ENGINEERING SPECIFICATION

SuperTEK® Range

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0.0 Contents

This document contains a large amount of data, to expedite finding the pertinent information for your application, please use the lists of figures, tables and formulae to be re-directed to the page the information is presented on.

1.0 Foreword

Evolution Fasteners UK Ltd is a manufacturer of various fasteners and fixings for applications intended in the construction industry as well as aerospace, automotive and marine industries.

Evolution Fasteners UK Ltd is a UKAS (*United Kingdom Accreditation Service*) accredited testing laboratory. The laboratory holds accreditation to BS EN ISO/IEC 17025: 2017 and the UKAS Schedule of Accreditation is No. 7485[1].

Use of the National Accreditation Logo is in compliance with governmental regulations (HM Government: Department for Business, Energy & Industrial Strategy, 2018) and use of the ILAC (*International Laboratory Accreditation Cooperation*) MRA (*Mutual Recognition Agreement*) Logo is in compliance with ILAC regulations (International Laboratory Accreditation Cooperation, 2019).

Where data is presented from tests that are not included in our Schedule of Accreditation, they will be notated with “NC”. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

This document has been prepared by the Department of Engineering and Laboratory Services of Evolution Fasteners UK Ltd and takes a form (where possible) to conform with the general layout and conventions of ISO (*International Standards Organisation*) and CEN (*Comité Européen de Normalisation*) documents for the purposes of familiarity with readers.

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This document is updated periodically and latest revisions can be found at the links below:

Engineering and Technical Services

Laboratory and Analytical Services

NOTE: Compliance with this document does not of itself confer immunity from legal obligations.

[1] Current revision of the Schedule of Accreditation may be obtained from UKAS,

2.0 Scope

This document is intended to provide any prospective specifier (i.e. structural engineer, mechanical engineer or architect) with information above-and-beyond that which is generally available from our contemporaries which may assist them (as an educational tool) with their calculations and decision-making processes.

To that end this document specifies the characteristics and performance of Evolution SuperTEK® products, which are mechanical fasteners made of steel, intended for the fixing of steel fixtures to steel substrates or other ancillary products, as appropriate, in construction works.

The content of this document was, to the best of our knowledge, correct at time of publication, however is still provided on the basis of errors and omissions excepted.

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The use of this document does not alleviate, absolve or otherwise reprieve or diminish the user, designer or any other party from their respective obligations under the Building Regulations 2010, the Building (Amendment) Regulations 2018, the Construction (Design and Management) Regulations 2015 or any other law, statute, statutory instrument, directive, regulation or otherwise.

IMPORTANT NOTICE:

All values stated in this document are to be treated as characteristic loads. As such users of this document must treat the loads with factors of safety as part of their designs and calculations. Please refer to Appendix VII of this document.

For further information please contact the Technical Support Team.

3.0 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 166: 2002	*"Personal eye protection. Specifications.",*
BS EN 140: 1999	*"Respiratory protective devices. Half masks and quarter masks. Requirements, testing and marking.",*
BS EN 14387: 2004 & A1: 2008	*"Respiratory protective devices. Gas filter(s) and combined filter(s). Requirements, testing and marking.",*
BS EN 388: 2016	*"Protective gloves against mechanical risks.",*
Evolution EWD: 2019	*"Evolution Standard Product Warranty (2019 Edition).",*
BS EN ISO/IEC 17025: 2017	*"General requirements for the competence of testing and calibration laboratories.",*
UKAS Document M3003	*"The expression of uncertainty and confidence in measurement (3rd Edition).",*
ISO/IEC 17043: 2010	*"Conformity assessment. General requirements for proficiency testing.",*
BS ISO 9001: 2015	*"Quality management systems. Requirements.",*
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.",*
ASTM A240/ A240M – 18	*"Standard specification for chromium and chromium-nickel stainless steel plate, sheet and strip for pressure vessels and for general applications.",*
MIL-STD-1312-13	*"Military standard. Fastener test methods (method 13). Double shear test.",*
BS EN ISO 10666: 1999	*"Drilling screws with tapping screw thread – mechanical and functional properties.",*
BS EN ISO 6507-1: 2018	*"Metallic materials – Vickers hardness test – Part 1: test method.",*

BS EN ISO 898-1: 2013	*“Mechanical properties of fasteners made of carbon steel and alloy steel. Part 1: bolts, screws and studs with specified property classes. Coarse thread and fine pitch thread.”,*
BS EN 10025-1: 2004	*“Hot rolled products of structural steels. General technical delivery conditions.”,*
BS EN 10025-2: 2019	*“Hot rolled products of structural steels. Technical delivery conditions for non-alloy structural steels.”,*
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 755-2: 2016	“Aluminium and aluminium alloys. Extruded rod/ bar, tube and profiles. Mechanical properties.”,
EAD 330046-01-0602	“Fastening screws for metal members and sheeting.”,

4.0 Terms, definitions, symbols and abbreviated terms

This document utilises SI units and nomenclature in relation to units and prefixes/ suffixes pursuant to the International System of Units.

Where possible all terms, definitions and symbols used in this document are pursuant to Eurocodes 0 through 8 so that they are familiar to readers. Where such terms, definitions and symbols deviate from Eurocodes, this is due to a regulatory, statutory or standard (i.e. test standard) takes precedence over the Eurocode.

4.1 Terms and definitions

For the purpose of this document, the following terms and definitions apply:

Stock Keeping Unit (SKU)
The unique identification code of the particular product in question, generally used *in lieu* of a longer description of the product.

Threads Per Inch (TPI)
Number of thread peaks per measured inch along the shank of the screw. An anachronistic unit of measuring thread pitch.

Central Limit Theorem (CLT)
A statistical analysis technique in probability theory, where standard deviations from mean provide an indicative % confidence.

Analysis of Variance (ANOVA)
A statistical analysis technique used to analyse the differences among group means in a given data-set.

Axial, tangential or radial plane
The cross-section through an object with respect to its' orientation in space. Refer to Annex V of this document for further explanation.

Material yield strength
The point on the stress/ strain graph where the material stops deforming elastically and begins to deform plastically.

Ultimate tensile strength
The point on the stress/ strain graph where the material has reached maximum plastic deformation. After this point the material will begin to weaken due to loss of cross-sectional area in necking.

Stress (ε)
Force per unit area.

Strain (σ_s)
Proportional deformation.

Young's modulus
Stiffness of a solid material, specifically the linear elasticity of a uniaxial deformation.

Elastic section modulus
Stiffness as a geometric property for a known cross-section in a flexural member.

Bending moment capacity
The capacity of a member to resist bending moment through the axial plane.

Lateral-Torsional Buckling (LTB) resistance
The capacity of a member to resist combined concurrent bending through the axial and tangential planes.

Polar moment of inertia
Rigidity of a cross-sectional area to resist deformation by torsion as function of its' shape.

Second moment of area
Rigidity of a cross-sectional area to resist deformation by deflection as a function of its' shape.

Poisson's ratio
The negative ratio of transverse strain to axial strain (i.e. transversal expansion divided by axial compression).

Elastic deformation (elasticity)
The ability of the material to deform under the application of a force and to return to its' original size and shape when such force is removed. This is the phase on a stress/ strain graph where the material is at a low stress and is fully recoverable once stress is removed.

Plastic deformation (plasticity)
The ability of the material to deform under the application of a force and to remain in a permanently different size and shape when such force is removed. This is the phase on a stress/ strain graph where the material is at a high stress and is non-reversibly changed once stress is removed.

Hooke's law
Fundamental law of physics that force applied to a body is proportional to the extension of that body.

