ENGINEERING SPECIFICATION

TSBWHT Range

Evolution Fasteners (UK) Ltd

Clyde Gateway Trade Park
Dalmarnock Road
Glasgow
G73 1AN

+44 (0) 141 647 7100
technical@evolutionfasteners.co.uk

ENGINEERING SPECIFICATION: TSBWHT Range

0.0 – Contents:

1.0 – Dimensional and metrological properties:

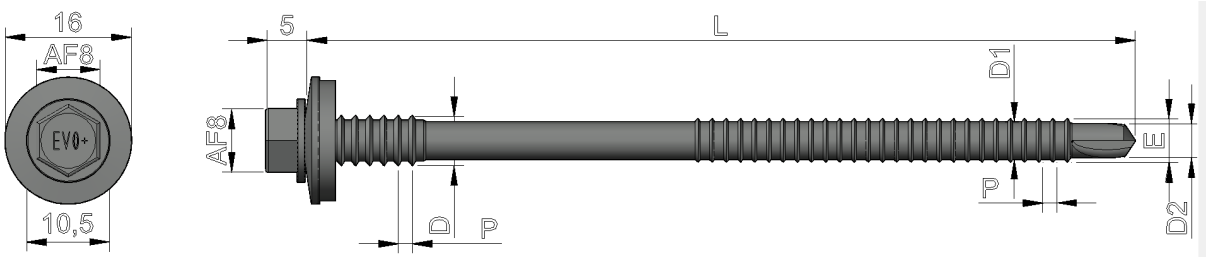


Table 01: Dimensional properties inc. tolerances (in mm)								
SKU[1]	**L**	**S**	**T**	**P**	**D1**	**D2**	**E**	**Washer**
TEK® 3 Products								
TSBWHT5.5-80-3	80.0 ± 1.0	55.50 ± 1.5	7.50 – 9.00	1.81 (14 TPI)	3.99 – 4.17	5.31 – 5.46	4.37 – 4.50	16
TSBWHT5.5-105-3	105.0 ± 1.0							
TSBWHT5.5-115-3	115.0 ± 1.0	75.0 ± 1.5						
TSBWHT5.5-135-3	135.0 ± 1.0							
TSBWHT5.5-150-3	150.0 ± 1.5							
TSBWHT16-5.5-185-3	185.0 ± 1.5							
TSBWHT19-5.5-80-3	80.0 ± 1.5	55.50 ± 1.5						19
TSBWHT19-5.5-105-3	105.0 ± 1.5							
TSBWHT19-5.5-135-3	135.0 ± 1.5	75.0 ± 1.5						
TSBWHT19-5.5-150-3	150.0 ± 1.5							
TSBWHT19-5.5-185-3	185.0 ± 1.5							
TSBWHT19-5.5-225-3	225.0 ± 2.0							
TSBWHT19-5.5-240-3	240.0 ± 2.0							
TSBWHT19-5.5-275-3	275.0 ± 1.5							
TSBWHT19-5.5-300-3	300.0 ± 1.5							
TEK® 5 Products								
TSBWHT5.5-85-5	85.0 ± 1.0	55.50 ± 1.5	14.50 - 15.50	1.06 (24 TPI)	4.70 - 4.75	5.31 – 5.49	4.80 – 5.00	16
TSBWHT5.5-105-5	105.0 ± 1.0							
TSBWHT5.5-125-5	125.0 ± 1.0	75.0 ± 1.5						
TSBWHT5.5-150-5	150.0 ± 1.5							
TSBWHT5.5-185-5	185.0 ± 1.5							19
TSBWHT5.5-235-5	235.0 ± 2.0							

[1] SKU = Stock Keeping Unit (synonymous with "part number").

2.0 – <u>Standard product details</u>:

Table 02: Product Details	
Designed for/ purpose:	Fastening composite panels or brick-tie channels to steel or aluminium[2] structural sections.
Head style and drive:	5/16" hexagonal (male) socket with flange.
Thread form:	TEK® 3 SKUs = Coarse (1.80mm pitch), TEK® 5 SKUs = Fine (1.06mm or 1.27mm pitch).
Material type and grade:	SAE C1022 Carbon Steel (Hardened ≥ 55 HRC).
Coating and corrosion resistance:	1. EvoShield® 500 proprietary ceramic coating, 2. ≥ 500 Hour corrosion resistance (when tested in 5% NaCl accelerated corrosion test as per BS EN ISO 9227). 3. For use in atmospheric corrosivity categories of C3 (limited), C2 and C1 as per BS EN ISO 12994-2 and BS EN ISO 9223.
Washer details[3]:	Compression disc = 1.0mm thick galvanised steel (16mm OD & 7.6mm ID), Gasket = 2.0mm thick EPDM (Ethylene propylene diene monomer).

NOTE: Readers should always check the Evolution Fasteners (UK) Ltd website[4] for the latest version of this document.

3.0 - <u>Installation instructions</u>[5]:

NOTE: Failure to abide by these instructions may void any warranty provided by Evolution Fasteners (UK) Ltd. This document does not alleviate the user, designer or any other party from their respective obligations under the terms of the Warranty[6]. **The use of impact tooling voids the Warranty.**

1. Clear installation area of dirt and debris and ensure that there are no other contaminating substances (i.e. oil, grease, etc),

2. Using a non-impacting TEK screwdriver (such as Makita FS2500), insert the screw into the fixture and substrate material perpendicularly (± 5˚ from the normal) using not greater than 1,500 RPM and a steady pressure on the tooling only (do not force the tool, allow the screw to cut),

[2] The data presented in the document relates only to common steel grades in the UK, if you require information for mechanical performance in aluminium alloys, please contact the Evolution Technical Department,
[3] Only relates to products prefixed with BMBW,
[4] Latest versions can be found at http://www.evolutionfasteners.co.uk,
[5] Video instructions available on our YouTube™ channel (Evolution Technical Services and Laboratory),
[6] For further information, refer to the Evolution Product Warranty document hosted on our website.

3. Stop inserting the screw once the underside of the flange makes contact with the topside of the fixture material for non-washered screws. For washered screws continue inserting until the compression disc of the washer changes from convex to flat. There should be no torque applied to the fasteners post-installation.

