

Current Date: 13/07/2021 10:02 AM

Units system: SI

File name: H:\J 2188\Switchrooms\RAM Conn\JB4\_BMEP with JB3.rcnx

## Steel connections

### Results

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**Connection name : BEP\_AS\_BCF**  
**Connection ID : 1**

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Family: Beam - Column flange (BCF)

Type: Bolted end plate

Design code: AS4100-1998

#### DEMANDS

Description	Beam						
	N*f <sub>top</sub> [kN]	N*f <sub>bot</sub> [kN]	N*w [kN]	M*w [kN]	V*v [kN]	N*fr [kN]	
<hr/>							
DL	168.38	-168.38	0.00	0.00	62.00	0.00	-100.38

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#### GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
<hr/>						
<u>CHECK 1 - Detailing requirements</u>						
End plate width, b <sub>i</sub>	[mm]	140.00	170.00	145.00	✗	DG12 Sec. 9.1
b <sub>min</sub> = b <sub>fb</sub> + 20 [mm]						
= 150 [mm] + 20 [mm]						DG12 Sec. 9.1
= 170 [mm]						ASI DG12 Table 3
						ASI DG12 Table 3
b <sub>max</sub> = b <sub>fc</sub> + 20 [mm]						
= 125 [mm] + 20 [mm]						DG12 Sec. 9.1
= 145 [mm]						ASI DG12 Table 3
						ASI DG12 Table 3
Bolt gauge, s <sub>g</sub>	[mm]	70.00	120.00	75.00	✗	DG12 Sec. 9.1
s <sub>gmin</sub> = 120 [mm]						DG12 Sec. 9.1
						ASI DG12 Table 3
						ASI DG12 Table 3
s <sub>gmax</sub> = Min(b <sub>fb</sub> , b <sub>fc</sub> - 2.5*d <sub>f</sub> )						
= Min(150 [mm], 125 [mm] - 2.5*20 [mm])						DG12 Sec. 9.1
= 75 [mm]						ASI DG12 Table 3

## ASI DG12 Table 3

Edge distance, ae $a_{emin} = 30 \text{ [mm]}$	[mm]	35.00	30.00	50.00	✓	DG12 Sec. 9.1 DG12 Sec. 9.1
$a_{emax} = 2.5 * d_f$ $= 2.5 * 20 \text{ [mm]}$ $= 50 \text{ [mm]}$						DG12 Sec. 9.1
End plate thickness, ti	[mm]	16.00	16.00	40.00	✓	ASI DG12 Table 3 ASI DG12 Table 3
						ASI DG12 Table 3
						ASI DG12 Table 3
						ASI DG12 Table 3
Bolt diameter, df	[mm]	20.00	20.00	610.00	✓	ASI DG12 Table 3 ASI DG12 Table 3
						ASI DG12 Table 3
						ASI DG12 Table 3
Beam size (unhaunched)	[mm]	300.00	200.00	610.00	✓	ASI DG12 Table 3 ASI DG12 Table 3
						ASI DG12 Table 3
						ASI DG12 Table 3
Clearance, top spo	[mm]	65.00	40.00	75.00	✓	ASI DG12 Table 3 ASI DG12 Table 3
						ASI DG12 Table 3
Clearance, bottom spo	[mm]	65.00	40.00	75.00	✓	ASI DG12 Table 3 ASI DG12 Table 3
						ASI DG12 Table 3
<u>CHECK 22 - Transverse stiffeners</u>						
Plate width, bs $b_{sb} = (b_{fb} - t_{wb})/2.0$ $= (150 \text{ [mm]} - 6.5 \text{ [mm]})/2.0$ $= 71.75 \text{ [mm]}$	[mm]	54.00	47.00	59.50	✓	DG. 12 p. 62
$b_{sc} = (b_{fb}/3.0) - (t_{wc}/2.0)$ $= (150 \text{ [mm]}/3.0) - (6 \text{ [mm]}/2.0)$ $= 47 \text{ [mm]}$						DG. 12 p. 62
$b_{smax} = (b_{fc} - t_{wc})/2.0$ $= (125 \text{ [mm]} - 6 \text{ [mm]})/2.0$ $= 59.5 \text{ [mm]}$						DG. 12 p. 62