4.2 Symbols and abbreviated terms

For the purpose of this simplification in product marking and performance information characteristics may be identified through the symbols and abbreviations given in Table 1:

Table 01: Symbols and designations		
Symbol	**Unit**	**Designation**
L	mm	Overall length of the screw.
S	mm	Length of threaded portion of the screw (including length of self-drilling point).
T	mm	Length of the self-drilling point.
P	mm	Pitch of the screw thread (peak to peak distance).
$D1$	mm	Diameter of the major thread.
$D2$	mm	Diameter of the minor thread.
E	mm	Diameter of the self-drilling point.
$X_{st,m}$		Statistical mean of a data set derived from empirical testing.
X_n		Number of individual results in a data set derived from empirical testing.
σ		Standard deviation of a data set derived from empirical testing.
f_y	N/mm^2	Material yield strength (synonymous with R_{eH} pursuant to BS EN ISO 6892-1).
R_m	N/mm^2	Ultimate tensile strength pursuant to BS EN ISO 6892-1).
F_{eH}	N	Force recorded at f_y.
F_m	N	Force recorded at R_m.
V_m	N	Force recorded at ultimate shear failure.
S_0	mm^2	Smallest cross-sectional area subjected to stress/ strain.
Y	GPa	Young’s modulus.
G	GPa	Shear modulus (sometimes referred to as Modulus of rigidity).
W_{eL}	mm^3	Elastic section modulus.
$M_{c,Rd}$	Nm	Bending moment capacity.
$M_{b,Rd}$	Nm	Lateral-torsional buckling resistance.
J	mm^4	Polar moment of inertia.
τ_m	Nm	Ultimate torsional strength.
v		Poisson’s ratio.
$H_{surface}$	HV	Surface hardness.
N_{Rk}	N	Characteristic withdrawal resistance (refer to Appendix VII of this document).
V_{Rk}	N	Characteristic lap-shearing resistance (refer to Appendix VII of this document).
N_{Rd}	N	Design withdrawal resistance (refer to Appendix VII of this document).
V_{Rd}	N	Design lap-shearing resistance (refer to Appendix VII of this document).
N_{rec}	N	Recommended withdrawal resistance (refer to Appendix VII of this document).
V_{rec}	N	Recommended lap-shearing resistance (refer to Appendix VII of this document).

5.0 Dimensions and metrological properties

Standard product dimensions and tolerance are shown, *inter alia*, in Figure 1 and Table 2.

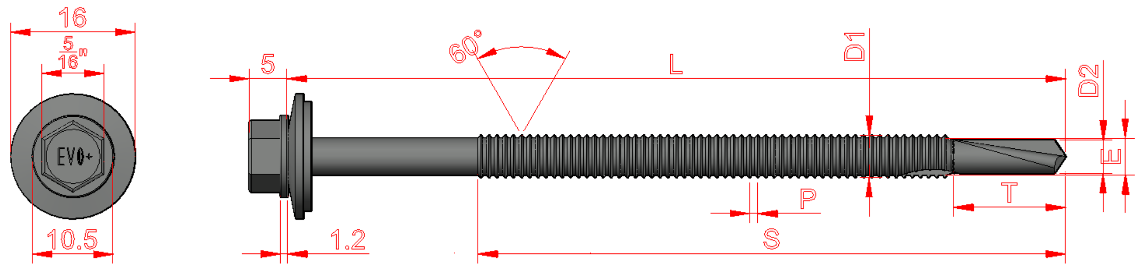


Figure 1 – Schematic showing standard dimensions

Table 02: Dimensional properties inc. tolerances (in mm)							
SKU[2]	**L**	**S**	**T**	**P**	**D1**	**D2**	**E**
SuperTEK® 6 Products							
TSBW5.5-38-6	38.0 ± 1.0	FULL	15.00 - 17.00	1.06 (24 TPI)	5.28 – 5.48	4.70 - 4.75	4.80 – 5.00
SuperTEK® 7 Products							
TSHW5.5-50-7	50.0 ± 1.0	FULL	21.00 - 23.00	1.06 (24 TPI)	5.28 – 5.48	4.70 - 4.75	4.90 – 5.10
TSBW5.5-50-7[3]	50.0 ± 1.0						
TSHW5.5-75-7	75.0 ± 1.0						
TSHW5.5-100-7	100.0 ± 1.0						
TSBWHT5.5-150-7[3]	150.0 ± 1.5	75.0 ± 1.5					
SuperTEK® 8 Products							
TSHW6.3-60-8	60.0 ± 1.0	FULL	24.50 – 26.50	1.81 (14 TPI)	6.10 – 6.25	4.70 – 4.88	5.65 – 5.80
TSHW6.3-100-8	100.0 ± 1.0						
SuperTEK® X Products							
TSHW6.3-135-X	135.0 ± 1.5	75.0 ± 1.5	33.00 – 35.00	1.81 (14 TPI)	6.10 – 6.25	4.70 – 4.88	5.65 – 5.80

For a description of the limitations of self-drilling points, refer to Annex IV of this document.

[2] SKU = Stock Keeping Unit (synonymous with "part number"),
[3] Supplied with EPDM washer,

6.0 Installation instructions[4]

Failure to abide by these instructions may void any warranty provided by Evolution Fasteners UK Ltd. This document does not alleviate, absolve or otherwise reprieve or diminish the user, designer or any other party from their respective obligations under the terms of the Warranty[5].

The use of impact tooling is prohibited. Using such tooling will void the Warranty. Please refer to our Qualified Vendors List (QVL) in Appendix I of this document to confirm if your tooling is approved or prohibited.

Before installing the screws, please make sure that you have all appropriate tooling, equipment and apparatus before starting.

A REQUIRED EQUIPMENT AND APPARATUS

I Personal Protective Equipment (PPE):

1. Eyeglasses meeting BS EN 166: 2002 Class 1F (or better),
2. Dust mask with face piece meeting BS EN 140: 1999 and filters meeting BS EN 14387: 2004 & 2008 (or better),
3. Safety gloves meeting BS EN 388: 2016 (or better).

II Hand tools, accessories and other small items:

4. Degreasing agent and/ or cleaning solvent,
5. Wire brush or steel wool,
6. Automatic centre punch.

III Power tools:

7. Construction screwdriver (sometimes referred to as TEK screwdriver) with appropriate depth stopping nose-piece and a no-load RPM of ≥ 1,250 ≤ 2,500 RPM.

B INSTALLATION PROCEDURE

1. Ensure environmental conditions are correct for use and installation of the product, specifically (list is not exhaustive) that:

   a) The products are being used in a dry and internal place (where possible), if being used externally: ensure that exposure of the screws does not exceed the appropriate corrosivity category for the product (for further information please refer to Appendix II of this document),

[4] Video instructions available on our YouTube™ channel,
[5] For further information, refer to the Evolution Product Warranty document hosted on our website,

b) The products are being used in the correct application as per the limitations prescribed in Evolution Fasteners UK technical literature (Technical Manual, Technical Datasheet and Engineering Specification). If unsure, please contact the Evolution Technical Support Team either by phone to +44 (0) 141 647 7100 or e-mail to technical@evolutionfasteners.co.uk.

2. Clear the area of dirt and debris and ensure that no other contaminating substances such as oil, grease, etc present. If required, use a suitable degreasing agent or solvent and allow to air dry before installing the screws.

3. In accordance with the Engineers' drawings, mark out where the fixings are to be placed as appropriate.

4. Using an automatic centerpunch, deform (punch) where screws will be installed as this will aid the user during screw installation as it stops screws "*walking*" on the face of the fixture material.

