
Σf_i =	11.0 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 481 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 2025 in-lbs
Factor of Safety
FOS = 4.214
NO UPLIFT - NO ANCHORS REQUIRED

Base Reactions:

Reactions (Service Loads):	LC #1		LC #2	
R_h =	6 lbs		4 lbs	
R_v =	0 lbs	(No Uplift)	0 lbs	(No Uplift)
Overturning FOS =	5.424	>= 1.5	4.214	>= 1.5
Sliding Restraint force, R_{RST} / FOS =	33lbs / 5.332 >= 1.5 OK		21lbs / 5.483 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	18 lbs		11 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	270 lbs		131 lbs	



END CAP PLAN VIEW

Anchor Design (using "Cracked Concrete" Properties)
Try: 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.

Embedment =	2 in	
f'_c =	3500 psi	
e_n' =	0 in	<--- Eccen. Of Anchor
h_{ef} =	1.33 in	$1.5(h_{ef})$ = 1.995 in
c_a =	5 in	$1.5(c_a)$ = 7.500 in
Conc. thickness, t =	4 in	
# of Anchors, n =	1	- anchors per connection
S_X =	0 in	
A_{se} =	0.094 in^2	

Tension Allowables

Steel Strength, ϕN_{sa} =	5675 lbs	<--ACI 318-14 Eq 17.4.1.2
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	752 lbs	<--ACI 318-14 Eq 17.4.2.1a
Pullout Strength, $(0.75)\phi N_{pn}$ =	519 lbs	<--ACI 318-14 Eq 17.4.3.1

	LC #1		LC #2	
Factored Tension Load (N_u) =	0 lbs		0 lbs	
max tension stress ratio (TSR) =	0.000	OK	0.000	OK

Shear Allowables

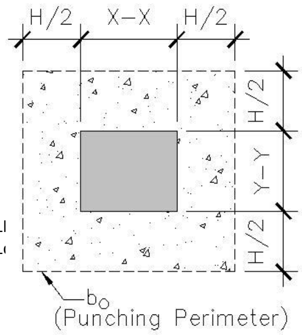
Steel Strength, ϕV_{sa} =	1449 lbs	<--ACI 318-14 Eq 17.5.1.2b
Concrete breakout, ϕV_{cbg} =	2334 lbs	<--ACI 318-14 Eq 17.5.2.1a
Concrete pryout, ϕV_{cpg} =	1080 lbs	<--ACI 318-14 Eq 17.5.3.1a

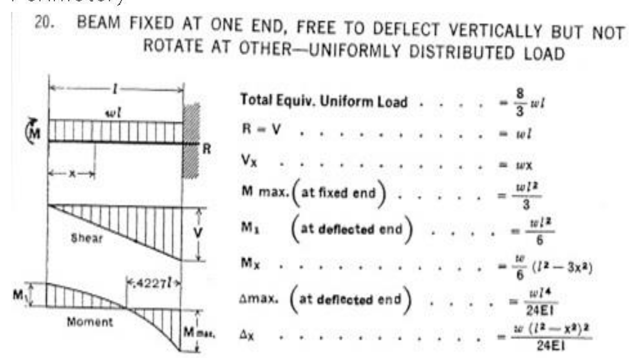
	LC #1		LC #2	
Factored Shear Load (V_u) =	18 lbs		11 lbs	
Max shear stress ratio (VSR) =	0.016	OK	0.010	OK
Combined shear and tension stress ratio (TSR + VSR) =	0.016	< 1.2 OK - LC#1 (controls)		

USE: NO UPLIFT - USE (1) 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed. ICC REPORT #ESR-3889

Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	270	lbs	
Slab Concrete f'_c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	2	in.	
Rack Post Y-Y =	2	in.	
b_o =	24.00	in.	
β =	1.00		
V_n =	22718	lbs	Table 14.5.5.1l
V_n max =	15145	lbs	Table 14.5.5.1(
ϕV_n =	9087.10	lbs	
$V_u/\phi V_n$ =	0.030	< 1.0 O.K.	



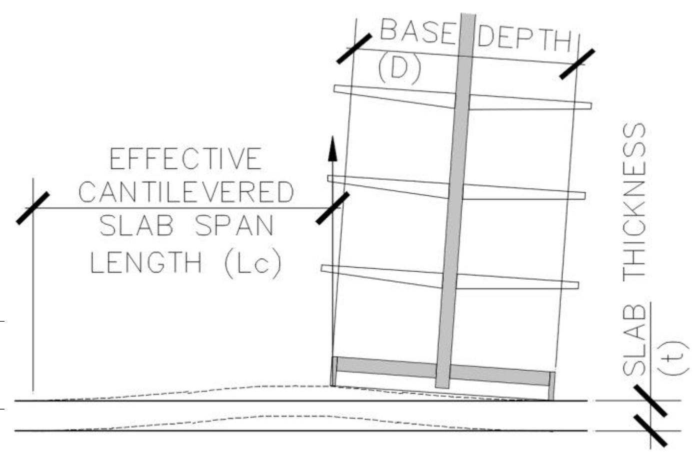


Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf
Max. Vertical Load (Service) (P) =	204	lbs
Area reqd. for bearing (A_{reqd}) =	0.14	ft^2
"b" distance =	4.43	in
Slab thickness (t) =	4.00	in
$S = (1")(t)^2/6$ =	2.67	in^3/in
ϕM_{nt} (tension allowable) = $\phi_t(7.5)[(f'_c)^{1/2}](S)$ =	710	in-lb/in
Factored uniform bearing, $w_u = P_u / A_{reqd}$ =	14	lb/in/in
$M_u = w_u L^2/3 = (w_u)[(b-(2"))/2)^2] / 3$ =	6.76	in-lb/in - Defl. End M1 = 4 in-lb/in
$M_u/\phi M_{nt}$ =	0.010	< 1.0 O.K.

Shelving Fixture FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	27	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, f_r = 7.5*SQRT(f'c) =	443.7	psi
Concrete Slab Section Modulus, $S = b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, $M_{all}/FS = S*f_r/1.5$ =	1183.2	ft*lbs/ft
Effective Cantilever Span Length (L_c) at M_{all} =	6.9	ft
Total Length of Slab (l_c + Width of Single Rack) =	9.1	ft
Trib. Width of Slab = Trib width of Rack =	2.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	913	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)} = P_{conc} * L_c/2$ =	50010	in*lbs
Load Combination #1: M_{OT} =	664	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	53610	in*lbs
Total Overturning FOS =	80.777	OK
Load Combination #2: M_{OT} =	481	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	52035	in*lbs
Total Overturning FOS =	108.277	OK



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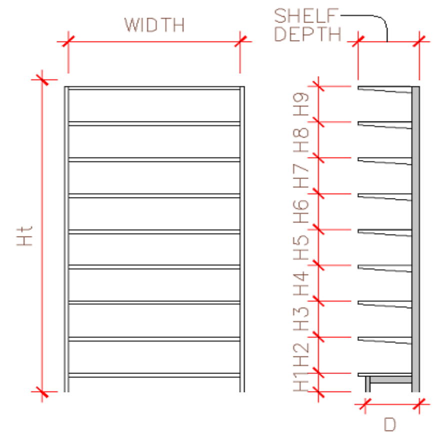
PROJECT NO:	SHEET NO:	OF:
2431906958	31	44
PROJECT NAME: #6958 - Cameron, NC		
MADE BY: RBC	DATE: 01/03/25	
CHECKED BY:	DATE:	

Shelving / Single Sided 84" Tall "3RX" 9 Level 9-3RX

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor =	1.0		
Supported on Elevated Floor (Y/N):	No		
Total Load per shelf =	15 lbs		
# of Levels =	Wall 9 Level		
Uniform Weight per level =	5.00 psf/shelf		
Weight of Unit =	100 lbs		
Anchorage spacing/Trib width =	4 ft	*(Frames are assumed to be 4'-0" oc)*	
Shelf depth =	9 in	Shelf Load / Level	
h_9 =	9.5 in	15 lbs	
h_8 =	10 in	15 lbs	
h_7 =	9.5 in	15 lbs	
h_6 =	10 in	15 lbs	
h_5 =	9.5 in	15 lbs	
h_4 =	10 in	15 lbs	
h_3 =	9.5 in	15 lbs	
h_2 =	10 in	15 lbs	
h_1 =	6 in	15 lbs	
Total Shelf Height, H_t =	84 in		
Unit Height, H_u =	84 in		
Unit Base Depth, D =	6.5 in		



Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1* [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ =	0.055 W_s (Cross-Aisle)	
$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ =	160.6 lbs	
Base Shear, $V = C_sI_pW_s$ =	8.8 lbs	
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)		
(Service Loads, E = 0.7) F_9 =	0.6 lbs	@ 90 in (CM)
F_8 =	0.6 lbs	@ 80.5 in (CM)
F_7 =	0.5 lbs	@ 70.5 in (CM)
F_6 =	0.4 lbs	@ 61 in (CM)
F_5 =	0.4 lbs	@ 51 in (CM)
F_4 =	0.3 lbs	@ 41.5 in (CM)
F_3 =	0.2 lbs	@ 31.5 in (CM)
F_2 =	0.2 lbs	@ 22 in (CM)
F_1 =	0.1 lbs	@ 12 in (CM)
F_u =	2.9 lbs	@ 42 in (CM)
Σf_i =	8.8 lbs	(@ Factored Loads)

Note:
(CM) = Product Center of Mass typically 6 inches above the top of shelf at each level.

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 329 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 618 in-lbs
Factor of Safety
FOS = 1.875
NO UPLIFT - NO ANCHORS REQUIRED

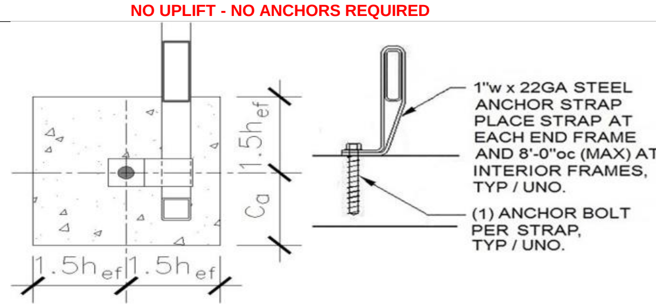
Load Case 2* [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ =	0.055 W_s (Cross-Aisle)	
$W_s = (0.67)(PL_{RF})((1)PL)+DL$ =	110.1 lbs	
Base Shear, $V = C_sI_pW_s$ =	6.1 lbs	
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)		
(Service Loads) F_9 =	1.0 lbs	@ 90in (CM)
F_8 =	0.0 lbs	
F_7 =	0.0 lbs	
F_6 =	0.0 lbs	
F_5 =	0.0 lbs	
F_4 =	0.0 lbs	
F_3 =	0.0 lbs	
F_2 =	0.0 lbs	
F_1 =	0.0 lbs	
F_u =	3.2 lbs	@ 42in (CM)
Σf_i =	6.1 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 227 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 374 in-lbs
Factor of Safety
FOS = 1.643
NO UPLIFT - NO ANCHORS REQUIRED

Base Reactions:

Reactions (Service Loads):	LC #1		LC #2	
R_h =	3 lbs		2 lbs	
R_v =	0 lbs	(No Uplift)	0 lbs	(No Uplift)
Overturning FOS =	1.875	>= 1.5	1.643	>= 1.5
Sliding Restraint force, R_{RST} / FOS =	33lbs / 10.591 >= 1.5 OK		23lbs / 10.622 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	9 lbs		6 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	254 lbs		146 lbs	



Anchor Design (using "Cracked Concrete" Properties)

Try: 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.