4.0 – <u>General mechanical properties of the screws</u>:

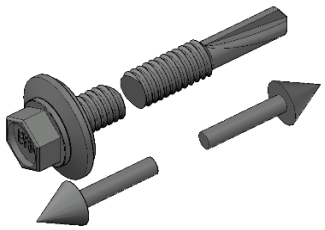
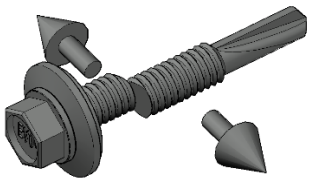
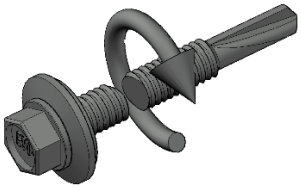
Mechanical Properties of Screws		
		
Tensile Capacity	**Shear Capacity**	**Torque Capacity**

Table 03: Mechanical Properties for C1022 Carbon Steel Screws[7]

Parameter	Symbol	Unit	Nominal Diameter/ TEK® Point				
			4.8mm TEK® 3	5.5mm TEK® 3	6.3mm TEK® 3	5.5mm TEK® 5	6.3mm TEK® 5
Material yield strength[8]	f_y	N/mm²	970				
Ultimate tensile strength[9]	R_m	N/mm²	1,220				
Maximum force at elastic limit	F_{eH}	N	8,960	12,120	16,820	15,840	17,620
Ultimate force at plastic limit	F_m	N	11,270	15,250	21,160	19,920	22,160
Cross-sectional area	S_0	mm²	9.24	12.50	17.35	16.33	18.17
Young's modulus of elasticity	E	N/mm²	203,000				
Elastic section modulus	W_{eL}	mm³	4.14	6.14	7.03	9.56	10.95
Bending moment capacity	$M_{c,Rd}$	Nm	2.97	4.76	5.47	7.42	8.53
Lateral-torsional buckling resistance	$M_{b,Rd}$	Nm	1.38	2.05	2.36	3.19	3.67
Polar moment of inertia	J	mm⁴	14.40	24.87	28.60	43.93	50.52
Modulus of rigidity/ Shear modulus[10]	G	N/mm²	80,000				
Ultimate force at shear failure[11]	V_m	N	5,530	7,270	8,360	9,670	11,120
Ultimate torsional strength[12]	τ_m	Nm	14.56	15.12	17.39	16.68	19.18

[7] $X_{st,m} = \left(\left({\sum X_{st,m}}/{X_n} \right) - 2 \cdot \sigma \right)$, rounded down to nearest 10 N,

[8] Derived from empirical testing performed to BS EN ISO 6892-1 (for the purposes of this document, $f_y = R_{eH}$),

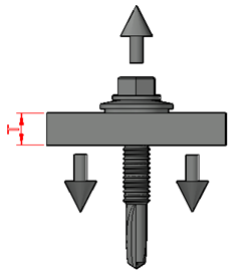
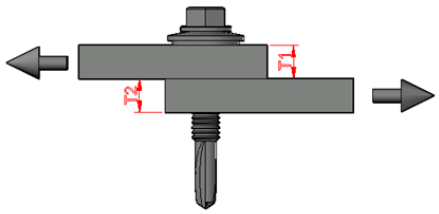
[9] Derived from empirical testing performed to BS EN ISO 6892-1,

[10] As specified in ASTM A240/ A240M,

[11] Derived from empirical testing performed to MIL-STD-1312,

[12] Derived from empirical testing performed to BS EN ISO 10666.

5.0 – <u>Mechanical performance of the screws in various substrates</u>:

Mechanical Properties of Substrate	
	
Withdrawal Resistance	**Lap-shearing Resistance**

IMPORTANT NOTICE:

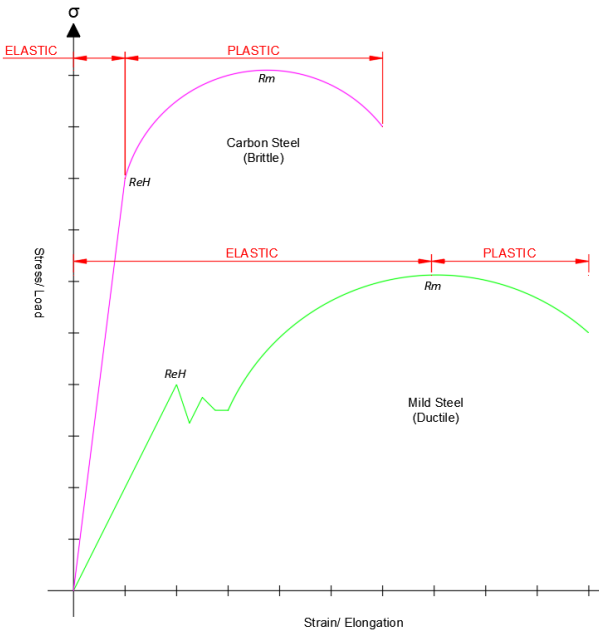
In the following tables, there are two values supplied for each grade of steel at a given thickness, *t*, these values refer to:

Non-bracketed values	=	Load where the substrate reaches upper yield strength,
[Square-bracketed] values	=	Load where the substrate reaches ultimate tensile strength,
"Yield"	=	Load where the fastener reaches upper yield strength (see table 03),
"Ultimate"	=	Load where the fastener reaches ultimate tensile strength (see table 03).

It is recommended by Evolution Fasteners (UK) Ltd that designers ensure that the screws remain in their elastic phase and as such limit themselves to F_{eH} as per Table 03.

Users of this document should be aware that they have to consider the fact that the mechanical properties of the screws and the substrate they are being used in are very different. An example stress/ strain graph is included to the side (indicative use only) to illustrate typical stress/ strain patterns in various steel types.

Carbon steel is generally more brittle and higher tensile strength than either mild or austenitic stainless steels: which are more ductile and lower tensile strength.