5. Using a non-impacting construction screwdriver, insert the screw into the fixture and substrate perpendicularly (maximum of ± 5° deviation from normal) using not greater than 1,750 RPM and a steady pressure on the tooling only (do not force the tool, allow the screw to cut).

6. Stop inserting the screw once the underside of the flange makes contact with the topside of the fixture material for screws which do not incorporate a washer.

   For screws which incorporate a washer: continue inserting until the compression disc of the washer changes from convex to flat (not that if washer concaves, you have applied to much torque and need to remove the fastener and try again with an unused fastener).

If you are experiencing difficulties when installing screws, please refer to Appendix III of this document.

7.0 Standard product details

Standard product dimensions and tolerance are shown, *inter alia*, in Table 3.

Table 03: Standard product details	
Designed for/ purpose:	Fastening steel sections, sheeting, panels etc to steel or structural sections.
Head style and drive:	5/16” hexagonal (male) socket with flange.
Thread form:	SuperTEK® 6 and 7 SKUs = Fine (1.06mm pitch), SuperTEK® 8 and X SKUs = Coarse (1.80mm pitch).
Material type and grade:	SAE C1022 carbon steel. For elemental composition see Appendix II of this document (Bringas, 2004)
Coating and corrosion resistance:	1. ≥ 1,000 Hour corrosion resistance (when tested in 5% NaCl accelerated corrosion test as per BS EN ISO 9227). 2. For use in atmospheric corrosivity categories of C3, C2 and C1 as per BS EN ISO 12994-2 and BS EN ISO 9223.
Washer details[6]:	Compression disc = 1.0mm thick galvanised steel (16mm OD & 7.6mm ID), Gasket = 2.0mm thick EPDM (ethylene propylene diene monomer).

[6] Only relates to products prefixed with TSBW or TSBWHT,

8.0 General mechanical properties of the screws

General mechanical properties of the screws are shown, *inter alia*, in Figure 2 and Table 5.

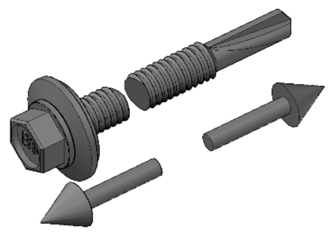
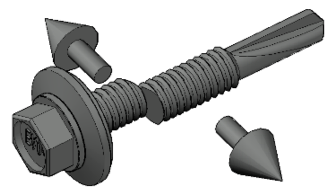
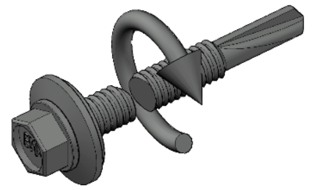
Mechanical Properties of Screws		
		
Tensile Capacity	**Shear Capacity**	**Torque Capacity**

Figure 2 – Graphical representation of failure modes of screws.

When interpreting the data in Table 05, it is important for the reader to understand that we analyse our empirical test data in accordance with UKAS Document M3003 and ISO/IEC 17043: 2010.

We use central limit theorem[7] and ANOVA (Analysis of Variances) approach (Rutherford, 2011) to produce our stated performance values. Using a risk-based approach based on our ISO 9001 QMS we adopt the principals shown in Table 04 and illustrated in Figure 3:

Table 04: Formula applied to data-sets arising from empirical testing			
Data Type	**Risk Level**	**Formula**	**Formula[8] No.**
Mechanical properties of screws	Low	$X_{st,m} = \left(\left(\sum X_{st,m} / X_n\right) - 2 \cdot \sigma\right)$	1
Mechanical properties of substrates	High	$X_{st,m} = \left(\left(\sum X_{st,m} / X_n\right) - 3 \cdot \sigma\right)$	2

[7] More information on central limit theorem can be obtained from Wikipedia,
[8] Refer to Section 12 of this document,

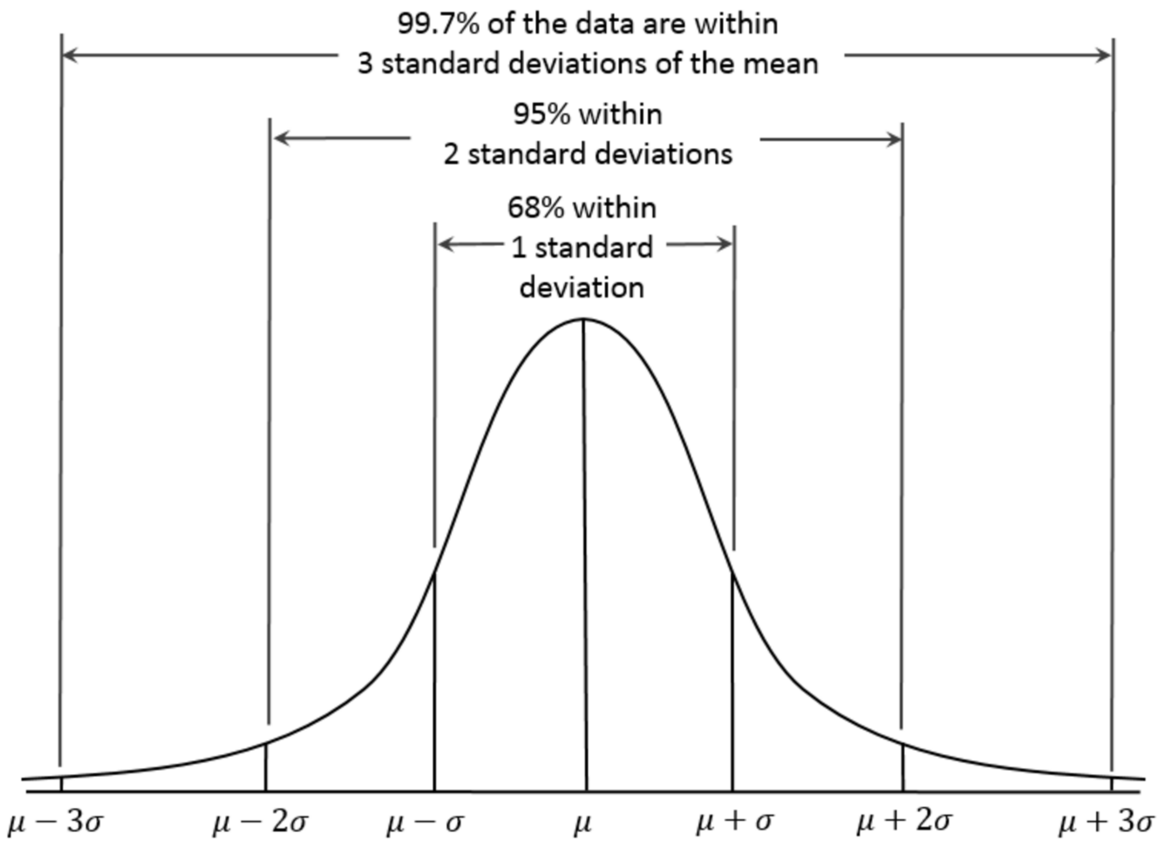


Figure 3 – Distribution and number of standard deviations from mean resulting in confidence %

Should you reader require more information on our testing methodology as well as our data analysis methodology, they can call our Technical Support Team who would be happy to discuss any issues the reader may have in following the methodology.

Please note that we give data on the performance of our screws and substrates that we test our screws in for both elastic and plastic deformation phases. For a more detailed explanation of the meanings, please refer to Appendix VI.

