Project: **C 60**
Project no:
Author:

Project data

Project name	C 60
Project number	
Author	
Description	
Date	7/11/2023
Code	AISC/ACI

Material

Steel	A36, 350W, A992

Project: C 60
Project no:
Author:

Project item BEAM B1 w1 - BEAM B1 w1

Design

Name	BEAM B1 w1 - BEAM B1 w1
Description	
Analysis	Stress, strain/ simplified loading
Design code	AISC - LRFD (2016)

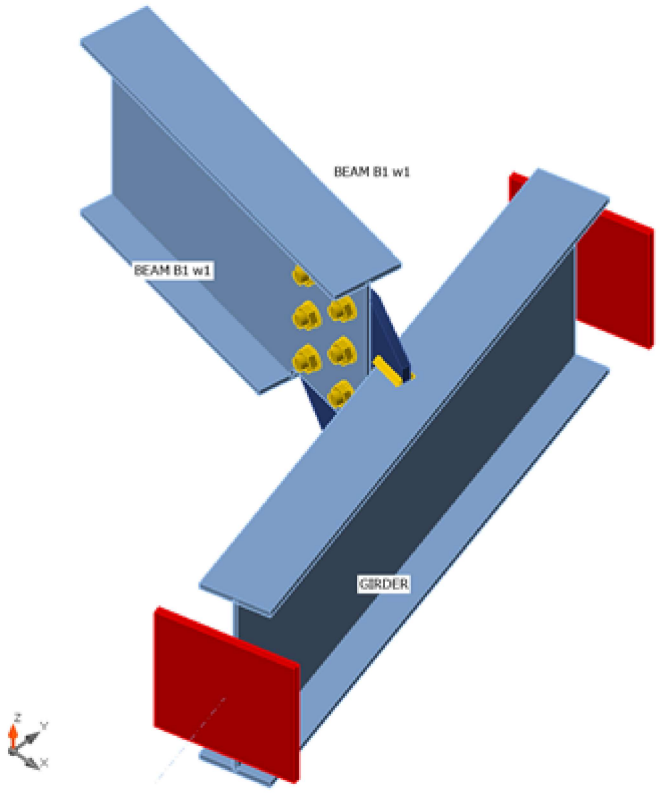
Members

Geometry

Name	Cross-section	β – Direction [°]	γ - Pitch [°]	α - Rotation [°]	Offset ex [in]	Offset ey [in]	Offset ez [in]
GIRDER	6 - I12	105.0	0.0	0.0	0.000	0.000	-5.188
BEAM B1 w1	6 - I12	-10.0	0.0	0.0	0.000	0.000	-0.063

Supports and forces

Name	Support	Forces in	X [in]
GIRDER / begin	N-Vy-Vz-Mx-My-Mz	Node	0.000
GIRDER / end	N-Vy-Vz-Mx-My-Mz	Node	0.000
BEAM B1 w1 / begin		Bolts	6.079



Cross-sections

Name	Material
6 - I12	A992

Project: C 60
Project no:
Author:

Bolts

Name	Bolt assembly	Diameter [in]	f_u [ksi]	Gross area [in^2]
19 A325	19 A325	0.750	120.0	0.442

Load effects (Equilibrium not required)

Name	Member	N [kip]	Vy [kip]	Vz [kip]	Mx [kip.ft]	My [kip.ft]	Mz [kip.ft]
LE1	BEAM B1 w1 / Begin	0.000	0.000	-25.000	0.00	0.00	0.00

Check

Summary

Name	Value	Check status
Analysis	100.0%	OK
Plates	6.4 > 5.0%	**Not OK!**
Bolts	25.9 < 100%	OK
Welds	91.0 < 100%	OK
Buckling	Not calculated	

Plates

Name	Material	t_p [in]	Loads	σ_{Ed} [ksi]	ε_{Pl} [%]	$\sigma_{c,Ed}$ [ksi]	Status
GIRDER-bfl 1	A992	3/8	LE1	46.9	6.4	0.0	**Not OK!**
GIRDER-tfl 1	A992	3/8	LE1	46.8	6.3	0.0	**Not OK!**
GIRDER-w 1	A992	1/4	LE1	45.3	1.1	0.0	OK
BEAM B1 w1-bfl 1	A992	3/8	LE1	20.3	0.0	0.0	OK
BEAM B1 w1-tfl 1	A992	3/8	LE1	20.3	0.0	0.0	OK
BEAM B1 w1-w 1	A992	1/4	LE1	35.2	0.0	1.8	OK
SHEAR PLATE	A36	1/2	LE1	32.5	0.5	1.8	OK

