



# Bolt resistances: Class 10.9 Standard TCB & TCB Stud:

## Non-preloaded using S275

Diameter of bolt	Tensile stress area	Tension resistance	Shear resistance		Bolts in tension
			Single shear	Double shear	Min. thickness for punching shear
$d$	$A_s$	$F_{t,Rd}$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	$t_{min}$
mm	mm <sup>2</sup>	kN	kN	kN	mm
12	84.3	60.7	28.7	57.3	4.7
16	157	113	62.8	125.6	6.8
20	245	176	98	196	8.6
22	303	218	121	242	9.5
24	353	254	141	282	9.6
27	459	330	184	367	11.2
30	561	404	224	449	12.6
36	817	588	327	654	15.2

Diameter of bolt	Minimum				Bearing resistance (kN)											
	End distance	Edge distance	Pitch	Gauge	Thickness in mm of ply											
	$e_1$	$e_2$	$p_1$	$p_2$	5	6	7	8	9	10	12	15	20	25	30	
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	
12	25	20	35	40	26.4	31.7	37.0	42.2	47.5	52.8	63.4	79.2	105.6	132.0	158.4	
16	35	25	50	50	37.2	44.7	52.1	59.6	67.0	74.5	89.3	111.7	148.9	186.1	223.4	
20	40	30	60	60	42.1	50.5	58.9	67.4	75.8	84.2	101.1	126.3	168.4	210.5	252.6	
22	45	35	65	70	53.7	64.5	75.2	86.0	96.7	107.5	129.0	161.2	215.0	268.7	322.5	
24	50	35	70	70	52.2	62.6	73.1	83.5	94.0	104.4	125.3	156.6	208.8	261.0	313.2	
27	55	40	80	80	55.0	66.0	77.0	88.0	99.0	110.0	132.1	165.1	220.1	275.1	330.1	
30	60	45	85	90	63.2	75.8	88.4	101.1	113.7	126.3	151.6	189.5	252.6	315.8	379.0	
36	75	50	105	100	71.5	85.8	100.1	114.4	128.7	143.0	171.6	214.6	286.1	357.6	429.1	

Diameter of bolt	Minimum				Bearing resistance (kN)											
	End distance	Edge distance	Pitch	Gauge	Thickness in mm of ply											
	$e_1$	$e_2$	$p_1$	$p_2$	5	6	7	8	9	10	12	15	20	25	30	
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	
12	40	25	50	45	46.3	55.5	64.8	74.0	83.3	92.5	111.1	138.8	185.1	231.4	277.6	
16	50	30	65	55	60.7	72.9	85.0	97.2	109.3	121.5	145.8	182.2	243.0	303.7	364.4	
20	60	35	80	70	74.5	89.5	104.4	119.3	134.2	149.1	178.9	223.6	298.2	372.7	447.3	
22	70	40	90	75	87.7	105.2	122.8	140.3	157.9	175.4	210.5	263.1	350.8	438.5	526.2	
24	75	40	95	80	94.6	113.5	132.5	151.4	170.3	189.2	227.1	283.8	378.5	473.1	567.7	
27	85	45	110	90	104.6	125.5	146.4	167.3	188.2	209.1	250.9	313.7	418.2	522.8	627.3	
30	90	50	115	100	111.8	134.2	156.5	178.9	201.3	223.6	268.4	335.5	447.3	559.1	670.9	
36	110	60	145	120	138.8	166.5	194.3	222.0	249.8	277.5	333.0	416.3	555.1	693.8	832.6	

Checked by CB Structures Ltd

Notes:

Eurocode 3 (in accordance with the UK National Annex) (BS EN 1993-1-8: 2005, BS EN ISO 4014: 2011, BS EN ISO 4017: 2014)

See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners

Values of bearing resistance in green cells are less than the single shear resistance of the bolt

Values of bearing resistance in blue cells are greater than the double shear resistance of the bolt

Bearing values assume standard clearance holes

If oversize or short slotted holes are used, bearing values should be multiplied by 0.8