5.1 - Hot-rolled mild structural steel (as per BS EN 10025-1):

5.1.1 – 4.8mm diameter products:

5.1.1.1 - TEK® 3 products:

5.1.1.1.1 – Withdrawal resistance:

Table 04: Characteristic withdrawal resistance[13,14] of TEK® 3 products (of 4.8mm nominal diameter) from hot-rolled mild structural steels[15] (in Newtons)

Grade	Substrate thickness, *t*						
	1.2mm	1.5mm	2.0mm	2.5mm	3.0mm	4.0mm	5.0mm
S235JR	700 [1,080]	880 [1,350]	1,170 [1,800]	1,470 [2,250]	1,760 [2,700]	2,350 [3,600]	2,940 [4,510]
S275JR	820 [1,230]	1,030 [1,540]	1,370 [2,050]	1,720 [2,560]	2,060 [3,080]	2,750 [4,100]	3,440 [5,130]
S355JR	1,060 [1,410]	1,330 [1,760]	1,770 [2,350]	2,220 [2,940]	2,660 [3,530]	3,550 [4,710]	4,440 [5,880]
S450J0	1,290 [1,650]	1,610 [2,060]	2,150 [2,750]	2,690 [3,440]	3,230 [4,130]	4,310 [5,510]	5,380 [6,890]
E295	880 [1,470]	1,100 [1,840]	1,470 [2,450]	1,840 [3,060]	2,210 [3,680]	2,950 [4,910]	3,690 [6,130]

[13] Values without brackets refer to characteristic value at R_{eH} of substrate and values in [brackets] refer to characteristic value at R_m of substrate (tested in accordance with BS EN ISO 6892-1), rounded down to nearest 10 N,

[14] Derived from empirical tests as per BS EN 14566: 2008 & A1: 2012,

[15] Conforming to BS EN 10025-1,

E335	1,000 [1,770]	1,250 [2,210]	1,670 [2,950]	2,090 [3,690]	2,510 [4,430]	3,350 [5,910]	4,190 [7,390]
E360	1,080 [2,070]	1,350 [2,590]	1,800 [3,450]	2,250 [4,320]	2,700 [5,180]	2,600 [6,910]	4,510 [8,640]

The loads presented without brackets relate to the failure point when the female thread cut in the substrate reaches its' elastic limit (i.e. past that point the substrate is plastic).

The loads presented with square brackets relate to the failure point when the female thread cut in the substrate reaches its' plastic limit (i.e. the maximum load the substrate can achieve before it fails).

It is important to note that in all cases in Table 04, the fastener itself **does not fail**. Rather, it is the substrate which fails around the fastener.

5.1.1.1.2 – <u>Lap-shearing resistance</u>:

Table 05: Characteristic lap-shearing resistance[16,17] of TEK® 3 products (of 4.8mm nominal diameter) from hot-rolled mild structural steels[16] (in Newtons)

Grade	Substrate thickness, *t*						
	1.2mm	**1.5mm**	**2.0mm**	**2.5mm**	**3.0mm**	**4.0mm**	**5.0mm**
S235JR	420 [640]	530 [810]	700 [1,080]	880 [1,350]	1,060 [1,620]	1,410 [2,160]	1,760 [2,700]
S275JR	490 [740]	620 [920]	820 [1,230]	1,030 [1,540]	1,240 [1,840]	1,650 [2,460]	2,060 [3,080]
S355JR	640 [840]	800 [1,060]	1,060 [1,410]	1,330 [1,760]	1,600 [2,120]	2,130 [2,820]	2,660 [3,530]
S450J0	770 [990]	970 [1,240]	1,290 [1,650]	1,610 [2,060]	1,930 [2,480]	2,580 [3,300]	3,230 [4,130]
E295	530 [880]	660 [1,100]	880 [1,470]	1,100 [1,840]	1,330 [2,210]	1,770 [2,940]	2,210 [3,680]
E335	600 [1,060]	750 [1,330]	1,000 [1,770]	1,250 [2,210]	1,510 [2,660]	2,010 [3,540]	2,510 [4,430]
E360	640 [1,240]	810 [1,550]	1,080 [2,070]	1,350 [2,590]	1,620 [3,110]	2,160 [4,140]	2,700 [5,180]

[16] Values without brackets refer to characteristic value at R_{eH} of substrate and values in [brackets] refer to characteristic value at R_m of substrate (tested in accordance with BS EN ISO 6892-1), rounded down to nearest 10 N,

[17] Derived from empirical tests as per EAD No. 330046-01-0602 (as published by EOTA – European Organisation for Technical Approvals),

The loads presented without brackets relate to the failure point when the female thread cut in the substrate reaches its' elastic limit (i.e. past that point the substrate is plastic).

The loads presented with square brackets relate to the failure point when the female thread cut in the substrate reaches its' plastic limit (i.e. the maximum load the substrate can achieve before it fails).

It is important to note that in all cases in Table 05, the fastener itself **does not fail**. Rather, it is the substrate which fails around the fastener.

5.1.2 – 5.5mm diameter products:

5.1.2.1 - TEK® 3 products:

5.1.2.1.1 – Withdrawal resistance:

Table 06: Characteristic withdrawal resistance of TEK® 3 products (of 5.5mm nominal diameter) from hot-rolled mild structural steels[18] (in Newtons)

Grade	Substrate thickness, *t*						
	1.2mm	**1.5mm**	**2.0mm**	**2.5mm**	**3.0mm**	**4.0mm**	**5.0mm**
S235JR	970 [1,490]	1,220 [1,870]	1,620 [2,490]	2,030 [3,120]	2,440 [3,740]	3,250 [4,990]	4,070 [6,240]
S275JR	1,140 [1,700]	1,430 [2,130]	1,900 [2,840]	2,380 [3,550]	2,860 [4,260]	3,810 [5,680]	4,760 [7,100]
S355JR	1,470 [1,950]	1,840 [2,440]	2,460 [3,250]	3,070 [4,070]	3,690 [4,880]	4,920 [6,510]	6,150 [8,140]
S450J0	1,780 [2,280]	2,230 [2,860]	2,980 [3,810]	3,720 [4,760]	4,470 [5,270]	5,960 [7,620]	7,450 [9,530]
E295	1,220 [2,030]	1,530 [2,540]	2,040 [3,390]	2,550 [4,240]	3,060 [5,090]	4,090 [6,790]	5,110 [8,490]
E335	1,390 [2,450]	1,740 [3,060]	2,320 [4,090]	2,900 [5,110]	3,480 [6,130]	4,640 [8,180]	5,800 [10,220]
E360	1,490 [2,870]	1,870 [3,580]	2,490 [4,780]	3,120 [5,980]	3,740 [7,170]	4,990 [9,560]	6,240 [Ultimate[19]]

[18] Conforming to BS EN 10025-1,

[19] "Ultimate" refers to the fact the screw fails in ultimate tensile strength as opposed to the substrate failing,

The loads presented without brackets relate to the failure point when the female thread cut in the substrate reaches its' elastic limit (i.e. past that point the substrate is plastic).

The loads presented with square brackets relate to the failure point when the female thread cut in the substrate reaches its' plastic limit (i.e. the maximum load the substrate can achieve before it fails).