Embedment =	2 in		
f'_c =	3500 psi		
e_n' =	0 in	<--- Eccen. Of Anchor	
h_{ef} =	1.33 in	$1.5(h_{ef})$ =	1.995 in
c_a =	5 in	$1.5(c_a)$ =	7.500 in
Conc. thickness, t =	4 in		
# of Anchors, n =	1	- anchors per connection	
S_X =	0 in		
A_{se} =	0.094 in^2		

Tension Allowables

Steel Strength, ϕN_{sa} =	5675 lbs	<--ACI 318-14 Eq 17.4.1.2		
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	752 lbs	<--ACI 318-14 Eq 17.4.2.1a		
Pullout Strength, $(0.75)\phi N_{pn}$ =	519 lbs	<--ACI 318-14 Eq 17.4.3.1		
	LC #1		LC #2	
Factored Tension Load (N_u) =	0 lbs		0 lbs	
max tension stress ratio (TSR) =	0.000	OK	0.000	OK

Shear Allowables

Steel Strength, ϕV_{sa} =	1449 lbs	<--ACI 318-14 Eq 17.5.1.2b		
Concrete breakout, ϕV_{cbg} =	2334 lbs	<--ACI 318-14 Eq 17.5.2.1a		
Concrete pryout, ϕV_{cpg} =	1080 lbs	<--ACI 318-14 Eq 17.5.3.1a		
	LC #1		LC #2	
Factored Shear Load (V_u) =	9 lbs		6 lbs	
Max shear stress ratio (VSR) =	0.008	OK	0.006	OK
Combined shear and tension stress ratio (TSR + VSR) =	0.008	< 1.2 OK - LC#1 (controls)		

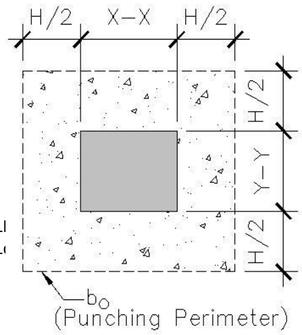
USE: NO UPLIFT - USE (1) 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed. ICC REPORT #ESR-3889

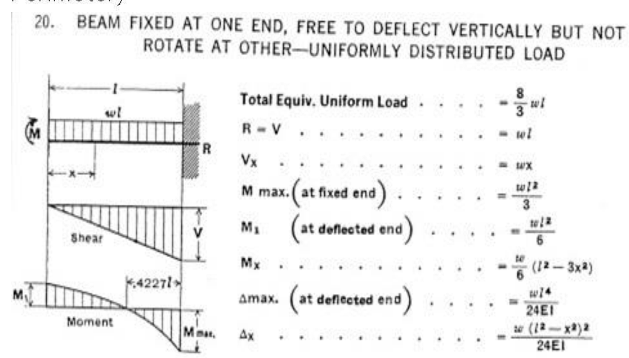
Shelving / Single Sided 84" Tall "3RX" 9 Level 9-3RX

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	254	lbs	
Slab Concrete f'_c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	2	in.	
Rack Post Y-Y =	2	in.	
b_o =	24.00	in.	
β =	1.00		
V_n =	22718	lbs	Table 14.5.5.1l
V_n max =	15145	lbs	Table 14.5.5.1(
ϕV_n =	9087.10	lbs	
$V_u/\phi V_n$ =	0.028	< 1.0 O.K.	



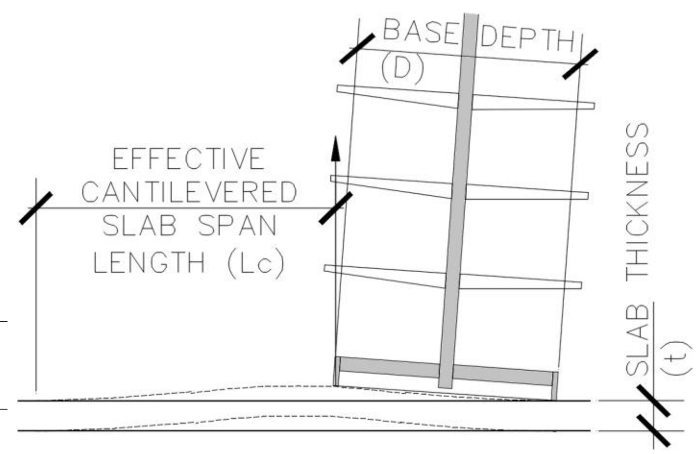


Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf
Max. Vertical Load (Service) (P) =	162	lbs
Area reqd. for bearing (A_{reqd}) =	0.11	ft^2
"b" distance =	3.94	in
Slab thickness (t) =	4.00	in
$S = (1")(t)^2/6$ =	2.67	in^3/in
ϕM_{nt} (tension allowable) = $\phi_t(7.5)[(f'_c)^{1/2}](S)$ =	710	in-lb/in
Factored uniform bearing, $w_u = P_u / A_{reqd}$ =	16	lb/in/in
$M_u = w_u L^2/3 = (w_u)[(b-(2"))/2)^2] / 3$ =	5.14	in-lb/in - Defl. End M1 = 3 in-lb/in
$M_u/\phi M_{nt}$ =	0.007	< 1.0 O.K.

Shelving Fixture FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	6.5	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, f_r = 7.5*SQRT(f'c) =	443.7	psi
Concrete Slab Section Modulus, $S = b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, $M_{all}/FS = S*f_r/1.5$ =	1183.2	ft*lbs/ft
Effective Cantilever Span Length (L_c) at M_{all} =	6.9	ft
Total Length of Slab (l_c + Width of Single Rack) =	7.4	ft
Trib. Width of Slab = Trib width of Rack =	4.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	1484	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)} = P_{conc} * L_c/2$ =	66090	in*lbs
Load Combination #1: M_{OT} =	329	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	66707	in*lbs
Total Overturning FOS =	202.522	OK
Load Combination #2: M_{OT} =	227	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	66464	in*lbs
Total Overturning FOS =	292.251	OK



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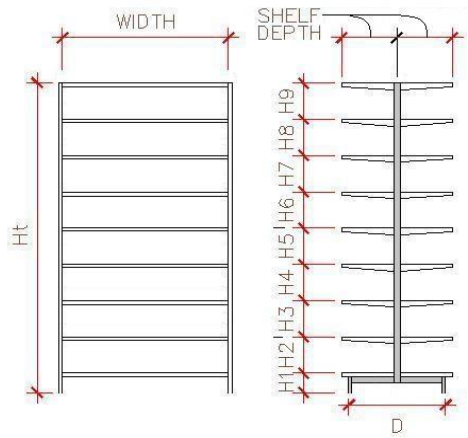
PROJECT NO:	SHEET NO:	OF:
2431906958	33	44
PROJECT NAME: #6958 - Cameron, NC		
MADE BY: RBC	DATE: 01/03/25	
CHECKED BY:	DATE:	

Shelving / Double Sided | 84" Tall "3RX" 9 Level | 18-3RX

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor =	1.0	
Supported on Elevated Floor (Y/N):	No	
Total Load per shelf =	15 lbs	<---assumes (2) shelves per level
# of Levels =	9 Level	
Uniform Weight per level =	5.00 psf/shelf	
Weight of Unit =	100 lbs	
Upright Frame anchorage spacing (Trib width) =	4 ft	(*Frames are assumed to be 4'-0" oc*)
Shelf depth (ea. side) =	9 in	Shelf Load / Level / Frame
h_9 =	9.5 in	30 lbs
h_8 =	10 in	30 lbs
h_7 =	9.5 in	30 lbs
h_6 =	10 in	30 lbs
h_5 =	9.5 in	30 lbs
h_4 =	10 in	30 lbs
h_3 =	9.5 in	30 lbs
h_2 =	10 in	30 lbs
h_1 =	6 in	30 lbs
Total Shelf Height, H_t =	84 in	Unit Height, H_u = 84 in
Unit Base Depth, D =	8.5 in	



Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1* [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]
Seismic $(C_s)(I_p)$ = 0.055 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ = 221.2 lbs
Base Shear, $V = C_sI_pW_s$ = 12.2 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

(Service Loads, E = 0.7)

F_9 =	1.1 lbs	@ 90 in (CM)
F_8 =	1.0 lbs	@ 80.5 in (CM)
F_7 =	0.9 lbs	@ 70.5 in (CM)
F_6 =	0.8 lbs	@ 61 in (CM)
F_5 =	0.6 lbs	@ 51 in (CM)
F_4 =	0.5 lbs	@ 41.5 in (CM)
F_3 =	0.4 lbs	@ 31.5 in (CM)
F_2 =	0.3 lbs	@ 22 in (CM)
F_1 =	0.2 lbs	@ 12 in (CM)
F_u =	2.7 lbs	@ 42 in (CM)
Σf_i =	12.2 lbs	(@ Factored Loads)

Note:
(CM) = Product Center of Mass typically 6 inches above the top of shelf at each level.

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_ih_i$
M_{OT} = 484 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 1194 in-lbs
Factor of Safety
FOS = 2.468
NO UPLIFT - NO ANCHORS REQUIRED

Load Case 2* [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]
Seismic $(C_s)(I_p)$ = 0.055 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((1)PL)+DL$ = 120.1 lbs
Base Shear, $V = C_sI_pW_s$ = 6.6 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

(Service Loads)

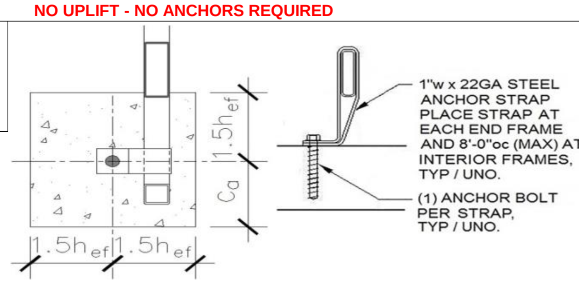
F_9 =	1.8 lbs	@ 90in (CM)
F_8 =	0.0 lbs	
F_7 =	0.0 lbs	
F_6 =	0.0 lbs	
F_5 =	0.0 lbs	
F_4 =	0.0 lbs	
F_3 =	0.0 lbs	
F_2 =	0.0 lbs	
F_1 =	0.0 lbs	
F_u =	2.8 lbs	@ 42in (CM)
Σf_i =	6.6 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_ih_i$
M_{OT} = 281 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 553 in-lbs
Factor of Safety
FOS = 1.966
NO UPLIFT - NO ANCHORS REQUIRED

Check Single Frame / Bay Overturning Stability:

M_{OT} (LC#1) =	484 in-lbs		M_{OT} (LC#2) =	281 in-lbs	
M_{RST} (LC#1) =	1194 in-lbs		M_{RST} (LC#2) =	553 in-lbs	
FOS=M_{RST} / M_{OT} =	2.468	≥ 1.5 No AB Reqd	FOS = M_{RST} / M_{OT} =	1.966	≥ 1.5 No AB Reqd

--> No Anchorage Reqd - No Net Uplift at LC#1 and LC#2



Base Reactions:

Reactions (Service Loads):	LC #1		LC #2	
R_h =	4 lbs		2 lbs	
R_v =	0 lbs	(No Uplift)	0 lbs	(No Uplift)
Overturning FOS =	2.468	>= 1.5	1.966	>= 1.5
Sliding Restraint force, R_{RST} / FOS =	42lbs / 9.834 >= 1.5 OK		23lbs / 10.069 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	12 lbs		7 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	351 lbs		151 lbs	