If long slotted holes are used, bearing values should be multiplied by 0.6

In single lap joints with only one bolt row, the design bearing resistance for each bolt should be limited to  $1.5f_u d t / \gamma_{M2}$



# Bolt resistances: Class 10.9 Standard TCB & TCB Stud:

## Non-preloaded using S355

Diameter of bolt	Tensile stress area	Tension resistance	Shear resistance		Bolts in tension
			Single shear	Double shear	Min. thickness for punching shear
$d$	$A_s$	$F_{t,Rd}$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	$t_{min}$
mm	mm <sup>2</sup>	kN	kN	kN	mm
12	84.3	60.7	28.7	57.3	4.1
16	157	113	62.8	125.6	5.9
20	245	176	98	196	7.5
22	303	218	121	242	8.3
24	353	254	141	282	8.4
27	459	330	184	367	9.7
30	561	404	224	449	11.0
36	817	588	327	654	13.3

Diameter of bolt	Minimum				Bearing resistance (kN)										
	End distance	Edge distance	Pitch	Gauge	Thickness in mm of ply										
$d$	$e_1$	$e_2$	$p_1$	$p_2$	5	6	7	8	9	10	12	15	20	25	30
mm	mm	mm	mm	mm											
12	25	20	35	40	30.3	36.3	42.4	48.4	54.5	60.5	72.6	90.8	121.1	151.3	181.6
16	35	25	50	50	42.7	51.2	59.7	68.3	76.8	85.4	102.4	128.0	170.7	213.4	256.1
20	40	30	60	60	48.3	57.9	67.6	77.2	86.9	96.5	115.8	144.8	193.1	241.3	289.6
22	45	35	65	70	61.6	73.9	86.3	98.6	110.9	123.2	147.9	184.8	246.4	308.0	369.7
24	50	35	70	70	59.8	71.8	83.8	95.8	107.7	119.7	143.6	179.5	239.4	299.2	359.1
27	55	40	80	80	63.1	75.7	88.3	100.9	113.5	126.1	151.4	189.2	252.3	315.4	378.4
30	60	45	85	90	72.4	86.9	101.4	115.8	130.3	144.8	173.8	217.2	289.6	362.0	434.4
36	75	50	105	100	82.0	98.4	114.8	131.2	147.6	164.0	196.8	246.0	327.9	409.9	491.9

Diameter of bolt	Minimum				Bearing resistance (kN)										
	End distance	Edge distance	Pitch	Gauge	Thickness in mm of ply										
$d$	$e_1$	$e_2$	$p_1$	$p_2$	5	6	7	8	9	10	12	15	20	25	30
mm	mm	mm	mm	mm											
12	40	25	50	45	53.0	63.7	74.3	84.9	95.5	106.1	127.3	159.1	212.2	265.2	318.3
16	50	30	65	55	69.6	83.6	97.5	111.4	125.3	139.3	167.1	208.9	278.5	348.1	417.8
20	60	35	80	70	85.5	102.5	119.6	136.7	153.8	170.9	205.1	256.4	341.8	427.3	512.7
22	70	40	90	75	100.5	120.6	140.7	160.8	181.0	201.1	241.3	301.6	402.1	502.6	603.2
24	75	40	95	80	108.5	130.2	151.8	173.5	195.2	216.9	260.3	325.4	433.8	542.3	650.8
27	85	45	110	90	119.9	143.8	167.8	191.8	215.7	239.7	287.6	359.6	479.4	599.3	719.1
30	90	50	115	100	128.2	153.8	179.5	205.1	230.7	256.4	307.6	384.5	512.7	640.9	769.1
36	110	60	145	120	159.1	190.9	222.7	254.5	286.3	318.2	381.8	477.2	636.3	795.4	954.5

Checked by CB Structures Ltd

Notes:

Eurocode 3 (in accordance with the UK National Annex) (BS EN 1993-1-8: 2005, BS EN ISO 4014: 2011, BS EN ISO 4017: 2014)

See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners

Values of bearing resistance in green cells are less than the single shear resistance of the bolt

Values of bearing resistance in blue cells are greater than the double shear resistance of the bolt