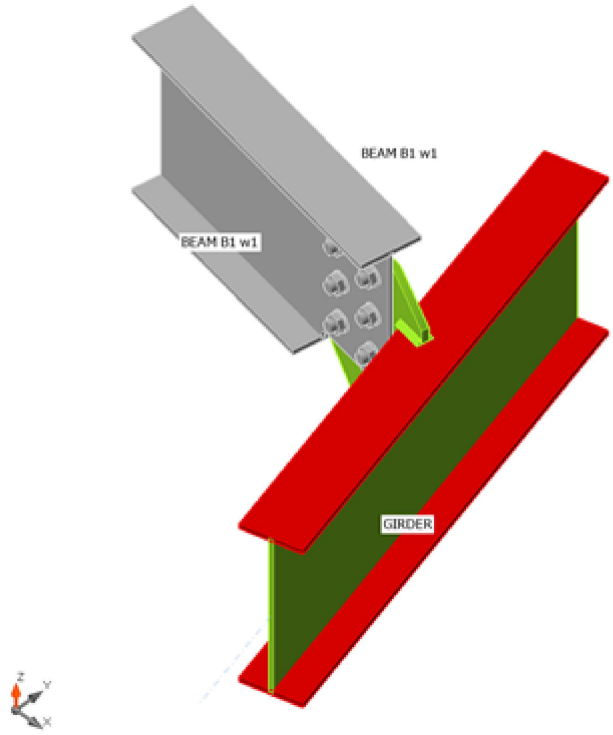
Design data

Material	F_y [ksi]	ε_{lim} [%]
A992	50.0	5.0
A36	36.0	5.0

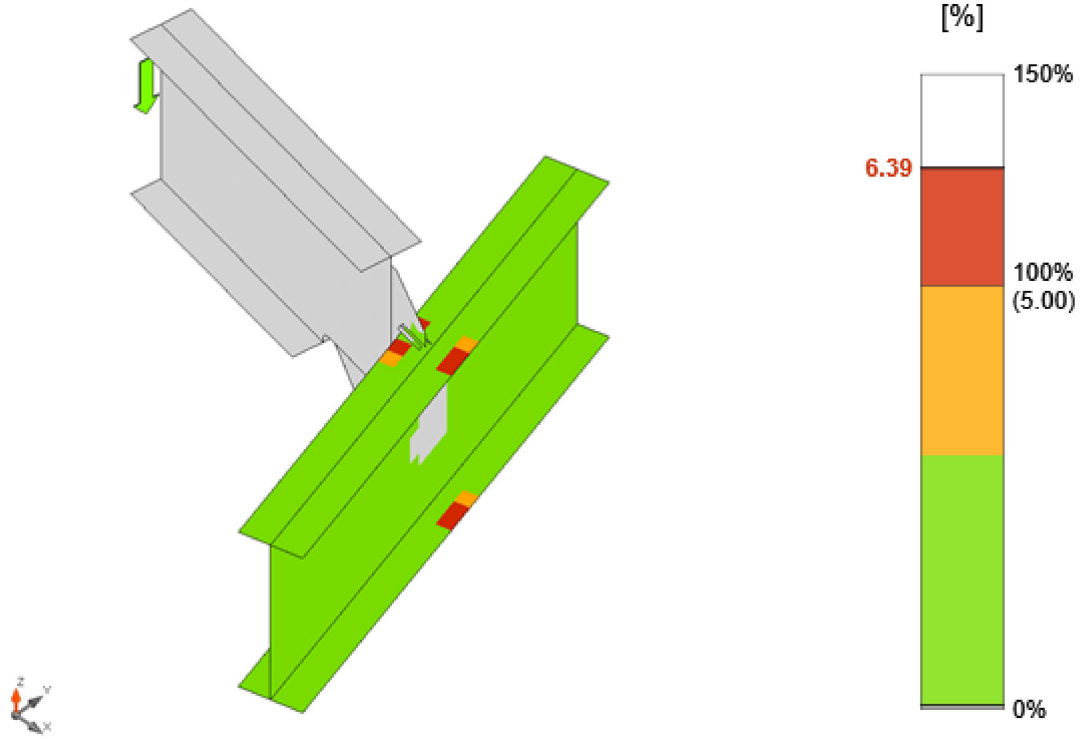
Symbol explanation

t_p	Plate thickness
σ_{Ed}	Equivalent stress
ε_{Pl}	Plastic strain
$\sigma_{c,Ed}$	Contact stress
F_y	Yield strength
ε_{lim}	Limit of plastic strain

Project: C 60
Project no:
Author:

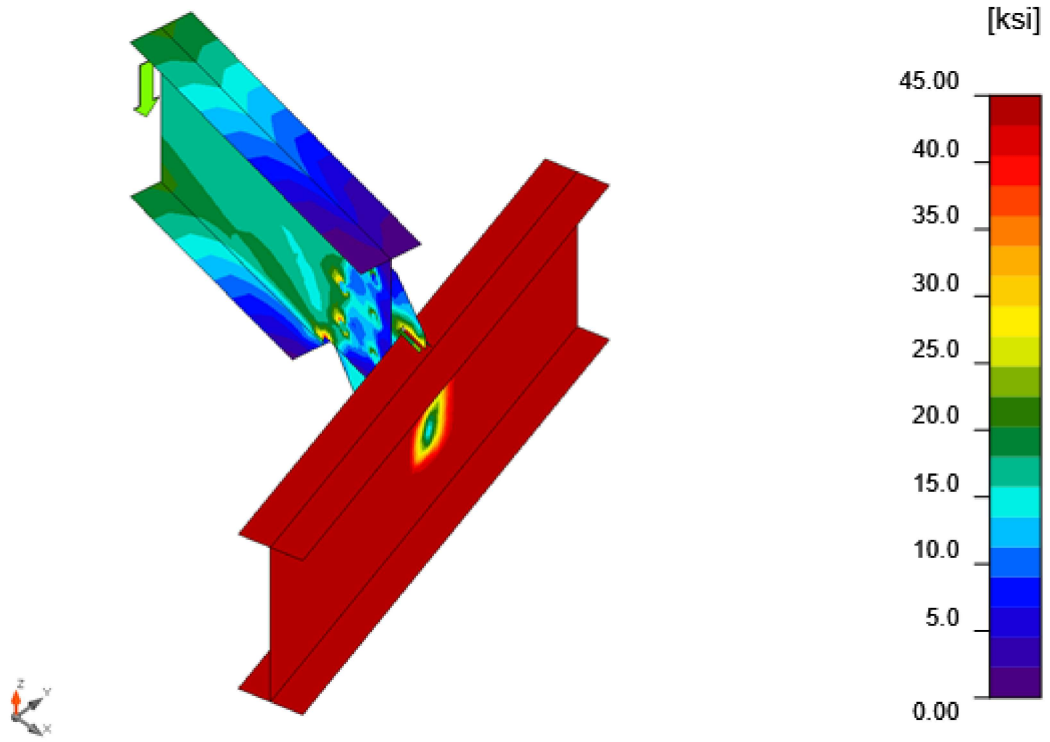


Overall check, LE1



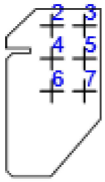
Strain check, LE1

Project: C 60
Project no:
Author:



Equivalent stress, LE1

Bolts

Shape	Item	Grade	Loads	F_t [kip]	V [kip]	$\phi R_{n,bearing}$ [kip]	Ut_t [%]	Ut_s [%]	Ut_{ts} [%]	Status
	B2	19 A325 - 1	LE1	1.113	3.761	21.938	3.7	21.0	-	OK
	B3	19 A325 - 1	LE1	0.670	3.867	21.938	2.2	21.6	-	OK
	B4	19 A325 - 1	LE1	0.848	4.129	21.938	2.8	23.1	-	OK
	B5	19 A325 - 1	LE1	0.713	4.181	21.938	2.4	23.4	-	OK
	B6	19 A325 - 1	LE1	0.725	4.436	21.938	2.4	24.8	-	OK
	B7	19 A325 - 1	LE1	0.883	4.628	21.938	3.0	25.9	-	OK