Tension Allowables

Steel Strength, ϕN_{sa} =	5675 lbs	<--ACI 318-14 Eq 17.4.1.2
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	752 lbs	<--ACI 318-14 Eq 17.4.2.1b
Pullout Strength, $(0.75)\phi N_{pn}$ =	519 lbs	<--ACI 318-14 Eq 17.4.3.1

Anchor Design (using "Cracked Concrete" Properties)

Try:	3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.	
Embedment =	2 in	
f'_c =	3500 psi	
e_n' =	0 in	<--- Eccen. Of Anchor
h_{ef} =	1.33 in	$1.5(h_{ef})$ = 1.995 in
c_a =	5 in	$1.5(c_a)$ = 7.500 in
Conc. thickness, t =	4 in	
# of Anchors, n =	1	- anchors per connection
S_X =	0 in	
A_{se} =	0.094 in^2	

	LC #1		LC #2	
Factored Tension Load (N_u) =	0 lbs		0 lbs	
max tension stress ratio (TSR) =	0.000	OK	0.000	OK

Shear Allowables

Steel Strength, ϕV_{sa} =	1449 lbs	<--ACI 318-14 Eq 17.5.1.2b
Concrete breakout, ϕV_{cbg} =	2334 lbs	<--ACI 318-14 Eq 17.5.2.1b
Concrete pryout, ϕV_{cpg} =	1080 lbs	<--ACI 318-14 Eq 17.5.3.1b

	LC #1		LC #2	
Factored Shear Load (V_u) =	12 lbs		7 lbs	
Max shear stress ratio (VSR) =	0.011	OK	0.006	OK
Combined shear and tension stress ratio (TSR + VSR) =	0.011	< 1.2 OK - LC#1 (controls)		

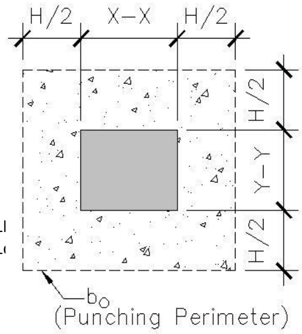
USE: NO UPLIFT - USE (1) 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed. ICC REPORT #ESR-3889

Shelving / Double Sided   84" Tall "3RX" 9 Level   18-3RX

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

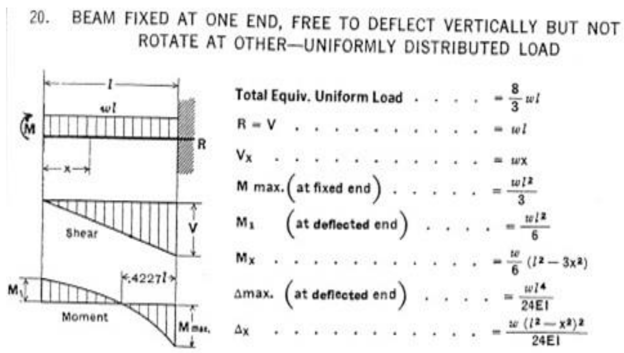
Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	351	lbs	
Slab Concrete f 'c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	2	in.	
Rack Post Y-Y =	2	in.	
b_o =	24.00	in.	
β =	1.00		
V_n =	22718	lbs	Table 14.5.5.1l
V_n max =	15145	lbs	Table 14.5.5.1
ϕV_n =	9087	lbs	
$V_u/\phi V_n$ =	0.039	< 1.0 O.K.	



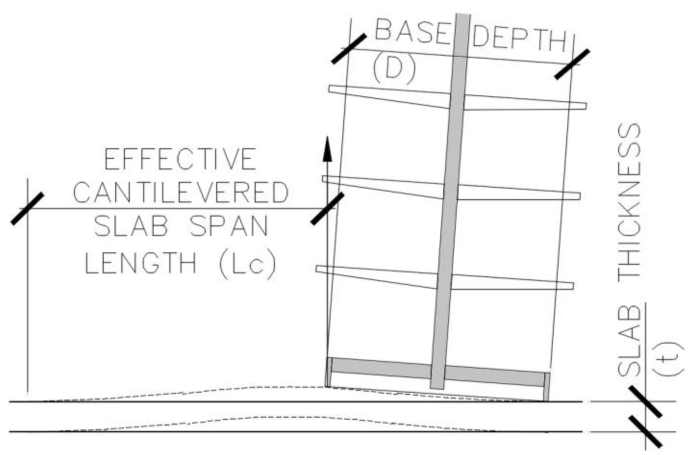
Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf
Max. Vertical Load (Service) (P) =	239	lbs
Area reqd. for bearing (A_{reqd}) =	0.16	ft^2
"b" distance =	4.79	in
Slab thickness (t) =	4.00	in
S = (1")$(t)^2/6$ =	2.67	in^3/in
ϕM_{nt} (tension allowable) = $\phi_t(7.5)[(f'_c)^{1/2}](S)$ =	710	in-lb/in
Factored uniform bearing, $w_u = P_u / A_{reqd}$ =	15.30	lb/in/in
$M_u = w_uL^2/3 = (w_u)[(b-(2"))/2)^2] / 3$ =	9.92	in-lb/in - Defl. End M1 = 5 in-lb/in
$M_u/\phi M_{nt}$ =	0.014	< 1.0 O.K.



Shelving Fixture FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	8.5	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, f_r = 7.5*SQRT(f'c) =	443.7	psi
Concrete Slab Section Modulus, S = $b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, $M_{all} = S*f_r$ =	1183.2	ft*lbs/ft
Effective Cantilever Span Length (L_c) at M_{all} =	6.9	ft
Total Length of Slab (l_c + Width of Single Rack) =	7.6	ft
Trib. Width of Slab = Trib width of Rack =	4.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	1518	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)} = P_{conc} * L_c/2$ =	69092	in*lbs
Load Combination #1: M_{OT} =	484	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	70286	in*lbs
Total Overturning FOS =	145.321	OK
Load Combination #2: M_{OT} =	281	in*lbs
$M_{RST(Rack)} + M_{RST(slab)}$ =	69644	in*lbs
Total Overturning FOS =	247.800	OK



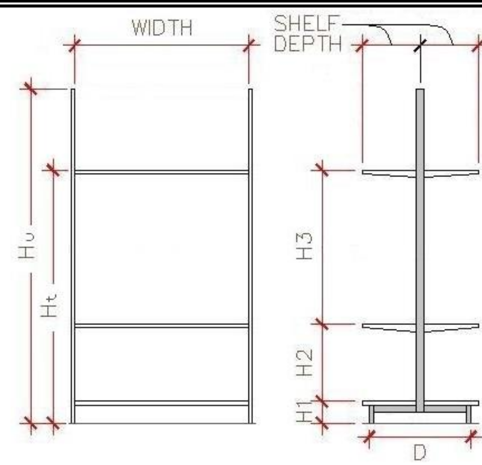
JOHNSTON BURKHOLDER ASSOCIATES	PROJECT NO: 2431906958	SHEET NO: 35	OF: 44
consulting structural engineers	PROJECT NAME: #6958 - Cameron, NC		
930 CENTRAL · KANSAS CITY, MO 64105	MADE BY: RBC	DATE: 01/03/25	
816.421.4200 · WWW.JBAENGR.COM	CHECKED BY:	DATE:	

Shelving / Double Sided | 120" Tall "FW" 3 Level | 36FW

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor = 1.5
Supported on Elevated Floor (Y/N): No
Total Load per shelf = 50 lbs <---assumes (2) shelves per level
\# of Levels = 3 LEVEL - FW
Uniform Weight per level = 8.33 psf/shelf
Weight of Unit = 100 lbs
Upright Frame anchorage spacing (Trib width) = 4 ft (*Frames are assumed to be 4'-0" oc*)
Shelf depth (ea. side) = 18 in

		Shelf Load / Level / Frame
h_9 =	0 in	
h_8 =	0 in	
h_7 =	0 in	
h_6 =	0 in	
h_5 =	0 in	
h_4 =	0 in	
h_3 =	66 in	100 lbs
h_2 =	12 in	100 lbs
h_1 =	6 in	100 lbs
Total Shelf Height, H_t =	84 in	Unit Height, H_u = 120 in
Unit Base Depth, D =	24 in	



Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1* [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]
Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ = 234.7 lbs
Base Shear, $V = C_sI_pW_s$ = 19.4 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)
(Service Loads, E = 0.7)

Note:
(CM) = Product Center of Mass typically 6 inches above the top of shelf at each level.

F_9 =	0.0 lbs	@ 0 in (CM)
F_8 =	0.0 lbs	@ 0 in (CM)
F_7 =	0.0 lbs	@ 0 in (CM)
F_6 =	0.0 lbs	@ 0 in (CM)
F_5 =	0.0 lbs	@ 0 in (CM)
F_4 =	0.0 lbs	@ 0 in (CM)
F_3 =	5.7 lbs	@ 90 in (CM)
F_2 =	1.5 lbs	@ 24 in (CM)
F_1 =	0.8 lbs	@ 12 in (CM)
F_u =	5.6 lbs	@ 60 in (CM)
Σf_i =	19.4 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 892 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 3612 in-lbs
Factor of Safety
FOS = 4.048
NO UPLIFT - NO ANCHORS REQUIRED

Load Case 2* [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]
Seismic $(C_s)(I_p)$ = 0.083 W_s (Cross-Aisle)
$W_s = (0.67)(PL_{RF})((1)PL)+DL$ = 167.0 lbs
Base Shear, $V = C_sI_pW_s$ = 13.8 lbs
Horizontal forces per level, $F_x = C_{vx}V$ (RMI sect 2.6.6)
(Service Loads)

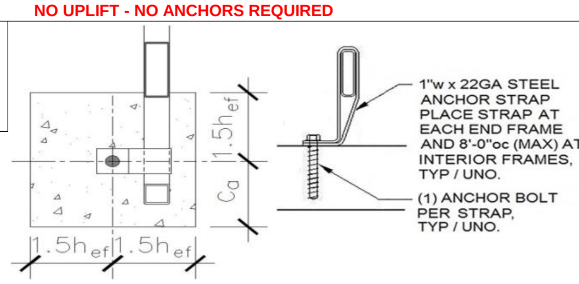
F_9 =	0.0 lbs	
F_8 =	0.0 lbs	
F_7 =	0.0 lbs	
F_6 =	0.0 lbs	
F_5 =	0.0 lbs	
F_4 =	0.0 lbs	
F_3 =	5.8 lbs	@ 90in (CM)
F_2 =	0.0 lbs	
F_1 =	0.0 lbs	
F_u =	3.9 lbs	@ 60in (CM)
Σf_i =	13.8 lbs	(@ Factored Loads)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 752 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 2400 in-lbs
Factor of Safety
FOS = 3.190
NO UPLIFT - NO ANCHORS REQUIRED

Check Single Frame / Bay Overturning Stability:

M_{OT} (LC#1) =	892 in-lbs		M_{OT} (LC#2) =	752 in-lbs	
M_{RST} (LC#1) =	3612 in-lbs		M_{RST} (LC#2) =	2400 in-lbs	
$FOS=M_{RST}/M_{OT}$ =	4.048	≥ 1.5 No AB Reqd	$FOS = M_{RST}/M_{OT}$ =	3.190	≥ 1.5 No AB Reqd

--> No Anchorage Reqd - No Net Uplift at LC#1 and LC#2



Base Reactions:

Reactions (Service Loads):	LC #1		LC #2	
R_h =	7 lbs		5 lbs	
R_v =	0 lbs	(No Uplift)	0 lbs	(No Uplift)
Overturning FOS =	4.048	>= 1.5	3.190	>= 1.5
Sliding Restraint force, R_{RST} / FOS =	39lbs / 5.701 >= 1.5 OK		29lbs / 5.954 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	19 lbs		14 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	328 lbs		191 lbs	

Anchor Design (using "Cracked Concrete" Properties)

Try: 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.

