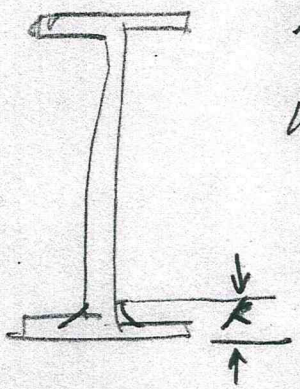
Savoy Engineering

Project: CAVENDISH ER BRF **Date:** 1-2/14 **Sheet** __ **of** __

Prepared By: Phil Savoy P.E. **Project Details** STRUCTURALS

GIRDERS, CHECK BUCKLING



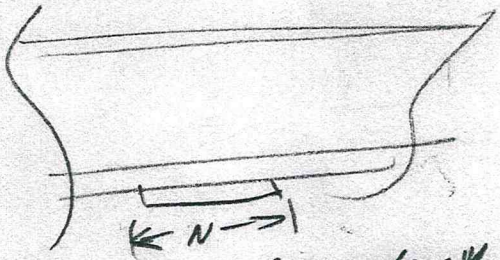
MAX BUCKLING LOAD, KIPS = $0.66 F_{yw} t_w (N + 5k)$

WHERE; $F_{yw} = 36$ KIPS

$t_w = 0.5''$

$N = 12''$

$K = 1.375''$



N = Bearing Length, 12"

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MAX LOAD = $(0.66)(36)(0.5)(12 + (5)1.375)$

= 224.23 KIPS

100 TON JACK USED = $(100)(2000) = 200{,}000\#$ = 200 KIPS

200 KIPS MAX OUTPUT OF JACK

MAX GIRDER WGT; ON EACH JACK ⇒ 46,250# ⇒ 46.25 KIPS

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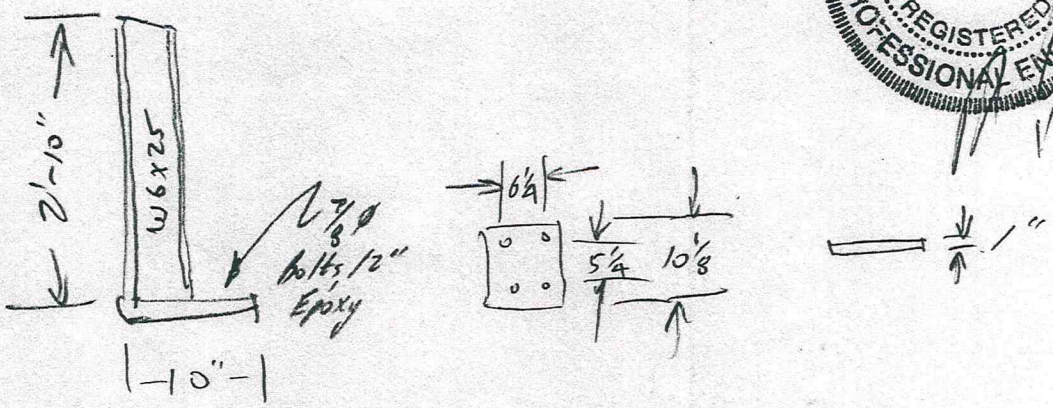
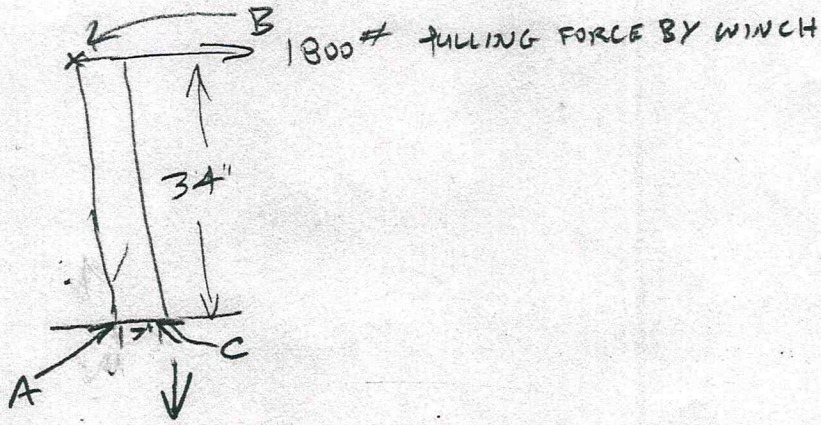
ANCHOR POST CHECK





