Cives Steel Company
NEW ENGLAND DIVISION

Maine Medical Center - East Tower

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Calculations Number: P7

Revision Mumber: 0

Approved By: BMV

Date: 2/15/18

TURNER CONSTRUCTION COMPANY
Reviewed for General Acceptance only. This review does not relieve the Subcontractor of the responsibility for making the work conform to the requirements of the contract. The Subcontractor is responsible for all dimensions, correct fabrication and accurate fit with the work of other trades.
SUBJECT TO ARCHITECTS APPROVAL
Signed rmartineau Date Feb 20, 2018
Submittal No. 051200-001-0

P7 WAT 1/26

BEAM SHEAR REACTION TABLE WITH MINIMUM WEB THICKNESS REQUIRED FOR HORIZONTAL FACTORED TENSILE FORCE (REFERENCE BEAM SHEAR REACTION TABLE FROM DETAIL 1, DRAWING S00-21)				
BEAM SIZE	VERTICAL FACTORED (LOAD) REACTION (KIPS)	MINIMUM NUMBER OF BOLTS	HORIZONTAL FACTORED TENSILE FORCE (KIPS)	MINIMUM WEB THICKNESS REQUIRED (IN)
W8X24 AND LIGHTER	29	2	20	0.100
W8X28 AND HEAVIER	30	2	20	0.100
W10x26 AND LIGHTER	30	2	20	0.100
W10x30 AND HEAVIER	30	2	20	0.100
W12x22 AND LIGHTER	30	2	20	0.100
W12x26 AND HEAVIER	40	3	27	0.106
W14x26 AND LIGHTER	44	3	30	0.106
W14x30 AND HEAVIER	47	3	32	0.106
W16x31 AND LIGHTER	47	3	32	0.106
W16x36 AND HEAVIER	64	4	43	0.107
W18x46 AND LIGHTER	64	4	43	0.107
W18x50 AND HEAVIER	80	5	54	0.125
W21x62 AND LIGHTER	78	5	52	0.125
W21x68 AND HEAVIER	105	6	70	0.144
W24x55 AND LIGHTER	94	5	63	0.125
W24x62 AND HEAVIER	109	6	73	0.144
W27x94 AND LIGHTER	130	6	87	0.144
W27x102 AND HEAVIER	130	6	87	0.144
W30x99 AND LIGHTER	130	6	87	0.144
W30x108 AND HEAVIER	130	6	87	0.144
W33/W36	140	8	94	0.117
W40	140	9	94	0.104
C6	23	2	16	0.106
C8	25	2	17	0.106
C10/C12	28	2	19	0.106

Note:
P7 has been prepared to address the integrity requirements outlined by the project. P7 will be referenced for all standard shear P-sheets on the project. P7 is signed and sealed and by reference, the standard shear P-sheets which are also signed and sealed will cover both the standard shear portion and the integrity requirements for the project. P7 aims to capture the demand per the "Beam Shear Reaction Table" shown S00-21. Special shear values that are shown on the plans and are outside of this chart will be handled on a case by case basis within the shear P-sheet.

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Design No. P7 Made by WDT Sheet 2 of 26

Checked by Date 2/15/18

Subject Structural Integrity for Beam Connection

Bolts = A325N 7/8 ϕ $F_v = 54$ ksi

$r_v = 54\left(\frac{\pi}{4}\right)(0.875)^2 = 32.5$ k/bolt

Plates = 1/2 x 5 A572-50

Holes = HSSL in plates – 15/16 x 1 1/8

STD in Beam Webs, 15/16 ϕ

Beams = A992, $F_y = 50$, $F_u = 65$

Channels: A36, $F_y = 36$, $F_u = 58$

Required Axial Demand per S00-21, detail 1

Limit States = Checked (For Plate and Beam web)

1. Bolt shear: r_v Table J3.2
2. Tearout: r_{to} J3.10
3. Bearing: r_p J3.10
4. Net Tension: R_{nt} J4.1
5. Block shear, "L" and "U" shaped modes, BS_L and BS_U. J4.3
6. Weld for plate J2.4

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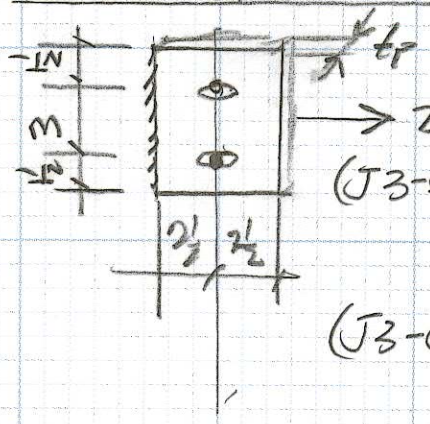
Design No. P7 Made by WAT Sheet 3 of 20

Checked by _____ Date 2/15/18

Subject _____

2 Rows of Bolts $A_r = 20^K$

Plate



1. $R_x = 32.5(2) = 65^K$

(J3-6b) 2. $r_{to} = 1.5(65)[2.5 - 0.5(1.125)]t_p$

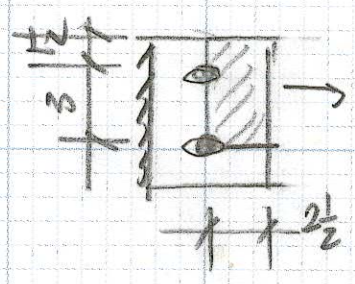
$= 189\,t_p$ $R_{to} = 2(189)t_p = 378t_p$

(J3-6b) 3. $r_p = 3.0(65)(0.875)(t_p)$

$= 171\,t_p$ $R_p = 2(171t_p) = 342t_p$

4. $R_{Nt} = 65)[6 - 2(1.0)]t_p = 260\,t_p$

5. a BS_L



$A_{gv} = (2.5)(t_p) = 2.5t_p$

$A_{nv} = [2.5 - 0.5(1.1875)]t_p = 1.91\,t_p$

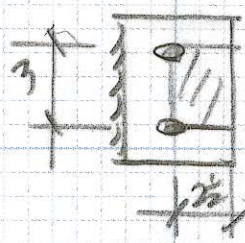
$A_{nt} = [4.5 - 1.5(1.0)]t_p = 3.0\,t_p$

