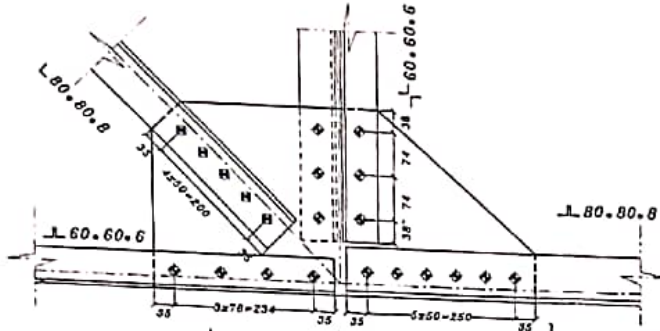


امتحان مقرر منشآت معدنية /2/
السنة الرابعة – مدني عام - الفصل الثاني 2024-2025

السؤال الأول: 30 درجة

صمم عدد براغي الوصلة الموضحة بالشكل للعنصر الأفقي اليساري Lower Chord ثم حقق إجهاد الصفيحة.



B mm	60	fy MPa	275
t mm	6	fu MPa	430
d mm	16	Bolt Class	4.6
Clearance	2	fu b Mpa	400
do mm	18	Slip Resistance	0
A mm ²	360	Threaded Portion	1
e1 mm	25	Force kN	50
p1mm	40		
e2 mm	40		
p2 mm	50		
Rows	1		
Angles	2		
Gusset	6		

السؤال الثاني: 40 درجة

صمم عقدة ارتباط العنصر (1) في الشكل السابق بعمود IPE360 سماكة الجناح 10mm حيث:

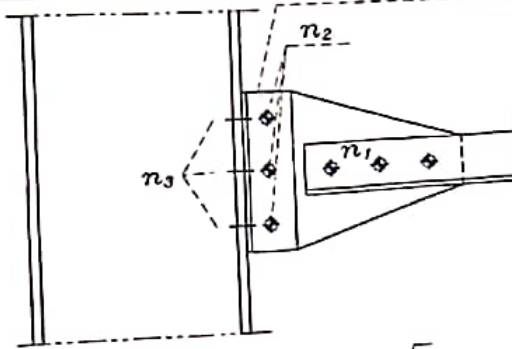
B mm	80	fy MPa	275
t mm	8	fu MPa	430
d mm	16	Bolt Class	4.6
Clearance	2	Slip Resistance	0
do mm	18	Threaded Portion	1
e1 mm	35	Force kN	150
e2 mm	35		
p2 mm	50		
Rows	1		
Gusset mm	7		

د. ریم خرتش

مع التّمنيات بالتّوفيق والنّجاح

Sketch

Sketch
للتوضيح فقط



$$f_{vw,d} = \frac{f_u / \sqrt{3}}{\beta_w \gamma_{M2}}$$

$$F_{w,Rd} = f_{vw,d} a$$

$$F_{LRd} = \frac{k_2 f_{ub} A_s}{\gamma_{M2}}$$

where $k_2 = 0,63$ for countersunk bolt,
otherwise $k_2 = 0,9$.

Shear plane Table 3.4 EC3-8
(a) at threaded portion (b) at unthreaded portion
 $F_{v,Rd} = \alpha_v f_{ub} \frac{A_f}{\gamma_{M2}}$ $F_{v,Rd} = 0,6 f_{ub} \frac{A}{\gamma_{M2}}$ Gross cross-section
Factor Table 3.1, EC3-8

Table 3.4 EC3-8
Values for α_v

Bolt classes	α_v
4.6	0.5
4.8	0.5
5.6	0.6
5.8	0.5
6.8	0.5
8.8	0.6
10.9	0.5

Nominal size and thread diameter (mm)	Tensile stress area, A_t (mm ²)
12	84.3
16	157
20	245
22	303
24	353
27	459
30	561

$$\alpha_b = \min \left(\frac{e_1}{3d_0} ; \frac{f_{ub}}{f_u} ; 1.0 \right) \quad \text{For end bolts}$$

$$\alpha_b = \min \left(\frac{p_1}{3d_0} - \frac{1}{4} ; \frac{f_{ub}}{f_u} ; 1.0 \right) \quad \text{For inner bolts}$$

$$F_{b,Rd} = k_1 \alpha_b f_u \frac{dt}{\gamma_{M2}}$$

$$k_1 = \min \left(2.8 \frac{e_2}{d_0} - 1.7 ; 2.5 \right) \quad \text{For edge bolts}$$

$$k_1 = \min \left(1.4 \frac{p_2}{d_0} - 1.7 ; 2.5 \right) \quad \text{For inner bolts}$$

