



**ALCALDÍA MAYOR DE BOGOTÁ D.C.**  
SECRETARÍA DE EDUCACIÓN  
SUBSECRETARÍA DE ACCESO Y PERMANENCIA  
DIRECCIÓN DE CONSTRUCCIÓN Y CONSERVACIÓN DE ESTABLECIMIENTOS EDUCATIVOS

**PROYECTO: COLEGIO BOITÁ**  
CONTRATO DE CONSULTORÍA 519 DE 27/12/2019



CONSULTOR: MC CONSTRUCCIONES Y CONSULTORÍAS SAS



**ANEXO 9.3 Diseño de Elementos de Acero**

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AGOSTO 2020

Project:

Project no:

Author:



## Project data

Project name

Project number

Author

Description

Date 8/13/2020

Design code AISC 360-16

## Material

Steel A572 Gr.50, A500, Gr. B

## Project item CON1

### Design

Name CON1

Description

Analysis Stress, strain/ simplified loading

Design code AISC - LRFD

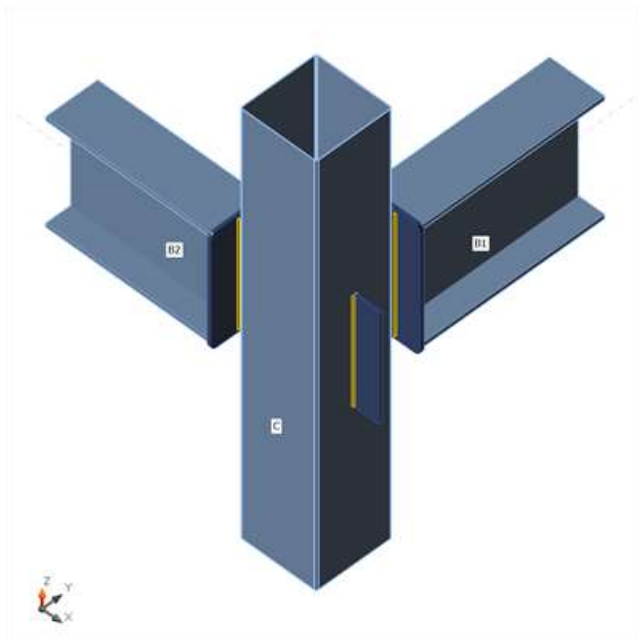
### Beams and columns

Name	Cross-section	$\beta$ - Direction [°]	$\gamma$ - Pitch [°]	$\alpha$ - Rotation [°]	Offset ex [mm]	Offset ey [mm]	Offset ez [mm]	Forces in
C	6 - RHS250x250	0.0	-90.0	0.0	0	0	0	Node
B1	3 - IPE400	90.0	0.0	0.0	0	0	0	Bolts
B2	5 - IPE360	180.0	0.0	0.0	0	0	0	Bolts

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## Cross-sections

Name	Material
6 - RHS250x250	A500, Gr. B
3 - IPE400	A572 Gr.50
5 - IPE360	A572 Gr.50

## Bolts

Name	Bolt assembly	Diameter [mm]	$f_u$ [MPa]	Gross area [mm <sup>2</sup> ]
3/4 A325	3/4 A325	19	825.0	285

## Load effects (equilibrium not required)

Name	Member	N [kN]	V <sub>y</sub> [kN]	V <sub>z</sub> [kN]	M <sub>x</sub> [kNm]	M <sub>y</sub> [kNm]	M <sub>z</sub> [kNm]
LE1	B1	0.0	0.0	-85.0	0.0	0.0	0.0
	B2	0.0	0.0	-80.0	0.0	0.0	0.0

## Check

## Summary

Name	Value	Check status
Analysis	100.0%	OK
Plates	4.7 < 5%	OK
Bolts	99.3 < 100%	OK
Welds	80.7 < 100%	OK
Buckling	2.54	
GMNA	Calculated	

Project:

Project no:

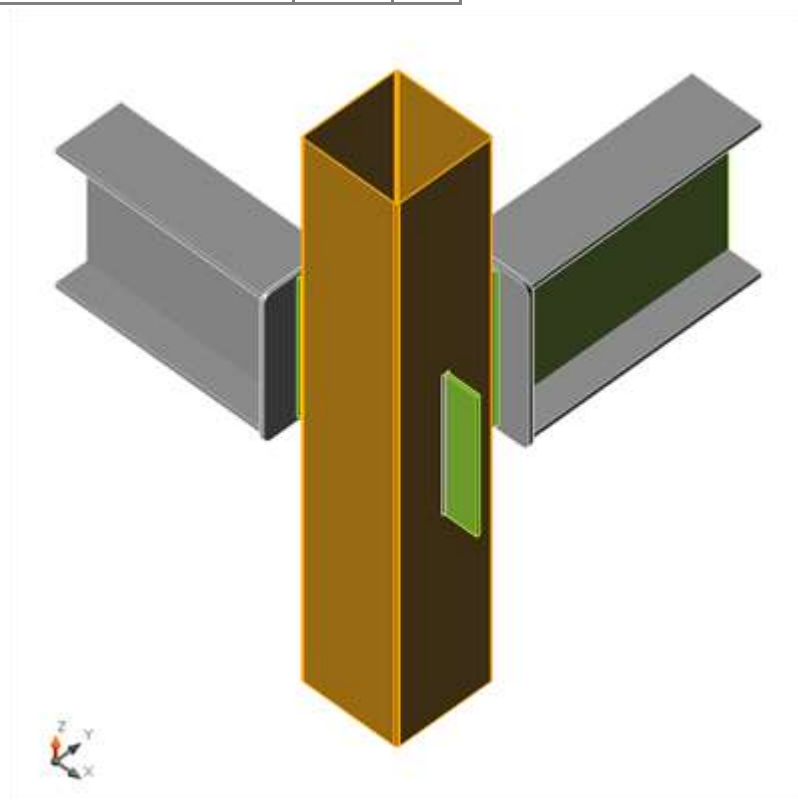
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## Plates

Name	Material	F <sub>y</sub> [MPa]	Thickness [mm]	Loads	σ <sub>Ed</sub> [MPa]	ε <sub>pl</sub> [%]	Check status
C	A500, Gr. B	290.0	2.5	LE1	270.5	4.7	OK
B1-bfl 1	A572 Gr.50	344.7	13.5	LE1	210.9	0.0	OK
B1-tfl 1	A572 Gr.50	344.7	13.5	LE1	143.3	0.0	OK
B1-w 1	A572 Gr.50	344.7	8.6	LE1	310.6	0.2	OK
B2-bfl 1	A572 Gr.50	344.7	12.7	LE1	131.3	0.0	OK
B2-tfl 1	A572 Gr.50	344.7	12.7	LE1	110.5	0.0	OK
B2-w 1	A572 Gr.50	344.7	8.0	LE1	114.8	0.0	OK
SP1	A572 Gr.50	344.7	9.0	LE1	310.6	0.1	OK
CPL1a	A572 Gr.50	344.7	9.0	LE1	285.3	0.0	OK
CPL1b	A572 Gr.50	344.7	12.0	LE1	20.3	0.0	OK
CPL1c	A572 Gr.50	344.7	12.0	LE1	231.1	0.0	OK
CPL1d	A572 Gr.50	344.7	12.0	LE1	225.8	0.0	OK
CPL2a	A572 Gr.50	344.7	9.0	LE1	50.3	0.0	OK
CPL2b	A572 Gr.50	344.7	9.0	LE1	310.5	0.1	OK