$F_u A_{nt} = 65(3.0\,t_p) = 195\,t_p$

$0.6F_y A_{gv} = 0.6(50)(2.5t_p) = 75\,t_p$

$0.6F_u A_{nv} = 0.6(65)(1.91\,t_p) = 74.5\,t_p$

b BS_U



(J4-5) $R_{BS_L} = 195\,t_p + 74.5\,t_p = 270\,t_p$

$A_{gv} = 2.5\,t_p(2) = 5t_p$

$A_{nv} = [2.5 - 0.5(1.187)]t_p(2) = 3.81t_p$

$A_{nt} = [3 - 1(1.0)]t_p = 2t_p$

$F_u A_{nt} = 65(2t_p) = 130\,t_p$

$0.6F_y A_{gv} = 0.6(50)(5t_p) = 150t_p$

$0.6F_u A_{nv} = 0.6(65)(3.81t_p) = 148.6t_p$

$R_{BS_{LL}} = 130 t_p + 149 = 279\ t_p$

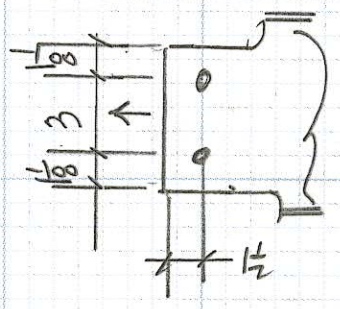
6. Weld $R_w = 0.6(70)(6)(0.625 t_p)(2)\frac{1}{\sqrt{2}} = 223\ t_p$

Since $t_p = 0.5$

$R_{plate} = \min\{65, 378 t_p, 392 t_p, 260 t_p, 270 t_p, 279 t_p, 223 t_p\}$
$= \min\{65, 223(0.5)\} = 65^k > 20^k$ ok

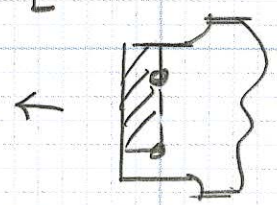
Shear plate ½" thick is OK

Beam Web Tensile Strength



Dimensions used are "worst" case dimensions

1. $R_x = 2(32.5) = 65^k$ ✓
2. $r_{to} = 1.5(65)[1.5 - 0.5(0.875)]t_w$
$= 101 t_w$ ✓
$R_{to} = 101 t_w (2) = 202 t_w$.
3. $r_p = 3.0(65)(0.875)(t_w) = 171 t_w$ ✓
$R_p = 171 t_w (2) = 342 t_w$.
4. $R_{nt} = 65[3 + 2(1.125) - 2(1.0)]t_w = 211 t_w$.
5. BS_L

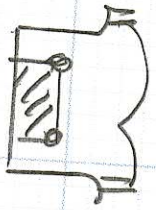


$A_{gv} = 1.5 t_w$.
$A_{nv} = [1.5 - 0.5(1.0)]t_w = 1 t_w$ ✓
$A_{nt} = [4.125 - 1.5(1.0)]t_w = 2.625 t_w$ ✓
$F_u A_{nt} = 65(2.625 t_w) = 171 t_w$.
$0.6 F_{ty} A_{gv} = 0.6(50)(1.5 t_w) = 45 t_w$.

$0.6 F_u A_{nv} = 0.6(65)(2t_w) = 39t_w$

$R_{BS_L} = (171+39)t_w = 210\,t_w$

BS U



$A_{gv} = 1.5(2)t_w = 3t_w$

$A_{nv} = [1.5 - 0.5(1.0)](2)t_w = 2t_w$

$A_{nt} = [3 - 1(1.0)]t_w = 2t_w$

$F_u A_{nt} = 65(2t_w) = 130t_w$

$0.6 F_y A_{gv} = 0.6(50)(3t_w) = 90\,t_w$

$0.6 F_u A_{nv} = 0.6(65)(2t_w) = 78t_w$

$R_{BS_U} = (130+78)t_w = 208\,t_w$

$R_{web} = \min\{65, 202t_w, 342t_w, 214t_w, 210t_w, 208t_w\}$

$202t_w \geq 20 \rightarrow t_w \geq 0.099$

Tearout Controls – Min web thickness is 0.099"

All W8's and W12's to W12x22 have webs $t_w > 0.099$"

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3 Rows of Bolts $A_r = 32^k$

Plate

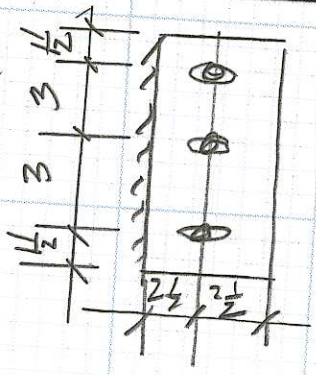


Plate is ½"

1.) Bolts max $R_v = 3 \times 32.5 = 97.5^k$

2.) Tearout

$R_{to} = 1.5(65)[2.5 - 0.5(1.125)](0.5)(3)$

$= 283^k$

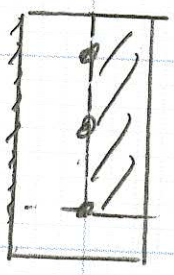
3. Bearing

$R_p = 3.0(65)(0.875)(0.5)(3) = 256^k$

4. Net Tension $R_{nt} = 65[9 - 3(1.0)](0.5) = 195^k$

5 Block Shear

a. L shaped



$A_{gv} = 2.5(0.5) = 1.25$

$A_{nv} = (2.5 - 0.5(1.875))(0.5) = 0.953$

$A_{nt} = (7.5 - 2.5(1.0))(0.5) = 2.5$

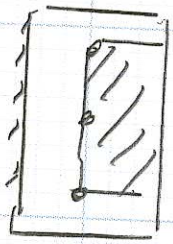
$F_u A_{nt} = 65(2.5) = 162^k$

$0.6 F_y A_{gv} = 0.6(50)(125) = 37.5$

$0.6 F_u A_{nv} = 0.6(65)(0.953) = 37.2$

$R_{BS_L} = 162 + 37.2 = 199^k$

b. Ushaped



$A_{gv} = 2.5(0.7)(2) = 2.5$

$A_{nv} = [2.5 - 0.5(1.875)](0.7)(2) = 1.91$

$A_{nt} = [6 - 2(1.0)](0.7) = 2.0$

$F_u A_{nt} = 65(2.0) = 130$

$0.6 F_y A_{gv} = 0.6(50)(2.5) = 75$

$0.6 F_u A_{nv} = 0.6(65)(2.0) = 78$

$R_{BS_U} = 130 + 75 = 205^k$

6. Weld $R_w = 0.6(70)\left(\frac{0.625}{\sqrt{2}}\right)(0.5)(9)(2) = 167^k$

$R_{plate} = \min\{97.5, 283, 256, 195, 199, 205, 167\} = 97.5^k$

1/2 shear plate is OK

32^k ea

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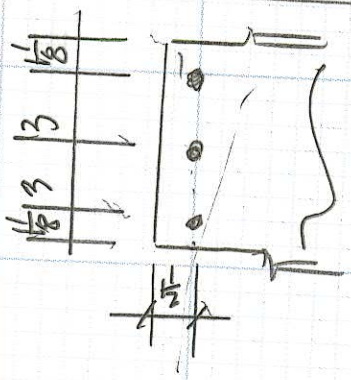
Design No. P7 | Made by WAF | Sheet 7 of 26