Bearing values assume standard clearance holes

If oversize or short slotted holes are used, bearing values should be multiplied by 0.8

If long slotted holes are used, bearing values should be multiplied by 0.6

In single lap joints with only one bolt row, the design bearing resistance for each bolt should be limited to  $1.5f_u d t / \gamma_{M2}$



# Bolt resistances: Class 10.9 Standard TCB & TCB Stud:

## Non-preloaded using S460

Diameter of bolt	Tensile stress area	Tension resistance	Shear resistance		Bolts in tension
			Single shear	Double shear	Min. thickness for punching shear
$d$	$A_s$	$F_{t,Rd}$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	$t_{min}$
mm	mm <sup>2</sup>	kN	kN	kN	mm
12	84.3	60.7	28.7	57.3	3.5
16	157	113	62.8	125.6	5.0
20	245	176	98	196	6.4
22	303	218	121	242	7.1
24	353	254	141	282	7.2
27	459	330	184	367	8.3
30	561	404	224	449	9.4
36	817	588	327	654	11.3

Diameter of bolt	Minimum				Bearing resistance (kN)										
	End distance	Edge distance	Pitch	Gauge	Thickness in mm of ply										
$d$	$e_1$	$e_2$	$p_1$	$p_2$	5	6	7	8	9	10	12	15	20	25	30
mm	mm	mm	mm	mm											
12	25	20	35	40	35.4	42.5	49.6	56.7	63.8	70.8	85.0	106.3	141.7	177.1	212.5
16	35	25	50	50	49.9	59.9	69.9	79.9	89.9	99.9	119.9	149.8	199.8	249.7	299.6
20	40	30	60	60	56.5	67.8	79.1	90.4	101.7	113.0	135.6	169.5	225.9	282.4	338.9
22	45	35	65	70	72.1	86.5	100.9	115.4	129.8	144.2	173.0	216.3	288.4	360.5	432.6
24	50	35	70	70	70.0	84.0	98.0	112.1	126.1	140.1	168.1	210.1	280.1	350.2	420.2
27	55	40	80	80	73.8	88.6	103.3	118.1	132.9	147.6	177.1	221.4	295.2	369.1	442.9
30	60	45	85	90	84.7	101.7	118.6	135.6	152.5	169.5	203.3	254.2	338.9	423.6	508.4
36	75	50	105	100	95.9	115.1	134.3	153.5	172.7	191.9	230.3	287.8	383.8	479.7	575.6

Diameter of bolt	Minimum				Bearing resistance (kN)										
	End distance	Edge distance	Pitch	Gauge	Thickness in mm of ply										
$d$	$e_1$	$e_2$	$p_1$	$p_2$	5	6	7	8	9	10	12	15	20	25	30
mm	mm	mm	mm	mm											
12	40	25	50	45	62.1	74.5	86.9	99.3	111.7	124.1	149.0	186.2	248.3	310.4	372.4
16	50	30	65	55	81.5	97.8	114.1	130.4	146.7	163.0	195.6	244.4	325.9	407.4	488.9
20	60	35	80	70	100.0	120.0	140.0	160.0	180.0	200.0	240.0	300.0	400.0	500.0	600.0
22	70	40	90	75	117.6	141.2	164.7	188.2	211.8	235.3	282.3	352.9	470.6	588.2	705.8
24	75	40	95	80	126.9	152.3	177.7	203.1	228.5	253.8	304.6	380.8	507.7	634.6	761.5
27	85	45	110	90	140.3	168.3	196.4	224.4	252.5	280.5	336.6	420.8	561.0	701.3	841.5
30	90	50	115	100	150.0	180.0	210.0	240.0	270.0	300.0	360.0	450.0	600.0	750.0	900.0
36	110	60	145	120	186.2	223.4	260.6	297.8	335.1	372.3	446.8	558.5	744.6	930.8	1116.9

Checked by CB Structures Ltd

Notes:

Eurocode 3 (in accordance with the UK National Annex) (BS EN 1993-1-8: 2005, BS EN ISO 4014: 2011, BS EN ISO 4017: 2014)