Table 05: Mechanical Properties for C1022 Carbon Steel Screws[9]				
Parameter	Symbol	Unit	Nominal Diameter & TEK® Point	
			5.5mm SuperTEK® 6 & 7	6.3mm SuperTEK® 8 & X
Material yield strength[10]	f_y	N/mm²	810	
Ultimate tensile strength[11]	R_m	N/mm²	1,220	
Maximum force at elastic limit[10]	F_{eH}	N	12,780	13,130
Ultimate force at plastic limit[10]	F_m	N	19,250	19,780
Cross-sectional area	S_0	mm²	15.78	16.22
Young's modulus of elasticity	Y	N/mm²	205,000	
Elastic section modulus[12]	W_{eL}	mm³	10.36	10.79
Bending moment capacity[13]	$M_{c,Rd}$	Nm	6.71	6.99
Lateral-torsional buckling resistance[14]	$M_{b,Rd}$	Nm	2.89	3.01
Polar moment of inertia[15]	J	mm⁴	15.58	16.45
Modulus of rigidity/ Shear modulus[16]	G	N/mm²	74,000	
Ultimate force at shear failure[17]	V_m	N	14,435	14,835
Ultimate torsional strength[18]	τ_m	Nm	14.25	15.05
Poisson's Ratio[19]	v		0.290	
Surface Hardness (pre-hardening)[20]	$H_{surface,1}$	HV	112	
Surface Hardness (post-hardening)[21]	$H_{surface,2}$	HV	580	600

The information in the table above requires a certain level of engineering knowledge to understand what the figures are portraying. If the reader does not understand the nomenclature, terminology or figures/ data shown in the above table, please call our Technical Support Team who will be happy to provide explanations.

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

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

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

[12] Calculated as per formula 3,

[13] Calculated as per formula 4,

[14] Calculated as per formula 5,

[15] Calculated as per formula 6,

[16] As specified in ASTM A240/ A240M,

[17] Derived from empirical testing performed to MIL-STD-1312[NC], figure stated is the maximum shear during plastic deformation, if the reader requires the maximum shear during elastic deformation please contact the Technical Support Team,

[18] Derived from empirical testing performed to BS EN ISO 10666[NC], figure stated is the maximum torque during plastic deformation, if the reader requires the maximum torque during elastic deformation please contact the Technical Support Team,

[19] Data obtained from mill specification (AZO Materials, 2012),

[20] Data obtained from mill specification (AZO Materials, 2012),

[21] Derived from empirical testing performed to BS EN ISO 6507-1: 2018 and definition of "surface" as per BS EN ISO 898-1: 2013,

9.0 Mechanical properties of screws in conjunction with various substrates

When reading and interpreting the data in this section, it is important that the reader has a clear understanding of the mechanical relationship between the screw and the substrate the screw is being used in.

It is highly recommended that if the reader is unsure about the differences between elastic and plastic deformation that they read Annex VI of this document before continuing.

It is critical that the reader understands that in most cases, the screw itself is not failing, it is the substrate which is being deformed around the screw to a sufficient degree that the substrate itself has failed. For example, in withdrawal; it is likely that the female thread cut in the substrate will fail before the mail thread of the fastener. This is due to the fact that the screw has a much higher elastic and plastic tensile strengths compared to the substrate.

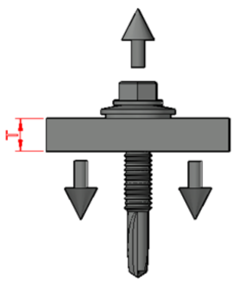
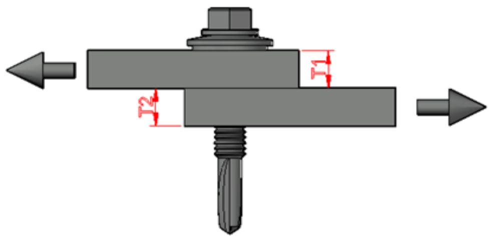
Mechanical Properties of Substrate	
	
Withdrawal Resistance	Lap-shearing Resistance

Figure 4 – Graphical representation of failure modes of substrate

IMPORTANT NOTICE:

1. In instances where the tabulated data uses the term “Yield”, this is because the elastic limit of the screw itself has been reached and the reader should use the appropriate value from Table 5 (i.e. F_{eH}),

2. In instances where the tabulated data uses the term “Ultimate”, this is because the ultimate plastic limit of the screw itself has been reached and the reader should use the appropriate value from Table 5 (i.e. F_m),

3. The tabulated data shows data without brackets and data within [brackets]:

    a. The data without brackets is the force in the elastic deformation state for the substrate,

    b. The data inside [brackets] is the force in the plastic deformation state for the substrate.

9.1 SuperTEK® 6 and 7 products

The data portrayed in sections 9.1.1 through 9.1.3 solely relate to the withdrawal and lap-shearing characteristics of SuperTEK® 6 and 7 products, which are fine threaded.

9.1.1 Hot-rolled mild structural steels (pursuant to BS EN 10025[22])

Table 06: Characteristic withdrawal resistance[23,24], N_{Rk}, of SuperTEK® 6 and 7 in various thicknesses of hot-rolled mild structural steels (in Newtons)

Grade	Substrate thickness, *t*						
	4.0mm	**5.0mm**	**8.0mm**	**10.0mm**	**12.5mm**	**15.0mm**	**18.0mm[25]**
S235 JR	3,430 [6,360]	4,290 [7,950]	6,870 [12,720]	8,590 [15,900]	10,730 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
S275 JR	4,020 [7,380]	5,020 [9,230]	8,040 [14,770]	10,050 [18,460]	12565 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
S355 JR	5,190 [8,700]	6,480 [10,870]	10,380 [17,400]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
S450 J0	6,580 [9,280]	8,220 [11,600]	Yield [18,570]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
E295	4,310 [8,400]	5,390 [10,510]	8,620 [16,810]	10,780 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
E335	4,890 [9,940]	6,120 [12,430]	9,790 [Ultimate]	12,240 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
E360	5,260 [11,620]	6,580 [14,530]	10,520 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
Interpolation between values is forbidden.							

IMPORTANT NOTICE:

Please note that values in this table, N_{Rk}, are "*characteristic loads*", therefore the reader should apply an appropriate factor of safety (depending on their adopted design methodology) to the stated values to yield their own design load or recommended load. For further information on characteristic loads, design loads and recommended loads, please refer to Appendix VII of this document.

22 Specifically, BS EN 10025-1:2004 and BS EN 10025-2: 2019,
23 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,
24 Derived from empirical tests as per BS EN 14566: 2008 & A1: 2012,
25 Relates only to SuperTEK® 7 product as this thickness of substrate is beyond the self-drilling capacity of SuperTEK® 6,

Table 07: Characteristic lap-shearing resistance[26,27], V_{Rk}, of SuperTEK® 6 and 7 in various thicknesses of hot-rolled mild structural steels (in Newtons)							
Grade	**Substrate thickness, *t***						
	4.0mm	**5.0mm**	**8.0mm**	**10.0mm**	**12.5mm**	**15.0mm**	**18.0mm[28]**
S235 JR	2,070 [4,990]	2,390 [5,760]	3,350 [8,080]	3,990 [9,620]	4,800 [11,550]	5,600 [13,490]	6,560 [Ultimate]
S275 JR	2,380 [5,750]	2,740 [6,640]	3,850 [9,320]	4,590 [11,100]	5,510 [13,330]	6,430 [Ultimate]	Yield [Ultimate]
S355 JR	3,140 [6,830]	3,630 [7,890]	5,090 [11,060]	6,070 [13,180]	7,290 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
S450 J0	3,990 [7,290]	4,610 [8,420]	6,460 [11,810]	Yield [14,060]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
E295	2,610 [6,600]	3,010 [7,620]	4,220 [10,690]	5,030 [12,730]	6,040 [Ultimate]	7,050 [Ultimate]	Yield [Ultimate]
E335	2,910 [7,830]	3,360 [9,040]	4,720 [12,680]	5,620 [Ultimate]	6,750 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
E360	3,140 [9,130]	3,630 [10,550]	5,090 [Ultimate]	6,070 [Ultimate]	7,290 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
Interpolation between values is forbidden.							