Plate length, $d_s$	[mm]	212.00	97.20	232.00	✓	DG. 12 p. 62
$d_s = 1.80 * b_s$						
$= 1.80 * 54 [\text{mm}]$						
$= 97.2 [\text{mm}]$						DG. 12 p. 62
$d_s = 0.50 * d_c$						
$= 0.50 * 250 [\text{mm}]$						
$= 125 [\text{mm}]$						DG. 12 p. 62
$d_{s\min} = \text{Min}(115 [\text{mm}], d_s, d_s)$						
$= \text{Min}(115 [\text{mm}], 97.2 [\text{mm}], 125 [\text{mm}])$						
$= 97.2 [\text{mm}]$						DG. 12 p. 62
Plate thickness, $t_s$	[mm]	10.00	4.50	--	✓	DG. 12 p. 62
$t_{s\min} = 0.5 * t_{fb}$						
$= 0.5 * 9 [\text{mm}]$						
$= 4.5 [\text{mm}]$						DG. 12 p. 62

## DESIGN CHECK

### Verification

Unit Capacity Demand Ctrl EQ Ratio References

#### CHECK 2 - Capacity of flange welds to beam

- Full penetration butt welds - no design check necessary

#### CHECK 3 - Capacity of web welds to beam

Web fillet weld shear capacity [KN] 275.65 62.00 DL **0.22** Handbook 1 Sec. 4.5, Cl 9.7.3.10

$$\phi V_w = \phi * 0.6 * f_{uw} * 0.7071 * t_w * k_r \\ = 0.8 * 0.6 * 480 [\text{N/mm}^2] * 0.7071 * 6 [\text{mm}] * 1 \\ = 0.977 [\text{kN/mm}]$$

Handbook 1 Sec. 4.5

$$\phi V_w = 2 * (\phi v_w * l_w) \\ = 2 * (0.977 [\text{kN/mm}] * 141 [\text{mm}]) \\ = 275.654 [\text{kN}]$$

Cl 9.7.3.10

Web fillet weld axial capacity [KN] 275.65 230.96 DL **0.84** Handbook 1 Sec. 4.5, Cl 9.7.3.10

$$\phi v_w = \phi * 0.6 * f_{uw} * 0.7071 * t_w * k_r \\ = 0.8 * 0.6 * 480 [\text{N/mm}^2] * 0.7071 * 6 [\text{mm}] * 1 \\ = 0.977 [\text{kN/mm}]$$

Handbook 1 Sec. 4.5

$$\phi V_w = 2 * (\phi v_w * l_w) \\ = 2 * (0.977 [\text{kN/mm}] * 141 [\text{mm}]) \\ = 275.654 [\text{kN}]$$

Cl 9.7.3.10

$$\phi N_{wt} = 0.9 * f_{yw} * t_{wb} * L_{wt} \\ = 0.9 * 280 [\text{N/mm}^2] * 6.5 [\text{mm}] * 141 [\text{mm}] \\ = 230.958 [\text{kN}]$$

DG12 Sec. 9.3

#### CHECK 4 - Capacity of bolts at tension flange

Top bolts moment capacity [KN\*m] 73.63 49.00 DL **0.67** Cl. 9.3.2.2, DG12 Sec. 9.4

$$\phi N_{tf} = \phi * A_s * f_{uf} \\ = 0.8 * 244.794 [\text{mm}^2] * 830 [\text{N/mm}^2] \\ = 162.543 [\text{kN}]$$

Cl. 9.3.2.2

$$\begin{aligned}\phi M_{bt} &= 2 * \phi N_{tf} * \sum d_i \\ &= 2 * 162.543[\text{kN}] * 226.5[\text{mm}] \\ &= \mathbf{73.632}[\text{kN*m}]\end{aligned}$$

DG12 Sec. 9.4

$$\begin{aligned}M^*_{\text{axial}} &= \text{Min}(N^*_{fr} * (d_b - t_{fb}), 0.25 * M^*) \\ &= \text{Min}(0[\text{kN}] * (300[\text{mm}] - 9[\text{mm}]), 0.25 * 49[\text{kN*m}]) \\ &= \mathbf{0}[\text{kN*m}]\end{aligned}$$

DG12 Sec. 9.4

$$\begin{aligned}M^*_{eq} &= M^* + M^*_{\text{axial}} \\ &= 49[\text{kN*m}] + 0[\text{kN*m}] \\ &= \mathbf{49}[\text{kN*m}]\end{aligned}$$

DG12 Sec. 9.4

<u>CHECK 5 - Capacity of bolts in shear</u>		[KN]	185.24	62.00	DL	<b>0.33</b>	Cl. 9.3.2.1, DG12 Sec. 9.5
Bolts shear capacity							

$$\begin{aligned}\phi V_{bi} &= \text{Min}(0.9 * 3.2 * d_i * t_i * f_{ui}, 0.9 * a_{ey} * t_i * f_{ui}) \\ &= \text{Min}(0.9 * 3.2 * 20[\text{mm}] * 16[\text{mm}] * 410[\text{N/mm2}], 0.9 * 104[\text{mm}] * 16[\text{mm}] * 410[\text{N/mm2}]) \\ &= \mathbf{377.856}[\text{kN}]\end{aligned}$$