See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners

Values of bearing resistance in green cells are less than the single shear resistance of the bolt

Values of bearing resistance in blue cells are greater than the double shear resistance of the bolt

Bearing values assume standard clearance holes

If oversize or short slotted holes are used, bearing values should be multiplied by 0.8

If long slotted holes are used, bearing values should be multiplied by 0.6

In single lap joints with only one bolt row, the design bearing resistance for each bolt should be limited to  $1.5f_u d t / \gamma_{M2}$



## Bolt resistances: Class 10.9 Standard TCB & TCB Stud:

Preloaded at Serviceability Limit State (Category B connection) using S275, S355 and S460

Diameter of bolt	Tensile stress area	Shear resistance		Slip resistance, $F_{s,Rd,ser}$							
		Single shear	Double shear	$\mu = 0.2$		$\mu = 0.3$		$\mu = 0.4$		$\mu = 0.5$	
$d$	$A_s$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	Single shear	Double shear	Single shear	Double shear	Single shear	Double shear	Single shear	Double shear
mm	mm <sup>2</sup>	kN	kN	kN	kN	kN	kN	kN	kN	kN	kN
12	84.3	28.7	57.3	10.7	21.5	16.1	32.2	21.5	42.9	26.8	53.6
16	157	62.8	126	20.0	40.0	30.0	59.9	40.0	79.9	50.0	99.9
20	245	98.0	196	31.2	62.4	46.8	93.5	62.4	124.7	78.0	155.9
22	303	121	242	38.6	77.1	57.8	115.7	77.1	154.3	96.4	192.8
24	353	141	282	44.9	89.9	67.4	134.8	89.9	179.7	112.3	224.6
27	459	183	366	58.4	116.8	87.6	175.3	116.8	233.7	146.0	292.1
30	561	224	449	71.4	142.8	107.1	214.2	142.8	285.6	178.5	357.0
36	817	327	654	104.0	208.0	156.0	311.9	208.0	415.9	260.0	519.9

Checked by CB Structures Ltd

### Notes:

Eurocode 3 (in accordance with the UK National Annex) (BS EN 1993-1-8: 2005, BS EN 14399: 2015, BS EN 1090-2: 2008+A1: 2011, BS EN 1090-3: 2008)

For M12 bolts the design shear resistance  $F_{v,Rd}$  has been calculated as 0.85 times the value given in BS EN 1993-1-8, Table 3.4 (section 3.6.1(5))

See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners

Bearing resistances may be taken from the tables for non-preloaded bolts

The shear resistances are ULS values

The slip resistances are SLS values

Values have been calculated assuming  $k_s = 1$ . See BS EN 1993-1-8, Section 3.9 for other values of  $k_s$

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## Bolt resistances: Class 10.9 Standard TCB & TCB Stud:

Preloaded at Ultimate Limit State (Category C connection) using S275, S355 and S460

Diameter of bolt	Tensile stress area	Shear resistance		Slip resistance, $F_{s,Rd}$							
		Single shear	Double shear	$\mu = 0.2$		$\mu = 0.3$		$\mu = 0.4$		$\mu = 0.5$	
$d$	$A_s$	$F_{v,Rd}$	$2 \times F_{v,Rd}$	Single shear	Double shear	Single shear	Double shear	Single shear	Double shear	Single shear	Double shear
mm	mm <sup>2</sup>	kN	kN	kN	kN	kN	kN	kN	kN	kN	kN
12	84.3	28.7	57.3	9.4	18.9	14.2	28.3	18.9	37.8	23.6	47.2
16	157	62.8	126	17.6	35.2	26.4	52.8	35.2	70.3	44.0	87.9
20	245	98.0	196	27.4	54.9	41.2	82.3	54.9	109.8	68.6	137.2
22	303	121	242	33.9	67.9	50.9	101.8	67.9	135.7	84.8	169.7
24	353	141	282	39.5	79.1	59.3	118.6	79.1	158.1	98.8	197.7
27	459	183	366	51.4	102.8	77.1	154.2	102.8	205.6	128.5	257.0
30	561	224	449	62.8	125.7	94.2	188.5	125.7	251.3	157.1	314.2
36	817	327	654	91.5	183.0	137.3	274.5	183.0	366.0	228.8	457.5

