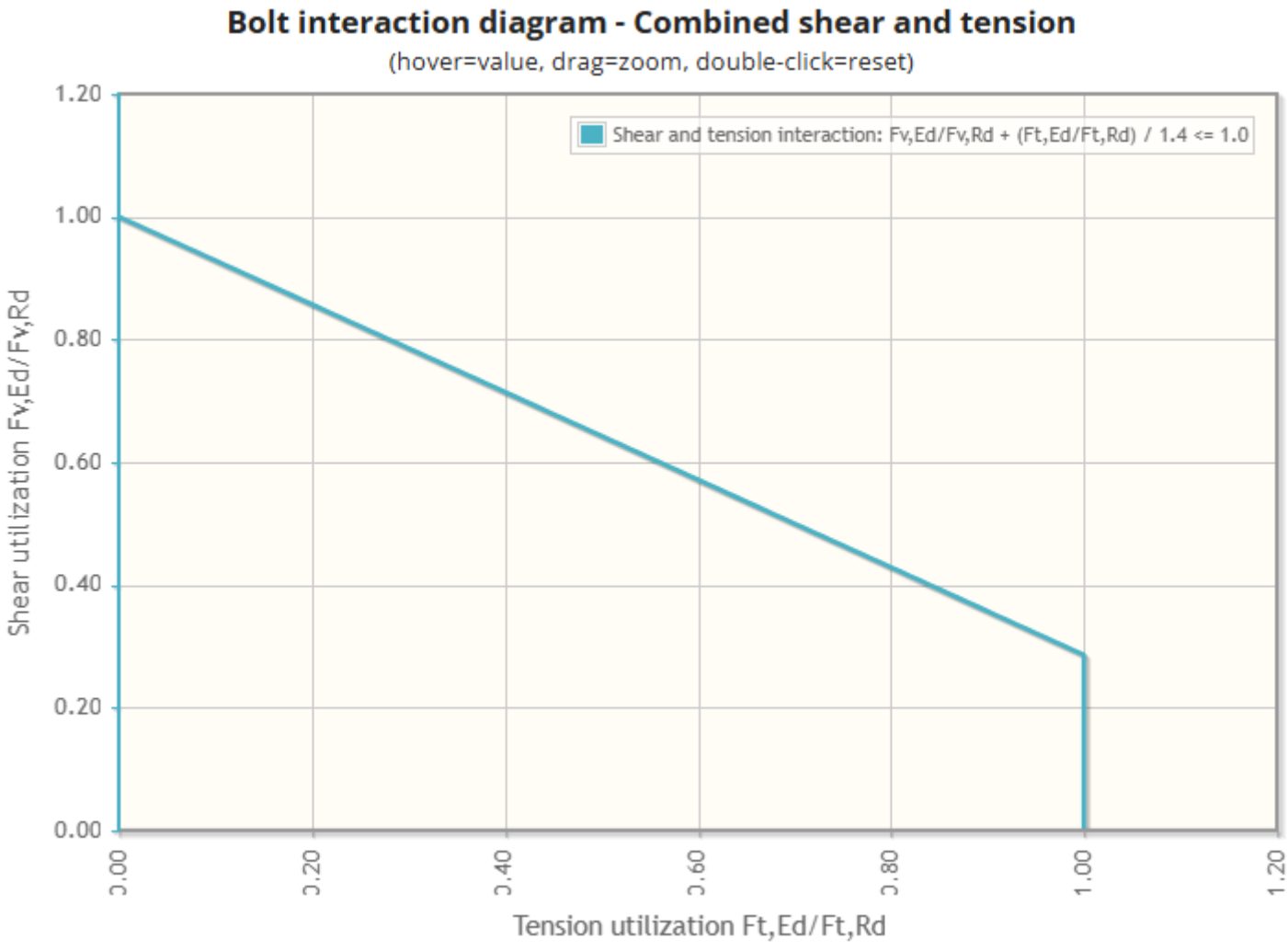
בורג אום

לפי תקן EN 1993-1-8:2005 Section 3.8

	Dimensions		Hole Diameter d_o [mm]				Areas	
Size	Nominal diameter d [mm]	Nut width across flats s [mm]	Normal round hole	Oversize round hole	Short slotted hole	Long slotted hole	Gross area (unthreaded part) A_g [mm²]	Stress area (threaded part) A_s [mm²]
M5	5	8	-	-	-	-	19.6	14.2
M6	6	10	-	-	-	-	28.3	20.1
M7	7	11	-	-	-	-	38.5	28.9
M8	8	13	-	-	-	-	50.3	36.6
M10	10	16	-	-	-	-	78.5	58.0
M12	12	18	13	15	16×13	30.0×13	113	84.3
M14	14	21	15	17	18×15	35.0×15	154	115
M16	16	24	18	20	22×18	40.0×18	201	157
M18	18	27	20	22	24×20	45.0×20	254	192
M20	20	30	22	24	26×22	50.0×22	314	245
M22	22	34	24	26	28×24	55.0×24	380	303
M24	24	36	26	30	32×26	60.0×26	452	353
M27	27	41	30	35	37×30	67.5×30	573	459
M30	30	46	33	38	40×33	75.0×33	707	561
M33	33	50	36	41	43×36	82.5×36	855	694
M36	36	55	39	44	46×39	90.0×39	1020	817
M39	39	60	42	47	49×42	97.5×42	1190	976

	Tensile Resistance $F_{t,Rd}$ [kN[						
Size	4.6	4.8	5.6	5.8	6.8	8.8	10.9
M5	4.09	4.09	5.11	5.11	6.13	8.18	10.2
M6	5.79	5.79	7.24	7.24	8.68	11.6	14.5
M7	8.32	8.32	10.4	10.4	12.5	16.6	20.8
M8	10.5	10.5	13.2	13.2	15.8	21.1	26.4
M10	16.7	16.7	20.9	20.9	25.1	33.4	41.8
M12	24.3	24.3	30.3	30.3	36.4	48.6	60.7
M14	33.1	33.1	41.4	41.4	49.7	66.2	82.8