The figures shown are for a single lap thickness only. If your application has more than one element, for the purposes of your calculation, use the data for the smallest thickness in that application.

IMPORTANT NOTICE:

Please note that values in this table, V_{Rk}, are "*characteristic loads*", therefore the reader should apply an appropriate factor of safety (depending on their adopted design methodology) to the stated values to yield their own design load or recommended load. For further information on characteristic loads, design loads and recommended loads, please refer to Appendix VII of this document.

[26] 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,

[27] Derived from empirical tests as per EAD 330046-01-0602[NC],

[28] Relates only to SuperTEK® 7 product as this thickness of substrate is beyond the self-drilling capacity of SuperTEK® 6,

9.1.2 Cold-rolled structural steels (pursuant to BS EN 10346[29])

Table 08: Characteristic withdrawal resistance[30,31], N_{Rk}, of SuperTEK® 6 and 7 in various thicknesses of cold-rolled structural steels (in Newtons)

Grade	Substrate thickness, *t*						
	4.0mm	**5.0mm**	**8.0mm**	**10.0mm**	**12.5mm**	**15.0mm**	**18.0mm[32]**
DX52D	3,210 [5,040]	4,020 [6,300]	6,430 [10,090]	8,040 [12,610]	10,050 [Ultimate]	12,060 [Ultimate]	Yield [Ultimate]
DX54D	2,480 [4,460]	3,100 [5,570]	4,970 [8,920]	6,210 [11,150]	7,760 [Ultimate]	9,320 [Ultimate]	11,180 [Ultimate]
S220GD	3,210 [4,380]	4,020 [5,480]	6,430 [8,770]	8,040 [10,960]	10,050 [Ultimate]	12,060 [Ultimate]	Yield [Ultimate]
S350GD	5,110 [6,140]	6,390 [7,670]	10,230 [12,280]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
S550GD	8,040 [8,180]	10,050 [10,230]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
HX340BD	5,410 [7,010]	6,760 [8,770]	10,820 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
HX500LAD	5,260 [11,620]	6,580 [Ultimate]	10,520 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
Interpolation between values is forbidden.							

IMPORTANT NOTICE:

Please note that values in this table, N_{Rk}, are "*characteristic loads*", therefore the reader should apply an appropriate factor of safety (depending on their adopted design methodology) to the stated values to yield their own design load or recommended load. For further information on characteristic loads, design loads and recommended loads, please refer to Appendix VII of this document.

[29] Specifically, BS EN 10346: 2014,
[30] 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,
[31] Derived from empirical tests as per BS EN 14566: 2008 & A1: 2012,
[32] Relates only to SuperTEK® 7 product as this thickness of substrate is beyond the self-drilling capacity of SuperTEK® 6,

Grade	Substrate thickness, *t*						
	4.0mm	**5.0mm**	**8.0mm**	**10.0mm**	**12.5mm**	**15.0mm**	**18.0mm**[35]
DX52D	1,910 [3,910]	2,210 [4,520]	3,100 [6,340]	3,700 [Ultimate]	4,440 [Ultimate]	5,180 [Ultimate]	6,080 [Ultimate]
DX54D	1,450 [3,450]	1,680 [3,980]	2,360 [5,590]	2,810 [6,660]	3,370 [Ultimate]	3,940 [Ultimate]	4,620 [Ultimate]
S220GD	1,910 [3,450]	2,210 [3,980]	3,100 [5,590]	3,700 [6,660]	4,440 [Ultimate]	5,180 [Ultimate]	6,080 [Ultimate]
S350GD	3,070 [4,830]	3,540 [5,580]	4,970 [Ultimate]	5,920 [Ultimate]	7,110 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
S550GD	4,830 [6,440]	5,580 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
HX340BD	3,220 [5,520]	3,720 [6,380]	5,220 [Ultimate]	6,220 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
HX500 LAD	3,140 [Ultimate]	3,630 [Ultimate]	5,090 [Ultimate]	6,070 [Ultimate]	7,290 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
Interpolation between values is forbidden.							

Table 09: Characteristic lap-shearing resistance[33,34], V_{Rk}, of SuperTEK® 6 and 7 in various thicknesses of cold-rolled structural steels (in Newtons)

The figures shown are for a single lap thickness only. If your application has more than one element, for the purposes of your calculation, use the data for the smallest thickness in that application.

IMPORTANT NOTICE:

Please note that values in this table, V_{Rk}, are "*characteristic loads*", therefore the reader should apply an appropriate factor of safety (depending on their adopted design methodology) to the stated values to yield their own design load or recommended load. For further information on characteristic loads, design loads and recommended loads, please refer to Appendix VII of this document.

[33] 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,
[34] Derived from empirical tests as per EAD 330046-01-0602[NC],
[35] Relates only to SuperTEK® 7 product as this thickness of substrate is beyond the self-drilling capacity of SuperTEK® 6,

9.1.3 Extruded aluminium alloys (pursuant to BS EN 485-2 or BS EN 755-2[36])

Table 10: Characteristic withdrawal resistance[37,38] , N_{Rk} , of SuperTEK® 6 and 7 in various thicknesses of extruded aluminium alloys (in Newtons)							
Grade	**Substrate thickness, *t***						
	4.0mm	**5.0mm**	**8.0mm**	**10.0mm**	**12.5mm**	**15.0mm**	**18.0mm[39]**
6061 – T6	3,500 [4,240]	4,380 [5,300]	7,010 [8,480]	8,770 [10,600]	10,960 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
6063 – T6	2,330 [2,770]	2,920 [3,470]	4,670 [5,550]	5,840 [6,940]	7,310 [8,680]	8,770 [10,410]	10,520 [12,500]
6082 – T6	3,720 [4,380]	4,660 [5,480]	7,450 [8,770]	8,320 [10,960]	11,650 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
6262 – T9	3,500 [3,800]	4,380 [4,750]	7,010 [7,600]	8,770 [9,500]	10,960 [11,880]	Yield [Ultimate]	Yield [Ultimate]
Interpolation between values is forbidden.							

IMPORTANT NOTICE:

Please note that values in this table, N_{Rk} , are "*characteristic loads*", therefore the reader should apply an appropriate factor of safety (depending on their adopted design methodology) to the stated values to yield their own design load or recommended load. For further information on characteristic loads, design loads and recommended loads, please refer to Appendix VII of this document.

[36] Specifically, BS EN 485-2: 2016 & A1: 2018 and/ or BS EN 755-2: 2016,
[37] 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,
[38] Derived from empirical tests as per BS EN 14566: 2008 & A1: 2012,
[39] Relates only to SuperTEK® 7 product as this thickness of substrate is beyond the self-drilling capacity of SuperTEK® 6,

Table 11: Characteristic lap-shearing resistance[40,41], V_{Rk}, of SuperTEK® 6 and 7 in various thicknesses of extruded aluminium alloys (in Newtons)							
Grade	Substrate thickness, *t*						
	4.0mm	5.0mm	8.0mm	10.0mm	12.5mm	15.0mm	18.0mm[42]
6061 – T6	2,070 [3,300]	2,390 [3,810]	3,350 [5,340]	3,990 [6,360]	4,800 [Ultimate]	5,600 [Ultimate]	6,560 [Ultimate]
6063 – T6	1,380 [2,140]	1,590 [2,480]	2,230 [3,480]	2,660 [4,140]	3,200 [4,970]	3,730 [5,810]	4,380 [6,800]
6082 – T6	2,220 [3,450]	2,570 [3,980]	3,600 [5,590]	4,290 [6,660]	5,150 [Ultimate]	6,010 [Ultimate]	7,050 [Ultimate]
6262 – T9	2,070 [2,990]	2,390 [3,450]	3,350 [4,840]	3,990 [5,770]	4,800 [6,930]	5,600 [Ultimate]	6,560 [Ultimate]
Interpolation between values is forbidden.							