It is important to note that in all cases in Table 05, the fastener itself **does not fail**. Rather, it is the substrate which fails around the fastener. The exception to this is where the word "ultimate" is used. In this instance the fastener itself fails in tension and the "*ultimate force at plastic limit, F_m*" from Table 03 (page 04) should be used.

5.1.2.1.1 – <u>Lap-shearing resistance</u>:

Table 07: Characteristic lap-shearing resistance of TEK® 3 products (of 5.5mm nominal diameter) from hot-rolled mild structural steels[16] (in Newtons)

Grade	Substrate thickness, *t*						
	1.2mm	**1.5mm**	**2.0mm**	**2.5mm**	**3.0mm**	**4.0mm**	**5.0mm**
S235JR	580 [890]	730 [1,120]	970 [1,490]	1,220 [1,870]	1,460 [2,240]	1,950 [2,990]	2,440 [3,740]
S275JR	680 [1,020]	850 [1,270]	1,140 [1,700]	1,430 [2,130]	1,710 [2,550]	2,280 [3,410]	2,860 [4,260]
S355JR	880 [1,170]	1,100 [1,460]	1,470 [1,950]	1,840 [2,440]	2,210 [2,930]	2,950 [3,910]	3,690 [4,880]
S450J0	1,070 [1,370]	1,340 [1,710]	1,780 [2,280]	2,230 [2,860]	2,680 [3,430]	3,570 [4,570]	4,470 [5,720]
E295	730 [1,220]	920 [1,520]	1,220 [2,030]	1,530 [2,540]	1,840 [3,050]	2,450 [4,070]	3,060 [5,090]
E335	830 [1,470]	1,040 [1,840]	1,390 [2,450]	1,740 [3,060]	2,090 [3,580]	2,780 [4,900]	3,480 [6,130]
E360	890 [1,720]	1,120 [2,150]	1,490 [2,870]	1,870 [3,580]	2,240 [4,300]	2,990 [5,740]	3,740 [7,170]

The loads presented without brackets relate to the failure point when the female thread cut in the substrate reaches its' elastic limit (i.e. past that point the substrate is plastic).

The loads presented with square brackets relate to the failure point when the female thread cut in the substrate reaches its' plastic limit (i.e. the maximum load the substrate can achieve before it fails).

It is important to note that in all cases in Table 07, the fastener itself **does not fail**. Rather, it is the substrate which fails around the fastener.

5.1.2.2 - TEK® 5 products:

5.1.2.2.1 – Withdrawal resistance:

Table 08: Characteristic withdrawal resistance of TEK® 5 products (of 5.5mm nominal diameter) from hot-rolled mild structural steels (in Newtons)

Grade	Substrate thickness, *t*				
	4.0mm	**5.0mm**	**8.0mm**	**10.0mm**	**12.5mm**
S235JR	2,220 [3,410]	2,780 [4,260]	4,450 [6,820]	5,560 [8,520]	6,950 [10,650]
S275JR	2,600 [3,880]	3,250 [4,850]	5,200 [7,760]	6,510 [9,700]	8,140 [12,130]
S355JR	3,360 [4,450]	4,200 [5,560]	6,720 [8,900]	8,400 [11,120]	10,500 [13,910]
S450J0	4,070 [5,200]	5,090 [6,510]	8,140 [10,410]	10,180 [13,020]	12,720 [16,270]
E295	2,790 [4,640]	3,490 [5,800]	5,580 [9,280]	6,980 [11,600]	8,730 [14,500]
E335	3,170 [5,580]	3,960 [6,980]	6,340 [11,170]	7,930 [13,970]	9,910 [17,460]
E360	3,410 [6,530]	4,260 [8,160]	6,820 [13,070]	8,520 [16,330]	10,650 [Ultimate]

The loads presented without brackets relate to the failure point when the female thread cut in the substrate reaches its' elastic limit (i.e. past that point the substrate is plastic).

The loads presented with square brackets relate to the failure point when the female thread cut in the substrate reaches its' plastic limit (i.e. the maximum load the substrate can achieve before it fails).

It is important to note that in all cases in Table 08, the fastener itself **does not fail**. Rather, it is the substrate which fails around the fastener. The exception to this is where the word "ultimate" is used. In this instance the fastener itself fails in tension and the "*ultimate force at plastic limit, F_m*" from Table 03 (page 04) should be used.

5.1.2.2.2 – <u>Lap-shearing resistance</u>:

Table 09: Characteristic lap-shearing resistance of TEK® 5 products (of 5.5mm nominal diameter) from hot-rolled mild structural steels (in Newtons)					
Grade	**Substrate thickness, *t***				
	4.0mm	**5.0mm**	**8.0mm**	**10.0mm**	**12.5mm**
S235JR	1,330 [2,040]	1,660 [2,550]	2,670 [4,090]	3,330 [5,110]	4,170 [6,390]
S275JR	1,560 [2,330]	1,950 [2,910]	3,120 [4,660]	3,900 [5,820]	4,880 [7,280]
S355JR	2,010 [2,670]	2,520 [3,330]	4,030 [5,340]	5,040 [6,670]	6,300 [8,340]
S450J0	2,440 [3,120]	3,050 [3,900]	4,880 [6,250]	6,100 [7,810]	7,630 [Ultimate]
E295	1,670 [2,780]	2,090 [3,480]	3,350 [5,560]	4,190 [6,960]	5,230 [8,700]
E335	1,900 [3,350]	2,380 [4,190]	3,800 [6,700]	4,760 [8,380]	5,940 [Ultimate]
E360	2,040 [3,920]	2,550 [4,900]	4,090 [7,840]	5,110 [Ultimate]	6,390 [Ultimate]

The loads presented without brackets relate to the failure point when the female thread cut in the substrate reaches its' elastic limit (i.e. past that point the substrate is plastic).

The loads presented with square brackets relate to the failure point when the female thread cut in the substrate reaches its' plastic limit (i.e. the maximum load the substrate can achieve before it fails).

It is important to note that in all cases in Table 09, the fastener itself **does not fail**. Rather, it is the substrate which fails around the fastener. The exception to this is where the word "ultimate" is used. In this instance the fastener itself fails in tension and the "*ultimate force at shear failure, V_m*" from Table 03 (page 04) should be used.