Embedment =	2 in		
f'_c =	3500 psi		
e_n' =	0 in	<--- Eccen. Of Anchor	
h_{ef} =	1.33 in	$1.5(h_{ef})$ =	1.995 in
c_a =	5 in	$1.5(c_a)$ =	7.500 in
Conc. thickness, t =	4 in		
\# of Anchors, n =	1	- anchors per connection	
S_X =	0 in		
A_{se} =	0.094 in^2		

Tension Allowables

Steel Strength, ϕN_{sa} =	5675 lbs	<--ACI 318-14 Eq 17.4.1.2		
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	752 lbs	<--ACI 318-14 Eq 17.4.2.1b		
Pullout Strength, $(0.75)\phi N_{pn}$ =	519 lbs	<--ACI 318-14 Eq 17.4.3.1		
	LC #1		LC #2	
Factored Tension Load (N_u) =	0 lbs		0 lbs	
max tension stress ratio (TSR) =	0.000	OK	0.000	OK

Shear Allowables

Steel Strength, ϕV_{sa} =	1449 lbs	<--ACI 318-14 Eq 17.5.1.2b		
Concrete breakout, ϕV_{cbg} =	2334 lbs	<--ACI 318-14 Eq 17.5.2.1b		
Concrete pryout, ϕV_{cpg} =	1080 lbs	<--ACI 318-14 Eq 17.5.3.1b		
	LC #1		LC #2	
Factored Shear Load (V_u) =	19 lbs		14 lbs	
Max shear stress ratio (VSR) =	0.018	OK	0.013	OK
Combined shear and tension stress ratio (TSR + VSR) =	0.018	< 1.2 OK - LC#1 (controls)		

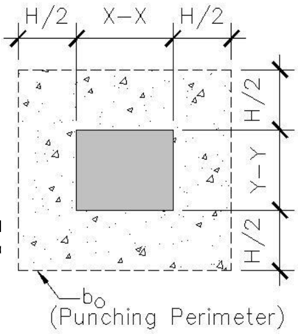
USE: (1) 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed. ICC REPORT #ESR-3889

Shelving / Double Sided 120" Tall "FW" 3 Level 36FW

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

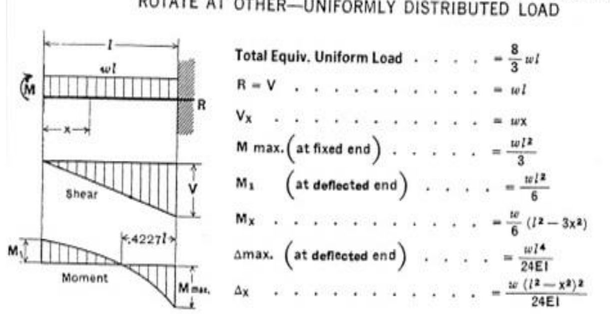
Max. Factored Vertical Load (P_u) =	328	lbs
Slab Concrete f 'c =	3500	psi
Slab thickness (t) =	4	in.
Rack Post X-X =	2	in.
Rack Post Y-Y =	2	in.
b_o =	24.00	in.
β =	1.00	
V_n =	22718	lbs Table 14.5.5.1l
V_n max =	15145	lbs Table 14.5.5.1
ϕV_n =	9087	lbs
$V_u/\phi V_n$ =	0.036	< 1.0 O.K.



Slab tension based on Soil bearing area check:

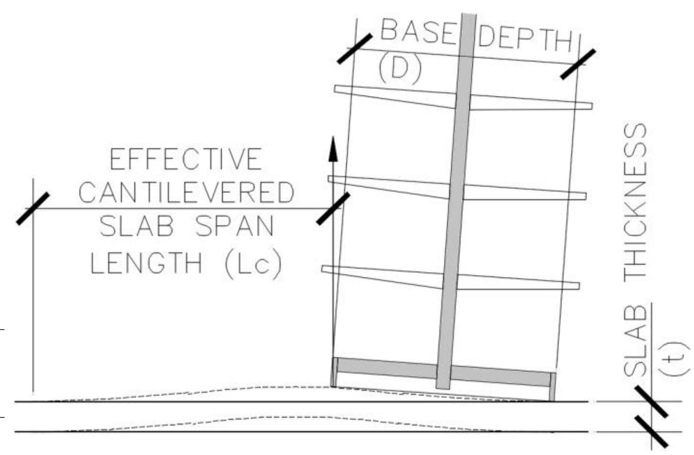
Allowable soil bearing =	1500	psf
Max. Vertical Load (Service) (P) =	240	lbs
Area reqd. for bearing (A_{reqd}) =	0.16	ft^2
"b" distance =	4.80	in
Slab thickness (t) =	4.00	in
$S = (1")(t)^2/6$ =	2.67	in^3/in
ϕM_{nt} (tension allowable) = $\phi_t(7.5)[(f'_c)^{1/2}](S)$ =	710	in-lb/in
Factored uniform bearing, $w_u = P_u / A_{reqd}$ =	14.24	lb/in/in
$M_u = w_u L^2/3 = (w_u)[(b-(2"))/2)^2] / 3$ =	9.30	in-lb/in - Defl. End M1 = 5 in-lb/in
$M_u/\phi M_{nt}$ =	0.013	< 1.0 O.K.

20. BEAM FIXED AT ONE END, FREE TO DEFLECT VERTICALLY BUT NOT ROTATE AT OTHER—UNIFORMLY DISTRIBUTED LOAD



Shelving Fixture FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	24	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, f_r = 7.5*SQRT(f'c) =	443.7	psi
Concrete Slab Section Modulus, $S = b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, $M_{all} = S*f_r$ =	1183.2	ft*lbs/ft
Effective Cantilever Span Length (L_c) at M_{all} =	6.9	ft
Total Length of Slab (l_c + Width of Single Rack) =	8.9	ft
Trib. Width of Slab = Trib width of Rack =	4.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	1776	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)} = P_{conc} * L_c/2$ =	94616	in*lbs
Load Combination #1: M_{OT} =	892	in*lbs
$M_{RST(Rack)}$ + $M_{RST(slab)}$ =	98228	in*lbs
Total Overturning FOS =	110.078	OK
Load Combination #2: M_{OT} =	752	in*lbs
$M_{RST(Rack)}$ + $M_{RST(slab)}$ =	97016	in*lbs
Total Overturning FOS =	128.968	OK

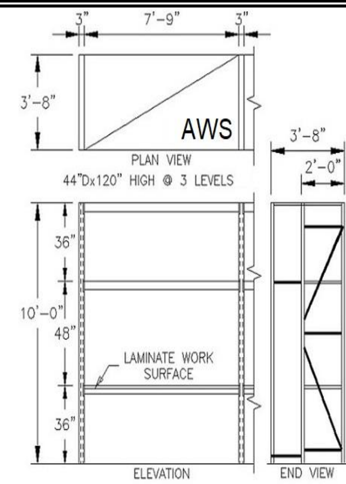


JOHNSTON BURKHOLDER ASSOCIATES consulting structural engineers 930 CENTRAL · KANSAS CITY, MO 64105 816.421.4200 · WWW.JBAENGR.COM	PROJECT NO: 2431906958	SHEET NO: 37	OF: 44
	PROJECT NAME: #6958 - Cameron, NC		
	MADE BY: RBC	DATE: 01/03/25	
	CHECKED BY:	DATE:	

Storage Rack - Seismic Design | Rack AWS | 24/44-120 075A

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor (I_p) =	1.0	<--- No Public Access Allowed (Typ. at Back Stockroom / Grocery Storage Areas)	
Supported on Elevated Floor (Y/N):	No		
Max. Weight per level (2 Pallets / shelf) =	1200 lbs/shelf		
Weight of Unit =	250 lbs	<--- Shipping weight per Manuf.	
Rack Trib width (CL-to-CL of frames) =	96 in		Total Shelf Load
h_9 =	0 in		0 lbs
h_8 =	0 in		0 lbs
h_7 =	0 in		0 lbs
h_6 =	0 in		0 lbs
h_5 =	0 in		0 lbs
h_4 =	0 in		0 lbs
h_3 =	36 in		1200 lbs
h_2 =	48 in		1200 lbs
h_1 =	36 in		500 lbs
Total Shelf Height, H_t =	120 in		
Unit Height, H_u =	120 in		
Unit Base Depth, D =	24 in		



Note: Per ANSI MH16.1, effective lengths may be determined by rational methods consistent with AISI or AISC. AISC Design by Second-Order Analysis, Section C2.2a is used. Notional loads are applied to gravity load cases and K=1.0 is used since the ratio of second-order drift to first-order drift (P-δ) / (P-Δ) < 1.1.

Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1 [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic (C_s)(I_p) =	0.055 W_s (Braced)	
	0.021 W_s (Down Aisle)	
W_s = (0.67)(PL_{RF})((0.67)PL)+DL =	1551.8 lbs	
Base Shear, V = $C_sI_pW_s$ =	85.3 lbs	(Braced)
	32.8 lbs	(Down Aisle)

Horizontal forces / level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

(Service Loads, E = 0.7)	F_9 =	0.0 lbs	@ 0 in (CM)
Note:	F_8 =	0.0 lbs	@ 0 in (CM)
(CM) = Product Center of	F_7 =	0.0 lbs	@ 0 in (CM)
Mass typically 20 inches	F_6 =	0.0 lbs	@ 0 in (CM)
above the top of shelf at	F_5 =	0.0 lbs	@ 0 in (CM)
each level.	F_4 =	0.0 lbs	@ 0 in (CM)
	F_3 =	29.3 lbs	@ 140 in (CM)
	F_2 =	21.3 lbs	@ 102 in (CM)
	F_1 =	5.2 lbs	@ 60 in (CM)
	F_u =	3.9 lbs	@ 60 in (CM)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 6823 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 26316 in-lbs
Factor of Safety, $FOS_{OT} = M_{RST}/M_{OT}$ = 3.857
NO UPLIFT - NO ANCHORS REQUIRED

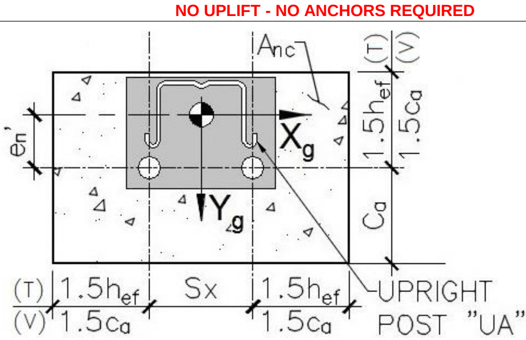
Load Case 2 [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic (C_s)(I_p) =	0.055 W_s (Braced)	
	0.021 W_s (Down Aisle)	
W_s = (0.67)(PL_{RF})((1)PL)+DL =	1054.0 lbs	
Base Shear, V = $C_sI_pW_s$ =	58.0 lbs	(Braced)
	22.3 lbs	(Down Aisle)