M16	45.2	45.2	56.5	56.5	67.8	90.4	113.0
M18	55.3	55.3	69.1	69.1	82.9	110.6	138.2
M20	70.6	70.6	88.2	88.2	105.8	141.1	176.4
M22	87.3	87.3	109.1	109.1	130.9	174.5	218.2
M24	101.7	101.7	127.1	127.1	152.5	203.3	254.2
M27	132.2	132.2	165.2	165.2	198.3	264.4	330.5
M30	161.6	161.6	202.0	202.0	242.4	323.1	403.9
M33	199.9	199.9	249.8	249.8	299.8	399.7	499.7
M36	235.3	235.3	294.1	294.1	352.9	470.6	588.2
M39	281.1	281.1	351.4	351.4	421.6	562.2	702.7

	Shear resistance per shear plane $F_{v,Rd}$ [kN]						
Size	**4.6**	**4.8**	**5.6**	**5.8**	**6.8**	**8.8**	**10.9**
M5	2.73	2.27	3.41	2.84	3.41	5.45	5.68
M6	3.86	3.22	4.82	4.02	4.82	7.72	8.04
M7	5.55	4.62	6.94	5.78	6.94	11.1	11.6
M8	7.03	5.86	8.78	7.32	8.78	14.1	14.6
M10	11.1	9.28	13.9	11.6	13.9	22.3	23.2
M12	16.2	13.5	20.2	16.9	20.2	32.4	33.7
M14	22.1	18.4	27.6	23.0	27.6	44.2	46.0
M16	30.1	25.1	37.7	31.4	37.7	60.3	62.8
M18	36.9	30.7	46.1	38.4	46.1	73.7	76.8
M20	47.0	39.2	58.8	49.0	58.8	94.1	98.0
M22	58.2	48.5	72.7	60.6	72.7	116.4	121.2
M24	67.8	56.5	84.7	70.6	84.7	135.6	141.2
M27	88.1	73.4	110.2	91.8	110.2	176.3	183.6
M30	107.7	89.8	134.6	112.2	134.6	215.4	224.4
M33	133.2	111.0	166.6	138.8	166.6	266.5	277.6
M36	156.9	130.7	196.1	163.4	196.1	313.7	326.8
M39	187.4	156.2	234.2	195.2	234.2	374.8	390.4



