Resistance of bolted connections

EN 1993 is intended to be used with Eurocodes EN 1990 - Basis of Structural Design, EN 1991 - Actions on structures and EN 1992 to EN 1999, when steel structures or steel components are referred to.

Symbols

Bolt	-	Nominal designation
Bolt Class	-	Standard bolt class
f_{ub}	-	Ultimate tensile strength
f_{yb}	-	Ultimate yeld strength
A_s	-	Tensile stress area of the bolt in the threaded portion
d_m	-	The mean of the across points and across flats dimensions of the bolt head or the nut
d_0	-	The hole diameter for a bolt
α_v	-	Shear resistance factor
$F_{v,Rd}$	-	Design shear resistance per bolt
$F_{t,Rd}$	-	Design tension resistance per bolt
Steel grade	-	Standard steel grade
f_y	-	Yeld strength
f_u	-	Ultimate strength
t	-	Thinner outer connected part
e_1	-	End distance from the centre of a fastener hole to the adjacent end of any part, measured in the direction of load trasfer
e_2	-	Edge distance from the centre of a fastener hole to the adjacent end of any part, measured at right angles to the direction of load trasfer
p_1	-	Spacing between centres of fasteners in a line in the direction of load transfer
p_2	-	Spacing measured perpendicular to the load transfer direction between adjacent lines of fasteners
Hole type	-	Type of the hole
α_d	-	Factor for end and inner bolts
α_b	-	Factor for bearing resistance in the direction of load trasfer
k_1	-	Factor for bearing resistance perpendicular to the direction of load trasfer
$F_{b,Rd}$	-	Design bearing resistance per bolt
$B_{p,Rd}$	-	Design punching shear resistance per bolt
$F_{v,Ed}$	-	Design shear force per bolt for the ultimate limit state
$F_{t,Ed}$	-	Design tensile force per bolt for the ultimate limit state
SF	-	Safety factor

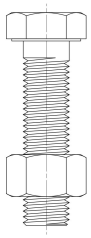
References

EN 1993-1-8:2005 "Eurocode 3: Design of steel structures - Part 1-8: Design of joints

Resistance of bolted connections

Object: Fastener M12

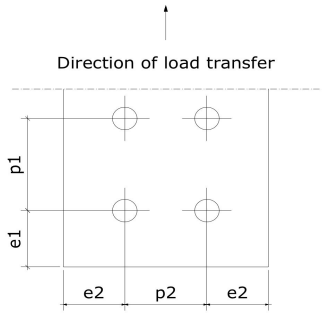
Bolt



Bolt	M12	d = 12 mm - Nominal bolt diameter
Bolt Class	8.8	
f_{ub} =	800 MPa	
f_{yb} =	640 MPa	
A_s =	84 mmq	Tensile stress area of the bolt in the threaded portion
d_m =	19,00 mm	Mean dimension of the bolt head or the nut
d_0 =	13,00 mm	Hole diameter

Bolt design resistance

α_v =	0,6	
$F_{v,Rd}$ =	32256 N	Shear resistance per shear plane
$F_{t,Rd}$ =	48384 N	Tension resistance



Connected steel member

Steel grade	S 235	
f_y =	235 MPa	
f_u =	360 MPa	
ε =	1,00	
t	10,00 mm	Thinner outer connected part

Spacing, end and edge distances

	Minimum	exposed)	not exposed)	(EN10025-5)	Design values
e_1	16 mm	80 mm		125 mm	40 mm
e_2	16 mm	80 mm		125 mm	40 mm
p_1	29 mm	140 mm	140 mm	140 mm	
p_2	31 mm	140 mm	140 mm	140 mm	

Note for p_1: Local buckling between fastener need not to be checked (Table 3.3(2))

Bearing and punching shear resistances

Hole type	normal	
α_d =	1,03	
α_b =	1,00	
k_1 =	2,50	
$F_{b,Rd}$ =	51840 N	Bearing resistance limited for single lap joints with only one bolt row §3.6.1(10)
$B_{p,Rd}$ =	103145 N	Punching shear resistance

Category A - Shear connections design check

SF

$F_{v,Ed}$ = $F_{v,Ed}/F_{v,Rd}$ = 0,00

$F_{v,Ed}/F_{b,Rd}$ = 0,00

Category D - Tension connections design check

SF

$F_{t,Ed}$ = $F_{t,Ed}/F_{t,Rd}$ = 0,00

$F_{t,Ed}/B_{p,Rd}$ = 0,00

Combined shear and tension design check

SF

$F_{v,Ed}/F_{v,Rd} + F_{t,Ed}/(1{,}4\ F_{t,Rd})$ = 0,00

Note:

Group of fasteners

The design resistance of a group of fasteners should be taken as the number of fasteners multiplied by the

National annex for EN 1993-1-8

EN 1993 gives values with notes indicating where national choices may have to be made. Therefore the National Standard implementing EN 1993-1 should have a National Annex containing all Nationally Determined Parameters to be used for the design of steel structures to be constructed in the relevant country.

The National Annex may only contain information on those parameters which are left open in the Eurocode for national choice, known as Nationally Determined Parameters, to be used for the design of buildings and civil engineering works to be constructed in the country concerned.

National choice is allowed in EN 1993-1-8 through the following values:

Action safety factors

γ_G	1,35
γ_Q	1,50

Materials safety factors

γ_{M0}	1,00
γ_{M1}	1,00
γ_{M2}	1,25

Table 3.1: Nominal values of the yeld strength fyb and the ultimate tensile strength fub for bolts

Bolt class	4.6	4.8	5.6	5.8	6.8	8.8	10.9
f_{yb} (N/mm^2)	240	320	300	400	480	640	900
f_{ub} (N/mm^2)	400	400	500	500	600	800	1000

Nominal values

Tensile stress area of the bolt in the threaded portion

	d (mm)	A (mm^2)	A_s (mm^2)		d_m (mm^2)
M12	12	113	84	0,74	19
M14	14	154	115	0,75	22
M16	16	201	157	0,78	24
M18	18	254	192	0,75	27
M20	20	314	245	0,78	30
M22	22	380	303	0,80	32
M24	24	452	353	0,78	36
M27	27	573	459	0,80	41
M30	30	707	561	0,79	46

Nominal values of yeld strength f_y and ultimate tensile strength f_u

Steel grade	f_y [N/mm^2]	f_u [N/mm^2]
S 235	235	360
S 275	275	430
S 355	355	510
S 450	440	550

Table 3.3: Minimum and maximum spacing, end and edge distances

Distances	Minimum	Maximum		
		Steel En 10025 exposed	Steel EN 10025 not exposed	Steel EN 10025 5
End distance e_1	1,2	4t + 40 mm		The larger of 8t or 125mm
Edge distance e_2	1,2	4t + 40 mm		The larger of 8t or 125mm
Distance e_3 in slotted holes	1,5			
Distance e_4 in slotted holes	1,5			
Spacing p_1	2,2	The smaller of 14t or 200mm	Tha smaller of 14t or 200mm	The smaller of 14t or 175mm
Spacing $p_{1,0}$		The smaller of 14t or 200mm		
Spacing $p_{1,i}$		The smaller of 28t or 400mm		
Spacing p_2	2,4	The smaller of 14t or 200mm	Tha smaller of 14t or 200mm	The smaller of 14t or 175mm