Horizontal forces / level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

(Service Loads)	F_9 =	0.0 lbs	
	F_8 =	0.0 lbs	
	F_7 =	0.0 lbs	
	F_6 =	0.0 lbs	
	F_5 =	0.0 lbs	
	F_4 =	0.0 lbs	
	F_3 =	37.3 lbs	@ 140 in (CM)
	F_2 =	0.0 lbs	
	F_1 =	0.0 lbs	
	F_u =	3.3 lbs	@ 60 in (CM)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 5415 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 17400 in-lbs
Factor of Safety, $FOS_{OT} = M_{RST}/M_{OT}$ = 3.213
NO UPLIFT - NO ANCHORS REQUIRED



Anchor Design (using "Cracked Concrete" Properties)

Upright Post Type =	UA		
Try:	1/2"Ø DeWalt Screw Bolt+ Anchor - 2 1/2" embed.		
Embedment (h_{nom}) =	2.5 in		
f_c' =	3500 psi		
e_n' =	1.875 in	<-- Eccen. of Anchor	
h_{ef} =	1.75 in	1.5(h_{ef}) =	2.625 in
Conc. thickness, t =	4 in	1.5(C_a) =	4.950 in
# of Anchors, n =	1		
Sx =	0.00 in		
Sy =	0.00 in		
A_{se} =	0.176 in^2		

Base Reactions:

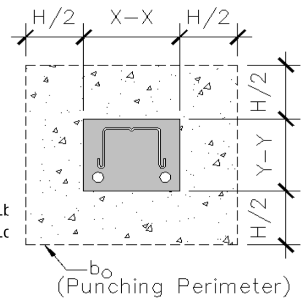
	LC #1		LC #2	
R_h =	30 lbs		20 lbs	
R_v =	0 lbs		0 lbs	
Overturning FOS =	3.857	>= 1.5	3.213	>= 1.5
Sliding Restraint, R_{RST}/FOS =	265lbs / 8.873 >= 1.5 OK		188lbs / 9.274 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	85 lbs		58 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	2565 lbs		1383 lbs	
Tension Allowables				
Steel Strength, ϕN_{sa} =	13309 lbs	<--ACI 318-14 Eq 17.4.1.2		
Concrete Breakout, (0.75)ϕN_{cbg} =	1135 lbs	<--ACI 318-14 Eq 17.4.2.1b		
Pullout Strength, (0.75)ϕN_{pn} =	949 lbs	<--ACI 318-14 Eq 17.4.3.1		
Factored Tension Load, (N_u) =	0 lbs	(LC #1)	0 lbs	(LC #2)
max tension stress ratio (TSR) =	0.000	OK (LC#1)	0.000	OK (LC#2)
Shear Allowables				
Steel Strength, ϕV_{sa} =	4254 lbs	<--ACI 318-14 Eq 17.5.1.2b		
Concrete breakout (Yg), ϕV_{cbg} =	1419 lbs	<--ACI 318-14 Eq 17.5.2.1b		
Concrete breakout (Xg), ϕV_{cbg} =	1029 lbs	<--ACI 318-14 Eq 17.5.2.1b		
Concrete pryout, ϕV_{cpg} =	1630 lbs	<--ACI 318-14 Eq 17.5.3.1b		
	LC #1		LC #2	
Factored Shear Load (V_u) : Braced =	85 lbs		58 lbs	
Down Aisle =	33 lbs		22 lbs	
Max shear stress ratio (VSR) : Braced =	0.060	OK	0.041	OK
Down Aisle =	0.032	OK	0.022	OK
Braced (TSR+VSR <= 1.2) =	0.060	<= 1.2 OK - LC #1 Controls		
Down Aisle (VSR <= 1.0) =	0.032	OK - LC #1 Controls		

USE: (1) 1/2"Ø DeWalt Screw Bolt+ Anchor - 2 1/2" embed. ICC REPORT #ESR-3889

Punching Shear Check:

(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	2565	lbs	
Slab Concrete f'c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	5.00	in.	
Rack Post Y-Y =	3.75	in.	
b_o =	33.50	in.	
β =	1.33		
V_n =	26425	lbs	Table 14.5.5.1b
V_n max =	21087	lbs	Table 14.5.5.1c
ϕV_n =	12652	lbs	
$V_u/\phi V_n$ =	0.203	< 1.0 O.K.	



Max Vertical Load (ASD) - RMI, sect 2.1 - LC#4:

P = (1+0.105Sds)DL+(3/4)[(1.4+0.14Sds)PL+(0.7)pEL]

S_{DS} =	0.220	(Ip=1)	
DL = (Frame Wt/2) =	125	lbs	
PL = Σ(Shelf Load h_1 - h_9)/2 =	1450	lbs	
EL = $M_{OT, LC\#1}$ / ((0.7)(D)) =	607	lbs	
P =	1897	lbs	<--- At Each Post

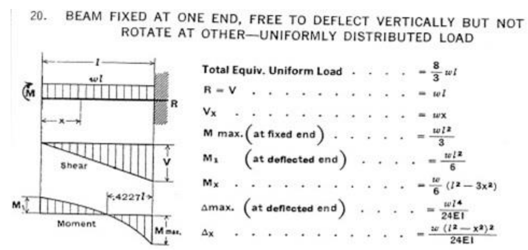
Max Vertical Load (LRFD) - RMI, sect 2.2 - LC#5:

P = (1.2+0.2SDS)DL + (1.2+0.2Sds)PL + ρEL

P_u =	2565	lbs	<--- At Each Post

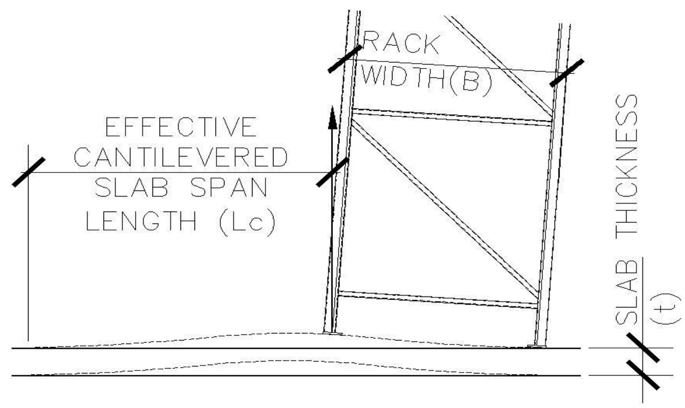
Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf
Max. Service Vertical Load (P) =	1897	lbs
Area reqd. for bearing (A_{reqd}) =	1.26	ft^2
"b" distance =	13.49	in
Slab thickness (t) =	4.00	in
$S = (1")(t)^2/6$ =	2.67	in^3/in
ϕM_{nt} (tension allowable) = f_t*7.5*[$(f'_c)^{1/2}$]*S =	709.93	in-lb/in
Factored uniform bearing, $w_u = P_u / A_{reqd}$ =	14.08	lb/in/in
$M_u = wL^2/3 = (w_u)[(b\text{-min}(X\text{-}X,Y\text{-}Y))/2)^2] / 3$ =	111.46	in-lb/in - Defl. End M1 = 56 in-lb/in
$M_u/\phi M_{nt}$ =	0.157	< 1.0 O.K.



Rack FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	24	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, f_r = 7.5*SQRT(f'c) =	443.7	psi
Concrete Slab Section Modulus, S = $b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, M_{all}/FS = S*f_r/1.5 =	788.8	ft*lbs/ft
Effective Cantilever Span Length (l_c) at M_{all} =	5.6	ft
Total Length of Slab (l_c + Width of Single Rack) =	7.6	ft
Trib. Width of Slab = Trib width of Rack =	8.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	3046.9	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)} = P_{conc} * l_c/2$ =	139251	in*lbs
Load Combination #1: M_{OT} =	6823	in*lbs
$M_{RST(Rack)}$ + $M_{RST(slab)}$ =	165567	in*lbs
Total Overturning FOS =	24.265	OK
Load Combination #2: M_{OT} =	5415	in*lbs
$M_{RST(Rack)}$ + $M_{RST(slab)}$ =	156651	in*lbs
Total Overturning FOS =	28.929	OK

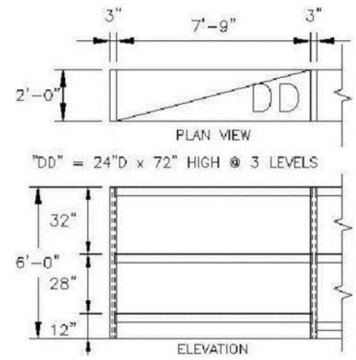


JOHNSTON BURKHOLDER ASSOCIATES consulting structural engineers 930 CENTRAL · KANSAS CITY, MO 64105 816.421.4200 · WWW.JBAENGR.COM	PROJECT NO: 2431906958	SHEET NO: 39	OF: 44
	PROJECT NAME: #6958 - Cameron, NC		
	MADE BY: RBC	DATE: 01/03/25	
	CHECKED BY:	DATE:	

Storage Rack - Seismic Design | Rack DD | 24-72 075A

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor (I_p) =	1.0	<--- No Public Access Allowed (Typ. at Back Stockroom / Grocery Storage Areas)	
Supported on Elevated Floor (Y/N):	No		
Max. Weight per level (2 Pallets / shelf) =	1200 lbs/shelf		
Weight of Unit =	250 lbs	<--- Shipping weight per Manuf.	
Rack Trib width (CL-to-CL of frames) =	96 in	Total Shelf Load	
h_9 =	0 in	0 lbs	
h_8 =	0 in	0 lbs	
h_7 =	0 in	0 lbs	
h_6 =	0 in	0 lbs	
h_5 =	0 in	0 lbs	
h_4 =	0 in	0 lbs	
h_3 =	32 in	1200 lbs	
h_2 =	28 in	1200 lbs	
h_1 =	12 in	1200 lbs	
Total Shelf Height, H_t =	72 in		
Unit Height, H_u =	72 in		
Unit Base Depth, D =	24 in		



Note: Per ANSI MH16.1, effective lengths may be determined by rational methods consistent with AISI or AISC. AISC Design by Second-Order Analysis, Section C2.2a is used. Notional loads are applied to gravity load cases and K=1.0 is used since the ratio of second-order drift to first-order drift (P-δ) / (P-Δ) < 1.1.

Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1 [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ =	0.055	W_s (Braced)
	0.020	W_s (Down Aisle)
$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ =	1866.0 lbs	
Base Shear, $V = C_sI_pW_s$ =	102.6 lbs	(Braced)
	37.4 lbs	(Down Aisle)

Horizontal forces / level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

(Service Loads, E = 0.7)	F_9 =	0.0 lbs	@ 0 in (CM)
Note:	F_8 =	0.0 lbs	@ 0 in (CM)
(CM) = Product Center of	F_7 =	0.0 lbs	@ 0 in (CM)
Mass typically 20 inches	F_6 =	0.0 lbs	@ 0 in (CM)
above the top of shelf at	F_5 =	0.0 lbs	@ 0 in (CM)
each level.	F_4 =	0.0 lbs	@ 0 in (CM)
	F_3 =	35.7 lbs	@ 92 in (CM)
	F_2 =	21.7 lbs	@ 56 in (CM)
	F_1 =	10.1 lbs	@ 26 in (CM)
	F_u =	4.3 lbs	@ 36 in (CM)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 4919 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 31944 in-lbs
Factor of Safety, $FOS_{OT} = M_{RST}/M_{OT}$ = 6.495
NO UPLIFT - NO ANCHORS REQUIRED

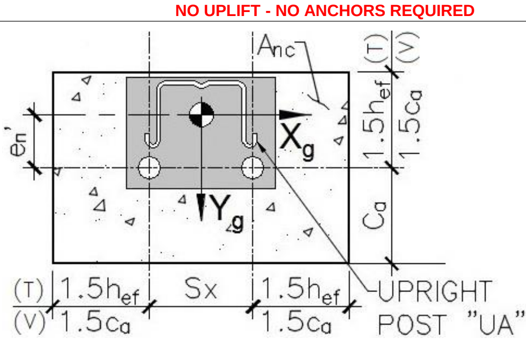
Load Case 2 [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ =	0.055	W_s (Braced)
	0.020	W_s (Down Aisle)
$W_s = (0.67)(PL_{RF})((1)PL)+DL$ =	1054.0 lbs	
Base Shear, $V = C_sI_pW_s$ =	58.0 lbs	(Braced)
	21.1 lbs	(Down Aisle)

Horizontal forces / level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

(Service Loads)	F_9 =	0.0 lbs	
	F_8 =	0.0 lbs	
	F_7 =	0.0 lbs	
	F_6 =	0.0 lbs	
	F_5 =	0.0 lbs	
	F_4 =	0.0 lbs	
	F_3 =	37.5 lbs	@ 92 in (CM)
	F_2 =	0.0 lbs	
	F_1 =	0.0 lbs	
	F_u =	3.1 lbs	@ 36 in (CM)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 3562 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 17400 in-lbs
Factor of Safety, $FOS_{OT} = M_{RST}/M_{OT}$ = 4.885
NO UPLIFT - NO ANCHORS REQUIRED



Anchor Design (using "Cracked Concrete" Properties)

Upright Post Type =	UA		
Try:	1/2"Ø DeWalt Screw Bolt+ Anchor - 2 1/2" embed.		
Embedment (h_{nom}) =	2.5 in		
f_c' =	3500 psi		
e_n' =	1.875 in	<-- Eccen. of Anchor	
h_{ef} =	1.75 in	$1.5(h_{ef})$ =	2.625 in
Conc. thickness, t =	4 in	$1.5(C_a)$ =	4.950 in
# of Anchors, n =	1		
Sx =	0.00 in		
Sy =	0.00 in		
A_{se} =	0.176 in^2		

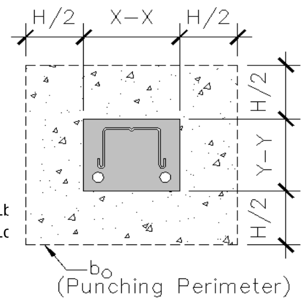
Base Reactions:

	LC #1		LC #2	
R_h =	36 lbs		20 lbs	
R_v =	0 lbs		0 lbs	
Overturning FOS =	6.495	>= 1.5	4.885	>= 1.5
Sliding Restraint, R_{RST}/FOS =	284lbs / 7.92 >= 1.5 OK		169lbs / 8.322 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	103 lbs		58 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	2832 lbs		1218 lbs	
Tension Allowables				
Steel Strength, ϕN_{sa} =	13309 lbs	<--ACI 318-14 Eq 17.4.1.2		
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	1135 lbs	<--ACI 318-14 Eq 17.4.2.1b		
Pullout Strength, $(0.75)\phi N_{pn}$ =	949 lbs	<--ACI 318-14 Eq 17.4.3.1		
Factored Tension Load, (N_u) =	0 lbs	(LC #1)	0 lbs	(LC #2)
max tension stress ratio (TSR) =	0.000	OK (LC#1)	0.000	OK (LC#2)
Shear Allowables				
Steel Strength, ϕV_{sa} =	4254 lbs	<--ACI 318-14 Eq 17.5.1.2b		
Concrete breakout (Yg), ϕV_{cbg} =	1419 lbs	<--ACI 318-14 Eq 17.5.2.1b		
Concrete breakout (Xg), ϕV_{cbg} =	1029 lbs	<--ACI 318-14 Eq 17.5.2.1b		
Concrete pryout, ϕV_{cpg} =	1630 lbs	<--ACI 318-14 Eq 17.5.3.1b		
	LC #1		LC #2	
Factored Shear Load (V_u) : Braced =	103 lbs		58 lbs	
Down Aisle =	37 lbs		21 lbs	
Max shear stress ratio (VSR) : Braced =	0.072	OK	0.041	OK
Down Aisle =	0.036	OK	0.020	OK
Braced (TSR+VSR <= 1.2) =	0.072	<= 1.2 OK - LC #1 Controls		
Down Aisle (VSR <= 1.0) =	0.036	OK - LC #1 Controls		

USE: NO UPLIFT - (1) 1/2"Ø DeWalt Screw Bolt+ Anchor - 2 1/2" embed.

Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	2832	lbs	
Slab Concrete f'c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	5.00	in.	
Rack Post Y-Y =	3.75	in.	
b_o =	33.50	in.	
β =	1.33		
V_n =	26425	lbs	Table 14.5.5.1b
V_n max =	21087	lbs	Table 14.5.5.1c
ϕV_n =	12652	lbs	
$V_u/\phi V_n$ =	0.224	< 1.0 O.K.	



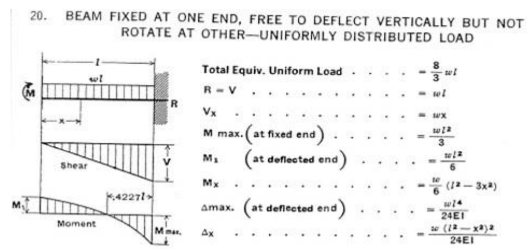
Max Vertical Load (ASD) - RMI, sect 2.1 - LC#4:
P = (1+0.105Sds)DL+(3/4)[(1.4+0.14Sds)PL+(0.7)pEL]

S_{DS} =	0.220	(Ip=1)
DL = (Frame Wt/2) =	125	lbs
PL = Σ(Shelf Load h_1 - h_9)/2 =	1800	lbs
EL = $M_{OT, LC\#1}$ / ((0.7)(D)) =	437	lbs
P =	2213	lbs <--- At Each Post

Max Vertical Load (LRFD) - RMI, sect 2.2 - LC#5:
P = (1.2+0.2SDS)DL + (1.2+0.2Sds)PL + ρEL
P_u = 2832 lbs <--- At Each Post

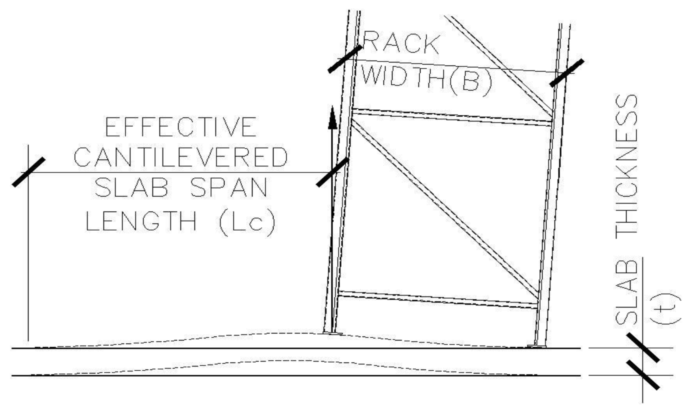
Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf
Max. Service Vertical Load (P) =	2213	lbs
Area reqd. for bearing (A_{reqd}) =	1.48	ft^2
"b" distance =	14.58	in
Slab thickness (t) =	4.00	in
S = (1")$(t)^2$/6 =	2.67	in^3/in
ϕM_{nt} (tension allowable) = f_t*7.5*[$(f'_c)^{1/2}$]*S =	709.93	in-lb/in
Factored uniform bearing, w_u = P_u / A_{reqd} =	13.33	lb/in/in
M_u = $wL^2/3$ = (w_u)[(b-min(X-X,Y-Y))/2)^2] / 3 =	130.19	in-lb/in - Defl. End M1 = 66 in-lb/in
$M_u/\phi M_{nt}$ =	0.183	< 1.0 O.K.



Rack FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	24	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, f_r = 7.5*SQRT(f'c) =	443.7	psi
Concrete Slab Section Modulus, S = $b(t)^2/6$ =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, M_{all}/FS = S*f_r/1.5 =	788.8	ft*lbs/ft
Effective Cantilever Span Length (l_c) at M_{all} =	5.6	ft
Total Length of Slab (l_c + Width of Single Rack) =	7.6	ft
Trib. Width of Slab = Trib width of Rack =	8.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	3046.9	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)}$ = P_{conc} * l_c/2 =	139251	in*lbs
Load Combination #1: M_{OT} =	4919	in*lbs
$M_{RST(Rack)}$ + $M_{RST(slab)}$ =	171195	in*lbs
Total Overturning FOS =	34.806	OK
Load Combination #2: M_{OT} =	3562	in*lbs
$M_{RST(Rack)}$ + $M_{RST(slab)}$ =	156651	in*lbs
Total Overturning FOS =	43.978	OK



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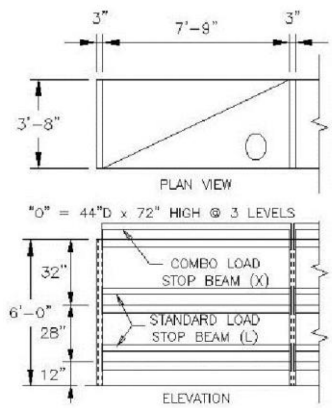
PROJECT NO:	SHEET NO:	OF:
2431906958	41	44
PROJECT NAME: #6958 - Cameron, NC		
MADE BY: RBC	DATE: 01/03/25	
CHECKED BY:	DATE:	

Storage Rack - Seismic Design — Rack O — 44-72 075A

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor (I_p) =	1.0	<--- No Public Access Allowed (Typ. at Back	
Supported on Elevated Floor (Y/N):	No	Stockroom / Grocery Storage Areas)	
Max. Weight per level (2 Pallets / shelf) =	1200 lbs/shelf		
Weight of Unit =	250 lbs	<--- Shipping weight per Manuf.	
Rack Trib width (CL-to-CL of frames) =	96 in		Total Shelf Load
h_9 =	0 in		0 lbs
h_8 =	0 in		0 lbs
h_7 =	0 in		0 lbs
h_6 =	0 in		0 lbs
h_5 =	0 in		0 lbs
h_4 =	0 in		0 lbs
h_3 =	32 in		1200 lbs
h_2 =	28 in		1200 lbs
h_1 =	12 in		1200 lbs
Total Shelf Height, H_t =	72 in		
Unit Height, H_u =	72 in		
Unit Base Depth, D =	44 in		



Note: Per ANSI MH16.1, effective lengths may be determined by rational methods consistent with AISI or AISC. AISC Design by Second-Order Analysis, Section C2.2a is used. Notional loads are applied to gravity load cases and K=1.0 is used since the ratio of second-order drift to first-order drift (P-δ) / (P-Δ) < 1.1.

Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1 [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic $(C_s)(I_p)$ = 0.055 W_s (Braced)
0.020 W_s (Down Aisle)

$W_s = (0.67)(PL_{RF})((0.67)PL)+DL$ = 1866.0 lbs
Base Shear, $V = C_s I_p W_s$ = 102.6 lbs (Braced)
37.4 lbs (Down Aisle)

Horizontal forces / level, $F_x = C_{vx}V$ (RMI sect 2.6.6)
(Service Loads, E = 0.7)

F_9 =	0.0 lbs	@ 0 in (CM)
F_8 =	0.0 lbs	@ 0 in (CM)
F_7 =	0.0 lbs	@ 0 in (CM)
F_6 =	0.0 lbs	@ 0 in (CM)
F_5 =	0.0 lbs	@ 0 in (CM)
F_4 =	0.0 lbs	@ 0 in (CM)
F_3 =	35.7 lbs	@ 92 in (CM)
F_2 =	21.7 lbs	@ 56 in (CM)
F_1 =	10.1 lbs	@ 26 in (CM)
F_u =	4.3 lbs	@ 36 in (CM)

Note:
(CM) = Product Center of Mass typically 20 inches above the top of shelf at each level.