DG12 Sec. 9.5

$$\begin{aligned}\phi V_{bc} &= \text{Min}(0.9 * 3.2 * d_f * t_{fc} * f_{uc}, 0.9 * a_{ey} * t_{fc} * f_{uc}) \\ &= \text{Min}(0.9 * 3.2 * 20[\text{mm}] * 9[\text{mm}] * 410[\text{N/mm2}], 0.9 * 5069[\text{mm}] * 9[\text{mm}] * 410[\text{N/mm2}]) \\ &= \mathbf{212.544}[\text{kN}]\end{aligned}$$

DG12 Sec. 9.5

$$k_r = 1.0$$

Cl. 9.3.2.1

$$\begin{aligned}\phi V_{fn} &= \phi * 0.62 * f_{uf} * k_r * (n_n * A_c) \\ &= 0.8 * 0.62 * 830[\text{N/mm2}] * 1 * (1 * 224.982[\text{mm}^2]) \\ &= \mathbf{92.62}[\text{kN}]\end{aligned}$$

Cl. 9.3.2.1

$$\begin{aligned}\phi V_{df} &= \text{Min}(\text{Min}(\phi V_{fn}, \phi V_{bi}), \phi V_{bc}) \\ &= \text{Min}(\text{Min}(92.62[\text{kN}], 377.856[\text{kN}]), 212.544[\text{kN}]) \\ &= \mathbf{92.62}[\text{kN}]\end{aligned}$$

DG12 Sec. 9.5

$$\begin{aligned}\phi V_{fb} &= n_{cw} * (\phi V_{df}) \\ &= 2 * (92.62[\text{kN}]) \\ &= \mathbf{185.241}[\text{kN}]\end{aligned}$$

DG12 Sec. 9.5

<u>CHECK 6 - Capacity of end plate at tension flange</u>		[KN*m]	72.47	49.00	DL	<b>0.68</b>	DG12 Sec. 9.6, DG12 Sec. 9.4
End plate tension top flange capacity							

$$\begin{aligned}a_h &= 0.5 * (b_i * s_g)^{1/2} \\ &= 0.5 * (140[\text{mm}] * 70[\text{mm}])^{1/2} \\ &= \mathbf{49.497}[\text{mm}]\end{aligned}$$

DG12 Sec. 9.6

$$\begin{aligned}Y_p &= 0.5 * b_i * (d_{11} * (1/s_{pi} + 1/a_h) - 0.5) + 2/s_g * (d_{11} * (s_{pi} + a_h)) \\ &= 0.5 * 140[\text{mm}] * (226.5[\text{mm}] * (1/60[\text{mm}] + 1/49.497[\text{mm}]) - 0.5) + 2/70[\text{mm}] * (226.5[\text{mm}] * (60[\text{mm}] + 49.497[\text{mm}])) \\ &= \mathbf{1258.17}[\text{mm}]\end{aligned}$$

DG12 Sec. 9.6

$$\begin{aligned}\phi M_{pt} &= 0.9 * f_{yi} * t_i^2 * Y_p \\ &= 0.9 * 250[\text{N/mm2}] * 16[\text{mm}]^2 * 1258.17[\text{mm}] \\ &= \mathbf{72.471}[\text{kN*m}]\end{aligned}$$

DG12 Sec. 9.6

$$\begin{aligned}M^*_{\text{axial}} &= \text{Min}(N^*_{fr} * (d_b - t_{fb}), 0.25 * M^*) \\ &= \text{Min}(0[\text{kN}] * (300[\text{mm}] - 9[\text{mm}]), 0.25 * 49[\text{kN*m}]) \\ &= \mathbf{0}[\text{kN*m}]\end{aligned}$$

DG12 Sec. 9.4

$$\begin{aligned} M^*_{eq} &= M^* + M^*_{axial} \\ &= 49[\text{kN}\cdot\text{m}] + 0[\text{kN}\cdot\text{m}] \\ &= \mathbf{49}[\text{kN}\cdot\text{m}] \end{aligned}$$