Design data

Grade	$\phi R_{n,tension}$ [kip]	$\phi R_{n,shear}$ [kip]
19 A325 - 1	29.795	17.877

Symbol explanation

F_t	Tension force
V	Resultant of bolt shear forces Vy and Vz in shear planes
$\phi R_{n,bearing}$	Bolt bearing resistance
Ut_t	Utilization in tension
Ut_s	Utilization in shear
Ut_{ts}	Utilization in tension and shear
$\phi R_{n,tension}$	Bolt tension resistance - AISC 360-16 – J3.6
$\phi R_{n,shear}$	Bolt shear resistance - AISC 360-16 – J3.6

Project: C 60
Project no:
Author:

Detailed result for B2

Tension resistance check (AISC 360-16 – J3-1)

$$\phi R_n = \phi \cdot F_{nt} \cdot A_b = \quad 29.795 \quad \text{kip} \quad \geq \quad F_t = \quad 1.113 \quad \text{kip}$$

Where:

$F_{nt} =$ 89.9 ksi – nominal tensile stress AISC 360-16 – Table J3.2

$A_b =$ 0.442 in^2 – gross bolt cross-sectional area

$\phi =$ 0.75 – resistance factor

Shear resistance check (AISC 360-16 – J3-1)

$$\phi R_n = \phi \cdot F_{nv} \cdot A_b = \quad 17.877 \quad \text{kip} \quad \geq \quad V = \quad 3.761 \quad \text{kip}$$

Where:

$F_{nv} =$ 54.0 ksi – nominal shear stress AISC 360-16 – Table J3.2

$A_b =$ 0.442 in^2 – gross bolt cross-sectional area

$\phi =$ 0.75 – resistance factor

Bearing resistance check (AISC 360-16 – J3-6)

$$R_n = 1.20 \cdot l_c \cdot t \cdot F_u \quad \leq \quad 2.40 \cdot d \cdot t \cdot F_u$$

$$\phi R_n = \quad 21.938 \quad \text{kip} \quad \geq \quad V = \quad 3.761 \quad \text{kip}$$

Where:

$l_c =$ 2.211 in – clear distance, in the direction of the force, between the edge of the hole and the edge of the adjacent hole or edge of the material

$t =$ 0.250 in – thickness of the plate

$d =$ 0.750 in – diameter of a bolt

$F_u =$ 65.0 ksi – tensile strength of the connected material

$\phi =$ 0.75 – resistance factor for bearing at bolt holes

Interaction of tension and shear check (AISC 360-16 – J3-2)

The required stress, in either shear or tension, is less than or equal to 30% of the corresponding available stress and the effects of combined stresses need not to be investigated.

Detailed result for B3

Tension resistance check (AISC 360-16 – J3-1)

$$\phi R_n = \phi \cdot F_{nt} \cdot A_b = \quad 29.795 \quad \text{kip} \quad \geq \quad F_t = \quad 0.670 \quad \text{kip}$$

Where:

$F_{nt} =$ 89.9 ksi – nominal tensile stress AISC 360-16 – Table J3.2

$A_b =$ 0.442 in^2 – gross bolt cross-sectional area

$\phi =$ 0.75 – resistance factor

Project: C 60
Project no:
Author:

Shear resistance check (AISC 360-16 – J3-1)

$\phi R_n = \phi \cdot F_{nv} \cdot A_b =$ 17.877 kip ≥ $V =$ 3.867 kip

Where:

$F_{nv} =$ 54.0 ksi – nominal shear stress AISC 360-16 – Table J3.2

$A_b =$ 0.442 in^2 – gross bolt cross-sectional area

$\phi =$ 0.75 – resistance factor

Bearing resistance check (AISC 360-16 – J3-6)

$R_n = 1.20 \cdot l_c \cdot t \cdot F_u \quad \leq \quad 2.40 \cdot d \cdot t \cdot F_u$

$\phi R_n =$ 21.938 kip ≥ $V =$ 3.867 kip

Where:

$l_c =$ 2.211 in – clear distance, in the direction of the force, between the edge of the hole and the edge of the adjacent hole or edge of the material

$t =$ 0.250 in – thickness of the plate

$d =$ 0.750 in – diameter of a bolt

$F_u =$ 65.0 ksi – tensile strength of the connected material

$\phi =$ 0.75 – resistance factor for bearing at bolt holes

Interaction of tension and shear check (AISC 360-16 – J3-2)

The required stress, in either shear or tension, is less than or equal to 30% of the corresponding available stress and the effects of combined stresses need not to be investigated.