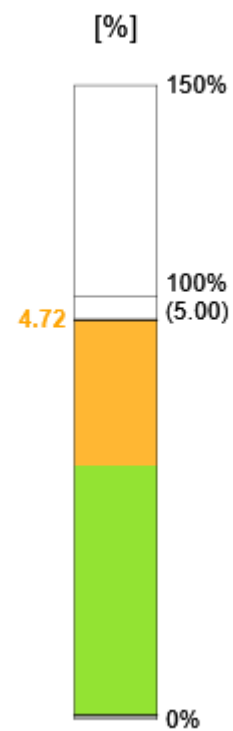
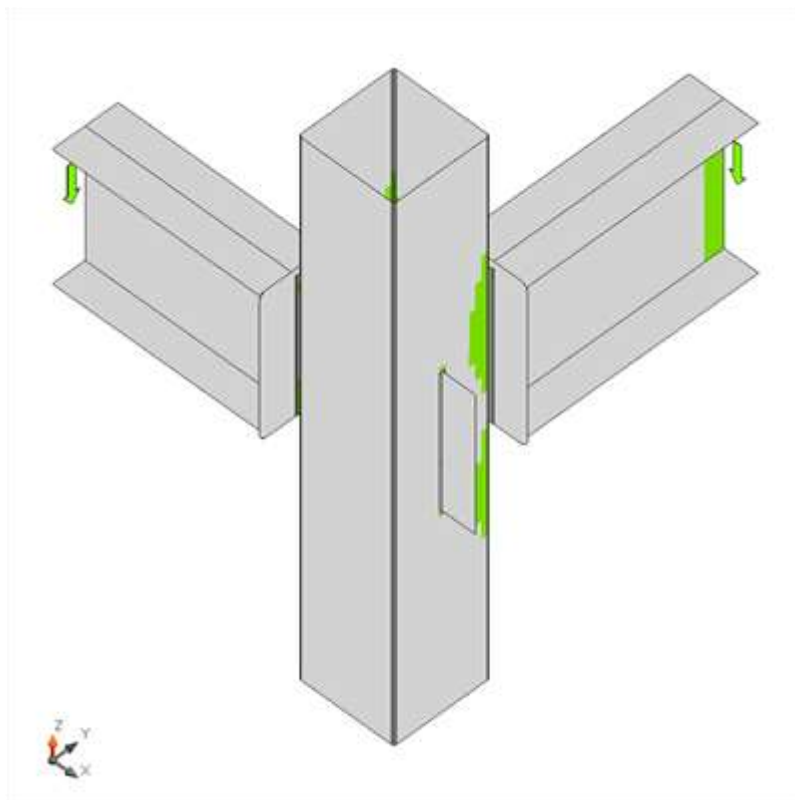
## Design data

Material	f <sub>y</sub> [MPa]	ε <sub>lim</sub> [%]
A500, Gr. B	290.0	5.0
A572 Gr.50	344.7	5.0

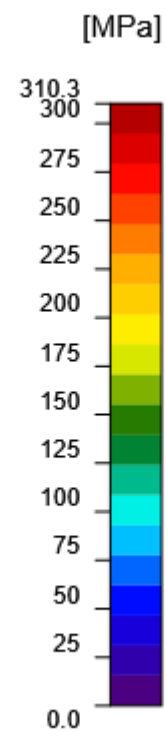
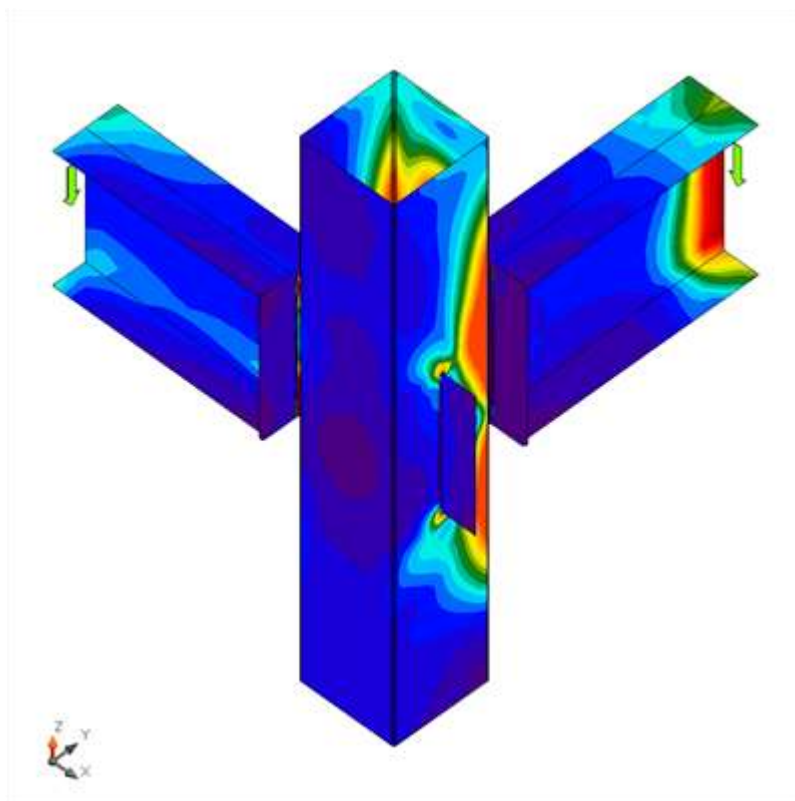


Overall check, LE1

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Strain check, LE1





Equivalent stress, LE1

Project:

Project no:

Author:

## Bolts

Shape	Item	Grade	Loads	$F_t$ [kN]	$V$ [kN]	$\phi R_{n,bearing}$ [kN]	$U_{t_t}$ [%]	$U_{t_s}$ [%]	$U_{t_{ts}}$ [%]	Status
	B1	3/4 A325 - 1	LE1	1.7	12.1	138.3	1.3	17.3	-	OK
	B2	3/4 A325 - 1	LE1	0.9	13.0	138.3	0.7	17.5	-	OK
	B3	3/4 A325 - 1	LE1	2.8	23.9	138.3	2.1	33.6	-	OK
	B4	3/4 A325 - 1	LE1	4.0	21.3	120.3	3.0	33.7	-	OK
	B5	3/4 A325 - 2	LE1	3.9	27.1	138.3	3.0	27.0	-	OK
	B6	3/4 A325 - 2	LE1	9.0	27.0	95.1	6.8	28.4	-	OK
	B7	3/4 A325 - 2	LE1	13.8	58.3	58.7	10.4	99.3	-	OK
	B8	3/4 A325 - 2	LE1	18.5	59.4	138.3	13.9	59.2	-	OK