DG12 Sec. 9.4

#### CHECK 7 - Capacity of end plate in shear

- No bolts outside tension flange - check not required

#### CHECK 12 - Local yielding of column web at beam compression flange

Column web yielding at beam bottom flange	[KN]	253.26	168.38 DL	<b>0.66</b>	DG. 12 p. 65, DG. 11 p. 22, DG. 12 p. 45
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$$\begin{aligned} b_{sc} &= t_{fb} \\ &= \mathbf{9}[\text{mm}] \end{aligned}$$

$$c_t = 1 \quad \text{DG. 11 p. 22}$$

$$\begin{aligned} \phi R_{wy} &= \phi * (b_{sc} + 5.0 * t_i * c_t + 5.0 * t_{fc} * c_t) * t_{wc} * 1.25 * f_{ycw} \\ &= 0.9 * (9[\text{mm}] + 5.0 * 16[\text{mm}] * 1 + 5.0 * 9[\text{mm}] * 1) * 6[\text{mm}] * 1.25 * 280[\text{N/mm}^2] \\ &= \mathbf{253.26}[\text{kN}] \end{aligned}$$

DG. 12 p. 45

#### CHECK 13 - Column web crippling at beam compression flange

Column web crippling at beam bottom flange	[KN]	209.61	168.38 DL	<b>0.80</b>	DG. 12 p. 65, DG. 11 p. 26
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$$\begin{aligned} b_{sc} &= t_{fb} \\ &= \mathbf{9}[\text{mm}] \end{aligned}$$

$$\begin{aligned} \phi R_{wc} &= (\phi * 0.8 * t_{wc}^2) * (1 + 3 * (b_{sc}/d_c) * (t_{wc}/t_{fc})^{1.5}) * ((200000 [\text{MPa}] * f_{ycw} * t_{fc})/t_{wc})^{1/2} \\ &= (0.75 * 0.8 * 6[\text{mm}]^2) * (1 + 3 * (9[\text{mm}]/250[\text{mm}]) * (6[\text{mm}]/9[\text{mm}])^{1.5}) * ((200000 [\text{MPa}] * 280[\text{N/mm}^2] * 9[\text{mm}])/(6[\text{mm}])^{1/2}) \\ &= \mathbf{209.605}[\text{kN}] \end{aligned}$$

DG. 11 p. 26

#### CHECK 14 - Column web compression buckling

Column web compression buckling	[KN]	261.37	168.38 DL	<b>0.64</b>	DG. 11 p. 28
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$$\begin{aligned} b_{bc} &= b_{sc} + 5.0 * t_{fc} + d_s \\ &= 9[\text{mm}] + 5.0 * 16[\text{mm}] + 5.0 * 9[\text{mm}] + 232[\text{mm}] \\ &= \mathbf{366}[\text{mm}] \end{aligned}$$

DG. 12 p. 49

$$\begin{aligned} A_{wc} &= b_{bc} * t_{wc} \\ &= 366[\text{mm}] * 6[\text{mm}] \\ &= \mathbf{2196}[\text{mm}^2] \end{aligned}$$

DG. 11 p. 28

$$\begin{aligned} \lambda_n &= (2.5 * (d_c - k_c top - k_c bottom)/t_{wc}) * (k_f)^{1/2} * (f_{ycw}/(250 [\text{MPa}]))^{1/2} \\ &= (2.5 * (250[\text{mm}] - 9[\text{mm}] - 9[\text{mm}])/6[\text{mm}]) * (1)^{1/2} * (280[\text{N/mm}^2]/(250 [\text{MPa}]))^{1/2} \\ &= \mathbf{102.302} \end{aligned}$$

DG. 11 p. 28

$$\begin{aligned} \alpha_a &= 2100 * (\lambda_n - 13.5) / (\lambda_n^2 - 15.3 * \lambda_n + 2050) \\ &= 2100 * (102.302 - 13.5) / (102.302^2 - 15.3 * 102.302 + 2050) \\ &= \mathbf{17.03} \end{aligned}$$

DG. 12 p. 49

$$\alpha_b = 0.50 \quad \text{DG. 12 p. 49}$$

$$\begin{aligned} \lambda &= \lambda_n + \alpha_a * \alpha_b \\ &= 102.302 + 17.03 * 0.5 \\ &= \mathbf{110.817} \end{aligned}$$

DG. 12 p. 49

$$\begin{aligned}\eta &= \text{Max}(0.00326 * (\lambda - 13.5), 0) \\ &= \text{Max}(0.00326 * (110.817 - 13.5), 0) \\ &= \mathbf{0.317}\end{aligned}$$

Cl. 6.3.3

$$\begin{aligned}\varepsilon &= ((\lambda/90)^2 + 1 + \eta)/(2.0 * (\lambda/90)^2) \\ &= ((110.817/90)^2 + 1 + 0.317)/(2.0 * (110.817/90)^2) \\ &= \mathbf{0.934}\end{aligned}$$