Detailed result for B4

Tension resistance check (AISC 360-16 – J3-1)

$\phi R_n = \phi \cdot F_{nt} \cdot A_b =$ 29.795 kip ≥ $F_t =$ 0.848 kip

Where:

$F_{nt} =$ 89.9 ksi – nominal tensile stress AISC 360-16 – Table J3.2

$A_b =$ 0.442 in^2 – gross bolt cross-sectional area

$\phi =$ 0.75 – resistance factor

Shear resistance check (AISC 360-16 – J3-1)

$\phi R_n = \phi \cdot F_{nv} \cdot A_b =$ 17.877 kip ≥ $V =$ 4.129 kip

Where:

$F_{nv} =$ 54.0 ksi – nominal shear stress AISC 360-16 – Table J3.2

$A_b =$ 0.442 in^2 – gross bolt cross-sectional area

$\phi =$ 0.75 – resistance factor

Project: C 60

Project no:

Author:

Bearing resistance check (AISC 360-16 – J3-6)

$$R_n = 1.20 \cdot l_c \cdot t \cdot F_u \quad \leq \quad 2.40 \cdot d \cdot t \cdot F_u$$

$$\phi R_n = \quad 21.938 \quad \text{kip} \quad \geq \quad V = \quad 4.129 \quad \text{kip}$$

Where:

$l_c = 2.211$ in	– clear distance, in the direction of the force, between the edge of the hole and the edge of the adjacent hole or edge of the material
$t = 0.250$ in	– thickness of the plate
$d = 0.750$ in	– diameter of a bolt
$F_u = 65.0$ ksi	– tensile strength of the connected material
$\phi = 0.75$	– resistance factor for bearing at bolt holes

Interaction of tension and shear check (AISC 360-16 – J3-2)

The required stress, in either shear or tension, is less than or equal to 30% of the corresponding available stress and the effects of combined stresses need not to be investigated.

Detailed result for B5

Tension resistance check (AISC 360-16 – J3-1)

$$\phi R_n = \phi \cdot F_{nt} \cdot A_b = \quad 29.795 \quad \text{kip} \quad \geq \quad F_t = \quad 0.713 \quad \text{kip}$$

Where:

$F_{nt} = 89.9$ ksi	– nominal tensile stress AISC 360-16 – Table J3.2
$A_b = 0.442$ in^2	– gross bolt cross-sectional area
$\phi = 0.75$	– resistance factor

Shear resistance check (AISC 360-16 – J3-1)

$$\phi R_n = \phi \cdot F_{nv} \cdot A_b = \quad 17.877 \quad \text{kip} \quad \geq \quad V = \quad 4.181 \quad \text{kip}$$

Where:

$F_{nv} = 54.0$ ksi	– nominal shear stress AISC 360-16 – Table J3.2
$A_b = 0.442$ in^2	– gross bolt cross-sectional area
$\phi = 0.75$	– resistance factor

Project: C 60

Project no:

Author:

Bearing resistance check (AISC 360-16 – J3-6)

$$R_n = 1.20 \cdot l_c \cdot t \cdot F_u \quad \leq \quad 2.40 \cdot d \cdot t \cdot F_u$$

$$\phi R_n = \quad 21.938 \quad \text{kip} \quad \geq \quad V = \quad 4.181 \quad \text{kip}$$

Where:

$l_c = 2.211$ in	– clear distance, in the direction of the force, between the edge of the hole and the edge of the adjacent hole or edge of the material
$t = 0.250$ in	– thickness of the plate
$d = 0.750$ in	– diameter of a bolt
$F_u = 65.0$ ksi	– tensile strength of the connected material
$\phi = 0.75$	– resistance factor for bearing at bolt holes

Interaction of tension and shear check (AISC 360-16 – J3-2)

The required stress, in either shear or tension, is less than or equal to 30% of the corresponding available stress and the effects of combined stresses need not to be investigated.