## Design data

Grade	$\phi R_{n,tension}$ [kN]	$\phi R_{n,shear}$ [kN]
3/4 A325 - 1	132.5	79.5
3/4 A325 - 2	132.5	100.3

## Detailed result for B7

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

$$\phi R_n = \phi \cdot F_{nt} \cdot A_b = 132.5 \text{ kN} \geq F_t = 13.8 \text{ kN}$$

Where:

$$F_{nt} = 620.0 \text{ MPa} \quad \text{-- nominal tensile stress from AISC 360-16 Table J3.2}$$

$$A_b = 285 \text{ mm}^2 \quad \text{-- gross bolt cross-sectional area}$$

$$\phi = 0.75 \quad \text{-- capacity factor}$$

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

$$\phi R_n = \phi \cdot F_{nv} \cdot A_b = 100.3 \text{ kN} \geq V = 58.3 \text{ kN}$$

Where:

$$F_{nv} = 469.0 \text{ MPa} \quad \text{-- nominal shear stress from AISC 360-16 Table J3.2}$$

$$A_b = 285 \text{ mm}^2 \quad \text{-- gross bolt cross-sectional area}$$

$$\phi = 0.75 \quad \text{-- capacity factor}$$

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

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

$$\phi R_n = 58.7 \text{ kN} \geq V = 58.3 \text{ kN}$$

Where:

$$l_c = 16 \text{ mm} \quad \text{-- clear distance, in the direction of the force, between the edge of the hole and the edge of the adjacent hole or edge of the material}$$

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- $t = 9 \text{ mm}$  – thickness of the ply  
 $d = 19 \text{ mm}$  – diameter of a bolt  
 $F_u = 448.2 \text{ MPa}$  – 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 <sub>h</sub> [mm]	L <sub>s</sub> [mm]	L [mm]	L <sub>c</sub> [mm]	F <sub>n</sub> [kN]	$\phi R_n$ [kN]	Ut [%]	Status
SP1	C-w 1	E70xx	▲3.2	▲4.5	359	16	4.1	11.5	35.8	OK
SP1	C-w 1	E70xx	▲3.2	▲4.5	359	16	4.4	11.5	38.6	OK
SP1	C-w 3	E70xx	▲3.2	▲4.5	358	16	5.0	13.9	36.3	OK
SP1	C-w 3	E70xx	▲3.2	▲4.5	358	16	4.6	15.4	30.0	OK
C-w 2	CPL1a	E70xx	▲3.2▲	▲4.5▲	399	15	11.9	15.3	77.8	OK
		E70xx	▲3.2▲	▲4.5▲	399	15	12.0	15.4	78.2	OK
CPL1b	CPL1c	E70xx	▲3.2	▲4.5	399	25	17.8	23.7	75.2	OK
CPL1b	CPL1d	E70xx	▲3.2	▲4.5	399	25	17.4	23.8	73.1	OK
CPL1b	B1-bfl 1	E70xx	▲3.2	▲4.5	180	45	13.1	46.1	28.4	OK
CPL1b	B1-tfl 1	E70xx	▲3.2	▲4.5	180	45	18.1	46.3	39.2	OK
CPL1b	B1-w 1	E70xx	▲3.2	▲4.5	386	48	25.8	38.9	66.4	OK
CPL2a	CPL2b	E70xx	▲3.2▲	▲4.5▲	358	22	11.5	15.6	74.1	OK
		E70xx	▲3.2▲	▲4.5▲	359	22	18.8	23.3	80.7	OK
CPL2a	B2-bfl 1	E70xx	▲3.2▲	▲4.5▲	170	42	16.0	43.3	36.9	OK
		E70xx	▲3.2▲	▲4.5▲	170	42	11.6	43.9	26.6	OK
CPL2a	B2-tfl 1	E70xx	▲3.2▲	▲4.5▲	170	42	11.5	43.7	26.4	OK
		E70xx	▲3.2▲	▲4.5▲	170	42	15.6	43.8	35.7	OK
CPL2a	B2-w 1	E70xx	▲3.2▲	▲4.5▲	347	43	17.9	38.9	46.0	OK
		E70xx	▲3.2▲	▲4.5▲	347	43	23.0	40.1	57.3	OK

## Detailed result for CPL2a / CPL2b

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

$$\phi R_n = \phi \cdot F_{nw} \cdot A_{we} = 23.3 \text{ kN} \geq F_n = 18.8 \text{ kN}$$

Where:

$$F_{nw} = 434.0 \text{ MPa} \quad \text{– nominal stress of weld material:}$$

$$F_{nw} = 0.6 \cdot F_{EXX} \cdot (1 + 0.5 \cdot \sin^{1.5} \theta)$$

, where:

$$F_{EXX} =$$

482.6 MPa – electrode classification number, i.e. minimum specified tensile strength

$$\theta =$$

86.6° – angle of loading measured from the weld longitudinal axis

$$A_{we} = 71 \text{ mm}^2 \quad \text{– effective area of weld critical element}$$

$$\phi = 0.75 \quad \text{– resistance factor for welded connections}$$


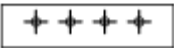



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## Buckling

Loads	Shape	Factor [-]
LE1	1	2.54
	2	2.67
	3	3.34
	4	3.35
	5	3.37
	6	3.50

## Bill of material



## Manufacturing operations

Name	Plates [mm]	Shape	Nr.	Welds [mm]	Length [mm]	Bolts	Nr.
SP1	P9.0x420.0-360.0 (A572 Gr.50)		1			3/4 A325	4
CUT3				Fillet: a = 3.2	1440.0		
CPL1	P9.0x400.0-100.0 (A572 Gr.50)		1	Double fillet: a = 3.2 Fillet: a = 3.2 Fillet: a = 3.2	400.0 580.0 966.5	3/4 A325	4
	P12.0x200.0-420.0 (A572 Gr.50)		1				
	P12.0x105.0-400.0 (A572 Gr.50)		1				
	P12.0x105.0-400.0 (A572 Gr.50)		1				



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CPL2	P9.0x190.0-380.0 (A572 Gr.50)		1	Double fillet: a = 3.2	1047.3	3/4 A325	4
	P9.0x105.0-360.0 (A572 Gr.50)		1				