DG. 12 p. 49

$$\begin{aligned}\alpha_c &= \varepsilon * (1 - (1 - (90 / (\varepsilon * \lambda)))^{2/1}) \\ &= 0.934 * (1 - (1 - (90 / (0.934 * 110.817)))^{2/1}) \\ &= \mathbf{0.472}\end{aligned}$$

DG. 12 p. 49

$$\begin{aligned}\phi R_{fc} &= 0.90 * \alpha_c * k_f * A_{wc} * f_{ywc} \\ &= 0.90 * 0.472 * 1 * 2196[\text{mm}^2] * 280[\text{N/mm}^2] \\ &= \mathbf{261.366[\text{kN}]}\end{aligned}$$

DG. 11 p. 28

#### CHECK 15 - Column web panel in shear

Column web panel in shear resistance	[KN]	210.47	100.38 DL	<b>0.48</b>	DG. 11 p. 29
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$$\begin{aligned}\phi N_s &= 0.9 * f_{yc} * A_n * k_f \\ &= 0.9 * 260[\text{N/mm}^2] * 3697[\text{mm}^2] * 1 \\ &= \mathbf{865.098[\text{kN}]}\end{aligned}$$

DG. 11 p. 29

$$k_N = 1 \quad \text{DG. 11 p. 29}$$

$$\begin{aligned}A_{wc} &= (d_c - t_{fc,top} - t_{fc,bot}) * t_{wc} \\ &= (250[\text{mm}] - 9[\text{mm}] - 9[\text{mm}]) * 6[\text{mm}] \\ &= \mathbf{1392[\text{mm}^2]}\end{aligned}$$

DG. 11 p. 29

$$\begin{aligned}\phi V_c &= \phi * (0.6 * f_{ywc} * A_{wc}) * k_N \\ &= 0.9 * (0.6 * 280[\text{N/mm}^2] * 1392[\text{mm}^2]) * 1 \\ &= \mathbf{210.47[\text{kN}]}\end{aligned}$$

DG. 11 p. 29

#### CHECK 22 - Column with transverse stiffeners at tension flange

Column flange local bending at beam top flange	[KN]	134.07	81.73 DL	<b>0.61</b>	Cl. 9.3.2.2, DG12 Sec. 9.4
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$$\begin{aligned}a_h &= 0.5 * (b_i * s_g)^{1/2} \\ &= 0.5 * (140[\text{mm}] * 70[\text{mm}])^{1/2} \\ &= \mathbf{49.497[\text{mm}]}\end{aligned}$$

DG12 Sec. 9.6

$$\begin{aligned}Y_{cs} &= 0.5 * b_{fc} * ((d_{11}/a_h) + (d_{11}/s_{pl})) + 2.0/s_g * (d_{11} * (a_h + s_{pl})) \\ &= 0.5 * 125[\text{mm}] * ((226.5[\text{mm}] / 49.497[\text{mm}]) + (226.5[\text{mm}] / 60[\text{mm}])) + 2.0 / 70[\text{mm}] * (226.5[\text{mm}] * (49.497[\text{mm}] + \\ &\quad 60[\text{mm}])) \\ &= \mathbf{1230.54[\text{mm}]}\end{aligned}$$

Flange doubler is not present in this example but RAMCON incorrectly calculates as "20 mm".

DG. 12 p. 63

$$\begin{aligned}\phi M_{ctd} &= \phi * (f_{ycl} * t_{fc}^2 + f_{yd} * t_{d1}) * Y_c \\ &= 0.9 * (260[\text{N/mm}^2] * 9[\text{mm}]^2 + 250[\text{N/mm}^2] * 20[\text{mm}]^2) * 1230.54[\text{mm}] \\ &= \mathbf{134.072[\text{kN*m}]}\end{aligned}$$

DG. 12 p. 51

$$\begin{aligned}\phi N_{tf} &= \phi * A_s * f_{uf} \\ &= 0.8 * 244.794[\text{mm}^2] * 8 \\ &= \mathbf{162.543[\text{kN}]}\end{aligned}$$

Cl. 9.3.2.2

$$\begin{aligned}\phi M_{bt} &= 2 * \phi N_{tf} * \sum d_i \\ &= 2 * 162.543[\text{kN}] * 226.5[\text{mm}] \\ &= \mathbf{73.632[\text{kN*m}]}\end{aligned}$$

DG12 Sec. 9.4

$$\begin{aligned}\phi M_{ct} &= 1.11 * \phi M_{bt} \\ &= 1.11 * 73.632 [\text{kN*m}] \\ &= \mathbf{81.732} [\text{kN*m}]\end{aligned}$$

