

Weldgroup Verification

This following document compares WeldGroup analysis results with the tabulated method provided in AISC. Tables 8-4 through 8-11 employ the instantaneous center of rotation method in accordance with AISC Specification Section J2.4 for the weld patterns and eccentric conditions indicated and inclined loads at 0°, 15°, 30°, 45°, 60°, and 75°. The tabulated non-dimensional coefficient, C , represents the effective strength of the weld group in resisting the eccentric shear force.

$$\phi R_n = \phi C C_1 D l$$

where

C = tabular value

C_1 = electrode coefficient from Table 8-3

D = number of sixteenths-of-an-inch in the weld size

l = length of the reference weld, in

ϕ = 0.75

Example 1

C-shaped weld group with dimensions $l = 10$ inches, $kl = 5$ inches, and fillet weld size $w = 1/4$ inch. Electrode strength $F_{EXX} = 70$ ksi. The in-plane resultant force $P = 45$ kips is applied concentrically (at C.G. of weld group) with an angle of 60°. Find available strength of connection.

a) Using WeldGroup spreadsheet $\phi R_n = 140.47$ kips

b) Using AISC table 8-8

$\phi = 0.75$ $C(k=0.5, \alpha=0) = 4.76$ $C_1 = 1.0$ $D = 4$ $l = 10$ in

$\phi R_n = \phi C C_1 D l = 0.75(4.76)1.0(4)10 = 142.80$ kips

c) WeldGroup Deviation = $(142.8-140.47)/142.8 = 1.63\%$

Example 2

C-shaped weld group with dimensions $l = 10$ inches, $kl = 12$ inches, and fillet weld size $w = 1/4$ inch. Electrode strength $F_{EXX} = 90$ ksi. The in-plane resultant force $P = 100$ kips is inclined 60° and applied with eccentricity $e_x = al = 14$ inch. Find available strength of connection.

a) Using WeldGroup spreadsheet $\phi R_n = 154.54$ kips

b) Using AISC table 8-8

$\phi = 0.75$ $C(k=1.2, \alpha=1.4) = 4.42$ $C_1 = 1.16$ $D = 4$ $l = 10$ in

$\phi R_n = \phi C C_1 D l = 0.75(4.42)1.16(4)10 = 153.82$ kips

c) WeldGroup Deviation = $(153.82-154.54)/153.82 = -0.47\%$

Example 3

C-shaped weld group with dimensions $l = 10$ inches, $kl = 4$ inches, and fillet weld size $w = 1/4$ inch. Electrode strength $FEXX = 70$ ksi. The in-plane resultant force $P = 100$ kips is inclined 60° and applied with eccentricity $e_x = al = 3$ inch. Find available strength of connection.

a) Using WeldGroup spreadsheet $\phi R_n = 109.45$ kips

b) Using AISC table 8-8

$$\phi = 0.75 \quad C(k=0.4, a=0.3) = 3.63 \quad C_1 = 1.0 \quad D = 4 \quad l = 10 \text{ in}$$

$$\phi R_n = \phi C C_1 D l = 0.75(3.63)1.0(4)10 = 108.9 \text{ kips}$$

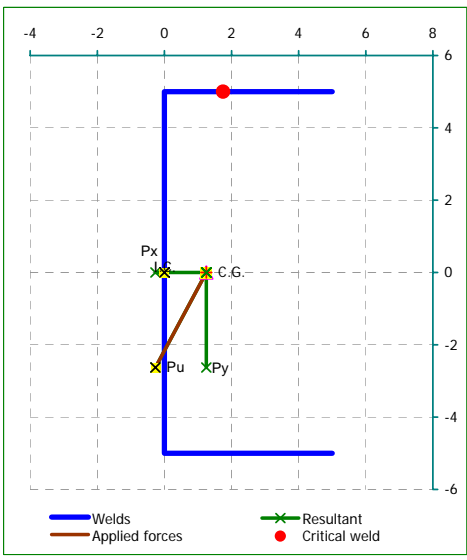
$$\text{c) WeldGroup Deviation} = (108.9 - 109.45) / 108.9 = -0.51\%$$

COMPANY NAME AND ADDRESS	Project: VERIFICATION MANUAL	Engineer: YP Date: 4/9/07	Project #
WeldGroup Copyright © 2006	Subject: EXAMPLE 1	Checker: Date:	Page:

ECCENTRICALLY LOADED WELD GROUP ANALYSIS

Measurement Units: **US**
 Fillet weld size, w = **0.25** in
 Electrode nominal strength, F_{EXX} = **70** ksi
 Adjusted for higher-strength electrode, φ₁F_{EXX} = 70 ksi
 Weld shear capacity per unit length
 φR_n = 0.75(0.6)φ₁F_{EXX}0.707w = 5.568 kip/in

Weld Group Geometry				
Weld No.	Node 1		Node 2	
	X1 (in)	Y1 (in)	X2 (in)	Y2 (in)
1	5	5	0	5
2	0	5	0	-5
3	0	-5	5	-5