Subject | Checked by | Date 2/15/18

Beam Web Tensile Strength



1.) Bolt shear

$R_v = 3(32.5) = 97.5^k$

2.) Bolt Tearout

$R_{to} = 1.5(65)[1.5 - 0.5(0.6875)]t_w(3) = 302 t_w$ ✓

3. Bolt Bearing

$R_{bp} = 3.0(65)(0.875)(t_w)(3) = 512 t_w$ ✓

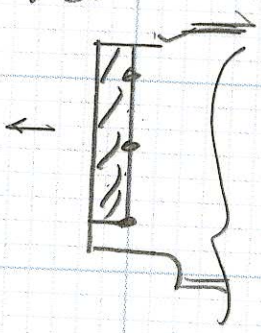
4. Net Tension

$R_{nt} = 65[8.25 - 3(1.0)]t_w = 341 t_w$ ✓

4a Gross Tension

$R_{gt} = 50(8.25)t_w = 412 t_w$ ← never controls ✓

5. Block Shear



a. L shaped

$A_{gv} = 1.5 t_w$

$A_{nv} = [1.5 - 0.5(1.0)]t_w = 1 t_w$ ✓

$A_{nt} = [7.125 - 2.5(1.0)]t_w = 4.625 t_w$ ✓

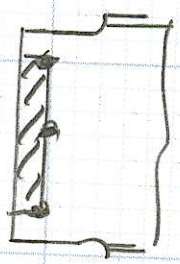
$F_u A_{nt} = 65(4.625 t_w) = 301 t_w$

$0.6 F_y A_{gv} = 0.6(50)(1.5 t_w) = 45 t_w$

$0.6 F_u A_{nv} = 0.6(65)(1.0 t_w) = 39 t_w$

$R_{bs_L} = (301 + 39)t_w = 340 t_w$

b.) U shaped



$A_{gv} = 3t_w$

$A_{nv} = 2t_w$

$A_{nt} = [6 - 2(1.0)]t_w = 4t_w$

$F_u A_{nt} = 65(4)t_w = 260\,t_w$

$0.6F_y A_{gv} = 0.6(50)(3t_w) = 90\,t_w$

$0.6F_u A_{nv} = 0.6(65)(2t_w) = 78\,t_w$

$R_{bsU} = (260 + 78)t_w = 338\,t_w$

$R_{web} = \min\{97.5,\ 302t_w,\ 512t_w,\ 341t_w,\ 390t_w,\ 338t_w\}$

$302t_w \geq 32 \quad t_w \geq 0.106$

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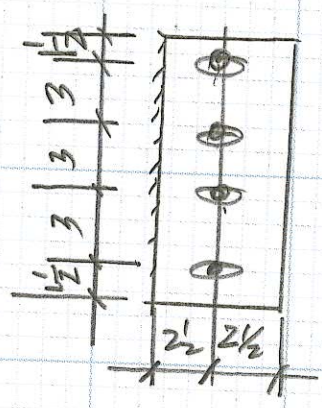
4 Rows of Bolts $A_r = 43^K$

Plate

$1/2 \times 5 \times 12$



1.) Bolt shear

$R_v = 32.5(4) = 130^K$

2.) Tearout

$R_{to} = 1.5(65)[2.5 - 0.5(1.125)]0.5(4)$

$= 378^K$

3.) Bearing

$R_p = 3.0(65)(0.875)(0.5)(4) = 341^K$

4.) Net Tension

$R_{nt} = [12 - 4(1.0)]65(0.5) = 260^K$

5.) Block shear

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Design No. P7 Made by WAT Sheet 9 of 26

Checked by Date 2/15/18

Subject

5a L shaped

$A_{gx} = 2.5(0.5) = 1.25$

$A_{nv} = (2.5 - 0.5(1.1875))(0.5) = 0.953$

$A_{nt} = (10.5 - 3.5(1.0))(0.5) = 3.5$

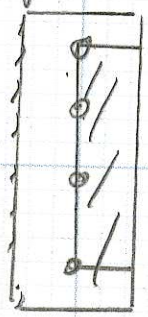
$F_u A_{nt} = 65(3.5) = 228$

$0.6 F_y A_{gv} = 0.6(50)(1.25) = 37.5$

$0.6 F_u A_{nv} = 0.6(65)(0.953) = 37.2$

$R_{BS_L} = (175.6 + 37.2) = 265^k$

5b U shaped



$A_{gv} = 2.5$

$A_{nv} = 1.91$

$A_{nt} = (9 - 3(1.0))(0.5) = 3.0$

$F_u A_{nt} = 65(3.0) = 195$

$0.6 F_y A_{gv} = 0.6(50)(2.5) = 75$

$0.6 F_u A_{nv} = 0.6(65)(1.91) = 74.5$

$R_{BS_U} = (195 + 74.5) = 270^k$

6. Weld $R_w = 0.6(70)\left(\frac{0.625 \times 0.5}{\sqrt{2}}\right) \times 12 \times 2 = 228^k$

$R_{plate} = \min\{130, 378, 341, 260, 265, 270, 228\}$

$= 130^k > 43^k$ OK

Beam Web

(OK)

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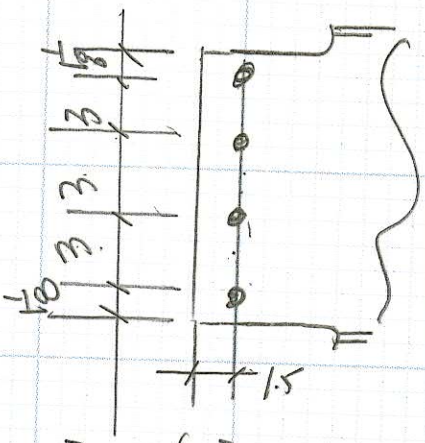
Design No. P7 Made by WAT Sheet 10 of 24

Checked by Date 7/15/18

Subject



1.) Bolt shear

$R_v = 4(32.5) = 130^k$

2.) Bolt Tearout

$R_{to} = 1.5(65)(1.5 - 0.5(0.9375)(t_w)(4) = 402 t_w$

3.) Bolt Bearing

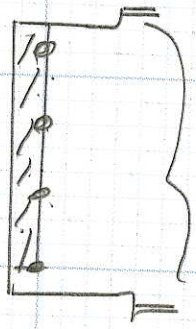
$R_p = 3.0(65)(0.875)(t_w)(4) = 682 t_w$