$$\frac{N_{Ed}}{N_{t,Rd}} \leq 1.0$$

Section with holes

$$N_{t,Rd} = N_{y,Rd} = \min(N_{pl,Rd}, N_{u,Rd})$$

$$N_{pl,Rd} = \frac{A f_y}{\gamma_{M0}}$$

design plastic resistance of the gross cross-section

Category C connection (ULS slip-resistant)

$$N_{t,Rd} = N_{net,Rd} = \frac{A_{net} f_u}{\gamma_{M0}}$$

$$N_{u,Rd} = \frac{0.9 A_{net} f_u}{\gamma_{M2}} \quad \text{design ultimate resistance of the net cross-section at holes for fasteners}$$

A = cross section area of plate
 A_{net} = cross section area of plate - hole

Diameter mm	At mm ²
12	84.3
16	157
20	245
22	303
24	353
27	459
30	561

Class	a_v	f_{ub}	f_y
4.6	0.6	400	240
4.8	0.5	400	320
5.6	0.6	500	300
5.8	0.5	500	400
6.8	0.5	600	480
8.8	0.6	800	640
10.9	0.5	1000	900

2L 80x80x8	
B mm	80
t mm	8
d mm	16
Clearance	2
do mm	18
A mm2	640
e1 mm	35 ok
p1mm	50 ok
e2 mm	35 ok
p2 mm	50 ok
Rows	1
Angles	2
Gusset	7
lmin	7
Shear in Bolts n1	
av	0.6
Al mm2	157
Fv,Rd (L)	30.144 min
Fv,Rd (2L)	60.288 edge B
n1	2.488057 inner B
No of Bolts	3 min

fy MPa	275
fu MPa	430
Bolt Class	4.6
fu b Mpa	400
Slip Resistance	0
Threaded Portion	1
Force kN	150

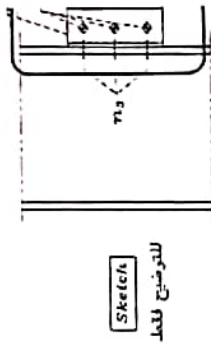
Bearing Resistance of Angle n1	
ab	0.648148148
ab	0.675925926
ab	0.648148148
k1	2.5
k1	2.188888889
k1	2.188888889
ifb,Rd	54.66060905
n1	2.744206525
No of Bolts	3
max	3

Tensile Resistance in Angle	
Npl,Rd	176
Anet1 mm2	496
Anet2 mm2	
Anet mm2	496
Nu,Rd kN	153.5616
Nl,r,d kN	153.5616
ratio	0.488403351

1/4 ال

2L 80x80x8	
B mm	80
t mm	8
d mm	16
Clearance	2
do mm	18
A mm ²	640
e1 mm	35 ok
p1mm	50 ok
e2 mm	35 ok
p2 mm	50 ok
Rows	1
Angles	2
Gusset	7
tmin	7
Shear in Bolts n2	
av	0.6 End B
At mm ²	157 Inner B
Fv,Rd (L)	30.144 min
Fv,Rd (2L)	60.288 edge B
n2	2.488057 inner B
No of Bolts	3 min

fy MPa	275
fu MPa	430
Bolt Class	4.6
fu b Mpa	400
Slip Resistance	0
Threaded Portion	1
Force kN	150



طول الزاوية الواحدة

L mm	170
Tensile Resistance in Angle	
Npl,Rd	374
Anet1 mm ²	928
Anet2 mm ²	
Anet mm ²	928
Nu,Rd kN	287.3088
Nl,Rd kN	287.3088
ratio	0.26104317

Bearing Resistance of Angle n2	
ab	0.648148148
ab	0.675925926
ab	0.648148148
k1	2.5
k1	2.188888889
k1	2.188888889
Fb,Rd	54.66060905
n2	2.744206525
No of Bolts	3
max	3

2L 80x80x8	
B mm	80
t mm	8
d mm	16
Clearance	2
do mm	18
A mm ²	640
e1 mm	35 ok
p1 mm	50 ok
e2 mm	35 ok
p2 mm	50 ok
Rows	1
Angles	2
Gusset	7
tmin	7
Tension in Bolts n3	
At mm ²	157
Ft,Rd (L)	31.6512
n3	4.739157
No of Bolts	5

fy MPa	275
fu MPa	430
Bolt Class	4.6
fu b Mpa	400
Slip Resistance	0
Threaded Portion	1
Force kN	150

Diameter mm	At mm ²
12	84.3
16	157
20	245
22	303
24	353
27	459
30	561