Weld Group Properties			
Total Length =	20 in	Center of Gravity (C.G.)	Instantaneous Center (IC)
Moment I _x =	333.3 in ⁴	X _C = 1.25 in	X _{IC} = 1.5829 in
Inertia I _y =	52.08 in ⁴	Y _C = 0 in	Y _{IC} = -0.179 in

Concentrated In-Plane Loads			
Location	Angle	Value	
X (in)	Y (in)	β (deg)	P (kip)
1.25	0	-120	100

Out-of-Plane Loads	
Pz =	0 kip (positive for tension)
Mx =	0 kip-in (top fibers in tension)
My =	0 kip-in (left fibers in tension)

In-Plane Force Resultants	
Total force P _u =	100 kip
P _x = Σ P _u cos(β _i) =	-50 kip
P _y = Σ P _u sin(β _i) =	-86.6 kip
β =	-120 deg
Moment about C.G., M _C =	0 kip-in
Eccentricity e = M _C /P _u =	0 in
X _p = X _c + e*sin(β) =	1.25 in
Y _p = Y _c - e*cos(β) =	0 in

In-plane Moment	
Mz =	0 kip-in

Analysis Results

1. Shear Capacity under in-Plane loads only

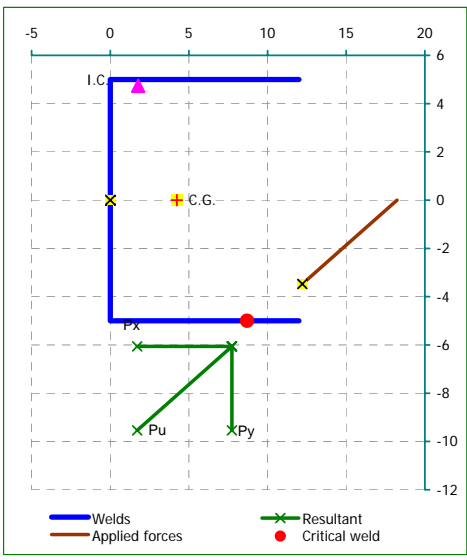
LRFD method: φP = 140.47 kip	≥	100	OK	Analysis Status Solved!
Elastic method: φP = 111.35 kip	≥	100	OK	

COMPANY NAME AND ADDRESS	Project: VERIFICATION MANUAL	Engineer: YP Date: 4/10/07	Project #
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ECCENTRICALLY LOADED WELD GROUP ANALYSIS

Measurement Units: US
 Fillet weld size, w = 0.25 in
 Electrode nominal strength, F_{EXX} = 90 ksi
 Adjusted for higher-strength electrode, φ₁F_{EXX} = 81 ksi
 Weld shear capacity per unit length
 φR_n = 0.75(0.6)φ₁F_{EXX}0.707w = 6.443 kip/in

Weld Group Geometry				
Weld No.	Node 1		Node 2	
	X1 (in)	Y1 (in)	X2 (in)	Y2 (in)
1	12	5	0	5
2	0	5	0	-5
3	0	-5	12	-5



Weld Group Properties			
Total Length =	34 in	Center of Gravity (C.G.)	Instantaneous Center (IC)
Moment I _x =	683.3 in ⁴	X _C = 4.2353 in	X _{IC} = 1.7772 in
Inertia I _y =	542.1 in ⁴	Y _C = 0 in	Y _{IC} = 4.7421 in

Concentrated In-Plane Loads			
Location	Angle	Value	
X (in)	Y (in)	β (deg)	P (kip)
18.235	0	-150	100

Out-of-Plane Loads	
P _z =	0 kip (positive for tension)
M _x =	0 kip-in (top fibers in tension)
M _y =	0 kip-in (left fibers in tension)

In-Plane Force Resultants	
Total force P _u =	100 kip
P _x = Σ P _u cos(β _i) =	-86.6 kip
P _y = Σ P _u sin(β _i) =	-50 kip
β =	-150 deg
Moment about C.G., M _C =	-700 kip-in
Eccentricity e = M _C /P _u =	-7 in
X _p = X _c + e*sin(β) =	7.7353 in
Y _p = Y _c - e*cos(β) =	-6.062 in

In-plane Moment	
M _z =	0 kip-in

Analysis Results

1. Shear Capacity under in-Plane loads only

LRFD method: φP = 154.54 kip	≥	100	OK	Analysis Status Solved!
Elastic method: φP = 80.48 kip	<	100	N.G.	