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 4919 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 58564 in-lbs
Factor of Safety, $FOS_{OT} = M_{RST}/M_{OT}$ = 11.907
NO UPLIFT - NO ANCHORS REQUIRED

Load Case 2 [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

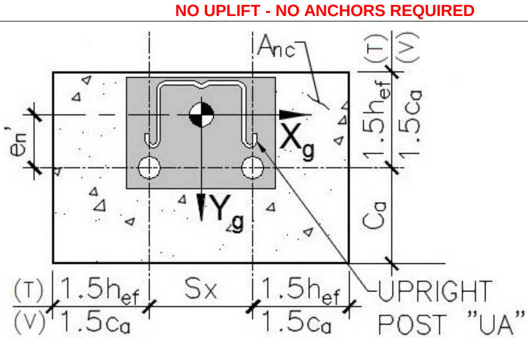
Seismic $(C_s)(I_p)$ = 0.055 W_s (Braced)
0.020 W_s (Down Aisle)

$W_s = (0.67)(PL_{RF})((1)PL)+DL$ = 1054.0 lbs
Base Shear, $V = C_s I_p W_s$ = 58.0 lbs (Braced)
21.1 lbs (Down Aisle)

Horizontal forces / level, $F_x = C_{vx}V$ (RMI sect 2.6.6)
(Service Loads)

F_9 =	0.0 lbs	
F_8 =	0.0 lbs	
F_7 =	0.0 lbs	
F_6 =	0.0 lbs	
F_5 =	0.0 lbs	
F_4 =	0.0 lbs	
F_3 =	37.5 lbs	@ 92 in (CM)
F_2 =	0.0 lbs	
F_1 =	0.0 lbs	
F_u =	3.1 lbs	@ 36 in (CM)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 3562 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 31900 in-lbs
Factor of Safety, $FOS_{OT} = M_{RST}/M_{OT}$ = 8.956
NO UPLIFT - NO ANCHORS REQUIRED



Anchor Design (using "Cracked Concrete" Properties)

Upright Post Type =	UA		
Try:	1/2"Ø DeWalt Screw Bolt+ Anchor - 2 1/2" embed.		
Embedment (h_{nom}) =	2.5 in		
f_c' =	3500 psi		
e_n' =	1.875 in	<-- Eccen. of Anchor	
h_{ef} =	1.75 in	$1.5(h_{ef})$ =	2.625 in
Conc. thickness, t =	4 in	$1.5(C_a)$ =	4.950 in
# of Anchors, n =	1		
Sx =	0.00 in		
Sy =	0.00 in		
A_{se} =	0.176 in^2		

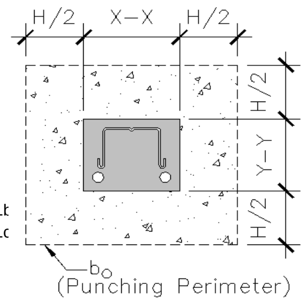
Base Reactions:

	LC #1		LC #2	
R_h =	36 lbs		20 lbs	
R_v =	0 lbs		0 lbs	
Overturning FOS =	11.907	>= 1.5	8.956	>= 1.5
Sliding Restraint, R_{RST}/FOS =	261lbs / 7.271 >= 1.5 OK		152lbs / 7.491 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	103 lbs		58 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	2633 lbs		1075 lbs	
Tension Allowables				
Steel Strength, ϕN_{sa} =	13309 lbs	<--ACI 318-14 Eq 17.4.1.2		
Concrete Breakout, $(0.75)\phi N_{cbg}$ =	1135 lbs	<--ACI 318-14 Eq 17.4.2.1b		
Pullout Strength, $(0.75)\phi N_{pn}$ =	949 lbs	<--ACI 318-14 Eq 17.4.3.1		
Factored Tension Load, (N_u) =	0 lbs	(LC #1)	0 lbs	(LC #2)
max tension stress ratio (TSR) =	0.000	OK (LC#1)	0.000	OK (LC#2)
Shear Allowables				
Steel Strength, ϕV_{sa} =	4254 lbs	<--ACI 318-14 Eq 17.5.1.2b		
Concrete breakout (Yg), ϕV_{cbg} =	1419 lbs	<--ACI 318-14 Eq 17.5.2.1b		
Concrete breakout (Xg), ϕV_{cbg} =	1029 lbs	<--ACI 318-14 Eq 17.5.2.1b		
Concrete pryout, ϕV_{cpg} =	1630 lbs	<--ACI 318-14 Eq 17.5.3.1b		
	LC #1		LC #2	
Factored Shear Load (V_u) : Braced =	103 lbs		58 lbs	
Down Aisle =	37 lbs		21 lbs	
Max shear stress ratio (VSR) : Braced =	0.072	OK	0.041	OK
Down Aisle =	0.036	OK	0.020	OK
Braced (TSR+VSR <= 1.2) =	0.072	<= 1.2 OK - LC #1 Controls		
Down Aisle (VSR <= 1.0) =	0.036	OK - LC #1 Controls		

USE: NO UPLIFT - (1) 1/2"Ø DeWalt Screw Bolt+ Anchor - 2 1/2" embed.

Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	2633	lbs	
Slab Concrete f'c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	5.00	in.	
Rack Post Y-Y =	3.75	in.	
b_o =	33.50	in.	
β =	1.33		
V_n =	26425	lbs	Table 14.5.5.1b
V_n max =	21087	lbs	Table 14.5.5.1c
ϕV_n =	12652	lbs	
$V_u/\phi V_n$ =	0.208	< 1.0 O.K.	



Max Vertical Load (ASD) - RMI, sect 2.1 - LC#4:
P = (1+0.105Sds)DL+(3/4)[(1.4+0.14Sds)PL+(0.7)ρEL]

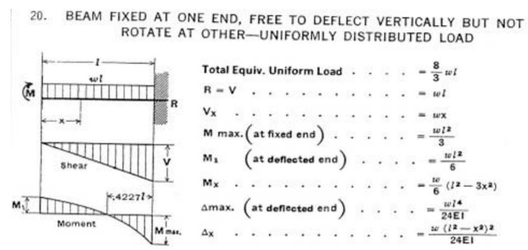
S_{DS} =	0.220	(Ip=1)
DL = (Frame Wt/2) =	125	lbs
PL = Σ(Shelf Load h_1 - h_9)/2 =	1800	lbs
EL = $M_{OT, LC\#1}$ / ((0.7)(D)) =	239	lbs
P =	2143	lbs <--- At Each Post

Max Vertical Load (LRFD) - RMI, sect 2.2 - LC#5:
P = (1.2+0.2SDS)DL + (1.2+0.2Sds)PL + ρEL

P_u = 2633 lbs <--- At Each Post

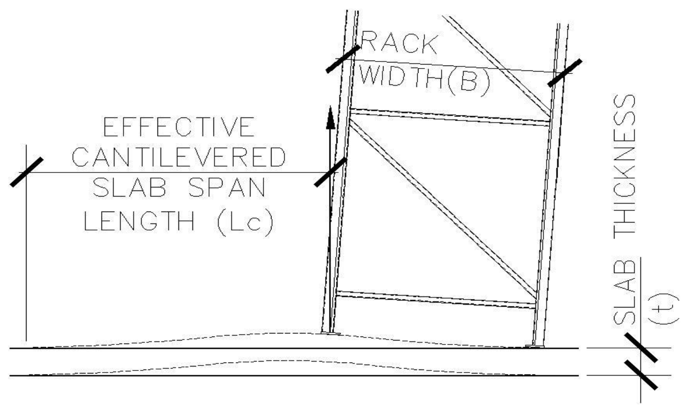
Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf
Max. Service Vertical Load (P) =	2143	lbs
Area reqd. for bearing (A_{reqd}) =	1.43	ft^2
"b" distance =	14.34	in
Slab thickness (t) =	4.00	in
S = (1")(t)^2/6 =	2.67	in^3/in
ϕM_{nt} (tension allowable) = f_t*7.5*[(f'$_c$)$^{1/2}$]*S =	709.93	in-lb/in
Factored uniform bearing, w_u = P_u / A_{reqd} =	12.80	lb/in/in
M_u = wL^2/3 = (w_u)[(b-min(X-X,Y-Y))/2)^2] / 3 =	119.68	in-lb/in - Defl. End M1 = 60 in-lb/in
$M_u/\phi M_{nt}$ =	0.169	< 1.0 O.K.



Rack FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	44	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, f_r = 7.5*SQRT(f'c) =	443.7	psi
Concrete Slab Section Modulus, S = b(t)^2/6 =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, M_{all}/FS = S*f_r/1.5 =	788.8	ft*lbs/ft
Effective Cantilever Span Length (l_c) at M_{all} =	5.6	ft
Total Length of Slab (l_c + Width of Single Rack) =	9.3	ft
Trib. Width of Slab = Trib width of Rack =	8.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	3713.5	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)}$ = P_{conc} * l_c/2 =	206854	in*lbs
Load Combination #1: M_{OT} =	4919	in*lbs
$M_{RST(Rack)}$ + $M_{RST(slab)}$ =	265418	in*lbs
Total Overturning FOS =	53.962	OK
Load Combination #2: M_{OT} =	3562	in*lbs
$M_{RST(Rack)}$ + $M_{RST(slab)}$ =	238754	in*lbs
Total Overturning FOS =	67.029	OK



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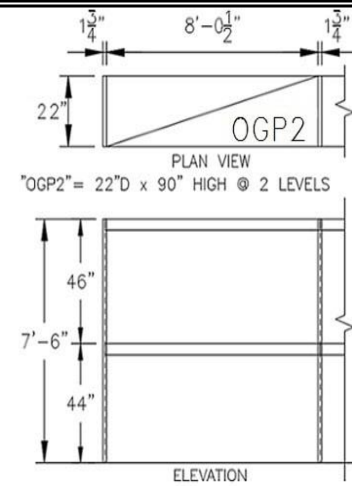
816.421.4200 · WWW.JBAENGR.COM

PROJECT NO:	SHEET NO:	OF:
2431906958	43	44
PROJECT NAME: #6958 - Cameron, NC		
MADE BY: RBC	DATE: 01/03/25	
CHECKED BY:	DATE:	

Storage Rack - Seismic Design — Rack OGP2 — 22-90 OGP

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Seismic Importance Factor (I_p) =	1.0	<--- No Public Access Allowed (Typ. at Back Stockroom / Grocery Storage Areas)	
Supported on Elevated Floor (Y/N):	No		
Max. Weight per level (2 Pallets / shelf) =	600 lbs/shelf		
Weight of Unit =	100 lbs	<--- Shipping weight per Manuf.	
Rack Trib width (CL-to-CL of frames) =	96.5 in		Total Shelf Load
h_9 =	0 in		0 lbs
h_8 =	0 in		0 lbs
h_7 =	0 in		0 lbs
h_6 =	0 in		0 lbs
h_5 =	0 in		0 lbs
h_4 =	0 in		0 lbs
h_3 =	0 in		0 lbs
h_2 =	46 in		600 lbs
h_1 =	44 in		600 lbs
Total Shelf Height, H_t =	90 in		
Unit Height, H_u =	90 in		
Unit Base Depth, D =	22 in		



Note: Per ANSI MH16.1, effective lengths may be determined by rational methods consistent with AISI or AISC. AISC Design by Second-Order Analysis, Section C2.2a is used. Notional loads are applied to gravity load cases and K=1.0 is used since the ratio of second-order drift to first-order drift (P-δ) / (P-Δ) < 1.1.