Checked by CB Structures Ltd

### Notes:

Eurocode 3 (in accordance with the UK National Annex) (BS EN 1993-1-8: 2005, BS EN 14399: 2015, BS EN 1090-2: 2008+A1: 2011, BS EN 1090-3: 2008)

For M12 bolts the design shear resistance  $F_{v,Rd}$  has been calculated as 0.85 times the value given in BS EN 1993-1-8, Table 3.4 (section 3.6.1(5))

See clause 3.7(1) of BS EN 1993-1-8: 2005 for calculation of the design resistance of a group of fasteners

Bearing resistances may be taken from the tables for non-preloaded bolts

The shear resistances are ULS values

The slip resistances are ULS values

Values have been calculated assuming  $k_s = 1$ . See BS EN 1993-1-8, Section 3.9 for other values of  $k_s$

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## Bolt resistances: Class 10.9 Standard TCB & TCB Stud: Preloaded in Tension (Category E connection) using S275

Diameter of bolt	Tensile stress area	Tension resistance	Bolts in tension
			Min. thickness for punching shear
$d$	$A_s$	$F_{t,Rd}$	$t_{min}$
mm	mm <sup>2</sup>	kN	mm
12	84.3	60.7	4.7
16	157	113.0	6.8
20	245	176.4	8.6
22	303	218.2	9.5
24	353	254.2	9.6
27	459	330.5	11.2
30	561	403.9	12.6
36	817	588.2	15.2

Checked by CB Structures Ltd

### Notes:

Eurocode 3 (in accordance with the UK National Annex) (BS EN 1993-1-8: 2005, BS EN 14399: 2015, BS EN 1090-2: 2008+A1: 2011, BS EN 1090-3: 2008)

The minimum thickness is such that the design punching shear resistance  $B_{p,Rd}$  is equal to the design tension resistance  $F_{t,Rd}$

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## Bolt resistances: Class 10.9 Standard TCB & TCB Stud: Preloaded in Tension (Category E connection) using S355

Diameter of bolt	Tensile stress area	Tension resistance	Bolts in tension
			Min. thickness for punching shear
$d$	$A_s$	$F_{t,Rd}$	$t_{min}$
mm	mm <sup>2</sup>	kN	mm
12	84.3	60.7	4.1
16	157	113.0	5.9
20	245	176.4	7.5
22	303	218.2	8.3
24	353	254.2	8.4
27	459	330.5	9.7
30	561	403.9	11.0
36	817	588.2	13.3

Checked by CB Structures Ltd

### Notes:

Eurocode 3 (in accordance with the UK National Annex) (BS EN 1993-1-8: 2005, BS EN 14399: 2015, BS EN 1090-2: 2008+A1: 2011, BS EN 1090-3: 2008)

The minimum thickness is such that the design punching shear resistance  $B_{p,Rd}$  is equal to the design tension resistance  $F_{t,Rd}$

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## Bolt resistances: Class 10.9 Standard TCB & TCB Stud: Preloaded in Tension (Category E connection) using S460

Diameter of bolt	Tensile stress area	Tension resistance	Bolts in tension
			Min. thickness for punching shear
$d$	$A_s$	$F_{t,Rd}$	$t_{min}$
mm	mm <sup>2</sup>	kN	mm
12	84.3	60.7	3.5
16	157	113.0	5.0
20	245	176.4	6.4
22	303	218.2	7.1
24	353	254.2	7.2
27	459	330.5	8.3
30	561	403.9	9.4
36	817	588.2	11.3

Checked by CB Structures Ltd

### Notes:

Eurocode 3 (in accordance with the UK National Annex) (BS EN 1993-1-8: 2005, BS EN 14399: 2015, BS EN 1090-2: 2008+A1: 2011, BS EN 1090-3: 2008)

The minimum thickness is such that the design punching shear resistance  $B_{p,Rd}$  is equal to the design tension resistance  $F_{t,Rd}$

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