Detailed result for B6

Tension resistance check (AISC 360-16 – J3-1)

$$\phi R_n = \phi \cdot F_{nt} \cdot A_b = \quad 29.795 \quad \text{kip} \quad \geq \quad F_t = \quad 0.725 \quad \text{kip}$$

Where:

$F_{nt} = 89.9$ ksi	– nominal tensile stress AISC 360-16 – Table J3.2
$A_b = 0.442$ in^2	– gross bolt cross-sectional area
$\phi = 0.75$	– resistance factor

Shear resistance check (AISC 360-16 – J3-1)

$$\phi R_n = \phi \cdot F_{nv} \cdot A_b = \quad 17.877 \quad \text{kip} \quad \geq \quad V = \quad 4.436 \quad \text{kip}$$

Where:

$F_{nv} = 54.0$ ksi	– nominal shear stress AISC 360-16 – Table J3.2
$A_b = 0.442$ in^2	– gross bolt cross-sectional area
$\phi = 0.75$	– resistance factor

Project: C 60

Project no:

Author:

Bearing resistance check (AISC 360-16 – J3-6)

$$R_n = 1.20 \cdot l_c \cdot t \cdot F_u \quad \leq \quad 2.40 \cdot d \cdot t \cdot F_u$$

$$\phi R_n = \quad 21.938 \quad \text{kip} \quad \geq \quad V = \quad 4.436 \quad \text{kip}$$

Where:

$l_c = 2.211$ in	– clear distance, in the direction of the force, between the edge of the hole and the edge of the adjacent hole or edge of the material
$t = 0.250$ in	– thickness of the plate
$d = 0.750$ in	– diameter of a bolt
$F_u = 65.0$ ksi	– tensile strength of the connected material
$\phi = 0.75$	– resistance factor for bearing at bolt holes

Interaction of tension and shear check (AISC 360-16 – J3-2)

The required stress, in either shear or tension, is less than or equal to 30% of the corresponding available stress and the effects of combined stresses need not to be investigated.

Detailed result for B7

Tension resistance check (AISC 360-16 – J3-1)

$$\phi R_n = \phi \cdot F_{nt} \cdot A_b = \quad 29.795 \quad \text{kip} \quad \geq \quad F_t = \quad 0.883 \quad \text{kip}$$

Where:

$F_{nt} = 89.9$ ksi	– nominal tensile stress AISC 360-16 – Table J3.2
$A_b = 0.442$ in^2	– gross bolt cross-sectional area
$\phi = 0.75$	– resistance factor

Shear resistance check (AISC 360-16 – J3-1)

$$\phi R_n = \phi \cdot F_{nv} \cdot A_b = \quad 17.877 \quad \text{kip} \quad \geq \quad V = \quad 4.628 \quad \text{kip}$$

Where:

$F_{nv} = 54.0$ ksi	– nominal shear stress AISC 360-16 – Table J3.2
$A_b = 0.442$ in^2	– gross bolt cross-sectional area
$\phi = 0.75$	– resistance factor

Project: C 60
Project no:
Author:

Bearing resistance check (AISC 360-16 – J3-6)

$$R_n = 1.20 \cdot l_c \cdot t \cdot F_u \quad \leq \quad 2.40 \cdot d \cdot t \cdot F_u$$

$$\phi R_n = \quad 21.938 \quad \text{kip} \quad \geq \quad V = \quad 4.628 \quad \text{kip}$$

Where:

$l_c = 2.211$ in – clear distance, in the direction of the force, between the edge of the hole and the edge of the adjacent hole or edge of the material

$t = 0.250$ in – thickness of the plate

$d = 0.750$ in – diameter of a bolt

$F_u = 65.0$ ksi – tensile strength of the connected material

$\phi = 0.75$ – resistance factor for bearing at bolt holes

Interaction of tension and shear check (AISC 360-16 – J3-2)

The required stress, in either shear or tension, is less than or equal to 30% of the corresponding available stress and the effects of combined stresses need not to be investigated.