Overturning Stability (Load cases are per ASCE 7 sect. 15.5.3.6):

Load Case 1 [per RMI sect. 2.6.9(1) - PL=0.67(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic (C_s)(I_p) =	0.055 W_s (Braced)	
	0.020 W_s (Down Aisle)	
W_s = (0.67)(PL_{RF})((0.67)PL)+DL =	638.7 lbs	
Base Shear, V = $C_s I_p W_s$ =	35.1 lbs	(Braced)
	12.8 lbs	(Down Aisle)

Horizontal forces / level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

(Service Loads, E = 0.7)	F_9 =	0.0 lbs	@ 0 in (CM)
Note:	F_8 =	0.0 lbs	@ 0 in (CM)
(CM) = Product Center of	F_7 =	0.0 lbs	@ 0 in (CM)
Mass typically 20 inches	F_6 =	0.0 lbs	@ 0 in (CM)
above the top of shelf at	F_5 =	0.0 lbs	@ 0 in (CM)
each level.	F_4 =	0.0 lbs	@ 0 in (CM)
	F_3 =	0.0 lbs	@ 0 in (CM)
	F_2 =	14.4 lbs	@ 110 in (CM)
	F_1 =	8.8 lbs	@ 67 in (CM)
	F_u =	1.5 lbs	@ 45 in (CM)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 2233 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 9944 in-lbs
Factor of Safety, $FOS_{OT} = M_{RST}/M_{OT}$ = 4.453
NO UPLIFT - NO ANCHORS REQUIRED

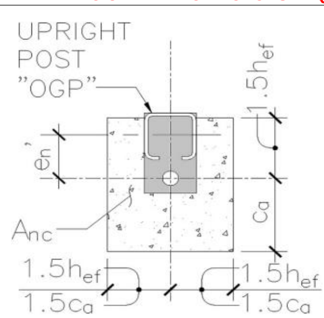
Load Case 2 [per RMI sect. 2.6.9(2) - PL=1.0(PL)]
[RMI sect 2.6.2, PLrf = 1.0]

Seismic (C_s)(I_p) =	0.055 W_s (Braced)	
	0.020 W_s (Down Aisle)	
W_s = (0.67)(PL_{RF})((1)PL)+DL =	502.0 lbs	
Base Shear, V = $C_s I_p W_s$ =	27.6 lbs	(Braced)
	10.0 lbs	(Down Aisle)

Horizontal forces / level, $F_x = C_{vx}V$ (RMI sect 2.6.6)

(Service Loads)	F_9 =	0.0 lbs	
	F_8 =	0.0 lbs	
	F_7 =	0.0 lbs	
	F_6 =	0.0 lbs	
	F_5 =	0.0 lbs	
	F_4 =	0.0 lbs	
	F_3 =	0.0 lbs	
	F_2 =	18.1 lbs	@ 110 in (CM)
	F_1 =	0.0 lbs	
	F_u =	1.2 lbs	@ 45 in (CM)

Calculate Overturning Moment (Service), $M_{OT} = \Sigma f_i h_i$
M_{OT} = 2046 in-lbs
Calculate Resisting Moment (Service), M_{RST}
M_{RST} = 7700 in-lbs
Factor of Safety, $FOS_{OT} = M_{RST}/M_{OT}$ = 3.764
NO UPLIFT - NO ANCHORS REQUIRED



Anchor Design (using "Cracked Concrete" Properties)

Upright Post Type =	OGP		
Try:	3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.		
Embedment (h_{nom}) =	2 in		
f_c' =	3500 psi		
e_n' =	1.875 in	<-- Eccen. of Anchor	
h_{ef} =	1.33 in	1.5(h_{ef}) =	1.995 in
Conc. thickness, t =	4 in	1.5(C_a) =	7.500 in
# of Anchors, n =	1		
Sx =	0.00 in		
Sy =	0.00 in		
A_{se} =	0.094 in^2		

Base Reactions:

	LC #1		LC #2	
R_h =	12 lbs		10 lbs	
R_v =	0 lbs		0 lbs	
Overturning FOS =	4.453	>= 1.5	3.764	>= 1.5
Sliding Restraint, R_{RST}/FOS =	105lbs / 8.558 >= 1.5 OK		86lbs / 8.899 >= 1.5 OK	
Reactions (Factored Loads):	LC #1		LC #2	
Base Shear (R_{uh}) =	35 lbs		28 lbs	
Net Uplift (R_{uv}) =	0 lbs		0 lbs	
Overturning + Gravity (P_u) =	1025 lbs		634 lbs	
Tension Allowables				
Steel Strength, ϕN_{sa} =	5675 lbs	<--ACI 318-14 Eq 17.4.1.2		
Concrete Breakout, (0.75)ϕN_{cbg} =	752 lbs	<--ACI 318-14 Eq 17.4.2.1b		
Pullout Strength, (0.75)ϕN_{pn} =	519 lbs	<--ACI 318-14 Eq 17.4.3.1		
Factored Tension Load, (N_u) =	0 lbs	(LC #1)	0 lbs	(LC #2)
max tension stress ratio (TSR) =	0.000	OK (LC#1)	0.000	OK (LC#2)
Shear Allowables				
Steel Strength, ϕV_{sa} =	1449 lbs	<--ACI 318-14 Eq 17.5.1.2b		
Concrete breakout (Yg), ϕV_{cbg} =	2334 lbs	<--ACI 318-14 Eq 17.5.2.1b		
Concrete breakout (Xg), ϕV_{cbg} =	1867 lbs	<--ACI 318-14 Eq 17.5.2.1b		
Concrete pryout, ϕV_{cpg} =	1080 lbs	<--ACI 318-14 Eq 17.5.3.1b		
	LC #1		LC #2	
Factored Shear Load (V_u) : Braced =	35 lbs		28 lbs	
Down Aisle =	13 lbs		10 lbs	
Max shear stress ratio (VSR) : Braced =	0.033	OK	0.026	OK
Down Aisle =	0.012	OK	0.009	OK
Braced (TSR+VSR <= 1.2) =	0.033	<= 1.2 OK - LC #1 Controls		
Down Aisle (VSR <= 1.0) =	0.012	OK - LC #1 Controls		

USE: NO UPLIFT - (1) 3/8"Ø DeWalt Screw Bolt+ Anchor - 2" embed.

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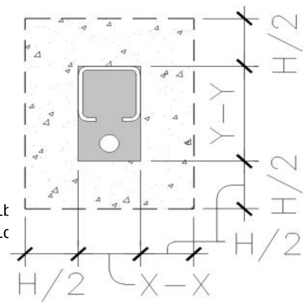
PROJECT NO:	SHEET NO:	OF:
2431906958	44	44
PROJECT NAME: #6958 - Cameron, NC		
MADE BY: RBC	DATE: 01/03/25	
CHECKED BY:	DATE:	

Storage Rack - Seismic Design   Rack OGP2   22-90 OGP

2018 NORTH CAROLINA BUILDING CODE / IBC 2015 / ASCE 7-10 / 2012 RMI (ANSI/MH16.1-12)

Punching Shear Check:
(Design per ACI 318-14 section 14.5.5)

Max. Factored Vertical Load (P_u) =	1025	lbs	
Slab Concrete f'c =	3500	psi	
Slab thickness (t) =	4	in.	
Rack Post X-X =	1.75	in.	
Rack Post Y-Y =	3.00	in.	
b_o =	25.50	in.	
β =	1.71		
V_n =	17433	lbs	Table 14.5.5.1b
V_n max =	16052	lbs	Table 14.5.5.1c
ϕV_n =	9631	lbs	
$V_u/\phi V_n$ =	0.106	< 1.0 O.K.	



Max Vertical Load (ASD) - RMI, sect 2.1 - LC#4:
P = (1+0.105Sds)DL+(3/4)[(1.4+0.14Sds)PL+(0.7)ρEL]

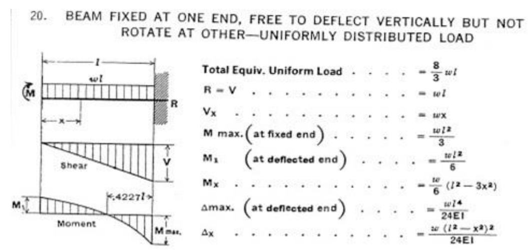
S_{DS} =	0.220	(Ip=1)
DL = (Frame Wt/2) =	50	lbs
PL = Σ(Shelf Load h_1 - h_9)/2 =	600	lbs
EL = $M_{OT, LC\#1}$ / ((0.7)(D)) =	217	lbs
P =	771	lbs <--- At Each Post

Max Vertical Load (LRFD) - RMI, sect 2.2 - LC#5:
P = (1.2+0.2SDS)DL + (1.2+0.2Sds)PL + ρEL

P_u =	1025	lbs <--- At Each Post

Slab tension based on Soil bearing area check:

Allowable soil bearing =	1500	psf
Max. Service Vertical Load (P) =	771	lbs
Area reqd. for bearing (A_{reqd}) =	0.51	ft^2
"b" distance =	8.60	in
Slab thickness (t) =	4.00	in
S = (1")$(t)^2$/6 =	2.67	in^3/in
ϕM_{nt} (tension allowable) = f_t*7.5*$[(f'_c)^{1/2}]$*S =	709.93	in-lb/in
Factored uniform bearing, w_u = P_u / A_{reqd} =	13.85	lb/in/in
M_u = wL^2/3 = $(w_u)[(b\text{-min(X-X,Y-Y)})/2)^2]$ / 3 =	54.20	in-lb/in - Defl. End M1 = 28 in-lb/in
$M_u/\phi M_{nt}$ =	0.076	< 1.0 O.K.



Rack FOS Overturning with Resistance from Effective Weight of Slab on Grade:

Width of Single Rack =	22	in
Slab thickness (t) =	4.0	in
Modulus of Rupture, f_r = 7.5*SQRT(f'c) =	443.7	psi
Concrete Slab Section Modulus, S = $b(t)^2$/6 =	32.0	in^3/ft
Allowable Concrete Slab Bending Moment, M_{all}/FS = S*f_r/1.5 =	788.8	ft*lbs/ft
Effective Cantilever Span Length (l_c) at M_{all} =	5.6	ft
Total Length of Slab (l_c + Width of Single Rack) =	7.5	ft
Trib. Width of Slab = Trib width of Rack =	8.0	ft
Weight of Concrete Slab at Rack (P_{conc}) =	2995.7	lbs
Resisting Moment - Concrete Slab at Rack, $M_{RST(slab)}$ = P_{conc} * l_c/2 =	133917	in*lbs
Load Combination #1: M_{OT} =	2233	in*lbs
$M_{RST(Rack)}$ + $M_{RST(slab)}$ =	143861	in*lbs
Total Overturning FOS =	64.416	OK
Load Combination #2: M_{OT} =	2046	in*lbs
$M_{RST(Rack)}$ + $M_{RST(slab)}$ =	141617	in*lbs
Total Overturning FOS =	69.224	OK