$\Sigma M_C = 0 = (B)34" - (A)7"$

$(1800)34 = A(7)$

$A = 8{,}742.8\#$, MAX PULL-UP LOAD

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Project:_____ **Date:**_____ **Sheet**__ **of**___

Prepared By:_____ **Project Details**_____

Pull-Out Load on Epoxy in Bolt Hole:

1" DIA HOLE, W/ 10" BOLT, F = 25,130 #,

PER 1 BOLT, OK

TENSILE STRENGTH OF BOLTS:

ASTM A325, YIELD KSI = 77 KSI

W/ 7/8 -9 BOLT; TENSILE AREA = 0.462 in²

MAX STRENGTH = $\frac{77000\ \#}{in^2} \cdot 0.462\ in^2 = 35,574\ \#$

PER 1 BOLT, OK

MAX PULL-UP LOAD = 8,742.8 # OK

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Project:_____ **Date:**_____ **Sheet**__ **of** ___

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SHEAR STRENGTH OF BOLTED JOINT

FOR WINCHING PBU:

(2) 7/8" DIA BOLTS

$A_T = 0.462\ in^2$, $\sigma_T = 77000\ psi$

SHEAR $= V = 5/3\ T = 5/3(77000) = 128,333\ psi$

MAX LOAD IN SHEAR $= (.462)\ in^2 \times 128333\ \frac{\#}{in^2} =$

$= 59,290\ \#$ FORCE PER BOLT.

PULLING FORCE $= 1,900\ \#$, OK.

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Project: Cavendish Bridge

Location: Multi-Loaded Multi-Span Beam 1
Multi-Loaded Multi-Span Beam
[2009 International Building Code(AISC 13th Ed ASD)]
A992-50 W6x25 x 6.4 FT (3.2 + 3.2)
Section Adequate By: 386.2%
Controlling Factor: Deflection

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StruCalc Version 8.0.113.0 1/21/2014 07:51:13

DEFLECTIONS

	Center		Right	
Live Load	0.00	IN L/9095	0.04	IN 2L/1750
Dead Load	0.00	in	0.00	in
Total Load	0.00	IN L/8974	0.04	IN 2L/1722

Live Load Deflection Criteria: L/360 Total Load Deflection Criteria: L/240

REACTIONS

	B
Live Load	5400 lb
Dead Load	160 lb
Total Load	5560 lb
Uplift (1.5 F.S)	**0 lb**
Bearing Length	0.71 in

BEAM DATA

	Center	Right
Span Length	3.2 ft	3.2 ft
Unbraced Length-Top	0 ft	0 ft
Unbraced Length-Bottom	3.2 ft	3.2 ft

STEEL PROPERTIES
W6x25 - A992-50

Properties:

Yield Stress:	Fy =	50	ksi
Modulus of Elasticity:	E =	29000	ksi
Depth:	d =	6.38	in
Web Thickness:	tw =	0.32	in
Flange Width:	bf =	6.08	in
Flange Thickness:	tf =	0.46	in
Distance to Web Toe of Fillet:	k =	0.71	in
Moment of Inertia About X-X Axis:	Ix =	53.4	in4
Section Modulus About X-X Axis:	Sx =	16.7	in3
Plastic Section Modulus About X-X Axis:	Zx =	18.9	in3

Design Properties per AISC 13th Edition Steel Manual:

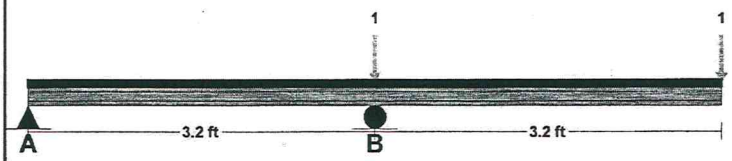
Flange Buckling Ratio:	FBR =	6.68	
Allowable Flange Buckling Ratio:	AFBR =	9.15	
Web Buckling Ratio:	WBR =	15.53	
Allowable Web Buckling Ratio:	AWBR =	90.55	
Controlling Unbraced Length:	Lb =	3.2	ft
Limiting Unbraced Length - for lateral-torsional buckling:	Lp =	5.37	ft
Elastic lateral-torsional buckling stress:	Fcr =	0	ksi
Nominal Flexural Strength w/ safety factor:	Mn =	47156	ft-lb
Controlling Equation:	F2-1		
Web height to thickness ratio:	h/tw =	15.53	
Limiting height to thickness ratio for eqn. G2-2:	h/tw-limit =	53.95	
Cv Factor:	Cv =	1	
Controlling Equation:	G2-2		
Nominal Shear Strength w/ safety factor:	Vn =	40832	lb