4.) Net Tension

$R_{nt} = 65[11.25 - 4(1.0)](t_w) = 471 t_w$

5.) Block shear

a. L shaped



$A_{gv} = 1.5 t_w$

$A_{nv} = (1.5 - 0.5(1.0))t_w = 1 t_w$

$A_{nt} = (10.125 - 3.5(1.0))t_w = 6.625 t_w$

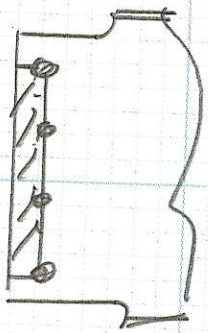
$F_u A_{nt} = 65(6.625) = 431 t_w$

$0.6 F_y A_{gv} = 0.6(50)(1.5) t_w = 45 t_w$

$0.6 F_u A_{nv} = 0.6(65)(1 t_w) = 39 t_w$

$R_{BS_L} = 431 + 39 = 470 t_w$

b. U shaped



$A_{gv} = 3 t_w$

$A_{nv} = 2 t_w$

$A_{nt} = [9 - 3(1.0)](t_w) = 6 t_w$

$F_u A_{nt} = 65(6 t_w) = 390 t_w$

$0.6(50)(3 t_w) = 90 t_w$

$0.6(65)(2 t_w) = 78 t_w$

$R_{BSU} = (340 + 78)t_w = 468 t_w$

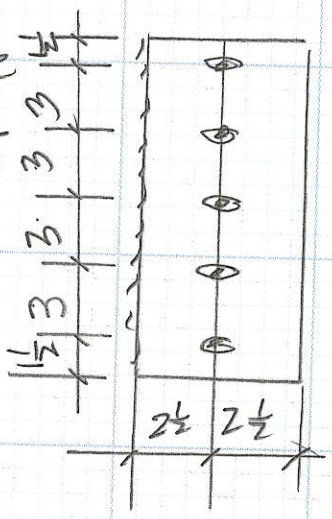
$R_{wcb} = \min\{130,\ 402t_w,\ 682t_w,\ 470t_w,\ 471t_w,\ 468t_w\}$

$402t_w \geq 43$

$t_w \geq 0.107$

5 Rows of Bolts $A_r = 63^K$

Plate $\frac{1}{2} \times 5 \times 15$



1.) Bolt shear

$R_v = 32.5(5) = 162^K$

2.) Tearout

$R_{to} = 1.5(65)(2.5 - 0.5(1.125))(0.5)(5)$

$= 472^K$

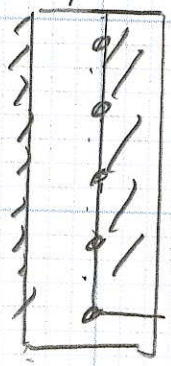
3. Bearing

$R_p = 3.0(65)(0.875)(0.5)(5) = 427^K$

4) Net Tension $R_{nt} = 65[15 - 5(1.0)](0.5) = 325^K$

5.) Block shear

a. L shaped



$A_{gv} = 2.5(0.5) = 1.25$

$A_{nv} = 0.953$

$A_{nt} = (13.5 - 4.5(1.0))(0.5) = 4.5$

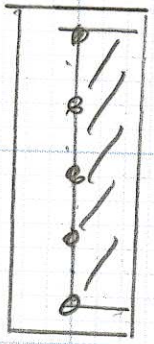
$F_u A_{nt} = 65(4.5) = 292$

$0.6 F_y A_{gv} = 0.6(50)(1.25) = 37.5$

$0.6 F_u A_{nv} = 0.6(65)(0.953) = 37.2$

$R_{BS_L} = 292 + 37.2 = 329^K$

b. Ushaped



$A_{gv} = 2.5$

$A_{nv} = 1.91$

$A_{nt} = (12 - 4(1.0))(0.5) = 4$

$F_u A_{nt} = 65(4) = 260$

$0.6 F_y A_{gv} = 0.6(50)(2.5) = 75$

$0.6 F_u A_{nv} = 0.6(65)(1.91) = 74.5$

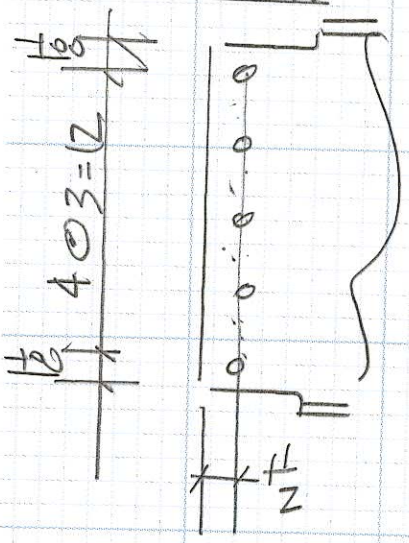
$R_{BS_U} = 260 + 74.5 = 334$

6. weld $R_w = 0.6(70)\left(0.625 \times \frac{0.5}{\sqrt{2}}\right)(15)(2) = 278$