## Welds

Type	Material	Throat thickness [mm]	Leg size [mm]	Length [mm]
Fillet	E70xx	3.2	4.5	2406.5
Double fillet	E70xx	3.2	4.5	1447.3
Fillet	E70xx	3.2	4.5	580.0

## Bolts

Name	Grip length [mm]	Count
3/4 A325	33	4
3/4 A325	18	4

## Symbol explanation

Symbol	Symbol explanation
$\epsilon_{Pl}$	Strain
$f_y$	Yield strength
$\epsilon_{lim}$	Limit of plastic strain
$F_t$	Tension force
$V$	Resultant of shear forces $V_y, V_z$ in bolt
$\phi R_n^{Bearing}$	Plate bearing resistance AISC 360-16 J3.10
$U_t$	Utilization
$U_{ts}$	Utilization in shear
$U_{tts}$	Utilization in tension and shear EN 1993-1-8 table 3.4
$\phi R_n^{Bearing}$	Bolt bearing resistance
$\phi R_n^{Shear}$	Bolt shear resistance AISC 360-16 – J3.8
$T_h$	Throat thickness of weld
$L_s$	Leg size of weld
$L$	Length of weld
$L_c$	Length of critical weld element
$F_n$	Force in weld critical element
$\phi R_n^w$	Weld resistance AISC 360-16 J2.4

## Code settings

Item	Value	Unit	Reference
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Project:

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Friction coefficient - concrete	0.40	-	ACI 349 – B.6.1.4
Friction coefficient in slip-resistance	0.30	-	AISC 360-16 – J3.8
Limit plastic strain	0.05	-	
Weld stress evaluation	Plastic redistribution		
Detailing	No		
Distance between bolts [d]	2.66	-	AISC 360-16 – J3.3
Distance between bolts and edge [d]	1.25	-	AISC 360-16 – J.3.4
Concrete breakout resistance	Yes		
Base metal capacity check at weld fusion face	No		AISC 360-16 – J2-2
Cracked concrete	Yes		ACI 318-14 – Chapter 17
Local deformation check	No		
Local deformation limit	0.03	-	CIDECT DG 1, 3 - 1.1
Geometrical nonlinearity (GMNA)	Yes		Allow large deformations of hollow sections
Braced system	No		

## Steel connections

### Results

Connection name : Fixed biaxial BP  
Connection ID : 1

Family: Column - Base (CB)  
Type: Base plate  
Design code: AISC 360-16 LRFD, ACI 318-08

#### DEMANDS

Description	Pu [Ton]	Mu22 [Ton*m]	Mu33 [Ton*m]	Vu2 [Ton]	Vu3 [Ton]	Load type
DL	13.00	0.50	1.46	1.00	1.00	Design

#### Design for major axis Base plate (AISC 360-16 LRFD)

#### GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
<u>Base plate</u>						
Distance from anchor to edge	[cm]	3.81	0.64	--	✓	
Weld size	[1/16in]	5	2	--	✓	table J2.4

#### DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
<u>Pedestal</u>						
Axial bearing	[Ton/cm2]	0.21	0.21	DL	1.00	DG1 3.1.1;
<u>Base plate</u>						
Flexural yielding (bearing interface)	[Ton*m/m]	4.56	2.13	DL	0.47	DG1 Eq. 3.3.13, DG1 Sec 3.1.2
Flexural yielding (tension interface)	[Ton*m/m]	4.56	3.87	DL	0.85	DG1 Eq. 3.3.13
<u>Column</u>						
Weld capacity	[Ton/m]	186.45	49.77	DL	0.27	p. 8-9, Sec. J2.5, Sec. J2.4, HSS Manual p. 7-10
Elastic method weld shear capacity	[Ton/m]	124.30	2.16	DL	0.02	p. 8-9, Sec. J2.5, Sec. J2.4
Elastic method weld axial capacity	[Ton/m]	186.45	33.73	DL	0.18	p. 8-9, Sec. J2.5, Sec. J2.4
<b>Ratio</b>	<b>1.00</b>					

#### Design for minor axis Base plate (AISC 360-16 LRFD)

#### GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
<u>Base plate</u>						
Distance from anchor to edge	[cm]	3.81	0.64	--	✓	

Weld size	[1/16in]	5	2	--	✓	table J2.4
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## DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
<u>Pedestal</u>						
Axial bearing	[Ton/cm2]	0.21	0.21	DL	1.00	DG1 3.1.1;
<u>Base plate</u>						
Flexural yielding (bearing interface)	[Ton*m/m]	4.56	1.78	DL	0.39	DG1 Eq. 3.3.13, DG1 Sec 3.1.2
Flexural yielding (tension interface)	[Ton*m/m]	4.56	3.87	DL	0.85	DG1 Eq. 3.3.13
<u>Column</u>						
Weld capacity	[Ton/m]	186.45	49.77	DL	0.27	p. 8-9, Sec. J2.5, Sec. J2.4, HSS Manual p. 7-10
Elastic method weld shear capacity	[Ton/m]	124.30	2.16	DL	0.02	p. 8-9, Sec. J2.5, Sec. J2.4
Elastic method weld axial capacity	[Ton/m]	186.45	20.80	DL	0.11	p. 8-9, Sec. J2.5, Sec. J2.4
<b>Ratio</b>	<b>1.00</b>					

## Major axis Anchors

## GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
<u>Anchors</u>						
Anchor spacing	[cm]	24.84	10.16	--	✓	Sec. D.8.1
Concrete cover	[cm]	6.35	5.08	--	✓	Sec. 7.7.1
Effective length	[cm]	41.65	--	88.35	✓	

## DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Anchor tension	[Ton]	11.95	6.32	DL	0.53	Eq. D-3
Pullout of anchor in tension	[Ton]	26.70	6.32	DL	0.24	Sec. D.4.1.1
Side-face blowout of anchor in tension	[Ton]	9.38	5.79	DL	0.62	Sec. D.5.4.1, Sec. D.4.1.1
Side-face blowout of group of anchors in tension	[Ton]	35.69	12.11	DL	0.34	Eq. D-17, Sec. D.4.1.1
Group of Anchors reinforcement in tension	[Ton]	14.97	14.41	DL	0.96	Sec. D.5.2.9, D.6.2.9
Anchor shear	[Ton]	6.22	0.35	DL	0.06	Eq. D-20
Pryout of anchor in shear	[Ton]	12.69	0.25	DL	0.02	Eq. D-4, Sec. D.4.1.1
Pryout of group of anchors in shear	[Ton]	20.09	1.00	DL	0.05	Eq. D-5, Sec. D.4.1.1
Group of Anchors reinforcement in shear	[Ton]	43.00	0.25	DL	0.01	Sec. D.5.2.9, D.6.2.9
Interaction of tensile and shear forces	[Ton]	1.20	0.00	DL	0.00	Eq. D-3, Sec. D.4.1.1, Sec. D.5.4.1, Eq. D-17, Eq. D-20, Eq. D-4, Eq. D-5, Sec. D.7
<b>Ratio</b>	<b>0.96</b>					