5.1.3 – 6.3mm diameter products:

5.1.3.1 - TEK® 3 products:

5.1.3.1.1 – Withdrawal resistance

Table 10: Characteristic withdrawal resistance of TEK® 3 products (of 6.3mm nominal diameter) from hot-rolled mild structural steels[20] (in Newtons)							
Grade	**Substrate thickness, *t***						
	1.2mm	**1.5mm**	**2.0mm**	**2.5mm**	**3.0mm**	**4.0mm**	**5.0mm**
S235JR	680 [1,040]	850 [1,300]	1,130 [1,730]	1,410 [2,170]	1,700 [2,600]	2,270 [3,470]	2,830 [4,340]
S275JR	790 [1,180]	990 [1,480]	1,320 [1,980]	1,660 [2,470]	1,990 [2,970]	2,650 [3,960]	3,320 [4,940]
S355JR	1,020 [1,360]	1,280 [1,700]	1,710 [2,270]	2,140 [2,830]	2,570 [3,400]	3,420 [4,530]	4,280 [5,670]
S450J0	1,240 [1,590]	1,550 [1,990]	2,070 [2,650]	2,590 [3,320]	3,110 [3,980]	4,150 [5,310]	5,190 [6,640]
E295	850 [1,420]	1,060 [1,770]	1,420 [2,360]	1,780 [2,950]	2,130 [3,540]	2,840 [4,730]	3,560 [5,910]
E335	970 [1,700]	1,210 [2,130]	1,610 [2,840]	2,020 [3,560]	2,420 [4,270]	3,230 [5,690]	4,040 [7,120]

[20] Conforming to BS EN 10025-1,

E360	1,040 [1,990]	1,300 [2,490]	1,730 [3,330]	2,170 [4,160]	2,600 [4,990]	3,470 [6,660]	4,340 [8,330]

The loads presented without brackets relate to the failure point when the female thread cut in the substrate reaches its' elastic limit (i.e. past that point the substrate is plastic).

The loads presented with square brackets relate to the failure point when the female thread cut in the substrate reaches its' plastic limit (i.e. the maximum load the substrate can achieve before it fails).

It is important to note that in all cases in Table 10, the fastener itself **does not fail**. Rather, it is the substrate which fails around the fastener.

5.1.3.1.2 – Lap-shearing resistance:

Table 11: Characteristic lap-shearing resistance of TEK® 3 products (of 6.3mm nominal diameter) from hot-rolled mild structural steels[16] (in Newtons)

Grade	Substrate thickness, *t*						
	1.2mm	**1.5mm**	**2.0mm**	**2.5mm**	**3.0mm**	**4.0mm**	**5.0mm**
S235JR	400 [620]	510 [780]	680 [1,040]	850 [1,300]	1,020 [1,560]	1,360 [2,080]	1,700 [2,600]
S275JR	470 [710]	590 [890]	790 [1,180]	990 [1,480]	1,190 [1,780]	1,590 [2,370]	1,990 [2,970]
S355JR	610 [810]	770 [1,020]	1,020 [1,360]	1,280 [1,700]	1,540 [2,040]	2,050 [2,720]	2,570 [3,400]
S450J0	740 [950]	930 [1,190]	1,240 [1,590]	1,550 [1,990]	1,860 [2,390]	2,490 [3,180]	3,110 [3,980]
E295	510 [850]	640 [1,060]	850 [1,420]	1,060 [1,770]	1,280 [2,120]	1,700 [2,830]	2,130 [3,540]
E335	580 [1,020]	720 [1,280]	970 [1,700]	1,210 [2,130]	1,450 [2,560]	1,940 [3,410]	2,420 [4,270]
E360	620 [1,190]	780 [1,490]	1,040 [1,990]	1,300 [2,490]	1,560 [2,990]	2,080 [3,990]	2,600 [4,990]

The loads presented without brackets relate to the failure point when the female thread cut in the substrate reaches its' elastic limit (i.e. past that point the substrate is plastic).

The loads presented with square brackets relate to the failure point when the female thread cut in the substrate reaches its' plastic limit (i.e. the maximum load the substrate can achieve before it fails).

It is important to note that in all cases in Table 11, the fastener itself **does not fail**. Rather, it is the substrate which fails around the fastener.

5.1.3.2 – TEK® 5 products:

5.1.3.2.1 – Withdrawal resistance:

Table 11: Characteristic withdrawal resistance of TEK® 5 products (of 6.3mm nominal diameter) from hot-rolled mild structural steels (in Newtons)					
Grade	**Substrate thickness, *t***				
	4.0mm	**5.0mm**	**8.0mm**	**10.0mm**	**12.5mm**
S235JR	1,890 [2,900]	2,360 [3,620]	3,790 [5,800]	4,730 [7,250]	5,920 [9,070]
S275JR	2,210 [3,300]	2,770 [4,130]	4,430 [6,610]	5,540 [8,260]	6,920 [10,330]
S355JR	2,860 [3,790]	3,570 [4,730]	5,720 [7,570]	7,150 [9,470]	8,940 [11,840]
S450J0	3,460 [4,430]	4,330 [5,540]	6,930 [8,860]	8,660 [11,080]	10,830 [13,850]
E295	2,370 [3,950]	2,970 [4,930]	4,750 [7,900]	5,940 [9,870]	7,430 [12,340]
E335	2,700 [4,750]	3,370 [5,940]	5,400 [9,510]	6,750 [11,890]	8,440 [14,860]
E360	2,900 [5,560]	3,620 [6,950]	5,800 [11,120]	7,250 [13,900]	9,070 [17,380]

The loads presented without brackets relate to the failure point when the female thread cut in the substrate reaches its' elastic limit (i.e. past that point the substrate is plastic).

The loads presented with square brackets relate to the failure point when the female thread cut in the substrate reaches its' plastic limit (i.e. the maximum load the substrate can achieve before it fails).

It is important to note that in all cases in Table 11, the fastener itself **does not fail**. Rather, it is the substrate which fails around the fastener.