$R_{plate} = \min\{162, 472, 427, 325, 329, 334, 278\}$

$= 162^k > 63^k$ OK

Beam Web



1. Bolt Shear

$R_v = 5(32.5) = 162.5^k > 63^k$ OK

2.) Bolt Tearout

$R_{to} = 1.5(65)[1.5 - 0.5(0.9375)]\, t_w(5) = 503 t_w$

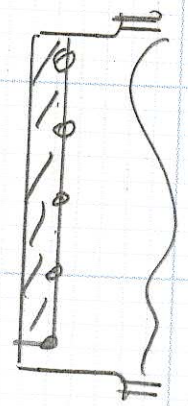
3.) Bolt Bearing

$R_p = 3.0(65)(0.875)(t_w)(5) = 853 t_w$

4.) Net Tension $R_{nt} = 65[14.25 - 5(1.0)]\, t_w = 601 t_w$

5. Block shear

a. L shaped



$A_{gx} = 1.5\,t_w$

$A_{nx} = 1\,t_w$

$A_{nt} = [13.125 - 4.5(1.0)]\,t_w = 8.625\,t_w$ ✓

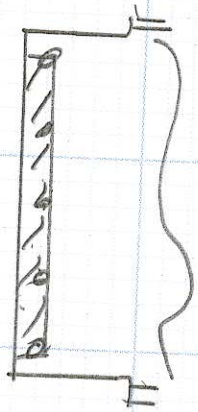
$F_{ut}A_{nt} = 65(8.625) = 561$

$0.6F_yA_{gx} = 0.6(50)(1.5\,t_w) = 45\,t_w$

$0.6F_uA_{nx} = 0.6(65)1\,t_w = 39\,t_w$

$R_{BS_L} = (561 + 39)t_w = 600\,t_w$ ✓

b. V shaped



$A_{gv} = 3.0\,t_w$ ✓

$A_{nx} = 2\,t_w$ ✓

$A_{nt} = (12 - 4(1))\,t_w = 8\,t_w$ ✓

$F_{ut}A_{nt} = 65(8\,t_w) = 520\,t_w$ ✓

$0.6F_yA_{gx} = 0.6(50)(3\,t_w) = 90\,t_w$

$0.6F_uA_{nx} = 0.6(65)(2\,t_w) = 78\,t_w$

$R_{BS_U} = (520 + 78)\,t_w = 598\,t_w$ ✓

$R_{web} = \min\{162.5,\ 503\,t_w, 853\,t_w, 601\,t_w, 600\,t_w, 598\,t_w\}$

$503\,t_w \geq 63$

$t_w \geq 0.125$

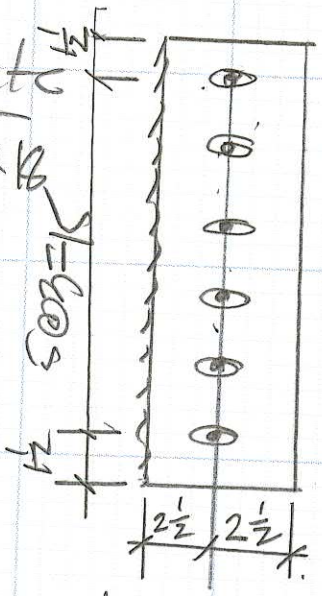
Cives Engineering Corporation

Design No. P7 Made by WAT Sheet 14 of 26

Subject Checked by Date 2/15/18

6 Rows of Bolts $A_r = 87^K$.

Plate $\frac{1}{2} \times 5 \times 16$



1.) Bolt shear

$R_V = 32.5(6) = 195^K$

2.) Bolt Tearout

$R_{to} = 1.5(65)(2.5 - 0.5(1.125))(0.5)(16) = 567^K$

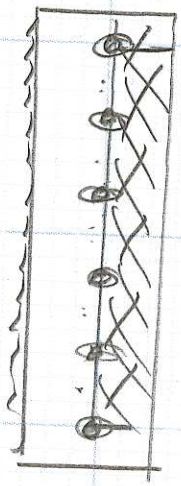
3. Bolt Bearing

$R_p = 3.0(65)(0.875)(t_w)(6) = 1024^K$

4.) Net Tension $R_{nt} = 65(18 - 6(1.0))(0.5) = 390^K$

5.) Block Shear

a. L



$A_{gx} = 1.25$

$A_{nx} = (2.5 - 0.5(1.1875))\,0.5 = 0.453$

$A_{nt} = (16.125 - 5.5(1.0))\,0.5 = 5.3125$

$F_u A_{nt} = 65(5.3125) = 345$

$0.6 F_y A_{gx} = 0.6(50)(1.25) = 37.5$

$0.6 F_u A_{nx} = 0.6(65)(0.953) = 37.2$

$R_{BS_L} = 345 + 37.2 = 382$

b. U

$A_{gx} = 2.5$

$A_{nx} = 1.91$

$A_{nt} = [5 - 5(1.0)]\,0.5 = 5$

$F_u A_{nt} = 325$

$0.6 F_y A_{gx} = 75$

$0.6 F_u A_{nx} = 74.5$

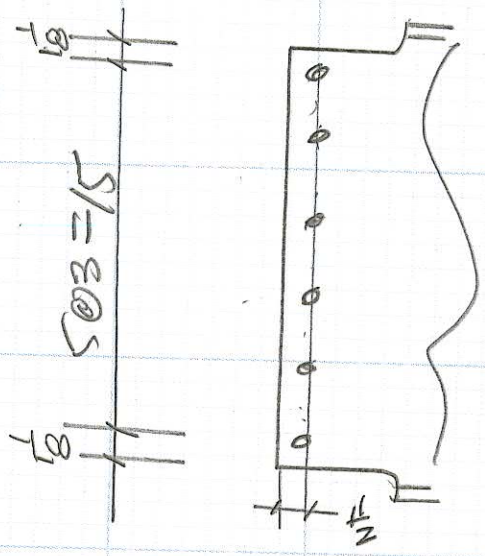
$R_{BLU} = 325 + 74.5 = 400$

6. weld $R_w = \frac{0.6(70)(0.625\times0.5)(18)(2)}{\sqrt{2}} = 334$ ✓

$R_{plate} = \min\{195, 567, 1024, 390, 382, 400, 334\}$

$= 195 > 87^K$ OK

Beam web



1.) Bolt shear

$R_v = 32.5(6) = 195^K$ ✓

2.) Tearout

$R_{to} = 1.5(65)(1.5 - 0.5(0.9375))t_w(6)$

$= 603 t_w$ ✓