DG. 12 p. 61

Top flange yield capacity

[KN] 252.72 104.30 DL **0.41** DG. 12 p. 61,  
DG. 12 p. 41

$$\begin{aligned}A_{sn} &= 2.0 * b_s * t_s \\ &= 2.0 * 54 [\text{mm}] * 10 [\text{mm}] \\ &= \mathbf{1080} [\text{mm}^2]\end{aligned}$$

DG. 12 p. 61

$$\begin{aligned}\phi R_{fts} &= 0.90 * f_y * A_s \\ &= 0.90 * 260 [\text{N/mm}^2] * 1080 [\text{mm}^2] \\ &= \mathbf{252.72} [\text{kN}]\end{aligned}$$

DG. 12 p. 61

$$\begin{aligned}a_h &= 0.5 * (b_i * s_g)^{1/2} \\ &= 0.5 * (140 [\text{mm}] * 70 [\text{mm}])^{1/2} \\ &= \mathbf{49.497} [\text{mm}]\end{aligned}$$

DG12 Sec. 9.6

$$\begin{aligned}Y_c &= 0.5 * b_{fc} * (d_{11}/a_h) + (2.0/s_g) * (d_{11} * (a_h + 0.75 * s_{pi}) + 0.5 * (s_{pi}^2)) + 0.5 * s_g \\ &= 0.5 * 125 [\text{mm}] * (226.5 [\text{mm}] / 49.497 [\text{mm}]) + (2.0 / 70 [\text{mm}]) * (226.5 [\text{mm}] * (49.497 [\text{mm}] + 0.75 * 60 [\text{mm}]) + 0.5 * (60 [\text{mm}]^2)) + 0.5 * 70 [\text{mm}] \\ &= \mathbf{983.962} [\text{mm}]\end{aligned}$$

DG. 12 p. 41

$$\begin{aligned}\phi M_{ct} &= 0.90 * f_{yc} * t_{fc}^2 * Y_c \\ &= 0.90 * 260 [\text{N/mm}^2] * 9 [\text{mm}]^2 * 983.962 [\text{mm}] \\ &= \mathbf{18.65} [\text{kN*m}]\end{aligned}$$

DG. 12 p. 41

$$\begin{aligned}\phi R_{ft} &= \phi M_{ct} / (d_b - t_{fb}) \\ &= 18.65 [\text{kN*m}] / (300 [\text{mm}] - 9 [\text{mm}]) \\ &= \mathbf{64.089} [\text{kN}]\end{aligned}$$

DG. 12 p. 61

$$\begin{aligned}b_{sc} &= t_{fb} \\ &= 9 [\text{mm}]\end{aligned}$$

DG. 12 p. 65

$$c_t = 0.5$$

DG. 11 p. 22

$$\begin{aligned}\phi R_{wt} &= \phi * (b_{sc} + 2.0 * t_i * c_t + 6.0 * k_c * c_t) * t_{wc} * f_{ycw} \\ &= 0.9 * (9 [\text{mm}] + 2.0 * 16 [\text{mm}] * 0.5 + 6.0 * 9 [\text{mm}] * 0.5) * 6 [\text{mm}] * 280 [\text{N/mm}^2] \\ &= \mathbf{78.624} [\text{kN}]\end{aligned}$$

DG. 12 p. 44

Top flange end weld capacity

[KN] 130.25 104.30 DL **0.80** Handbook 1 Sec. 4.5

$$\begin{aligned}\phi v_w &= \phi * 0.6 * f_{uw} * 0.7071 * t_w * k_r \\ &= 0.8 * 0.6 * 410 [\text{N/mm}^2] * 0.7071 * 6 [\text{mm}] * 1 \\ &= \mathbf{0.835} [\text{kN/mm}]\end{aligned}$$

Handbook 1 Sec. 4.5

$$\begin{aligned}L_w &= \text{Min}(4.0 * (b_s - 15 [\text{mm}]), 4.0 * (d_s - 15 [\text{mm}])) \\ &= \text{Min}(4.0 * (54 [\text{mm}] - 15 [\text{mm}]), 4.0 * (212 [\text{mm}] - 15 [\text{mm}])) \\ &= \mathbf{156} [\text{mm}]\end{aligned}$$

DG. 12 p. 61

$$\begin{aligned}\phi R_{ftw} &= \phi v_w * L_w \\ &= 0.835 [\text{kN/mm}] * 156 [\text{mm}] \\ &= \mathbf{130.251} [\text{kN}]\end{aligned}$$