5.1.3.2.2 – Lap-shearing resistance:

Table 12: Characteristic lap-shearing resistance of TEK® 5 products (of 6.3mm nominal diameter) from hot-rolled mild structural steels (in Newtons)

Grade	Substrate thickness, *t*				
	4.0mm	**5.0mm**	**8.0mm**	**10.0mm**	**12.5mm**
S235JR	1,130 [1,740]	1,420 [2,170]	2,270 [3,480]	2,840 [4,350]	3,550 [5,440]
S275JR	1,330 [1,980]	1,660 [2,470]	2,660 [3,960]	3,320 [4,950]	4,150 [6,190]
S355JR	1,710 [2,270]	2,140 [2,840]	3,430 [4,540]	4,290 [5,680]	5,360 [7,100]
S450J0	2,080 [2,660]	2,600 [3,320]	4,160 [5,320]	5,200 [6,650]	6,500 [8,310]
E295	1,420 [2,370]	1,780 [2,960]	2,850 [4,740]	3,560 [5,920]	4,460 [7,400]
E335	1,620 [2,850]	2,020 [3,560]	3,240 [5,700]	4,050 [7,130]	5,060 [8,920]
E360	1,740 [3,330]	2,170 [4,170]	3,480 [6,670]	4,350 [8,340]	5,440 [10,430]

The loads presented without brackets relate to the failure point when the female thread cut in the substrate reaches its' elastic limit (i.e. past that point the substrate is plastic).

The loads presented with square brackets relate to the failure point when the female thread cut in the substrate reaches its' plastic limit (i.e. the maximum load the substrate can achieve before it fails).

It is important to note that in all cases in Table 12, the fastener itself **does not fail**. Rather, it is the substrate which fails around the fastener.

5.2 – Cold-rolled mild structural steel (as per BS EN 10346):

5.2.1 - TEK® 3 products:

5.2.1.1 – 4.8mm diameter products:

5.2.1.1.1 – Withdrawal resistance:

Table 13: Characteristic withdrawal resistance of TEK® 3 products (of 4.8mm nominal diameter) from cold-rolled mild structural steels[21](in Newtons)							
Grade	**Substrate thickness, *t***						
	1.2mm	**1.5mm**	**2.0mm**	**2.5mm**	**3.0mm**	**4.0mm**	**5.0mm**
DX52D	650 [1,030]	820 [1,280]	1,090 [1,710]	1,370 [2,140]	1,640 [2,570]	2,190 [3,430]	2,740 [4,290]
DX54D	500 [910]	630 [1,140]	840 [1,520]	1,050 [1,900]	1,270 [2,280]	1,690 [3,040]	2,110 [3,800]
DX56D	440 [890]	560 [1,120]	740 [1,490]	930 [1,860]	1,120 [2,240]	1,490 [2,990]	1,860 [3,730]
S220GD	650 [900]	820 [1,130]	1,090 [1,500]	1,370 [1,870]	1,640 [2,250]	2,190 [3,000]	2,740 [3,740]
S280GD	830 [1,070]	1,040 [1,340]	1,390 [1,790]	1,740 [2,240]	2,090 [2,690]	2,790 [3,580]	3,480 [4,480]
S320GD	950	1,190	1,590	1,990	2,390	3,180	3,980

[21] Conforming to BS EN 10346.

	[1,160]	[1,450]	[1,940]	[2,420]	[2,910]	[3,880]	[4,850]
S350GD	1,040 [1,250]	1,300 [1,570]	1,740 [2,090]	2,180 [2,610]	2,610 [3,140]	3,480 [4,180]	4,360 [5,230]

The loads presented without brackets relate to the failure point when the female thread cut in the substrate reaches its' elastic limit (i.e. past that point the substrate is plastic).

The loads presented with square brackets relate to the failure point when the female thread cut in the substrate reaches its' plastic limit (i.e. the maximum load the substrate can achieve before it fails).

It is important to note that in all cases in Table 13, the fastener itself **does not fail**. Rather, it is the substrate which fails around the fastener.

5.2.1.1.2 – Lap-shearing resistance:

Table 14: Characteristic lap-shearing resistance of TEK® 3 products (of 4.8mm nominal diameter) from cold-rolled mild structural steels (in Newtons)

Grade	Substrate thickness, *t*						
	1.2mm	**1.5mm**	**2.0mm**	**2.5mm**	**3.0mm**	**4.0mm**	**5.0mm**
DX52D	390 [610]	490 [770]	650 [1,030]	820 [1,280]	980 [1,540]	1,310 [2,060]	1,640 [2,570]
DX54D	300 [540]	380 [680]	500 [910]	630 [1,140]	760 [1,360]	1,010 [1,820]	1,270 [2,280]
DX56D	260 [530]	330 [670]	440 [890]	560 [1,120]	670 [1,340]	890 [1,790]	1,120 [2,240]
S220GD	390 [540]	490 [680]	650 [900]	820 [1,130]	980 [1,350]	1,310 [1,800]	1,640 [2,250]
S280GD	500 [640]	620 [800]	830 [1,070]	1,040 [1,340]	1,250 [1,610]	1,670 [2,150]	2,090 [2,690]
S320GD	570 [700]	710 [870]	950 [1,160]	1,190 [1,450]	1,430 [1,740]	1,910 [2,330]	2,390 [2,910]
S350GD	620 [750]	780 [940]	1,040 [1,250]	1,300 [1,570]	1,570 [1,880]	2,090 [2,510]	2,610 [3,140]

The loads presented without brackets relate to the failure point when the female thread cut in the substrate reaches its' elastic limit (i.e. past that point the substrate is plastic).

The loads presented with square brackets relate to the failure point when the female thread cut in the substrate reaches its' plastic limit (i.e. the maximum load the substrate can achieve before it fails).

It is important to note that in all cases in Table 14, the fastener itself **does not fail**. Rather, it is the substrate which fails around the fastener.

5.2.1.2 – 5.5mm diameter products:

5.2.1.2.1 – Withdrawal resistance:

Table 15: Characteristic withdrawal resistance of TEK® 3 products (of 5.5mm nominal diameter) from cold-rolled mild structural steels[22](in Newtons)							
Grade	**Substrate thickness, *t***						
	1.2mm	**1.5mm**	**2.0mm**	**2.5mm**	**3.0mm**	**4.0mm**	**5.0mm**
DX52D	910 [1,420]	1,130 [1,780]	1,510 [2,370]	1,890 [2,970]	2,270 [3,560]	3,030 [4,750]	3,790 [5,940]
DX54D	700 [1,260]	870 [1,570]	1,170 [2,100]	1,460 [2,620]	1,750 [3,150]	2,340 [4,200]	2,930 [5,250]
DX56D	620 [1,240]	770 [1,550]	1,030 [2,060]	1,290 [2,580]	1,550 [3,100]	2,060 [4,130]	2,580 [5,170]
S220GD	910 [1,250]	1,130 [1,560]	1,510 [2,070]	1,890 [2,590]	2,270 [3,110]	3,030 [4,140]	3,790 [5,180]
S280GD	1,150 [1,480]	1,440 [1,860]	1,930 [2,480]	2,410 [3,100]	2,890 [3,720]	3,860 [4,960]	4,820 [6,200]
S320GD	1,320 [1,610]	1,650 [2,010]	2,200 [2,680]	2,750 [3,360]	3,310 [4,030]	4,410 [5,370]	5,510 [6,720]
S350GD	1,440 [1,730]	1,810 [2,170]	2,410 [2,890]	3,010 [3,620]	3,620 [4,340]	4,820 [5,790]	6,030 [7,240]

[22] Conforming to BS EN 10346.