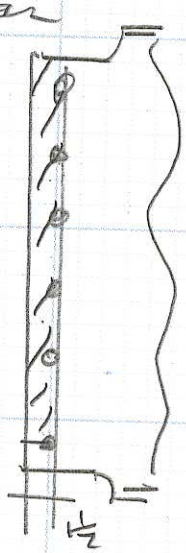
3. Bearing

$R_p = 3.0(65)(0.875)(t_w)(6) = 1024 t_w$ ✓

4.) Net Tension $R_{nt} = 65[17.25 - 6(1.0)]t_w = 731 t_w$ ✓

5. Block shear

a. L shaped



$A_{gv} = 1.5 t_a$

$A_{nv} = 1 t_w$

$A_{nt} = (16.125 - 5.5(1.0))t_w = 10.625 t_w$

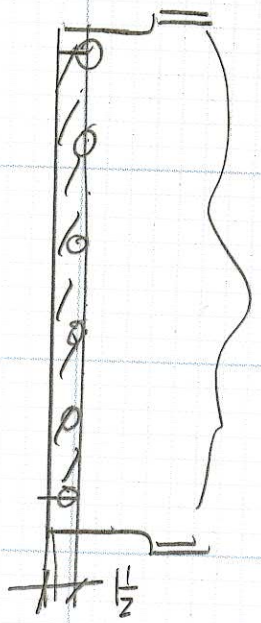
$F_u A_{nt} = 65(10.625 t_w) = 691 t_w$

$0.6 F_y A_{gv} = 95 t_a$

$0.6 F_u A_{nv} = 39 t_w$

$R_{BSL} = (691 + 39)t_w = 730 t_w$ ✓

b) U shaped



$A_{gv} = 1.5 t_w (2) = 3 t_w$

$A_{nv} = (1.5 - 0.5(1.0)) t_w (2) = 2 t_w$

$A_{nt} = (15 - 5(1.0))(t_w) = 10 t_w$ ✓

$F_u A_{nt} = 65)(10) t_w = 650 t_w$

$0.6 F_y A_{gv} = 0.6(50)(3) t_w = 90 t_w$

$0.6 F_u A_{nv} = 0.0(65)(2) t_w = 78 t_w$

$R_{BS_U} = (650 + 78) t_w = 728 t_w$

$R_{web} = \min\{195, 603 t_w, 1024 t_w, 734 t_w, 730 t_w, 728 t_w\}$

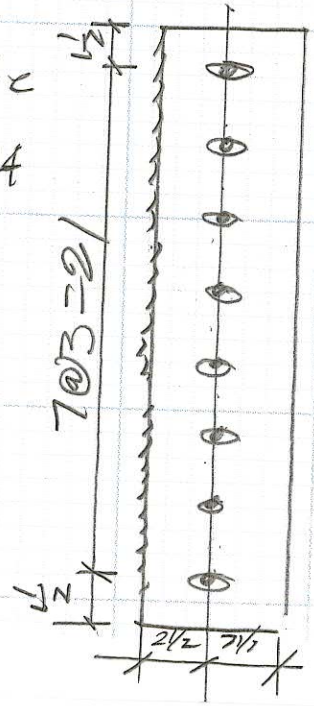
$603 t_w \geq 87$

$t_w \geq 0.144"$

---

8 Rods $A_r = 94$

Plate $\frac{1}{2} \times 15 \times 24$



1.) Bolt Shear

$R_v = 32.5(8) = 260^K$

2.) Bolt Tearout

$R_{to} = 1.5(65)(2.5 - 0.5(1.125))(0.5)(8) = 756^K$

3.) Bolt Bearing

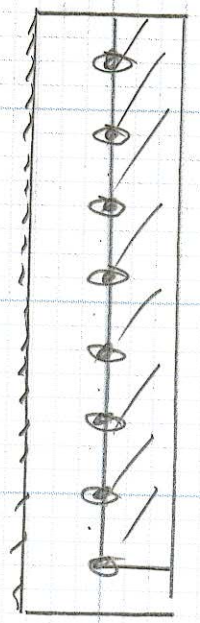
$R_p = 3.0(65)(0.875)(0.5)(8) = 682^K$

4.) Net Tension

$R_{nt} = 65[24 - 8(1.0)](0.5) = 520^K$

5.) Block shear

a. L shaped



$A_{gx} = 2.5(0.5) = 1.25$

$A_{nx} = (2.5 - 0.5(1.1875))(0.5) = 0.953$

$A_{nt} = (22.5 - 7.5(1.0))(0.5) = 7.5$

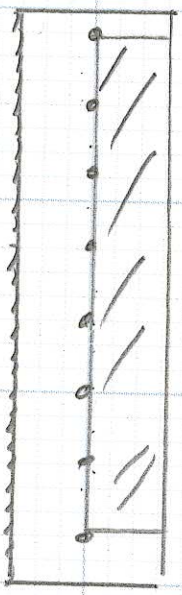
$F_u A_{nt} = 65(7.5) = 488$

$0.6 F_y A_{gx} = 0.6(50)(1.25) = 37.5$

$0.6 F_u A_{nx} = 0.6(65)(0.953) = 37.2$

$R_{bs_L} = 488 + 37.2 = 525 k$

b. U shaped



$A_{gv} = 2.5$

$A_{nv} = 1.91$

$A_{nt} = (21 - 7(1.0))(0.5) = 7.00$

$F_u A_{nt} = 65(7.00) = 455$

$0.6 F_y A_{gv} = 0.6(50)(2.5) = 75$

$0.6 F_u A_{nv} = 0.6(65)(1.91) = 74.5$

$R_{bs_U} = 455 + 74.5 = 529 k$

c. Weld

$$R_w = 0.6(70)\left(\frac{0.625 \times 0.5}{\sqrt{2}}\right)(24)(2) = 445$$

$R_{plate} = \min\{260, 756, 682, 520, 525, 529, 445\}$

$= 260 > 94 ok$

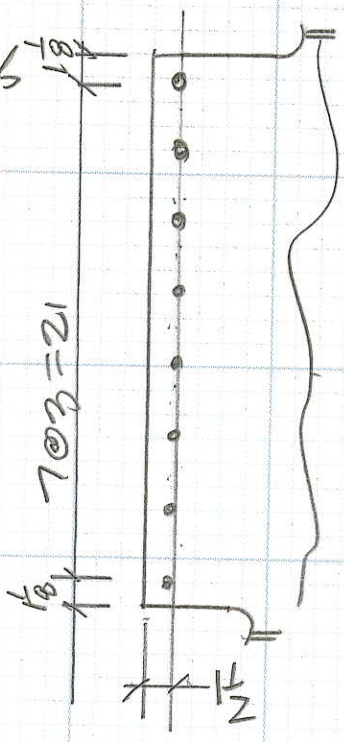
Cives Engineering Corporation

Design No. P7 Made by UAT Sheet 18 of 26

Checked by Date 2/16/18

Subject

Beam web



1.) Bolt shear

$R_v = 32.5(8) = 260k$

2.) Bolt Tearout

$R_{to} = 1.5(65)(1.5 - 0.5(0.9375))t_w(8)$

$= 804 t_w$

3.) Bolt Bearing

$R_p = 3.0(65)(0.875)(t_w)(8)$

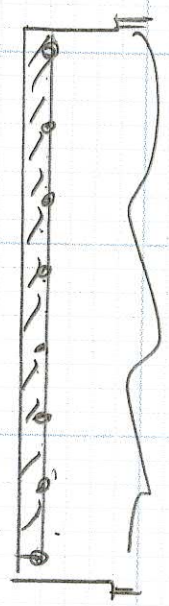
$= 1365\ t_w$

4.) Net Tension