DG. 12 p. 61

$$\begin{aligned}a_h &= 0.5 * (b_i * s_g)^{1/2} \\ &= 0.5 * (140 [\text{mm}] * 70 [\text{mm}])^{1/2} \\ &= \mathbf{49.497} [\text{mm}]\end{aligned}$$

DG12 Sec. 9.6

$$\begin{aligned}
Y_c &= 0.5 * b_{fc} * (d_{11}/a_h) + (2.0/s_g) * (d_{11} * (a_h + 0.75 * s_{pi}) + 0.5 * (s_{pi}^2)) + 0.5 * s_g \\
&= 0.5 * 125[\text{mm}] * (226.5[\text{mm}] / 49.497[\text{mm}]) + (2.0 / 70[\text{mm}]) * (226.5[\text{mm}] * (49.497[\text{mm}] + 0.75 * 60[\text{mm}]) + 0.5 * \\
&\quad (60[\text{mm}]^2)) + 0.5 * 70[\text{mm}] \\
&= \mathbf{983.962[\text{mm}]}
\end{aligned}$$

DG. 12 p. 41

$$\begin{aligned}
\phi M_{ct} &= 0.90 * f_{ycf} * t_{fc}^2 * Y_c \\
&= 0.90 * 260[\text{N/mm}^2] * 9[\text{mm}]^2 * 983.962[\text{mm}] \\
&= \mathbf{18.65[\text{kN*m}]}
\end{aligned}$$

DG. 12 p. 41

$$\begin{aligned}
\phi R_{ft} &= \phi M_{ct} / (d_b - t_{fb}) \\
&= 18.65[\text{kN*m}] / (300[\text{mm}] - 9[\text{mm}]) \\
&= \mathbf{64.089[\text{kN}]}
\end{aligned}$$

DG. 12 p. 61

$$\begin{aligned}
b_{sc} &= t_{fb} \\
&= 9[\text{mm}]
\end{aligned}$$

DG. 12 p. 65

$$c_t = 0.5$$

DG. 11 p. 22

$$\begin{aligned}
\phi R_{wt} &= \phi * (b_{sc} + 2.0 * t_i * c_t + 6.0 * k_c * c_t) * t_{wc} * f_{ycw} \\
&= 0.9 * (9[\text{mm}] + 2.0 * 16[\text{mm}] * 0.5 + 6.0 * 9[\text{mm}] * 0.5) * 6[\text{mm}] * 280[\text{N/mm}^2] \\
&= \mathbf{78.624[\text{kN}]}
\end{aligned}$$

DG. 12 p. 44

<b>Global critical strength ratio</b>	<b>0.84</b>
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## NOTES

- Unsuitable steel beam grade for recommended detailing, should be grade 300 or grade 350.

## NOTATION

$A_c$ :	Minor diameter area of the bolt
$a_{emax}$ :	Maximum edge distance
$a_{emin}$ :	Minimum edge distance
$a_{ey}$ :	min ( $a_{e2}$ , $a_{e1-1}$ )
$a_h$ :	Tension flange external yielding line distance
$A_n$ :	Net area of the cross section
$A_s$ :	Tensile stress area of the bolt
$A_{sn}$ :	Net stiffener area
$A_{wc}$ :	Area of web resisting shear force
$\alpha_a$ :	Compression member factor
$\alpha_b$ :	Compression member section constant
$\alpha_c$ :	Compression member slenderness reduction factor
$b_{bc}$ :	Distance dispersion line
$b_{fb}$ :	Beam flange width
$b_{fc}$ :	Column flange width
$b_i$ :	Plate width
$b_{imax}$ :	Maximum plate width
$b_{imin}$ :	Minimum plate width
$b_s$ :	Stiffener width
$b_{sb}$ :	Minimum stiffener width at beam side
$b_{sc}$ :	Minimum stiffener width at column side
$b_{sc}$ :	Stiff bearing dimension
$b_{smax}$ :	Maximum stiffener width
$c_i$ :	Continuing column
$d_{11}$ :	Distances from centre of beam compression flange to centre of bolt row
$d_5$ :	Dispersion distance
$d_b$ :	Bolt diameter
$d_c$ :	Depth of cope
$d_c$ :	Column depth
$d_i$ :	Nominal bolt diameter
$d_s$ :	Length of stiffener
$d_s$ :	Minimum stiffener length
$d_s$ :	Minimum stiffener length

