Verification example – Eccentric loads on bolt group

Type of connection: Eccentric loads on bolt group

Unit system: Metric
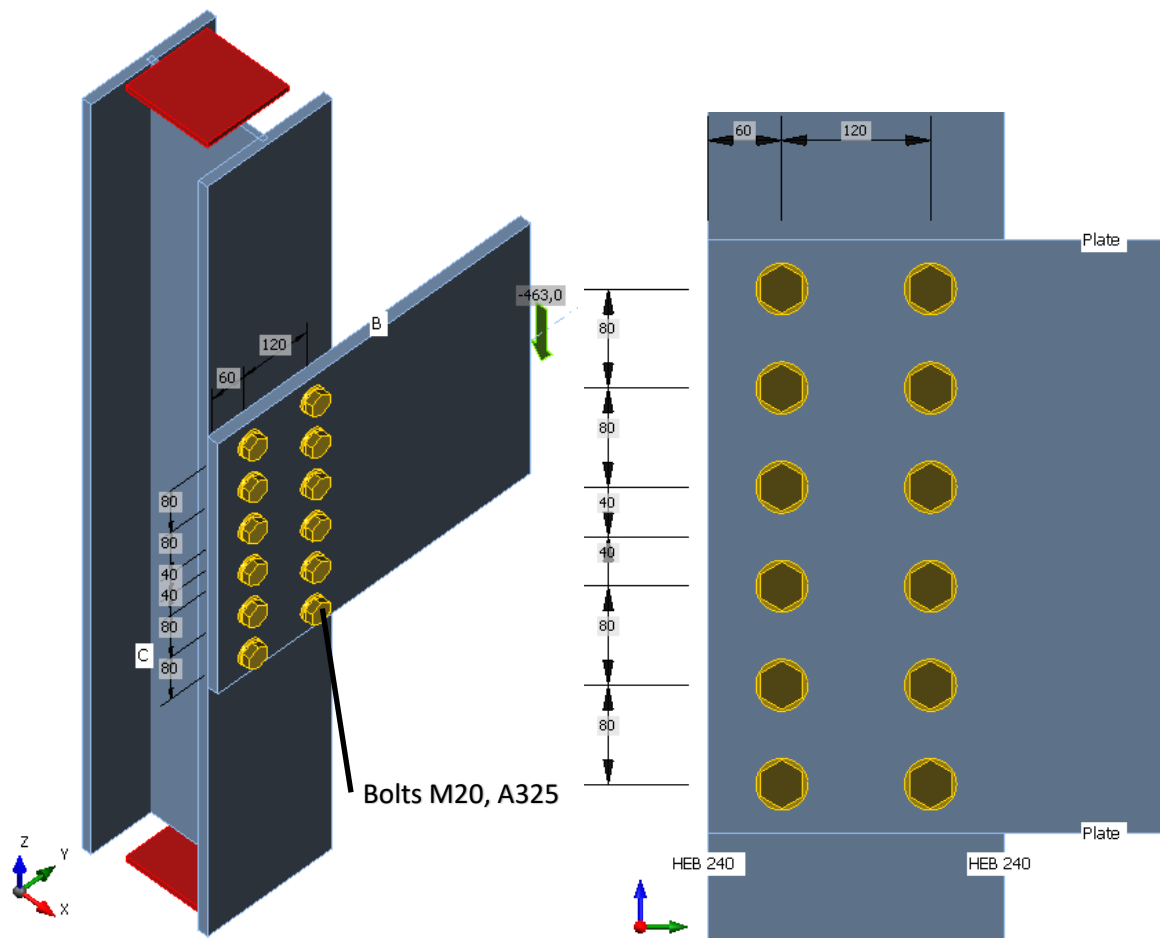
Designed acc. to: CSA S14-16

Investigated: Bolts

Plate Materials: Steel grade 350W,

Bolts: M20, grade A325

Geometry:

Bolts M20, A325

Applied forces:

N = 0 kN
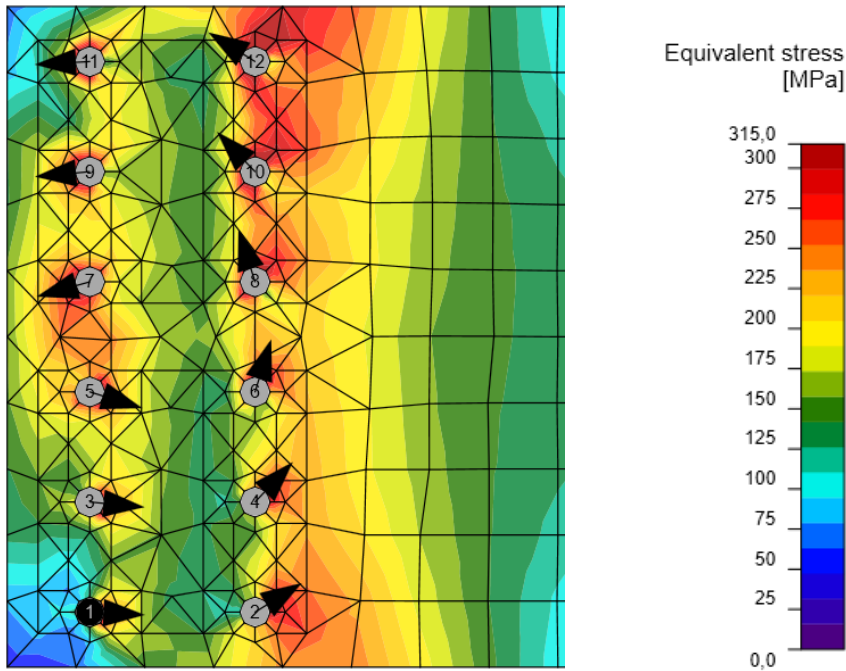
V = -465 kN at position 400 mm

M = 0 kNm

Procedure:

The example was taken from CISC Handbook of Steel Construction. Regular bolts M20, steel grade A325 (shear force transfer by bearing) are used, threads are excluded. Only one side of the column bracket was modelled and it was loaded with maximal force.

IDEA StatiCa Connection

Check of bolts for extreme load effect

		Item	Loads	Tf [kN]	Vf [kN]	Utt [%]	Uts [%]	Utts [%]	Status
>	⊞	B1	LE1	2,7	123,4	1,7	98,6	97,3	✅
	⊞	B2	LE1	1,6	125,0	1,0	99,9	99,8	✅
	⊞	B3	LE1	6,1	119,3	3,9	95,4	91,2	✅
	⊞	B4	LE1	1,8	123,7	1,1	98,9	97,9	✅
	⊞	B5	LE1	4,3	72,3	2,8	57,8	33,5	✅
	⊞	B6	LE1	1,7	123,5	1,1	98,7	97,5	✅
	⊞	B7	LE1	2,5	72,8	1,6	58,2	33,9	✅
	⊞	B8	LE1	4,0	121,4	2,6	97,1	94,3	✅
	⊞	B9	LE1	2,9	122,4	1,8	97,8	95,7	✅
	⊞	B10	LE1	6,8	119,7	4,3	95,7	91,8	✅
	⊞	B11	LE1	4,7	122,1	3,0	97,6	95,4	✅
	⊞	B12	LE1	3,0	124,4	1,9	99,4	98,9	✅

Design data

	Item	Tr [kN]	Vr [kN]	Br [kN]
>	20 A325M - 1	156,4	125,1	367,2

The shear resistance is at 99.9 % in case of bolt No. 2. Due to small deformation of the plate, the bolts are loaded also by a negligible tensile force. The bolts are fully utilized in IDEA when loaded by force 465 kN at lever arm 400 mm.
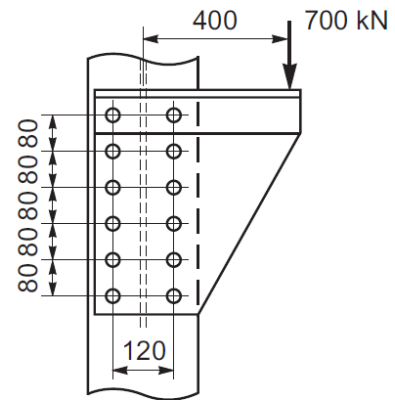
Manual assessment

The example was taken from CISC Handbook of Steel Construction, 8th edition, 2003.

Example

1. Given:

A double column bracket must be designed to support a factored load of 700 kN at an eccentricity of 400 mm. Find the number of M20 A325M bolts per flange required for a gauge dimension of 120 mm and a pitch of 80 mm assuming a bearing-type connection.

Solution:

$P_f = 700 / 2 = 350$ kN $L = 400$ mm

$V_r = 125$ kN (Table 3-4 page 3-8, single shear, threads excluded)

Required $C = 350 / 125 = 2.8$

From Tables 3-15 and 3-16, for 2 lines of bolts

6 rows at 80 mm gauge, $C = 3.49$

at 320 mm gauge, $C = 4.77$

Interpolating for 120 mm gauge $C = 3.49 + (4.77 - 3.49) \times 40 / 240 = 3.70$

Use 6 rows of bolts (total 12 bolts)

Capacity is $3.70 \times 125 = 463$ kN per side

Comparison:

The results of both IDEA StatiCa Connection design and manual computation according to CISC Handbook of Steel Construction gives similar values: The load resistance in IDEA is 465 kN while the CISC handbook gives resistance of 463 kN. There is nearly no difference (0.4 %) between IDEA and example from CISC Handbook of Steel Construction.