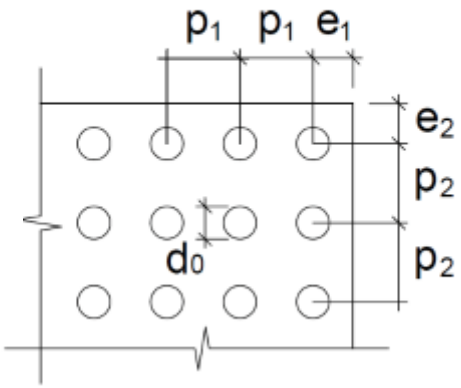
	Maximum bearing resistance per mm of connected plate thickness $F_{b,Rd}$ / t [kN/mm] (for adequate distances $e_1 \geq 3d_0$, $e_2 \geq 1.5d_0$, $p_1 \geq 3.75d_0$, $p_2 \geq 3d_0$)				
Size	**S235 / any**	**S275 / 4.6, 4.8**	**S275 / ≥5.6**	**S355 / 4.6, 4.8**	**S355 / ≥5.6**
M5	3.60	4.00	4.30	4.00	4.90
M6	4.32	4.80	5.16	4.80	5.88
M7	5.04	5.60	6.02	5.60	6.86
M8	5.76	6.40	6.88	6.40	7.84
M10	7.20	8.00	8.60	8.00	9.80
M12	8.64	9.60	10.32	9.60	11.76
M14	10.08	11.20	12.04	11.20	13.72
M16	11.52	12.80	13.76	12.80	15.68
M18	12.96	14.40	15.48	14.40	17.64
M20	14.40	16.00	17.20	16.00	19.60
M22	15.84	17.60	18.92	17.60	21.56
M24	17.28	19.20	20.64	19.20	23.52
M27	19.44	21.60	23.22	21.60	26.46
M30	21.60	24.00	25.80	24.00	29.40
M33	23.76	26.40	28.38	26.40	32.34
M36	25.92	28.80	30.96	28.80	35.28
M39	28.08	31.20	33.54	31.20	38.22

	Minimum bearing resistance per mm of connected plate thickness $F_{b,Rd}$ / t [kN/mm] [for minimum distances $e_1=1.2d_0$, $e_2=1.2d_0$, $p_1=2.2d_0$, $p_2=2.4d_0$]			Punching resistance per mm of plate thickness under bolt or nut $B_{p,Rd}$ / t_p [kN/mm]		
Size	**S235**	**S275**	**S355**	**S235**	**S275**	**S355**
M5	0.96	1.14	1.30	4.68	5.59	6.37
M6	1.15	1.37	1.56	5.85	6.99	7.96
M7	1.34	1.60	1.82	6.43	7.68	8.76
M8	1.53	1.83	2.08	7.60	9.08	10.35
M10	1.91	2.28	2.60	9.36	11.18	12.74
M12	2.29	2.74	3.12	10.53	12.57	14.33
M14	2.68	3.20	3.64	12.28	14.67	16.72
M16	3.06	3.65	4.16	14.04	16.77	19.11
M18	3.44	4.11	4.69	15.79	18.86	21.49
M20	3.82	4.57	5.21	17.55	20.96	23.88
M22	4.21	5.03	5.73	19.89	23.75	27.07
M24	4.59	5.48	6.25	21.05	25.15	28.66
M27	5.16	6.17	7.03	23.98	28.64	32.64
M30	5.74	6.85	7.81	26.90	32.13	36.62
M33	6.31	7.54	8.59	29.24	34.93	39.80
M36	6.88	8.22	9.37	32.17	38.42	43.78
M39	7.46	8.91	10.15	35.09	41.91	47.76

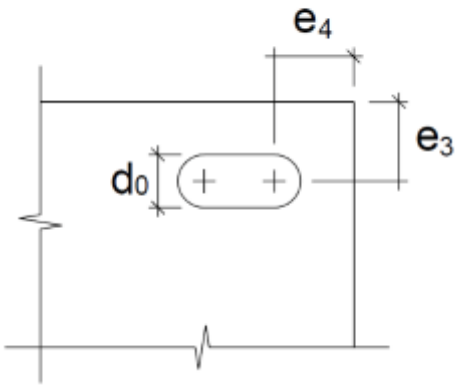
	Normal round holes			
Size	**Minimum end distance along load direction e_1 [mm] ($e_1 = 1.2d_0$)**	**Minimum edge distance perpendicular to load direction e_2 [mm] ($e_2 = 1.2d_0$)**	**Minimum center-to-center spacing along load direction p_1 [mm] ($p_1 = 2.2d_0$)**	**Minimum center-to-center spacing perpendicular to load direction p_2 [mm] ($p_2 = 2.4d_0$)**
M12	16	16	29	32
M14	18	18	33	36
M16	22	22	40	44
M18	24	24	44	48
M20	27	27	49	53
M22	29	29	53	58
M24	32	32	58	63
M27	36	36	66	72
M30	40	40	73	80
M33	44	44	80	87
M36	47	47	86	94
M39	51	51	93	101