## Minor axis Anchors

## GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
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**Anchors**

Anchor spacing	[cm]	24.84	10.16	--	✓	Sec. D.8.1
Concrete cover	[cm]	6.35	5.08	--	✓	Sec. 7.7.1
Effective length	[cm]	41.65	--	88.35	✓	

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**DESIGN CHECK**

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Anchor tension	[Ton]	11.95	6.32	DL	0.53	Eq. D-3
Pullout of anchor in tension	[Ton]	26.70	6.32	DL	0.24	Sec. D.4.1.1
Side-face blowout of anchor in tension	[Ton]	9.38	5.79	DL	0.62	Sec. D.5.4.1, Sec. D.4.1.1
Side-face blowout of group of anchors in tension	[Ton]	21.84	6.67	DL	0.31	Eq. D-17, Sec. D.4.1.1
Group of Anchors reinforcement in tension	[Ton]	14.97	14.41	DL	0.96	Sec. D.5.2.9, D.6.2.9
Anchor shear	[Ton]	6.22	0.35	DL	0.06	Eq. D-20
Pryout of anchor in shear	[Ton]	12.69	0.25	DL	0.02	Eq. D-4, Sec. D.4.1.1
Pryout of group of anchors in shear	[Ton]	20.09	1.00	DL	0.05	Eq. D-5, Sec. D.4.1.1
Group of Anchors reinforcement in shear	[Ton]	43.00	0.25	DL	0.01	Sec. D.5.2.9, D.6.2.9
Interaction of tensile and shear forces	[Ton]	1.20	0.00	DL	0.00	Eq. D-3, Sec. D.4.1.1, Sec. D.5.4.1, Eq. D-17, Eq. D-20, Eq. D-4, Eq. D-5, Sec. D.7

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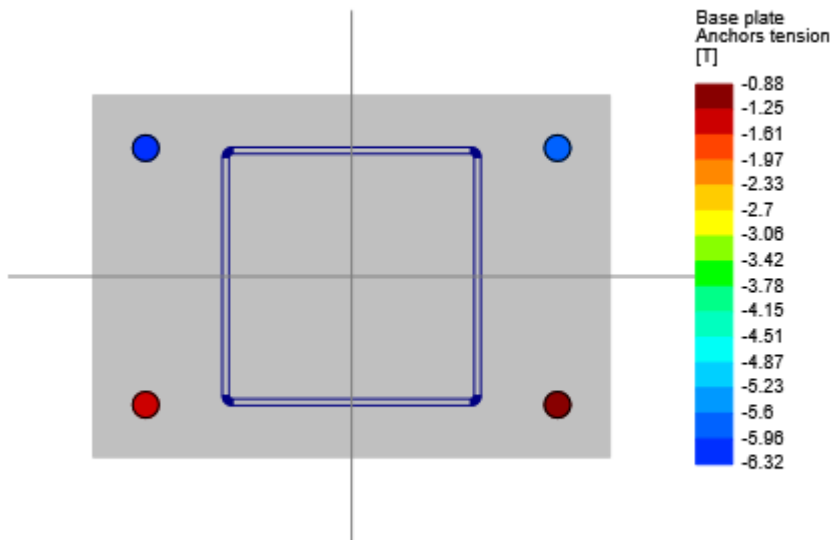
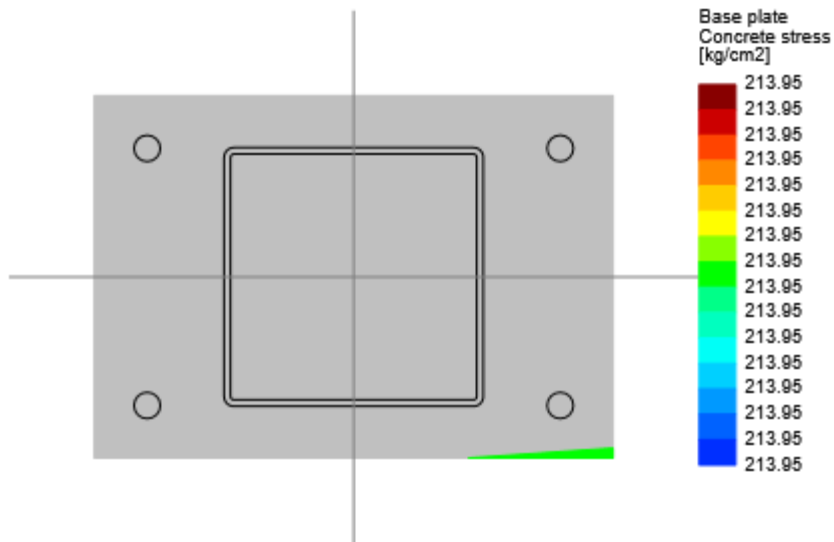
<b>Ratio</b>	<b>0.96</b>
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<b>Global critical strength ratio</b>	<b>1.00</b>
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**Biaxial****Maximum compression and tension (DL)**



Maximum bearing pressure	213.95	[Kg/cm <sup>2</sup> ]
Minimum bearing pressure	213.95	[Kg/cm <sup>2</sup> ]
Maximum anchor tension	6.32	[Ton]
Minimum anchor tension	0.88	[Ton]
Neutral axis angle	0.00	
Bearing length	0.94	[cm]

#### Anchors tensions

Anchor	Transverse [cm]	Longitudinal [cm]	Shear [Ton]	Tension [Ton]
1	-19.92	-12.42	0.25	1.42
2	19.92	-12.42	0.25	0.88
3	19.92	12.42	0.25	5.79
4	-19.92	12.42	0.25	6.32

## Steel connections

### Results

Connection name : Fixed biaxial BP  
Connection ID : 1

Family: Column - Base (CB)  
Type: Base plate  
Design code: AISC 360-16 LRFD, ACI 318-08

#### DEMANDS

Description	Pu [Ton]	Mu22 [Ton*m]	Mu33 [Ton*m]	Vu2 [Ton]	Vu3 [Ton]	Load type
DL	13.00	0.50	1.46	1.00	1.00	Design

#### Design for major axis Base plate (AISC 360-16 LRFD)

#### GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
<u>Base plate</u>						
Distance from anchor to edge	[cm]	3.81	0.64	--	✓	
Weld size	[1/16in]	5	2	--	✓	table J2.4

#### DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
<u>Pedestal</u>						
Axial bearing	[Ton/cm2]	0.21	0.21	DL	1.00	DG1 3.1.1;
<u>Base plate</u>						
Flexural yielding (bearing interface)	[Ton*m/m]	4.56	2.13	DL	0.47	DG1 Eq. 3.3.13, DG1 Sec 3.1.2
Flexural yielding (tension interface)	[Ton*m/m]	4.56	3.87	DL	0.85	DG1 Eq. 3.3.13
<u>Column</u>						
Weld capacity	[Ton/m]	186.45	49.77	DL	0.27	p. 8-9, Sec. J2.5, Sec. J2.4, HSS Manual p. 7-10
Elastic method weld shear capacity	[Ton/m]	124.30	2.16	DL	0.02	p. 8-9, Sec. J2.5, Sec. J2.4
Elastic method weld axial capacity	[Ton/m]	186.45	33.73	DL	0.18	p. 8-9, Sec. J2.5, Sec. J2.4
<b>Ratio</b>	<b>1.00</b>					

#### Design for minor axis Base plate (AISC 360-16 LRFD)

#### GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
<u>Base plate</u>						
Distance from anchor to edge	[cm]	3.81	0.64	--	✓	

Weld size	[1/16in]	5	2	--	✓	table J2.4
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## DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
<u>Pedestal</u>						
Axial bearing	[Ton/cm2]	0.21	0.21	DL	1.00	DG1 3.1.1;
<u>Base plate</u>						
Flexural yielding (bearing interface)	[Ton*m/m]	4.56	1.78	DL	0.39	DG1 Eq. 3.3.13, DG1 Sec 3.1.2
Flexural yielding (tension interface)	[Ton*m/m]	4.56	3.87	DL	0.85	DG1 Eq. 3.3.13
<u>Column</u>						
Weld capacity	[Ton/m]	186.45	49.77	DL	0.27	p. 8-9, Sec. J2.5, Sec. J2.4, HSS Manual p. 7-10
Elastic method weld shear capacity	[Ton/m]	124.30	2.16	DL	0.02	p. 8-9, Sec. J2.5, Sec. J2.4
Elastic method weld axial capacity	[Ton/m]	186.45	20.80	DL	0.11	p. 8-9, Sec. J2.5, Sec. J2.4
<b>Ratio</b>	<b>1.00</b>					

## Major axis Anchors

## GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
<u>Anchors</u>						
Anchor spacing	[cm]	24.84	10.16	--	✓	Sec. D.8.1
Concrete cover	[cm]	6.35	5.08	--	✓	Sec. 7.7.1
Effective length	[cm]	41.65	--	88.35	✓	

## DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Anchor tension	[Ton]	11.95	6.32	DL	0.53	Eq. D-3
Pullout of anchor in tension	[Ton]	26.70	6.32	DL	0.24	Sec. D.4.1.1
Side-face blowout of anchor in tension	[Ton]	9.38	5.79	DL	0.62	Sec. D.5.4.1, Sec. D.4.1.1
Side-face blowout of group of anchors in tension	[Ton]	35.69	12.11	DL	0.34	Eq. D-17, Sec. D.4.1.1
Group of Anchors reinforcement in tension	[Ton]	14.97	14.41	DL	0.96	Sec. D.5.2.9, D.6.2.9
Anchor shear	[Ton]	6.22	0.35	DL	0.06	Eq. D-20
Pryout of anchor in shear	[Ton]	12.69	0.25	DL	0.02	Eq. D-4, Sec. D.4.1.1
Pryout of group of anchors in shear	[Ton]	20.09	1.00	DL	0.05	Eq. D-5, Sec. D.4.1.1
Group of Anchors reinforcement in shear	[Ton]	43.00	0.25	DL	0.01	Sec. D.5.2.9, D.6.2.9
Interaction of tensile and shear forces	[Ton]	1.20	0.00	DL	0.00	Eq. D-3, Sec. D.4.1.1, Sec. D.5.4.1, Eq. D-17, Eq. D-20, Eq. D-4, Eq. D-5, Sec. D.7
<b>Ratio</b>	<b>0.96</b>					

## Minor axis Anchors

## GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
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**Anchors**

Anchor spacing	[cm]	24.84	10.16	--	✓	Sec. D.8.1
Concrete cover	[cm]	6.35	5.08	--	✓	Sec. 7.7.1
Effective length	[cm]	41.65	--	88.35	✓	

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**DESIGN CHECK**

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Anchor tension	[Ton]	11.95	6.32	DL	0.53	Eq. D-3
Pullout of anchor in tension	[Ton]	26.70	6.32	DL	0.24	Sec. D.4.1.1
Side-face blowout of anchor in tension	[Ton]	9.38	5.79	DL	0.62	Sec. D.5.4.1, Sec. D.4.1.1
Side-face blowout of group of anchors in tension	[Ton]	21.84	6.67	DL	0.31	Eq. D-17, Sec. D.4.1.1
Group of Anchors reinforcement in tension	[Ton]	14.97	14.41	DL	0.96	Sec. D.5.2.9, D.6.2.9
Anchor shear	[Ton]	6.22	0.35	DL	0.06	Eq. D-20
Pryout of anchor in shear	[Ton]	12.69	0.25	DL	0.02	Eq. D-4, Sec. D.4.1.1
Pryout of group of anchors in shear	[Ton]	20.09	1.00	DL	0.05	Eq. D-5, Sec. D.4.1.1
Group of Anchors reinforcement in shear	[Ton]	43.00	0.25	DL	0.01	Sec. D.5.2.9, D.6.2.9
Interaction of tensile and shear forces	[Ton]	1.20	0.00	DL	0.00	Eq. D-3, Sec. D.4.1.1, Sec. D.5.4.1, Eq. D-17, Eq. D-20, Eq. D-4, Eq. D-5, Sec. D.7