Controlling Moment: -5888 ft-lb
3.2 Ft from left support of span 2 (Center Span)
Created by combining all dead loads and live loads on span(s) 2, 3
Controlling Shear: -1880 lb
3.0 Ft from left support of span 2 (Center Span)
Created by combining all dead loads and live loads on span(s

Comparisons with required sections:

	Req'd	Provided
Moment of Inertia (deflection):	10.98 in4	53.4 in4
Moment:	-5888 ft-lb	47156 ft-lb
Shear:	-1880 lb	40832 lb

LOADING DIAGRAM



UNIFORM LOADS

	Center	Right
Uniform Live Load	0 plf	0 plf
Uniform Dead Load	0 plf	0 plf
Beam Self Weight	25 plf	25 plf
Total Uniform Load	25 plf	25 plf

POINT LOADS - CENTER SPAN

Load Number	One
Live Load	1800 lb
Dead Load	0 lb
Location	3.2 ft

RIGHT SPAN

Load Number	One
Live Load	1800 lb
Dead Load	0 lb
Location	3.2 ft

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NOTES
(ANCHOR POST BENDING LOAD)

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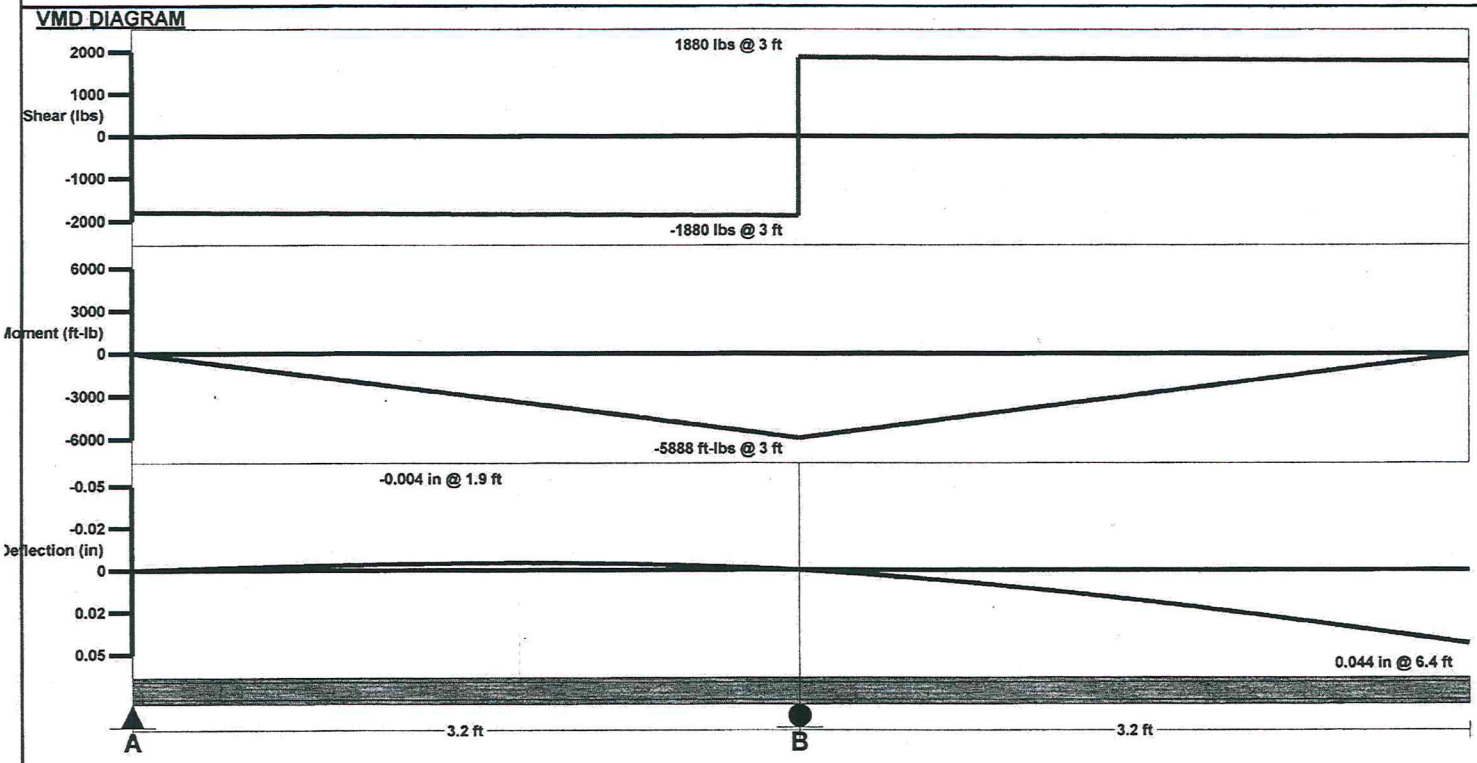
VMD DIAGRAM