	Oversize round holes			
Size	**Minimum end distance along load direction e_1 [mm] ($e_1 = 1.2d_0$)**	**Minimum edge distance perpendicular to load direction e_2 [mm] ($e_2 = 1.2d_0$)**	**Minimum center-to-center spacing along load direction p_1 [mm] ($p_1 = 2.2d_0$)**	**Minimum center-to-center spacing perpendicular to load direction p_2 [mm] ($p_2 = 2.4d_0$)**
M12	18	18	33	36
M14	21	21	38	41
M16	24	24	44	48
M18	27	27	49	53
M20	29	29	53	58
M22	32	32	58	63
M24	36	36	66	72
M27	42	42	77	84
M30	46	46	84	92
M33	50	50	91	99
M36	53	53	97	106
M39	57	57	104	113

a) Round holes



b) Slotted holes



	Slotted holes	
Size	**Minimum edge distance e_3 [mm] ($e_3 = 1.5d_0$)**	**Minimum edge distance e_4 [mm] ($e_4 = 1.5d_0$)**
M12	20	20
M14	23	23
M16	27	27
M18	30	30
M20	33	33
M22	36	36
M24	39	39
M27	45	45
M30	50	50
M33	54	54
M36	59	59
M39	63	63

Strength properties for bolt steel according to EN 1993-1-8 Table 3.1

		Bolt class						
Symbol	**Description**	**4.6**	**4.8**	**5.6**	**5.8**	**6.8**	**8.8**	**10.9**
f_{yb} (MPa)	Yield strength	240	320	300	400	480	640	900
f_{ub} (MPa)	Ultimate tensile strength	400	400	500	500	600	800	1000

Notes

1.The design resistance of a group of fasteners may be taken as the sum of the design bearing resistances $F_{b,Rd}$ of the individual fasteners provided that the shear resistance $F_{v,Rd}$ of each individual fastener is greater than or equal to the design bearing resistance $F_{b,Rd}$. Otherwise the design resistance of a group of fasteners should be taken as the number of fasteners multiplied by the smallest design resistance of any of the individual fasteners as specified in EN1993-1-8 § 3.7(1). For this case elastic linear distribution of internal forces should be used as specified in EN1993-1-8 §3.12.

2.For preloaded bolted connections which are slip-resistant at the Serviceability Limit State or the Ultimate Limit State the corresponding shear load $F_{v,Ed}$ should not exceed the design slip resistance as specified in EN1993-1-8 §3.9 and Table 3.2. Only bolt assemblies of classes 8.8 and 10.9 may be used as preloaded bolts.

3.According to EN1993-1-8 § 3.6.1(4) the design shear resistance $F_{v,Rd}$ should only be used where the bolts are used in holes with nominal clearances not exceeding those for normal holes as specified in EN 1090-2 'Requirements for the execution of steel structures'.

4.Minimum and maximum spacing p_1, p_2 and edge distances e_1, e_2 for bolts are given in EN1993-1-8 Table 3.3. The minimum values are: $e_1 \geq 1.2d_0$, $e_2 \geq 1.2d_0$, $p_1 \geq 2.2d_0$, $p_2 \geq 2.4d_0$, where d_0 is the diameter of the hole, e_1, p_1 are measured parallel to the load transfer direction and e_2, p_2 are measured perpendicular to the load transfer direction.

5.According to EN1993-1-8 Table 3.4 the bearing resistance $F_{b,Rd}$ of the bolt is not affected by the spacing p_1, p_2 and edge distances e_1, e_2 provided that the following limits are observed: $e_1 \geq 3.0d_0$, $e_2 \geq 1.5d_0$, $p_1 \geq 3.75d_0$, $p_2 \geq 3.0d_0$.

6.According to EN1993-1-8 § 3.6.1(12) where bolts transmitting load in shear and bearing pass through packing plates of total thickness t_p greater than d / 3 the design shear resistance $F_{v,Rd}$ should be multiplied by the reduction factor β_p specified in EN1993-1-8 equation 3.3.

7.According to EN1993-1-8 § 3.8(1) for long joints where the distance between the centers of the end fasteners measured in the direction of load transfer is more than $15d$ the design shear resistance $F_{v,Rd}$ of all the fasteners should be multiplied by the reduction factor β_{Lf} specified in EN1993-1-8 equation 3.5.

8.According to EN1993-1-8 Table 3.4 the bearing resistance $F_{b,Rd}$ for bolts in holes other than normal should be multiplied by the following reduction factors: Oversized holes = 0.8, slotted holes with longitudinal axis perpendicular to the load transfer direction = 0.6.

9.According to EN1993-1-8 Table 3.4 for countersunk bolts the tension resistance $F_{t,Rd}$ is evaluated by considering k_2 = 0.63 instead of k_2 = 0.9. Therefore for countersunk bolts the calculated tension resistance $F_{t,Rd}$ should be reduced by a factor of 0.63 / 0.9 = 0.7. In addition for countersunk bolts the bearing resistance $F_{b,Rd}$ should be based on a plate thickness t equal to the depth of the connected plate minus half the depth of the countersinking.

10.For bolts with cut threads where the threads do not comply with EN 1090 the relevant resistances should be multiplied by a factor of 0.85 according to EN1993-1-8 § 3.6.1(3)