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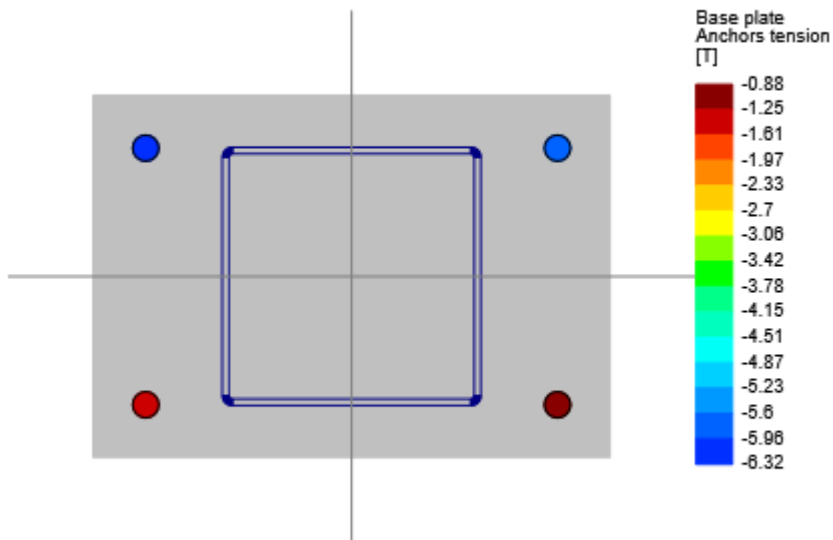
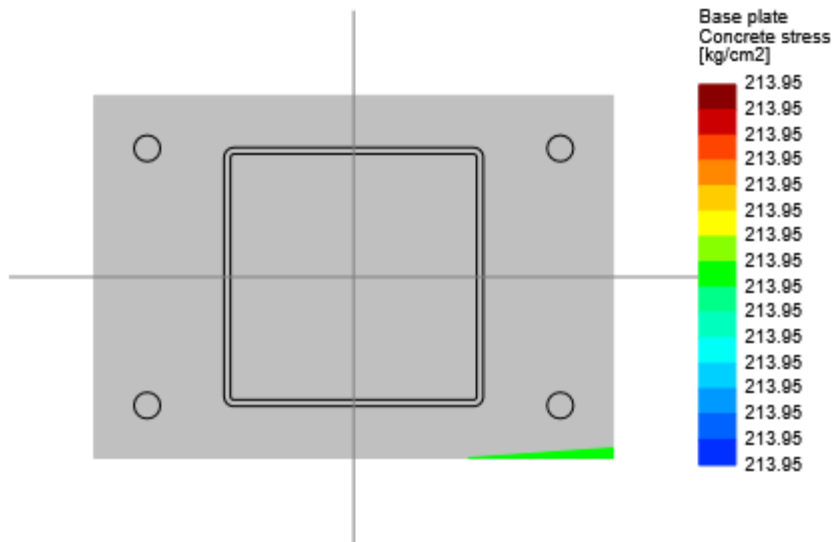
<b>Ratio</b>	<b>0.96</b>
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<b>Global critical strength ratio</b>	<b>1.00</b>
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**Biaxial****Maximum compression and tension (DL)**



Maximum bearing pressure	213.95	[Kg/cm2]
Minimum bearing pressure	213.95	[Kg/cm2]
Maximum anchor tension	6.32	[Ton]
Minimum anchor tension	0.88	[Ton]
Neutral axis angle	0.00	
Bearing length	0.94	[cm]

#### Anchors tensions

Anchor	Transverse [cm]	Longitudinal [cm]	Shear [Ton]	Tension [Ton]
1	-19.92	-12.42	0.25	1.42
2	19.92	-12.42	0.25	0.88
3	19.92	12.42	0.25	5.79
4	-19.92	12.42	0.25	6.32

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
<u>Shear plate</u>						
Bolts shear	[Ton]	29.60	29.55	DL	1.00	Tables (7-1..14)
Bolt bearing under shear load	[Ton]	40.05	27.00	DL	0.67	Eq. J3-6, p. 7-18
Shear yielding	[Ton]	52.20	27.00	DL	0.52	Eq. J4-3
Shear rupture	[Ton]	34.44	27.00	DL	0.78	Eq. J4-4
Block shear	[Ton]	37.70	27.00	DL	0.72	Eq. J4-5
Bolt bearing under axial load	[Ton]	38.70	12.00	DL	0.31	Eq. J3-6, p. 7-18
Tension yielding	[Ton]	78.30	12.00	DL	0.15	Eq. J4-1
Tension rupture	[Ton]	57.41	12.00	DL	0.21	Eq. J4-2
Tear out under axial load	[Ton]	49.91	12.00	DL	0.24	Eq. J4-5
Plate (support side)						

Weld capacity	[Ton]	61.77	29.55	DL	<b>0.48</b>	Tables 8-4 .. 8-11
<u>Beam</u>						
Bolt bearing under shear load	[Ton]	38.60	27.00	DL	<b>0.70</b>	Eq. J3-6, p. 7-18
Shear yielding	[Ton]	54.00	27.00	DL	<b>0.50</b>	Eq. J4-3
Shear rupture	[Ton]	38.02	27.00	DL	<b>0.71</b>	Eq. J4-4
Flexural yielding	[Ton]	67.79	27.00	DL	<b>0.40</b>	p. 9-6
Local web buckling	[Ton]	67.79	27.00	DL	<b>0.40</b>	p. 9-7
Block shear	[Ton]	34.20	27.00	DL	<b>0.79</b>	Eq. J4-5
Flexural rupture	[Ton]	73.43	27.00	DL	<b>0.37</b>	p. 9-6
Bolt bearing under axial load	[Ton]	39.06	12.00	DL	<b>0.31</b>	Eq. J3-6
Yielding strength due to axial load	[Ton]	230.01	12.00	DL	<b>0.05</b>	Eq. D2-1
Tension rupture	[Ton]	90.76	12.00	DL	<b>0.13</b>	Eq. J4-2
Tear out under axial load	[Ton]	44.69	12.00	DL	<b>0.27</b>	Eq. J4-5
<u>Support</u>						
Welds rupture	[Ton/m]	210.41	63.42	DL	<b>0.30</b>	p. 9-5

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**Global critical strength ratio** **1.00**

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Current Date: 8/13/2020 2:28 PM

Units system: Metric

File name: C:\ProgramData\Bentley\Engineering\RAM Connection\12.0.0\Data\CONEXIONES STEEL DECK BOITA.rcnx\

## Steel connections

### Results

**Connection name** : TP\_BCW\_1/2PL\_2B1  
**Connection ID** : 3V

Family: Beam - Column web (BCW)  
Type: Through Plate  
Design code: AISC 360-16 LRFD

### DEMANDS

Description	Beam		Column			Load type
	Ru [Ton]	Pu [Ton]	Pu [Ton]	Mu22 [Ton*m]	Mu33 [Ton*m]	
DL	20.00	10.00	0.00	0.00	0.00	Design

### GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
<u>Shear plate</u>						
Length	[cm]	31.75	16.55	33.10	✓	p. 10-104
<u>Plate (beam side)</u>						
Vertical edge distance	[cm]	4.44	2.54	--	✓	Tables J3.4, J3.5
Horizontal edge distance	[cm]	4.44	3.81	--	✓	p. 10-103
Vertical center-to-center spacing (pitch)	[cm]	7.62	5.08	20.64	✓	Sec. J3.3, Sec. J3.5
<u>Beam</u>						
Vertical edge distance	[cm]	8.57	2.54	--	✓	Tables J3.4, J3.5
Horizontal edge distance	[cm]	4.18	3.81	--	✓	p. 10-103
<u>Support</u>						
Maximum value of the specified yield stress	[Ton/cm2]	3.23	--	--	✓	
Yield stress to tensile stress ratio		0.79	--	0.80	✓	Table K2.1A, Table K2.1
Thickness	[cm]	0.63	--	0.66	✓	Sec. B4.2, p. 10-158
Weld size	[1/16in]	6	5	--	✓	p. 10-101

### DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
<u>Plate (beam side)</u>						
Bolts shear	[Ton]	30.04	22.36	DL	0.74	Tables (7-1..14)
Bolt bearing under shear load	[Ton]	82.43	20.00	DL	0.24	Eq. J3-6, p. 7-18
Bolt bearing under axial load	[Ton]	82.43	10.00	DL	0.12	Eq. J3-6, p. 7-18
Shear yielding	[Ton]	85.05	20.00	DL	0.24	Eq. J4-3
Tension yielding	[Ton]	127.57	10.00	DL	0.08	Eq. J4-1
Shear rupture	[Ton]	59.70	20.00	DL	0.33	Eq. J4-4
Tension rupture	[Ton]	99.51	10.00	DL	0.10	Eq. J4-2

Block shear	[Ton]	65.51	20.00	DL	<b>0.31</b>	Eq. J4-5
Tear out under axial load	[Ton]	87.90	10.00	DL	<b>0.11</b>	Eq. J4-5
<u>Plate (support side)</u>						
Weld capacity	[Ton]	108.88	26.10	DL	<b>0.24</b>	Tables 8-4 .. 8-11
Shear yielding/buckling and flexure yielding		1.00	0.06	DL	<b>0.06</b>	Eq. 10-5
<u>Beam</u>						
Bolt bearing under shear load	[Ton]	62.31	20.00	DL	<b>0.32</b>	Eq. J3-6, p. 7-18
Bolt bearing under axial load	[Ton]	55.68	10.00	DL	<b>0.18</b>	Eq. J3-6
Shear yielding	[Ton]	72.56	20.00	DL	<b>0.28</b>	Eq. J4-3
Yielding strength due to axial load	[Ton]	267.34	10.00	DL	<b>0.04</b>	Eq. D2-1
Tension rupture	[Ton]	166.75	10.00	DL	<b>0.06</b>	Eq. J4-2
Tear out under axial load	[Ton]	58.58	10.00	DL	<b>0.17</b>	Eq. J4-5
<u>Support</u>						
Welds rupture	[Ton/m]	154.14	47.67	DL	<b>0.31</b>	p. 9-5
Chord wall plastification	[Ton]	17.41	10.00	DL	<b>0.57</b>	Eq. J4-5

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**Global critical strength ratio**

**0.74**

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Current Date: 8/13/2020 1:49 PM

Units system: Metric

File name: C:\ProgramData\Bentley\Engineering\RAM Connection\12.0.0\Data\CONEXIONES STEEL DECK BOITA.rcnx\

## Steel connections

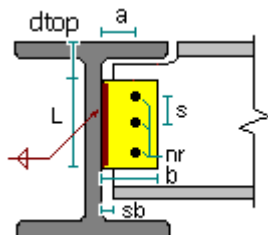
### Data

Connection name : SP BG  
Connection ID : 2V

Family: Beam - Girder (BG)  
Type: Single plate

### GENERAL INFORMATION

#### Connector



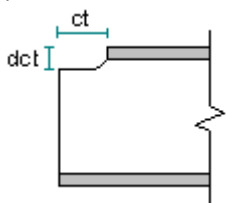
### MEMBERS

#### Beam

##### General

Beam section : IPE 360  
Beam material : A572 Gr50  
sb: Beam setback : 1 cm  
Beam to girder alignment : Top  
Horizontal angle (deg) : 0  
Vertical angle (deg) : 0

##### Coped



dct: Top cope depth : 4 cm  
ct: Top cope length : 9 cm  
dcb: Bottom cope depth : 0 cm  
cb: Bottom cope length : 7.15 cm

#### Girder

##### General

Girder section : IPE 400  
Girder material : A500 GrB rectangular

### SINGLE PLATE

#### Connector

Section : PL 0.9x8.9x27 1/2  
b: Width : 8.9 cm  
L: Length : 27.5 cm  
Plate type : Standard  
tp: Plate thickness : 0.9 cm  
Material : A572 Gr50  
Plate position on beam : Center  
Bolts : 3/4" A325 N

nr: Bolt rows	:	4
nc: Bolt columns	:	1
s: Pitch - longitudinal center-to-center spacing	:	6.5 cm
Lev: Vertical edge distance	:	4 cm
Leh: Horizontal edge distance	:	3.9 cm
a: Distance between weld and bolts	:	5 cm
Hole type on plate	:	Standard (STD)
Hole type on beam	:	Standard (STD)
Weld	:	E70XX
D: Weld size (1/16 in)	:	4
Wo: Obtuse side weld size (AWS) (1/16 in)	:	4
Wa: Acute side weld size (AWS) (1/16 in)	:	4
Wo: Obtuse side weld size (AISC) (1/16 in)	:	4
Wa: Acute side weld size (AISC) (1/16 in)	:	4



Current Date: 8/13/2020 2:07 PM

Units system: Metric

File name: C:\ProgramData\Bentley\Engineering\RAM Connection\12.0.0\Data\CONEXIONES STEEL DECK BOITA.rcnx\

## Steel connections

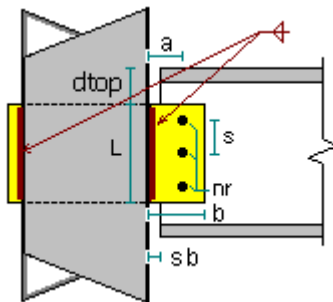
### Data

Connection name : TP\_BCW\_1/2PL\_2B1  
Connection ID : 3V

Family: Beam - Column web (BCW)  
Type: Through Plate

### GENERAL INFORMATION

#### Connector



### MEMBERS

#### Beam

##### General

Beam section : IPE 400  
Beam material : A572 Gr50  
sb: Beam setback : 1.27 cm

##### Coped

dct: Top cope depth : 0 cm  
ct: Top cope length : 0 cm  
dcb: Bottom cope depth : 0 cm  
cb: Bottom cope length : 0 cm

#### Column

##### General

Support section : EN\_TUBE 250x250x6.3  
Support material : A500 GrB rectangular

### SINGLE PLATE

#### Connector

Section : PL 1.27x36.42x31.75  
L: Length : 31.75 cm  
b: Width : 9.53 cm  
tp: Plate thickness : 1.27 cm  
Material : A572 Gr50

#### Beam side

Plate position on beam : Center  
Bolts : 3/4" A325 N  
nr: Rows of Bolts : 4  
nc: Bolt columns : 1  
s: Pitch - longitudinal center-to-center spacing : 7.62 cm  
Lev: Vertical edge distance : 4.45 cm  
Leh: Horizontal edge distance : 4.45 cm  
a: Distance between weld and bolts : 5.08 cm  
Hole type on plate : Standard (STD)  
Hole type on beam : Standard (STD)

#### Support side

Welding electrode to support	:	E70XX
D: Weld size to support (1/16 in)	:	6