Welds

Item	Edge	Xu	t_w [in]	w [in]	L [in]	L_c [in]	Loads	F_n [kip]	ϕR_n [kip]	Ut [%]	Status
GIRDER-bfl 1	SHEAR PLATE	E70xx	◢ 1/4 ◣	◢ 5/16 ◣	1.423	0.712	LE1	4.939	5.428	91.0	OK
		E70xx	◢ 1/4 ◣	◢ 5/16 ◣	1.423	0.712	LE1	5.647	7.431	76.0	OK
GIRDER-w 1	SHEAR PLATE	E70xx	◢ 1/4 ◣	◢ 5/16 ◣	10.199	0.785	LE1	4.061	5.533	73.4	OK
		E70xx	◢ 1/4 ◣	◢ 5/16 ◣	10.224	0.786	LE1	2.716	7.095	38.3	OK
GIRDER-tfl 1	SHEAR PLATE	E70xx	◢ 1/4 ◣	◢ 5/16 ◣	1.994	0.665	LE1	4.055	4.732	85.7	OK
		E70xx	◢ 1/4 ◣	◢ 5/16 ◣	1.994	0.665	LE1	4.338	5.695	76.2	OK
GIRDER-tfl 1	SHEAR PLATE	E70xx	◢ 1/4 ◣	◢ 5/16 ◣	1.423	0.712	LE1	4.350	5.187	83.9	OK
		E70xx	◢ 1/4 ◣	◢ 5/16 ◣	1.423	0.712	LE1	2.640	6.995	37.7	OK

Symbol explanation

t_w	Throat thickness of weld
w	Leg size of weld
L	Length of weld
L_c	Length of weld critical element
F_n	Force in weld critical element
ϕR_n	Weld resistance - AISC 360-16 – J2-4
Ut	Utilization
◢	Fillet weld

Project: C 60
Project no:
Author:

Detailed result for GIRDER-bfl 1 / SHEAR PLATE - 1

Weld resistance check (AISC 360-16 – J2-4)

$\phi R_n = \phi \cdot F_{nw} \cdot A_{we} =$ 5.428 kip ≥ $F_n =$ 4.939 kip

Where:

$F_{nw} =$ 46.0 ksi – nominal stress of weld material:

- $F_{nw} = 0.6 \cdot F_{EXX} \cdot (1 + 0.5 \cdot sin^{1.5}\theta)$, where:
  - $F_{EXX} =$ 70.0 ksi – electrode classification number, i.e. minimum specified tensile strength
  - $\theta =$ 19.4° – angle of loading measured from the weld longitudinal axis

$A_{we} =$ 0.157 in^2 – effective area of weld critical element

$\phi =$ 0.75 – resistance factor for welded connections

Detailed result for GIRDER-bfl 1 / SHEAR PLATE - 2

Weld resistance check (AISC 360-16 – J2-4)

$\phi R_n = \phi \cdot F_{nw} \cdot A_{we} =$ 7.431 kip ≥ $F_n =$ 5.647 kip

Where:

$F_{nw} =$ 63.0 ksi – nominal stress of weld material:

- $F_{nw} = 0.6 \cdot F_{EXX} \cdot (1 + 0.5 \cdot sin^{1.5}\theta)$, where:
  - $F_{EXX} =$ 70.0 ksi – electrode classification number, i.e. minimum specified tensile strength
  - $\theta =$ 89.4° – angle of loading measured from the weld longitudinal axis

$A_{we} =$ 0.157 in^2 – effective area of weld critical element

$\phi =$ 0.75 – resistance factor for welded connections

Detailed result for GIRDER-w 1 / SHEAR PLATE - 1

Weld resistance check (AISC 360-16 – J2-4)

$\phi R_n = \phi \cdot F_{nw} \cdot A_{we} =$ 5.533 kip ≥ $F_n =$ 4.061 kip

Where:

$F_{nw} =$ 42.6 ksi – nominal stress of weld material:

- $F_{nw} = 0.6 \cdot F_{EXX} \cdot (1 + 0.5 \cdot sin^{1.5}\theta)$, where:
  - $F_{EXX} =$ 70.0 ksi – electrode classification number, i.e. minimum specified tensile strength
  - $\theta =$ 5.1° – angle of loading measured from the weld longitudinal axis

$A_{we} =$ 0.173 in^2 – effective area of weld critical element

$\phi =$ 0.75 – resistance factor for welded connections

Project: C 60
Project no:
Author:

Detailed result for GIRDER-w 1 / SHEAR PLATE - 2

Weld resistance check (AISC 360-16 – J2-4)