$d_{smin}$ :	Minimum stiffener length
$\varepsilon$ :	Compression member factor
$\eta$ :	Compression member imperfection factor
$f_{uc}$ :	Tensile strength of supporting member
$f_{ut}$ :	Minimum tensile strength of bolt
$f_{ui}$ :	Tensile strength of component
$f_{uw}$ :	Tensile strength of supported member web
$f_{yc}$ :	Yield stress of supporting column web/wall
$f_{yf}$ :	Yield stress of column flange
$f_{yw}$ :	Yield stress of column web
$f_{yd}$ :	Yield stress of any flange doubler plate present
$f_{yi}$ :	Yield strength of component
$f_{ys}$ :	Yield stress of the stiffener
$f_{yw}$ :	Beam web yield stress
$f_{ywc}$ :	Yield stress of column web
$k_c$ :	Distance on column section from outer face of flange to inner termination of root radius
$k_{cbottom}$ :	Distance on column section from bottom outer face of flange to inner termination of root radius
$k_{ctop}$ :	Distance on column section from top outer face of flange to inner termination of root radius
$k_f$ :	Section form factor
$k_N$ :	Factor
$k_r$ :	Reduction factor for lap splice connections
$l_w$ :	Fillet length
$L_w$ :	Total weld group fillet length
$L_{wi}$ :	Distance from radius to inside face of tension flange to mid-depth of beam along end plate
$\lambda$ :	Slenderness
$\lambda_n$ :	Modified compression member slenderness
$M^*$ :	Design bending moment at connection
$M^{* axial}$ :	Equivalent design moment
$M^{* eq}$ :	Equivalent design moment
$n_{cw}$ :	Number of bolts in compression
$n_n$ :	Number of shear planes with threads intercepting the shear plane
$N^{*fr}$ :	Flange force due to tension/shear
$\phi$ :	Capacity factor
$\phi M_{bt}$ :	Design capacity of beam section at tension
$\phi M_{ct}$ :	Design capacity of column section at tension
$\phi M_{ctd}$ :	Design capacity of column flange section at tension
$\phi M_{cts}$ :	Design capacity of column section at tension
$\phi N_s$ :	Design section capacity in compression
$\phi N_{tf}$ :	Design tensile capacity for bolt
$\phi R_{fcb}$ :	Design buckling capacity of stiffener and web acting together
$\phi R_{ft}$ :	Tension flange capacity
$\phi R_{fts}$ :	Tension stiffener capacity
$\phi R_{fw}$ :	Tension flange capacity at web
$\phi R_{wc}$ :	Column web crippling at beam compression flange capacity
$\phi R_{wt}$ :	Tension web capacity
$\phi R_{wy}$ :	Yielding of column web at beam compression flange
$\phi V_c$ :	Shear in plate capacity
$\phi V_{fn}$ :	Design capacity in shear for bolt with threads included in the shear plane
$\phi v_w$ :	Design capacity of fillet weld per unit length
$\phi V_w$ :	Design capacity of fillet weld
$\phi M_{bt}$ :	Capacity of bolts at tension flange
$\phi M_{pt}$ :	Design capacity of end plate at tension flange
$\phi N_{tf}$ :	Design capacity of bolt in tension
$\phi N_{wt}$ :	Beam web axial capacity
$\phi V_{bc}$ :	Design capacity related to local bearing or end plate tearout in the supporting column flange
$\phi V_{bi}$ :	Design capacity related to local bearing or end plate tearout in the end plate component (single bolt)
$\phi V_{di}$ :	Design capacity of a single bolt in shear for the strength limit state
$\phi V_{fb}$ :	Design capacity of bolts in shear
$\phi V_{fn}$ :	Design capacity for a single bolt threads included
$s_g$ :	Bolt gauge (horizontal spacing between two columns)
$s_{gmax}$ :	Maximum bolt gauge
$s_{gmin}$ :	Minimum bolt gauge
$s_{pi}$ :	Internal distance from bolt centre-line to face of flange at tension flange
$\Sigma d$ :	Sum of bolt lever arms
$t_d$ :	Thickness of any flange doubler plate present
$t_{fb}$ :	Beam flange thickness

$t_{fc}$ :	Thickness of the column flange
$t_{fcbot}$ :	Column bottom flange thickness
$t_{fctop}$ :	Column top flange thickness
$t_i$ :	Connector thickness
$t_s$ :	Thickness of stiffener
$t_{smin}$ :	Minimum stiffener thickness
$t_w$ :	Weld fillet weld size
$t_{wb}$ :	Beam web thickness
$t_{wc}$ :	Supporting column web/wall thickness
$Y_c$ :	Unstiffened yielding line pattern factor
$Y_{cs}$ :	Yielding line pattern factor
$Y_p$ :	Factor related to yield line pattern