The figures shown are for a single lap thickness only. If your application has more than one element, for the purposes of your calculation, use the data for the smallest thickness in that application.

IMPORTANT NOTICE:

Please note that values in this table, V_{Rk}, are "*characteristic loads*", therefore the reader should apply an appropriate factor of safety (depending on their adopted design methodology) to the stated values to yield their own design load or recommended load. For further information on characteristic loads, design loads and recommended loads, please refer to Appendix VII of this document.

[40] 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,
[41] Derived from empirical tests as per EAD 330046-01-0602[NC],
[42] Relates only to SuperTEK® 7 product as this thickness of substrate is beyond the self-drilling capacity of SuperTEK® 6,

9.2 SuperTEK® 8 and X products

The data portrayed in sections 9.2.1 through 9.2.3 solely relate to the withdrawal and lap-shearing characteristics of SuperTEK® 8 and X products, which are coarse threaded.

9.2.1 Hot-rolled mild structural steels (pursuant to BS EN 10025[43])

Table 12: Characteristic withdrawal resistance[44,45], N_{Rk}, of SuperTEK® 8 and X in various thicknesses of hot-rolled mild structural steels (in Newtons)

Grade	Substrate thickness, *t*						
	10.0mm	12.5mm	15.0mm	20.0mm	25.0mm	30.0mm[46]	35.0mm[46]
S235 JR	5,460 [10,100]	6,820 [12,630]	8,190 [15,160]	10,920 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
S275 JR	6,390 [11,730]	7,980 [14,660]	9,580 [17,600]	12,780 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
S355 JR	8,240 [13,820]	10,310 [17,280]	12,370 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
S450 J0	10,450 [14,750]	13,070 [18,440]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
E295	6,850 [13,360]	8,560 [16,700]	10,280 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
E335	7,780 [15,800]	9,730 [19,750]	11,670 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
E360	8,360 [18,470]	10,450 [Ultimate]	12,540 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
Interpolation between values is forbidden.							

IMPORTANT NOTICE:

Please note that values in this table, N_{Rk}, are "*characteristic loads*", therefore the reader should apply an appropriate factor of safety (depending on their adopted design methodology) to the stated values to yield their own design load or recommended load. For further information on characteristic loads, design loads and recommended loads, please refer to Appendix VII of this document.

[43] Specifically, BS EN 10025-1:2004 and BS EN 10025-2: 2019,
[44] 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,
[45] Derived from empirical tests as per BS EN 14566: 2008 & A1: 2012,
[46] Relates only to SuperTEK® X product as this thickness of substrate is beyond the self-drilling capacity of SuperTEK® 8,

Table 13: Characteristic lap-shearing resistance[47,48], V_{Rk}, of SuperTEK® 8 and X in various thicknesses of hot-rolled mild structural steels (in Newtons)							
Grade	**Substrate thickness, *t***						
	10.0mm	**12.5mm**	**15.0mm**	**20.0mm**	**25.0mm**	**30.0mm[49]**	**35.0mm[49]**
S235 JR	2,710 [6,530]	3,180 [7,670]	3,660 [8,820]	4,610 [11,110]	5,560 [13,400]	6,510 [Ultimate]	7,470 [Ultimate]
S275 JR	3,110 [7,530]	3,660 [8,850]	4,200 [10,180]	5,300 [12,820]	6,390 [Ultimate]	7,480 [Ultimate]	Yield [Ultimate]
S355 JR	4,120 [8,940]	4,840 [10,510]	5,560 [12,080]	7,010 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
S450 J0	5,220 [9,540]	6,140 [11,220]	7,050 [12,890]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
E295	3,410 [8,640]	4,010 [10,150]	4,610 [11,670]	5,810 [14,700]	7,010 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
E335	3,810 [10,250]	4,480 [12,040]	5,150 [13,840]	6,490 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
E360	4,120 [11,960]	4,840 [14,050]	5,560 [Ultimate]	7,010 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
Interpolation between values is forbidden.							

The figures shown are for a single lap thickness only. If your application has more than one element, for the purposes of your calculation, use the data for the smallest thickness in that application.

IMPORTANT NOTICE:

Please note that values in this table, V_{Rk}, are "*characteristic loads*", therefore the reader should apply an appropriate factor of safety (depending on their adopted design methodology) to the stated values to yield their own design load or recommended load. For further information on characteristic loads, design loads and recommended loads, please refer to Appendix VII of this document.

[47] 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,

[48] Derived from empirical tests as per EAD 330046-01-0602[NC],

[49] Relates only to SuperTEK® X product as this thickness of substrate is beyond the self-drilling capacity of SuperTEK® 8,

9.2.2 Cold-rolled structural steels (pursuant to BS EN 10346[50])

Table 14: Characteristic withdrawal resistance[51,52], N_{Rk}, of SuperTEK® 8 and X in various thicknesses of cold-rolled structural steels (in Newtons)

Grade	Substrate thickness, *t*						
	10.0mm	**12.5mm**	**15.0mm**	**20.0mm**	**25.0mm**	**30.0mm[53]**	**35.0mm[53]**
DX52D	5,110 [8,010]	6,390 [10,020]	7,660 [12,020]	10,220 [Ultimate]	12,780 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
DX54D	3,950 [7,080]	4,930 [8,850]	5,920 [10,630]	7,900 [Ultimate]	9,870 [Ultimate]	11,850 [Ultimate]	Yield [Ultimate]
S220GD	5,110 [6,970]	6,390 [8,710]	7,660 [10,450]	10,220 [Ultimate]	12,780 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
S350GD	8,130 [9,750]	10,160 [12,190]	12,190 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
S550GD	12,780 [13,010]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
HX340BD	8,590 [11,150]	10,740 [Ultimate]	12,895 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
HX500 LAD	8,360 [Ultimate]	10,450 [Ultimate]	12,540 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
Interpolation between values is forbidden.							

IMPORTANT NOTICE:

Please note that values in this table, N_{Rk}, are "*characteristic loads*", therefore the reader should apply an appropriate factor of safety (depending on their adopted design methodology) to the stated values to yield their own design load or recommended load. For further information on characteristic loads, design loads and recommended loads, please refer to Appendix VII of this document.

[50] Specifically, BS EN 10346: 2014,
[51] 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,
[52] Derived from empirical tests as per BS EN 14566: 2008 & A1: 2012,
[53] Relates only to SuperTEK® X product as this thickness of substrate is beyond the self-drilling capacity of SuperTEK® 8,

Table 15: Characteristic lap-shearing resistance[54,55] , V_{Rk} , of SuperTEK® 8 and X in various thicknesses of cold-rolled structural steels (in Newtons)							
Grade	**Substrate thickness, *t***						
	10.0mm	**12.5mm**	**15.0mm**	**20.0mm**	**25.0mm**	**30.0mm[56]**	**35.0mm[56]**
DX52D	2,510 [5,120]	2,950 [6,020]	3,390 [6,920]	4,270 [Ultimate]	5,150 [Ultimate]	6,510 [Ultimate]	7,470 [Ultimate]
DX54D	1,900 [4,520]	2,240 [5,310]	2,570 [6,100]	3,240 [Ultimate]	3,910 [Ultimate]	7,480 [Ultimate]	Yield [Ultimate]
S220GD	2,510 [4,520]	2,950 [5,310]	3,390 [6,100]	4,270 [Ultimate]	5,150 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
S350GD	4,020 [6,330]	4,720 [7,440]	5,430 [Ultimate]	6,830 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
S550GD	6,330 [Ultimate]	7,440 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
HX340BD	4,220 [7,230]	4,960 [Ultimate]	5,700 [Ultimate]	7,180 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
HX500 LAD	4,120 [Ultimate]	4,840 [Ultimate]	5,560 [Ultimate]	7,010 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
Interpolation between values is forbidden.							