$\phi R_n = \phi \cdot F_{nw} \cdot A_{we} =$ 7.095 kip ≥ $F_n =$ 2.716 kip

Where:

$F_{nw} =$ 54.4 ksi – nominal stress of weld material:

- $F_{nw} = 0.6 \cdot F_{EXX} \cdot (1 + 0.5 \cdot sin^{1.5}\theta)$, where:
  - $F_{EXX} =$ 70.0 ksi – electrode classification number, i.e. minimum specified tensile strength
  - $\theta =$ 44.8° – angle of loading measured from the weld longitudinal axis

$A_{we} =$ 0.174 in^2 – effective area of weld critical element

$\phi =$ 0.75 – resistance factor for welded connections

Detailed result for GIRDER-tfl 1 / SHEAR PLATE - 1

Weld resistance check (AISC 360-16 – J2-4)

$\phi R_n = \phi \cdot F_{nw} \cdot A_{we} =$ 4.732 kip ≥ $F_n =$ 4.055 kip

Where:

$F_{nw} =$ 43.0 ksi – nominal stress of weld material:

- $F_{nw} = 0.6 \cdot F_{EXX} \cdot (1 + 0.5 \cdot sin^{1.5}\theta)$, where:
  - $F_{EXX} =$ 70.0 ksi – electrode classification number, i.e. minimum specified tensile strength
  - $\theta =$ 7.3° – angle of loading measured from the weld longitudinal axis

$A_{we} =$ 0.147 in^2 – effective area of weld critical element

$\phi =$ 0.75 – resistance factor for welded connections

Detailed result for GIRDER-tfl 1 / SHEAR PLATE - 2

Weld resistance check (AISC 360-16 – J2-4)

$\phi R_n = \phi \cdot F_{nw} \cdot A_{we} =$ 5.695 kip ≥ $F_n =$ 4.338 kip

Where:

$F_{nw} =$ 51.7 ksi – nominal stress of weld material:

- $F_{nw} = 0.6 \cdot F_{EXX} \cdot (1 + 0.5 \cdot sin^{1.5}\theta)$, where:
  - $F_{EXX} =$ 70.0 ksi – electrode classification number, i.e. minimum specified tensile strength
  - $\theta =$ 36.7° – angle of loading measured from the weld longitudinal axis

$A_{we} =$ 0.147 in^2 – effective area of weld critical element

$\phi =$ 0.75 – resistance factor for welded connections

Project: C 60
Project no:
Author:

Detailed result for GIRDER-tfl 1 / SHEAR PLATE - 1

Weld resistance check (AISC 360-16 – J2-4)

$\phi R_n = \phi \cdot F_{nw} \cdot A_{we} =$ 5.187 kip ≥ $F_n =$ 4.350 kip

Where:

$F_{nw} =$ 44.0 ksi – nominal stress of weld material:

- $F_{nw} = 0.6 \cdot F_{EXX} \cdot (1 + 0.5 \cdot sin^{1.5}\theta)$, where:
  - $F_{EXX} =$ 70.0 ksi – electrode classification number, i.e. minimum specified tensile strength
  - $\theta =$ 11.9° – angle of loading measured from the weld longitudinal axis

$A_{we} =$ 0.157 in^2 – effective area of weld critical element

$\phi =$ 0.75 – resistance factor for welded connections

Detailed result for GIRDER-tfl 1 / SHEAR PLATE - 2

Weld resistance check (AISC 360-16 – J2-4)

$\phi R_n = \phi \cdot F_{nw} \cdot A_{we} =$ 6.995 kip ≥ $F_n =$ 2.640 kip

Where:

$F_{nw} =$ 59.3 ksi – nominal stress of weld material:

- $F_{nw} = 0.6 \cdot F_{EXX} \cdot (1 + 0.5 \cdot sin^{1.5}\theta)$, where:
  - $F_{EXX} =$ 70.0 ksi – electrode classification number, i.e. minimum specified tensile strength
  - $\theta =$ 61.5° – angle of loading measured from the weld longitudinal axis

$A_{we} =$ 0.157 in^2 – effective area of weld critical element

$\phi =$ 0.75 – resistance factor for welded connections

Buckling

Buckling analysis was not calculated.