$R_{nt} = 65[23.25 - 8(1.0)]t_w = 991 t_w$

5a Block Shear

L



$A_{gv} = 1.5 t_w$

$A_{nv} = 1 t_w$

$A_{nt} = [22.125 - 7.5(1.0)]t_w = 14.625 t_w$

$F_u A_{nt} = 65(14.625)t_w = 951 t_w$

$0.6 F_y A_{gv} = 0.6(50)(1.5)t_w = 45 t_w$

$0.6 F_u A_{nv} = 0.6(65)(1)t_w = 39 t_w$

$R_{bs_L} = (951 + 39)t_w = 990\ t_w$

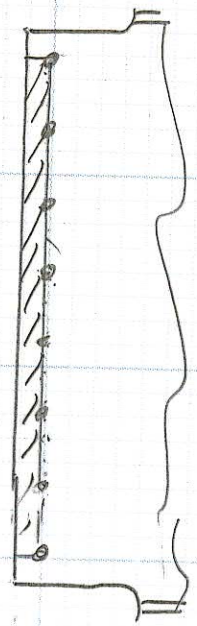
Cives Engineering Corporation

Design No. P7 Made by WAT Sheet 19 of 26

Checked by Date 2/15/18

Subject

5b Block Shear



$A_{gv} - 1.5\,t_w(2) = 3t_w$

$A_{nv} = [1.5 - 0.5(1.0)]\,t_w(2) = 2t_w$

$A_{nt} = [21 - 7(1.0)]\,t_w = 14t_w$

$F_u A_{nt} = 65(14t_w) = 910t_w$

$\phi 0.6 F_y A_{gv} = 0.6(50)(3t_w) = 910t_w$

$0.6 F_u A_{nv} = 0.6(65)(2t_w) = 78t_w$

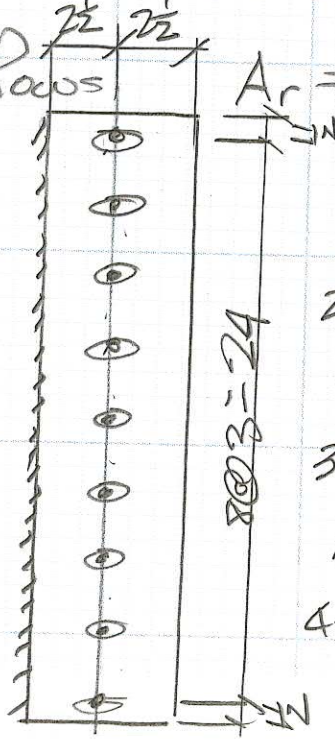
$R_{bsL} = (910 + 78)\,t_w = 988t_w$

$R_{web} = \min\{260,\ 804t_w,\ 1365t_w,\ 991t_w,\ 910t_w,\ 988t_w\}$

$804t_w \geq 94$

$t_w \geq 0.117''$

9 Rows



1.) Bolt Shear

$R_v = 9(32.5) = 292$

2.) Bolt Tearout

$R_{to} = 1.5(65)(2.5 - 0.5(1.125))(0.5)(9) = 850^k$

3.) Bolt Bearing

$R_p = 3.0(65)(0.875)(0.5)(9) = 768^k$

4.) Net Tension

$R_{nt} = 65[27 - 9(1.0)](0.5) = 585^k$

Cives Engineering Corporation

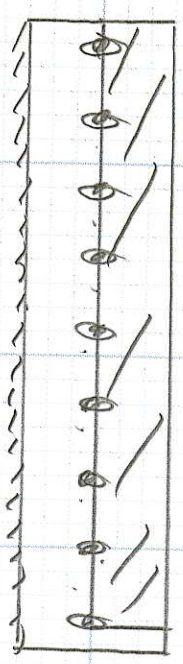
Design No. P7 Made by WAT Sheet 20 of 26

Checked by Date 2/15/18

Subject

6. Block shear

a. L shaped



$A_{gx} = 2.5(0.5) = 1.25$

$A_{nx} = [2.5 - 0.5(1.1875)](0.5) = 0.953$

$A_{nt} = [25.125 - 8.5(1.0)](0.5) = 8.3125$

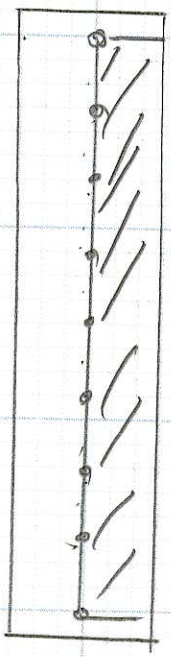
$F_u A_{nt} = 65(8.3125) = 540$

$0.6 F_y A_{gx} = 0.6(50)(1.25) = 37.5$

$0.6 F_u A_{nx} = 0.6(65)(0.953) = 37.2$

$R_{BS_L} = 540 + 37.2 = 577^K$

b. U shaped



$A_{gx} = 2.5$

$A_{nx} = 1.91$

$A_{nt} = [24 - 8(1.0)](0.5) = 8.0$

$0.6 F_y A_{gx} = 75$

$0.6 F_u A_{nx} = 74.5$

$F_u A_{nt} = 65(8) = 520$

$R_{BSU} = 520 + 74.5 = 594$

6. Weld $R_w = 0.6(70)\left(0.625 \times \frac{0.5}{\sqrt{2}}\right)(27)(2) = 501$

$R_{plate} = \min\{242, 880, 768, 585, 577, 594, 501\}$

$= 242^K > 94^K$ OK

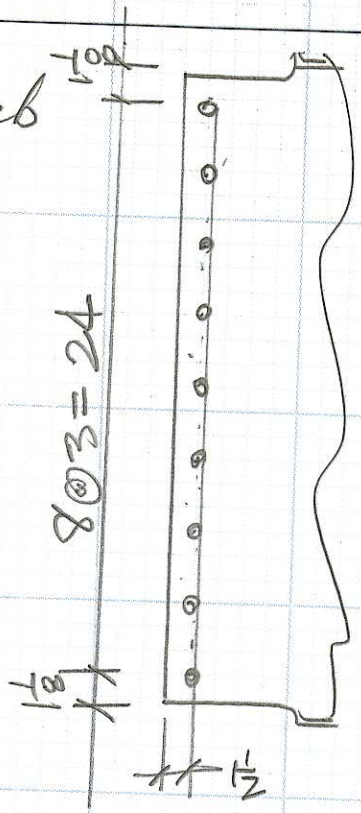
Cives Engineering Corporation

Design No. P7 Made by WAT Sheet 21 of 26

Checked by Date 2/16/18

Subject

Beam web



1.) Bolt Shear

$R_v = 32.5(9) = 292^k$

2.) Bolt Tearout

$R_{to} = 1.5(65)(1.5 - 0.5(0.9375)t_w(9) = 905 t_w$

3. Bolt Bearing

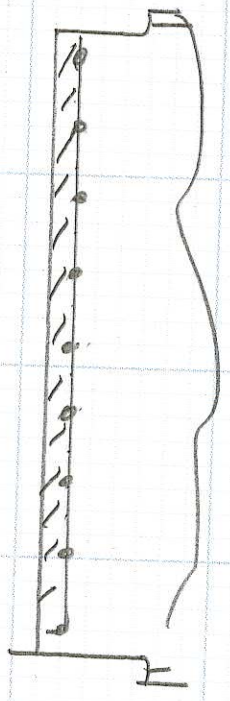
$R_p = 3.0(65)(0.875)(t_w)(9) = 1536 t_w$