The loads presented without brackets relate to the failure point when the female thread cut in the substrate reaches its' elastic limit (i.e. past that point the substrate is plastic).

The loads presented with square brackets relate to the failure point when the female thread cut in the substrate reaches its' plastic limit (i.e. the maximum load the substrate can achieve before it fails).

It is important to note that in all cases in Table 15, the fastener itself **does not fail**. Rather, it is the substrate which fails around the fastener.

5.2.1.2.2 – Lap-shearing resistance:

Table 16: Characteristic lap-shearing resistance of TEK® 3 products (of 5.5mm nominal diameter) from cold-rolled mild structural steels (in Newtons)

Grade	Substrate thickness, *t*						
	1.2mm	**1.5mm**	**2.0mm**	**2.5mm**	**3.0mm**	**4.0mm**	**5.0mm**
DX52D	540 [850]	680 [1,070]	910 [1,420]	1,130 [1,780]	1,360 [2,140]	1,820 [2,850]	2,270 [3,560]
DX54D	420 [750]	520 [940]	700 [1,260]	870 [1,570]	1,050 [1,890]	1,400 [2,520]	1,750 [3,150]
DX56D	370 [740]	460 [930]	620 [1,240]	770 [1,550]	930 [1,860]	1,240 [2,480]	1,550 [3,100]
S220GD	540 [750]	680 [940]	910 [1,250]	1,130 [1,560]	1,360 [1,870]	1,820 [2,490]	2,270 [3,110]
S280GD	690 [890]	860 [1,110]	1,150 [1,480]	1,440 [1,860]	1,730 [2,230]	2,310 [2,970]	2,890 [3,720]
S320GD	790 [960]	990 [1,210]	1,320 [1,610]	1,650 [2,010]	1,980 [2,420]	2,640 [3,220]	3,310 [4,030]
S350GD	860 [1,040]	1,080 [1,300]	1,440 [1,730]	1,810 [2,170]	2,170 [2,600]	2,890 [3,470]	3,620 [4,340]

The loads presented without brackets relate to the failure point when the female thread cut in the substrate reaches its' elastic limit (i.e. past that point the substrate is plastic).

The loads presented with square brackets relate to the failure point when the female thread cut in the substrate reaches its' plastic limit (i.e. the maximum load the substrate can achieve before it fails).

It is important to note that in all cases in Table 16, the fastener itself **does not fail**. Rather, it is the substrate which fails around the fastener.

5.2.1.3 – 6.3mm diameter products:

5.2.1.3.1 – Withdrawal resistance:

Table 17: Characteristic withdrawal resistance of TEK® 3 products (of 6.3mm nominal diameter) from cold-rolled mild structural steels[23](in Newtons)

Grade	Substrate thickness, *t*						
	1.2mm	1.5mm	2.0mm	2.5mm	3.0mm	4.0mm	5.0mm
DX52D	630 [1,000]	790 [1,240]	1,060 [1,660]	1,320 [2,080]	1,590 [2,490]	2,120 [3,330]	2,650 [4,160]
DX54D	490 [880]	610 [1,100]	820 [1,470]	1,020 [1,840]	1,230 [2,200]	1,640 [2,940]	2,050 [3,680]
DX56D	430 [860]	540 [1,080]	720 [1,440]	900 [1,810]	1,080 [2,170]	1,440 [2,890]	1,810 [3,620]
S220GD	630 [870]	790 [1,090]	1,060 [1,450]	1,320 [1,820]	1,590 [2,180]	2,120 [2,900]	2,650 [3,630]
S280GD	810 [1,040]	1,010 [1,300]	1,350 [1,730]	1,690 [2,170]	2,020 [2,600]	2,700 [3,470]	3,380 [4,340]
S320GD	920 [1,130]	1,150 [1,410]	1,540 [1,880]	1,930 [2,350]	2,310 [2,820]	3,090 [3,760]	3,860 [4,700]
S350GD	1,010 [1,210]	1,260 [1,520]	1,690 [2,020]	2,110 [2,530]	2,530 [3,040]	3,380 [4,050]	4,220 [5,070]

[23] Conforming to BS EN 10346.

The loads presented without brackets relate to the failure point when the female thread cut in the substrate reaches its' elastic limit (i.e. past that point the substrate is plastic).

The loads presented with square brackets relate to the failure point when the female thread cut in the substrate reaches its' plastic limit (i.e. the maximum load the substrate can achieve before it fails).

It is important to note that in all cases in Table 17, the fastener itself **does not fail**. Rather, it is the substrate which fails around the fastener.

5.2.1.3.2 – Lap-shearing resistance:

Table 18: Characteristic lap-shearing resistance of TEK® 3 products (of 6.3mm nominal diameter) from cold-rolled mild structural steels (in Newtons)

Grade	Substrate thickness, *t*						
	1.2mm	1.5mm	2.0mm	2.5mm	3.0mm	4.0mm	5.0mm
DX52D	380 [600]	470 [750]	630 [1,000]	790 [1,240]	950 [1,490]	1,270 [1,990]	1,590 [2,490]
DX54D	290 [530]	360 [660]	490 [880]	610 [1,100]	730 [1,320]	980 [1,760]	1,230 [2,200]
DX56D	260 [520]	320 [650]	430 [860]	540 [1,080]	650 [1,300]	860 [1,730]	1,080 [2,170]
S220GD	380 [530]	470 [660]	630 [870]	790 [1,090]	950 [1,310]	1,270 [1,740]	1,590 [2,180]
S280GD	480 [620]	600 [780]	800 [1,040]	1,010 [1,300]	1,210 [1,560]	1,620 [2,080]	2,020 [2,600]
S320GD	550 [670]	690 [840]	920 [1,130]	1,150 [1,410]	1,390 [1,690]	1,850 [2,260]	2,310 [2,820]
S350GD	600 [730]	760 [910]	1,010 [1,210]	1,260 [1,520]	1,520 [1,820]	2,020 [2,430]	2,530 [3,040]

The loads presented without brackets relate to the failure point when the female thread cut in the substrate reaches its' elastic limit (i.e. past that point the substrate is plastic).