Table 8-8 (continued) Coefficients C for Eccentrically Loaded Weld Groups Angle = 60°

Available Strength of a weld group, ϕR_n or R_n/Ω , is determined with

$$R_n = CC_1 D l \quad (\phi = 0.75, \Omega = 2.00)$$

or

LRFD	ASD
$C_{min} = \frac{P_u}{\phi C_1 D l} \quad D_{min} = \frac{P_u}{\phi C C_1 l} \quad l_{min} = \frac{\Omega P_u}{\phi C C_1 D}$	$C_{min} = \frac{\Omega P_a}{C_1 D l} \quad D_{min} = \frac{\Omega P_a}{C C_1 l} \quad l_{min} = \frac{\Omega P_a}{C C_1 D}$

where

P = required force, P_u or P_a , kips

D = number of sixteenths-of-an-inch in the fillet weld size

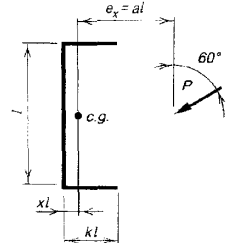
l = characteristic length of weld group, in.

$a = e_x / l$

e_x = horizontal component of eccentricity of P with respect to centroid of weld group, in.

C = coefficient tabulated below

C_1 = electrode strength coefficient from Table 8-4 (1.0 for E70XX electrodes)



a	k																	
	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0		
0.00	2.57	3.01	3.45	3.88	4.32	4.76	5.20	5.63	6.07	6.51	6.94	7.82	8.69	9.57	10.4	11.3		
0.100	2.43	2.86	3.30	3.75	4.21	4.68	5.14	5.61	6.07	6.53	6.99	7.89	8.78	9.66	10.5	11.4		
0.150	2.31	2.74	3.17	3.62	4.07	4.54	5.01	5.49	5.96	6.44	6.91	7.83	8.74	9.63	10.5	11.4		
0.200	2.18	2.61	3.04	3.47	3.92	4.39	4.86	5.34	5.83	6.31	6.79	7.73	8.66	9.57	10.5	11.4		
0.250	2.07	2.49	2.91	3.33	3.77	4.23	4.70	5.18	5.67	6.16	6.64	7.61	8.55	9.48	10.4	11.3		
0.300	1.96	2.37	2.78	3.20	3.63	4.07	4.54	5.02	5.51	5.99	6.49	7.46	8.42	9.36	10.3	11.2		
0.400	1.79	2.16	2.54	2.94	3.35	3.77	4.22	4.69	5.17	5.66	6.15	7.14	8.12	9.09	10.0	11.0		
0.500	1.63	1.97	2.33	2.71	3.09	3.50	3.93	4.38	4.85	5.33	5.81	6.80	7.79	8.77	9.73	10.7		
0.600	1.49	1.81	2.15	2.50	2.87	3.26	3.67	4.10	4.55	5.02	5.50	6.48	7.46	8.42	9.38	10.3		
0.700	1.37	1.67	1.99	2.32	2.67	3.04	3.44	3.85	4.29	4.74	5.21	6.16	7.14	8.07	9.03	10.0		
0.800	1.26	1.54	1.84	2.16	2.49	2.85	3.23	3.63	4.05	4.48	4.93	5.85	6.83	7.73	8.69	9.66		
0.900	1.17	1.43	1.71	2.01	2.33	2.67	3.04	3.43	3.83	4.24	4.68	5.56	6.57	7.40	8.35	9.31		
1.00	1.08	1.33	1.60	1.89	2.19	2.52	2.87	3.24	3.63	4.03	4.45	5.30	6.17	7.09	8.02	8.97		
1.20	0.945	1.17	1.41	1.67	1.95	2.25	2.57	2.92	3.28	3.65	4.04	4.82	5.65	6.52	7.42	8.34		
1.40	0.835	1.03	1.25	1.49	1.75	2.03	2.33	2.65	2.98	3.32	3.68	4.42	5.18	6.01	6.87	7.76		
1.60	0.747	0.928	1.13	1.34	1.58	1.84	2.12	2.41	2.72	3.05	3.38	4.07	4.79	5.56	6.38	7.24		
1.80	0.675	0.840	1.02	1.22	1.44	1.68	1.94	2.22	2.51	2.81	3.12	3.76	4.44	5.17	5.95	6.76		
2.00	0.615	0.767	0.935	1.12	1.32	1.55	1.79	2.05	2.32	2.60	2.89	3.49	4.14	4.83	5.56	6.34		
2.20	0.564	0.704	0.860	1.03	1.22	1.43	1.66	1.90	2.15	2.42	2.69	3.26	3.87	4.52	5.22	5.99		
2.40	0.521	0.652	0.796	0.957	1.13	1.33	1.54	1.77	2.01	2.26	2.51	3.05	3.63	4.25	4.91	5.61		
2.60	0.484	0.605	0.741	0.892	1.06	1.24	1.44	1.66	1.88	2.12	2.36	2.86	3.41	4.01	4.64	5.31		
2.80	0.452	0.565	0.692	0.833	0.992	1.17	1.35	1.56	1.77	1.99	2.21	2.70	3.22	3.79	4.39	5.03		
3.00	0.423	0.531	0.651	0.783	0.933	1.10	1.27	1.47	1.67	1.88	2.09	2.55	3.05	3.59	4.16	4.78		
x	0.000	0.008	0.029	0.056	0.089	0.125	0.164	0.204	0.246	0.289	0.333	0.424	0.516	0.610	0.704	0.800		