4.) Net Tension

$R_{nt} = 65[26.25 - 9(1.0)]t_w = 1121 t_w$

5a Block Shear

L shaped



$A_{gv} = 1.5 t_w$

$A_{nv} = 1 t_w$

$A_{nt} = [25.125 - 8.5(1.0)]t_w$

$= 16.6 t_w$

$F_u A_{nt} = 65(16.6 t_w) = 1080 t_w$

$0.6 F_y A_{gv} = 0.6(50)(1.5 t_w)$

$= 45 t_w$

$0.6 F_u A_{nv} = 0.6(65)(1 t_w)$

$= 39 t_w$

$R_{bs_L} = (1080 + 39)t_w = \underline{1120 t_w}$

Cives Engineering Corporation

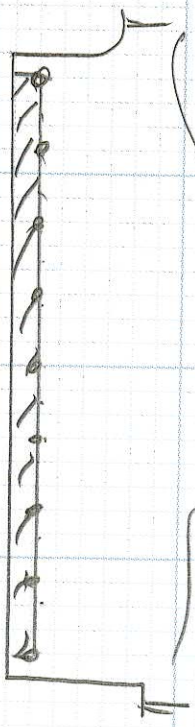
Design No. P7 Made by WJT Sheet 22 of 26

Checked by _____ Date 2/15/18

Subject _____

5b Block Shear

L shaped



$A_{gx} = 3t_w$

$A_{nx} = 2t_w$

$A_{nt} = [24 - 8(1.0)]t_w = 16t_w$

$F_u A_{nt} = 65(16t_w) = 1040t_w$

$0.6F_y A_{gx} = 0.6(50)(3t_w)$

$= 90t_w$

$0.6F_u A_{nx} = 0.6(65)(2t_w)$

$= 78t_w$

$R_{DS_L} = (1040 + 78)t_w = 1120t_w$

$R_{web} = \min\{ 202, 90t_w, 1536t_w, 1114t_w, 1120t_w, 1120t_w \}$

$90.5t_w \geq 94$

$t_w \geq 0.104$

channels, C6, C8, C10, C12 – 2 Rows of Bolts

use A36

$A_r = 19^k$ (Required Axial Load)

Cives Engineering Corporation

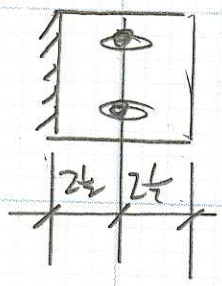
Design No. P7 Made by WAT Sheet 23 of 26

Checked by Date 2/15/18

Subject

2 Rows of Bolts $A_r = 19^{k}$

Plate $\frac{1}{2} \times 5 \times 6$



1.) Bolt Shear

$R_x = 32.5(2) = 65^{k}$

2.) Bolt Tearout

$R_{to} = 1.5(65)(2.5 - 0.5(1.125))(0.5)(2) = 189^{k}$

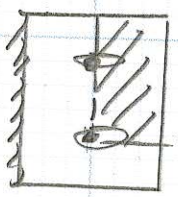
3. Bolt Bearing

$R_p = 3.0(65)(0.875)(0.5)(2) = 171^{k}$

4. Net Tension

$R_{nt} = 65[6 - 2(1.0)](0.5) = 130^{k}$

5.a Block Shear L shaped



$A_{gv} = 2.5(0.5) = 1.25$

$A_{nv} = [2.5 - 0.5(1.1875)]0.5$

$= 0.953$

$A_{nt} = (4.5 - 1.5(1.0))(0.5) = 1.5$

$F_u A_{nt} = 65(1.5) = 97.5$

$0.6 F_y A_{gv} = 0.6(50)(1.25) = 37.5$

$0.6 F_u A_{nv} = 0.6(65)(0.953) = 37.2$

$R_{bs_L} = 97.5 + 37.2 = 135^{k}$

Cives Engineering Corporation

Design No. P7 Made by WJT Sheet 24 of 26

Checked by _____ Date 2/15/18

Subject _____

5b Block shear L shaped

$A_{gv} = 2.5(0.5)(2) = 2.5$

$A_{nv} = (2.5 - 0.5(1.1875))(0.5)(2) = 1.91$ ✓

$A_{nt} = (3 - 1(1.0))(0.5) = 1.0$

$F_u A_{nt} = 65(1.0) = 65$

$0.6 F_y A_{gv} = 0.6(50)(2.5) = 75$

$0.6 F_u A_{nv} = 0.6(65)(1.91) = 74.5$

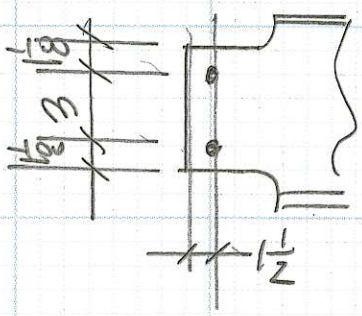
$RBS_L = 65 + 74.5 = 140^k$

6. Weld $R_w = 0.6(70)(0.625 \times 0.5)(6)(2) = 111^k$

$R_{plate} = \min\{65, 189, 171, 130, 135, 140, 111\} = 65$

since $c \overset{k}{>} 19^k$ 1/2 plate is ok for Axial integrity load.

Channel web



Dimensions used are "worst" cases. 1⅛ is minimum edge dist. for a 7/8 ϕ Bolt

1.) Bolt Shear

$R_v = 32.5(2) = 65^k$

2.) Bolt Tearout

$R_{to} = 1.5(58)(1.5 - 0.5(0.9375))t_w(2) = 179 t_w$

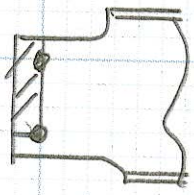
3.) Bolt Bearing $R_p = 3.0(58)(0.875)(t_w)(2) = 304 t_w$

4.) Net Tension $R_{nt} = 58[5.25 - 2(1.0)]t_w = 188t_w$

& a Gross Tension $R_{gt} = 36(5.25)(t_w) = 189t_w$.
(net tension controls)

5 Block shear

a. L shaped



$A_{gv} = 1.5t_w$

$A_{nv} = (1.5 - 0.5(1.0))t_w = 1t_w$

$A_{nt} = (4.125 - 1.5(1.0))t_w$
$= 2.625t_w$

$F_u A_{nt} = 58(2.625t_w) = 152t_w$

$0.6F_y A_{gv} = 0.6(36)(1.5t_w) = 32.4t_w$

$0.6F_u A_{nv} = 0.6(58)(1t_w) = 34.8t_w$.

$R_{BSL} = (152 + 32.4)t_w = 184t_w$

b. U shaped

$A_{gv} = 3t_w$

$A_{nv} = 2t_w$

$A_{nt} = (3 - 1(1.0))t_w = 2t_w$

$F_u A_{nt} = 58(2t_w) = 116t_w$

$0.6F_y A_{gv} = 0.6(36)(3t_w) = 64.8t_w$

$0.6F_u A_{nv} = 0.6(58)(2t_w) = 69.6t_w$

$R_{BSU} = (116 + 64.8)t_w = 181t_w$

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Sheet 24 of 24

Date 2/15/18

Subject

$$R_{web} = \min\{65, 179t_w, 304t_w, 188t_w, 184t_w, 181t_w\}$$

$179t_w \geq 19$

$t_w \geq 0.106$