The loads presented with square brackets relate to the failure point when the female thread cut in the substrate reaches its' plastic limit (i.e. the maximum load the substrate can achieve before it fails).

It is important to note that in all cases in Table 18, the fastener itself **does not fail**. Rather, it is the substrate which fails around the fastener.

6.0 – Normative references and notes:

IMPORTANT NOTICE 01:

All values provided in this document are **characteristic values**, specifically meaning that they are expressed as the mean ultimate value (from a dataset generated from the results of empirical testing in our UKAS accredited testing laboratory) minus two standard deviations. This is in-line with standard practice using Central Limit Theorem in accordance with UKAS Document M3003 "*The Expression of Uncertainty and Confidence in Measurement*" (3rd Edition).

Individual test results are validated using the Z-score method in ISO/IEC Guide No. 43-1 "Proficiency testing by interlaboratory comparisons" and the EN ratio method in UKAS Document LAB 46 "*UKAS Policy for Participation in Measurement Audits and Interlaboratory Comparisons"* (3rd Edition).

As such **no values provided in this datasheet have been treated with a factor of safety**. It is the responsibility of the user of this document to use a factor of safety appropriate to their designs.

From our experience[24], designers have their own favoured approach. Some prefer to use a conservative approach as (1) below, others prefer a method used in Eurocodes[25] as per (2) below:

[24] This is not an instruction nor does it alleviate the responsibilities of the reader, designer or any other third party,

[25] BS EN 1993-1-1 (Eurocode 3).

(1) $\gamma_m = 3.0$

(2) $\gamma_m = (\gamma_{gk} \cdot \gamma_{qk}) = (1.35 \times 1.50) = 2.025$

IMPORTANT NOTICE 02:

Applicable DoPs (Declaration of Performance) and ETAs (European Technical Assessments) for Evolution Fasteners products can be found on our website (www.evolutionfasteners.co.uk). Please note that not all products fall under the mandatory CE marking requirements pursuant to European Regulation No. 305/2011 (commonly referred to as the Construction Products Regulations).

Certificates of Conformance are available upon request from the Evolution Technical Department and follow the form of F2.1 "Fastener Inspection Documents" pursuant to the requirements of BS EN ISO 16228: 2018 (and subsequently BS EN ISO 3269: 2001).

For further information or to discuss details relating to the information published in this document, please contact the Evolution Technical Department.

NORMATIVE REFERENCES:

BS EN ISO 9001: 2015	*"Quality management systems. Requirements.",*
BS EN ISO/IEC 17025: 2017	*"General requirements for the competence of testing and calibration laboratories.",*
BS EN ISO 9227: 2017	*"Corrosion tests in artificial atmospheres. Salt spray tests.",*
BS EN ISO 12944-2: 2017	*"Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Classification of environments.",*
BS EN ISO 9223: 2012	*"Corrosion of metals and alloys. Corrosivity of atmospheres. Classification, determination and estimation.",*
BS EN 3506-1: 2009	*"Mechanical properties of corrosion-resistant stainless-steel fasteners. Bolts, screws and studs.",*
BS EN 10088-3: 2014	*"Stainless steels. Technical delivery conditions for semi-finished products, bards, rods, wires, sections and bright products of corrosion resisting steels for general purposes.",*
BS EN ISO 6892-1: 2016^{NC}	*"Metallic materials. Tensile testing. Method of test at room temperature.",*

BS ISO/IEC Guide 43-1: 1997	*"Proficiency testing by interlaboratory comparisons. Part 1: Development and operation of proficiency testing schemes.",*
UKAS Document M3003	*"The expression of uncertainty and confidence in measurement. 3rd Edition.". Published by the United Kingdom Accreditation Service on behalf of HM Government's Department for Business, Innovation and Skills,*
MIL-STD-1312-13NC	*"Military Standard: Fastener test methods (method 13), double shear test.". Published by the United States Department of Defence,*
BS EN ISO 10666: 1999NC	*"Drilling screws with tapping screw threads. Mechanical and functional properties.",*
BS EN 10025-1: 2004	*"Hot rolled products of structural steels. General technical delivery conditions.",*
BS EN 14566: 2008 & A1: 2009	*"Mechanical fasteners for gypsum plasterboard systems. Definitions, requirements and test methods.",*
EAD 330046-01-0602	*"European Assessment Document: Fastening screws for metal members and sheeting.". Published by the European Organisation for Technical Assessments,*
BS EN 10346: 2015	*"Continuously hot-dip coated steel flat products for cold forming. Technical delivery conditions.",*
BS EN 485-2: 2016 & A1: 2018	*"Aluminium and aluminium alloys. Sheet, strip and plate. Mechanical properties.",*
BS EN 1993-1-1: 2005 & A1: 2014	*"Eurocode 3: Design of steel structures. General rules and rules for buildings.",*
UKAS Document LAB 46	*"UKAS policy for participation in measurement audits and interlaboratory comparisons. 3rd Edition.". Published by the United Kingdom Accreditation Service on behalf of HM Government's Department for Business, Innovation and Skills,*
BS EN ISO 16228: 2018	*"Fasteners. Types of inspection documents.",*
BS EN ISO 3269: 2001	*"Fasteners. Acceptance inspection.".*

DISCLAIMER:

This document is provided for educational purposes only and remains the intellectual property of Evolution Fasteners (UK) Ltd. The information provided in this document does not alleviate any responsibility on the part

of any third party, nor does Evolution Fasteners (UK) Ltd accept any liability for any failures in practice, design or otherwise by any third parties using this document.

Evolution Fasteners (UK) Ltd retain all rights in relation to this document. This document shall not be reproduced except in full, without written approval from Evolution Fasteners (UK) Ltd.

Whilst every effort was made to ensure that all information in this document is accurate, it is provided strictly on the basis errors and omissions excepted.

It is the recommendation of Evolution Fasteners (UK) Ltd that any third party seeking to use our products should enquire directly with the Evolution Technical Department either by e-mail to technical@evolutionfasteners.co.uk or phone call to +44 (0) 141 647 7100. Written enquires can be made to:

Technical Department and Laboratory Services
Evolution Fasteners (UK) Ltd
Clyde Gateway Trade Park
Dalmarnock Road
Glasgow
G73 1AN
United Kingdom

[END OF DOCUMENT]