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EQUIPMENT FOUNDATION SYSTEMS

Chockfast® ESCOWELD

Calculating Anchor Bolt Pullout Strength

Technical Bulletin # 691B

Bulletin Description

Anchor bolt Pull Out Strength is the force required to pull a single bolt out of its foundation. The separation can occur between the epoxy grout and the concrete foundation or it can occur between the anchor bolt and the epoxy grout itself. This bulletin provides the formulas needed to calculate the force required to pull an anchor bolt out in either manner.

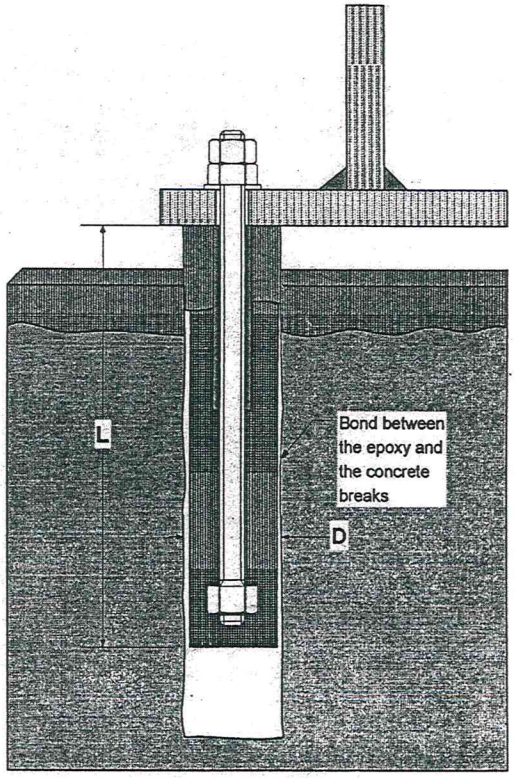
To calculate the Total Pull Out Strength of the entire machine, multiply the force required to pull one bolt out times the total number of bolts.

When calculating Pull Out Strength it is assumed that:

1. A clean, threaded rod or bolt with a coarse surface profile is used.
2. A nut and washer are installed at the bottom of the rod to act as a mechanical interference.
3. The anchor bolt hole is clean and dry, with no contaminants.

Bond Strength Epoxy to Concrete

The bond of the epoxy grout to the concrete foundation is stronger than the bond of the concrete to itself. Typically, concrete will separate next to the bond line of the epoxy and concrete. Therefore, the weakest link in the bond of epoxy to concrete is the concrete itself. The force required to pull concrete apart is called its *Shear Strength*. A conservative value for concrete shear strength is 800 psi. To determine the force required to pullout the bolt separating it at the epoxy to concrete bond, use the following calculation:



$$\text{Force} = D \times \pi \times L \times 800 \text{ psi}$$

Where:
F = Bolt Pullout Force in lbs.
D = Grout Hole Diameter in inches
L = Length in inches of the grout hole

π = 3.1415

Below are examples of the force required to pull out various size bolts out of various size holes.

PULL OUT STRENGTH IN POUNDS				
	BOLT LENGTH			
HOLE DIAMETER	3"	4"	5"	10"
5/8"	4,710	6,280	7,850	15,700
3/4"	5,650	7,530	9,420	18,840
1"	7,530	10,050	12,560	25,130
1.5"	11,309	15,070	18,840	37,690
2.0"	15,070	20,100	25,130	50,260

ITW PHILADELPHIA RESINS
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ISO 9001:2000 CERTIFIED