The figures shown are for a single lap thickness only. If your application has more than one element, for the purposes of your calculation, use the data for the smallest thickness in that application.

IMPORTANT NOTICE:

Please note that values in this table, V_{Rk} , are "*characteristic loads*", therefore the reader should apply an appropriate factor of safety (depending on their adopted design methodology) to the stated values to yield their own design load or recommended load. For further information on characteristic loads, design loads and recommended loads, please refer to Appendix VII of this document.

[54] 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,

[55] Derived from empirical tests as per EAD 330046-01-0602[NC],

[56] Relates only to SuperTEK® X product as this thickness of substrate is beyond the self-drilling capacity of SuperTEK® 8,

9.2.3 Extruded aluminium alloys (pursuant to BS EN 485-2 or BS EN 755-2[57])

Table 16: Characteristic withdrawal resistance[58,59], N_{Rk}, of SuperTEK® 8 and X in various thicknesses of extruded aluminium alloys (in Newtons)							
Grade	**Substrate thickness, *t***						
	10.0mm	**12.5mm**	**15.0mm**	**20.0mm**	**25.0mm**	**30.0mm[60]**	**35.0mm[60]**
6061 – T6	5,570 [6,730]	6,970 [8,420]	8,360 [10,100]	11,150 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
6063 – T6	3,710 [4,410]	4,640 [5,510]	5,570 [6,620]	7,430 [8,825]	9,290 [11,035]	11,150 [Ultimate]	13,010 [Ultimate]
6082 – T6	5,920 [6,970]	7,400 [8,710]	8,880 [10,450]	11,850 [Ultimate]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
6262 – T9	5,570 [6,040]	6,970 [7,550]	8,360 [9,060]	11,150 [12,080]	Yield [Ultimate]	Yield [Ultimate]	Yield [Ultimate]
Interpolation between values is forbidden.							

IMPORTANT NOTICE:

Please note that values in this table, N_{Rk}, are "*characteristic loads*", therefore the reader should apply an appropriate factor of safety (depending on their adopted design methodology) to the stated values to yield their own design load or recommended load. For further information on characteristic loads, design loads and recommended loads, please refer to Appendix VII of this document.

[57] Specifically, BS EN 485-2: 2016 & A1: 2018 and/ or BS EN 755-2: 2016,
[58] 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,
[59] Derived from empirical tests as per BS EN 14566: 2008 & A1: 2012,
[60] Relates only to SuperTEK® X product as this thickness of substrate is beyond the self-drilling capacity of SuperTEK® 8,

Table 17: Characteristic lap-shearing resistance[61,62], V_{Rk}, of SuperTEK® 8 and X in various thicknesses of extruded aluminium alloys (in Newtons)							
Grade	Substrate thickness, *t*						
	10.0mm	12.5mm	15.0mm	20.0mm	25.0mm	30.0mm[63]	35.0mm[46]
6061 – T6	2,710 [4,320]	3,180 [5,070]	3,660 [5,830]	4,610 [7,350]	5,560 [Ultimate]	6,510 [Ultimate]	7,470 [Ultimate]
6063 – T6	1,800 [2,810]	2,120 [3,300]	2,440 [3,800]	3,070 [4,780]	3,710 [5,770]	4,340 [6,760]	4,980 [Ultimate]
6082 – T6	2,910 [4,520]	3,420 [5,310]	2,930 [6,100]	4,950 [Ultimate]	5,980 [Ultimate]	7,000 [Ultimate]	Yield [Ultimate]
6262 – T9	2,710 [3,910]	3,180 [4,600]	3,660 [5,290]	4,610 [6,660]	5,560 [Ultimate]	6,510 [Ultimate]	7,470 [Ultimate]
Interpolation between values is forbidden.							

The figures shown are for a single lap thickness only. If your application has more than one element, for the purposes of your calculation, use the data for the smallest thickness in that application.

IMPORTANT NOTICE:

Please note that values in this table, V_{Rk}, are "*characteristic loads*", therefore the reader should apply an appropriate factor of safety (depending on their adopted design methodology) to the stated values to yield their own design load or recommended load. For further information on characteristic loads, design loads and recommended loads, please refer to Appendix VII of this document.

[61] 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,

[62] Derived from empirical tests as per EAD 330046-01-0602[NC],

[63] Relates only to SuperTEK® X product as this thickness of substrate is beyond the self-drilling capacity of SuperTEK® 8,

10.0 List of figures

11.0 List of tables

12.0 List of formulae

Equation 01: Formula to derive a statistical minimum value from a dataset for a low risk parameter. The resulting stated value shall have a confidence of 95.00%. (United Kingdom Accreditation Service, 2012)

$$X_{st,m} = \left(\left(\sum X_{st,m} / X_n\right) - 2 \cdot \sigma\right)$$

Where:
- $X_{st,m}$ is the statistical minimum value
- $\sum X_{st,m}$ is the summation of values in the dataset
- X_n is the number of incidences of values in the dataset
- σ is the statistical standard deviation of the dataset

Equation 02: Formula to derive a statistical minimum value from a dataset for a medium risk parameter. The resulting stated value shall have a confidence of 99.75%. (United Kingdom Accreditation Service, 2012)

$$X_{st,m} = \left(\left(\sum X_{st,m} / X_n\right) - 3 \cdot \sigma\right)$$

Where:
- $X_{st,m}$ is the statistical minimum value
- $\sum X_{st,m}$ is the summation of values in the dataset
- X_n is the number of incidences of values in the dataset
- σ is the statistical standard deviation of the dataset

Equation 03: Formula to derive the elastic section modulus. (Gere, 1980)

$$W_{eL} = \frac{\pi \cdot d^3}{32}$$

Where:
- W_{eL} is the elastic section modulus
- π is Pi
- d^3 is the minor thread diameter (cubed)

Equation 04: Formula to derive the bending moment capacity of an individual fastener. (European Committee for Standardisation, 2014)

$$M_{c,Rd} = \frac{W_{eL} \cdot f_y}{\gamma_{M0}}$$

Where:
- $M_{c,Rd}$ is the bending moment capacity
- W_{eL} is the elastic section modulus
- f_y is the material yield strength
- γ_{M0} is the partial safety factor for material strength

Equation 05: Formula to derive the lateral-torsional buckling resistance of an individual fastener. (European Committee for Standardisation, 2014)

$$M_{b,Rd} = X_{LT} \cdot W_{eL} \cdot \left(\frac{f_y}{\gamma_{M0}}\right)$$

Where:
- $M_{b,Rd}$ lateral-torsional buckling resistance
- X_{LT} reduction factor for lateral-torsional buckling (Brettle, 2009)
- W_{eL} elastic section modulus
- f_y material yield strength
- γ_{M0} partial safety factor for material strength

Equation 06: Formula to derive the polar moment of inertia of a fastener. (Cobb, 2004)

$$J = \frac{1}{2} \cdot \pi \cdot r^4$$

Where:
- J is the polar moment of inertia
- π is Pi
- r^4 is the minor thread radius (fourth power of)

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14.0 Index

APPENDIX I Qualified vendors list (power tools for use with SuperTEK® products)

The list in this appendix is not exhaustive and is provided only to give an indication of tooling which we have deemed acceptable for the installation of our products. Where a product is marked "*prohibited*", the use of such tool will invalidate the Evolution Product Warranty.