Size	Series	Tensile stress area A_s (in.^{2})	Preload (F_p) at 25 KSI (kip)	Torque to achieve 25 KSI (in.-lb)
7/16 - 16	UN	0.1114	2.785	244
7/16 - 20	UNF	0.1187	2.968	260
7/16 - 28	UNEF	0.1274	3.185	279
7/16 - 32	UN	0.1301	3.253	285
1/2 - 13	UNC	0.1419	3.548	354.8
1/2 - 16	UN	0.151	3.775	378
1/2 - 20	UNF	0.1599	3.998	399.8
1/2 - 28	UNEF	0.170	4.250	425
1/2 - 32	UN	0.173	4.325	433
9/16 - 12	UNC	0.182	4.550	512
9/16 - 16	UN	0.198	4.950	557
9/16 - 18	UNF	0.203	5.075	571
9/16 - 20	UN	0.207	5.175	583
9/16 - 24	UNEF	0.214	5.350	602
9/16 - 28	UN	0.219	5.475	616
9/16 - 32	UN	0.222	5.550	625
5/8 - 11	UNC	0.226	5.650	706
5/8 - 12	UN	0.232	5.800	725
5/8 - 16	UN	0.250	6.25	781
5/8 - 18	UNF	0.256	6.400	800
5/8 - 20	UN	0.261	6.525	816
5/8 - 24	UNEF	0.268	6.700	838
5/8 - 28	UN	0.274	6.850	856
5/8 - 32	UN	0.278	6.950	869
13/16 - 12	UN	0.289	7.225	994
11/16 - 16	UN	0.308	7.700	1,060
11/16 - 20	UN	0.320	8.000	1,101

Size	Series	Tensile stress area A_s (in.^{2})	Preload (F_p) at 25 KSI (kip)	Torque achiev 25 KSI (in.-lb
11/16 - 24	UNEF	0.329	8.225	1,132
11/16 - 28	UN	0.335	8.375	1,152
11/16 - 32	UN	0.339	8.475	1,166
3/4 - 10	UNC	0.334	8.350	1,253
3/4 - 12	UN	0.351	8.775	1,316
3/4 - 16	UNF	0.373	9.325	1,399
3/4 - 20	UNEF	0.386	9.650	1,448
3/4 - 28	UN	0.402	10.05	1,508
3/4 - 32	UN	0.407	10.18	1,527
13/16 - 12	UN	0.420	10.50	1,707
13/16 - 16	UN	0.444	11.10	1,805
13/16 - 20	UNEF	0.458	11.45	1,862
13/16 - 28	UN	0.475	11.88	1,932
13/16 - 32	UN	0.480	12.00	1,951
7/8 - 9	UNC	0.462	11.55	2,021
7/8 - 12	UN	0.495	12.38	2,167
7/8 - 14	UNF	0.509	12.73	2,228
7/8 - 16	UN	0.521	13.03	2,280
7/8 - 20	UNEF	0.536	13.40	2,345
7/8 - 28	UN	0.554	13.85	2,424
7/8 - 32	UN	0.560	14.00	2,450
15/16 - 12	UN	0.576	14.40	2,701
15/16 - 16	UN	0.604	15.10	2,833
15/16 - 20	UNEF	0.620	15.50	2,908
15/16 - 28	UN	0.640	16.00	3,003
15/16 - 32	UN	0.646	16.15	3,030

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Spec.	Grade	Proof KSI	Proof MPa	Yield KSI	Yield MPa
	B6X			70	483
	B7			75-95	517-724
	B7M			80	552
	B8-CL 1			30-35	207-241
	CL 2			50-100	345-689
	B16			85-105	586-724
ASTM A320	L7			105	724
	L8			30	207
	B8			50	345
ASTM A325				77	531
ASTM A354	BC			109-115	752-793
	BD			140-150	965-1034
ASTM A449				55-95	379-655
ASTM A453	660			85	586
	651			50-70	345-483
	662			80-85	552-586
	665			120	827
ASTM A490				115-125	793-862
ASTM A540	B21-B24			150	1034
	-Class 1			140	965
	-Class 2			130	896
	-Class 3			120	827
	-Class 4			100	689
	-Class 5				

Spec.	Grade	Proof KSI	Proof Mpa	Yield KSI	Yield MPa
AISI	1141			36	248
	1144			36	248
	4040			130-165	896-1137
	4340			150-170	1033-1171
Stainless steel	304			40	276
	316			45	310
	XM7			45	310
	384			45	310
	410-H			95	655
	410-HT			135	931
	416-H			95	655
	416-HT			135	931
	430			40	276
British standards					
BS 1768: 1963	P	40	276		
	S	76	524		
	T	82	565		
	V	99.0	683		
	X	120	827		

Bolts: Metric

Spec.	Grade	Proof KSI	Proof MPa	Yield KSI	Yield MPa
ISO R898	3.6	26.7	184	28.4	196
	4.6	32.2	222	34.1	235

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