If your power tool is not included in these lists, please contact our Technical Support Team. As a rule, all power tools which use an impact action are prohibited, this includes all drill-drivers, combi-drills, impact screwdrivers, impact wrenches, rotary hammer drills, percussion drills and breakers.

BOSCH Invented for life	**Bosch® Power Tools** (logo and trademark are the property of Robert Bosch GmbH)
GSR 18 V-60 C	PROHIBITED
GSR 12 V-15 FC	PROHIBITED
GWB 10.8 V-LI	PROHIBITED
GSR 12 V-35	PROHIBITED
GWB 12 V-10	PROHIBITED
GSR 18 V-28	PROHIBITED
GSR 1440-LI	PROHIBITED
GSR 18 V-EC	PROHIBITED
GSR 18 V-EC FC2	PROHIBITED
GTB 12V-11	PROHIBITED
GSR 18 V-EC TE	PROHIBITED
GSB 18V-60 C	PROHIBITED
GSB 18V-28	PROHIBITED
GSB 18 VE-2-LI	PROHIBITED
GSB 36 VE-2-LI	PROHIBITED
GBH 18V-26 D	PROHIBITED
GBH 36 VF-LI	PROHIBITED
GDR 12V-105	PROHIBITED
GDR 18V-160	PROHIBITED
GDX 18V-180	PROHIBITED
GDS 18 V-EC 250	PROHIBITED
GDS 18 V-LI HT	PROHIBITED
GSB 16 RE	PROHIBITED
GSB 1600 RE	PROHIBITED
GSB 21-2 RCT	PROHIBITED
GSR 6-25 TE	APPROVED

DEWALT	DeWalt® Power Tools (logo and trademark are the property of Stanley Black & Decker inc)
DCD790D2	PROHIBITED
DCD791D2	PROHIBITED
DCD701D2	PROHIBITED
DCD985M2	PROHIBITED
DCD795M2	PROHIBITED
DCD797D2B	PROHIBITED
DCD716D2	PROHIBITED
DW217	PROHIBITED
DW221	PROHIBITED
DW241	PROHIBITED
D21717K	PROHIBITED
D2181KS	PROHIBITED
DWD524KS	PROHIBITED
DCH253N	PROHIBITED
DCH273P2	PROHIBITED
DCH333X2	PROHIBITED
D25333K	PROHIBITED
DCF620N	PROHIBITED
DCF22P2	APPROVED
DCF622N	APPROVED
DCF887P2	PROHIBITED
DCF888N	PROHIBITED
DCF894HN	PROHIBITED
DCF880M2	PROHIBITED
DW294	PROHIBITED
DCF889N	PROHIBITED
DCF899N	PROHIBITED
DCF897N	PROHIBITED
DCF902D2	PROHIBITED

FEIN® Power Tools (logo and trademark are the property of C & E Fein GmbH)	
ASCM 18 QSW	**PROHIBITED**
ASBU 12 W4	**PROHIBITED**
ABH18	**PROHIBITED**
ABOP 6	**PROHIBITED**
BOP 10	**PROHIBITED**
BOS 16	**PROHIBITED**
BOZ 32-4M	**PROHIBITED**
ASCD 18-300 W2 (or W4)	**PROHIBITED**
ASCD 12-150 W8 (or W4)	**PROHIBITED**
ASCD 12-100 W4C	**PROHIBITED**
ASM 18-12 PC	**PROHIBITED**
SCT 5-40 X	**PROHIBITED**
ASCT 14 M	**PROHIBITED**
ASCT 18	**PROHIBITED**
SCS 4.8-25	**PROHIBITED**
ASCS 6.3	**APPROVED**

HILTI® Power Tools (logo and trademark are the property of HILTI Corporation AG)	
TE 6-A22	**PROHIBITED**
TE 30-A36	**PROHIBITED**
TE 300-A36	**PROHIBITED**
TE 500-A36	**PROHIBITED**
SF 2H-A12	**PROHIBITED**
SFD 2-A12	**PROHIBITED**
SFC 22-A	**PROHIBITED**
SF 6H-A22	**PROHIBITED**
SF 8M-A22	**PROHIBITED**
SF 10W-A22 ATC	**PROHIBITED**
SD 5000-A22	**PROHIBITED**
ST 1800-A22	**APPROVED**
SBT 4-A22	**PROHIBITED**
SID 2-A12	**PROHIBITED**
SID 4-A22	**PROHIBITED**
SID 8-A22	**PROHIBITED**
SIW 22T-A	**PROHIBITED**
SIW 9-A22	**PROHIBITED**

Makita	**Makita® Power Tools** (logo and trademark are the property of Makita Kabushiki-gaisha Corporation)
BHR262TRDE (and all variants of)	PROHIBITED
DHR162RFE (and all variants of)	PROHIBITED
DHR171RMJ (and all variants of)	PROHIBITED
DHR202RMJ (and all variants of)	PROHIBITED
DHR243RMJW (and all variants of)	PROHIBITED
DHR280ZJ (and all variants of)	PROHIBITED
DHR400ZKU	PROHIBITED
HR166DZ	PROHIBITED
DHP458RF3J	PROHIBITED
DHP482RTJ	PROHIBITED
DTP141Z	PROHIBITED
DDF083Z	PROHIBITED
DDF453RFE	PROHIBITED
DDF458Z	PROHIBITED
DDF481RMJ	PROHIBITED
DDF484Z	PROHIBITED
DTD152RMJ	PROHIBITED
DTD154RTJ	PROHIBITED
DTD171Z	PROHIBITED
DTS141ZJ	PROHIBITED
DTW1001RTJ (and all variants of)	PROHIBITED
DTW285RMJ (and all variants of)	PROHIBITED
DTW450RMJ (and all variants of)	PROHIBITED
DFS140RTJ	PROHIBITED
DFS251RTJ	APPROVED
DFS251Z	APPROVED
FS2500	APPROVED
DFS451RMJ	PROHIBITED
DFS452RMJ	PROHIBITED

APPENDIX II Corrosion resistance and corrosivity categories

Metal corrosion (erroneously, but generally referred to as "*rusting*"[64]) is the formation of an oxide layer due to the oxidation of the metal.

The mechanism of this is the formation of local electrochemical electrode pairs on the metal surface (i.e. an anode and a cathode) in the presence of an electrolyte (which could simply be moisture from atmosphere combined with dust as water itself is ionically non-conductive). Positive ions are dissolved from the anode to the electrolyte solution and produce negative electrons in the metal lattice, which then migrate in the metal to the cathode. In the cathode, the electrons are consumed in cathodic reactions. Where the electrolyte contains an acid (i.e. sulphuric acid from rainfall), hydrogen gas is produced, while in pH neutral electrolytes oxygen reduction produces hydroxide ions. The electrically conductive electrolyte between the anode and cathode closes the circuit. The anode and cathode sites can be next to one another, resulting in the formation of uniform corrosion or separated from one another resulting in localised corrosion. The anode site is the metal surface's less noble site or a site with higher surface energy (Teknos Oy, 2013). Figure A.II-1 illustrates the formation of electrode pairs on the metal surface as well as the anodic and cathodic reactions for the oxidisation of Iron.

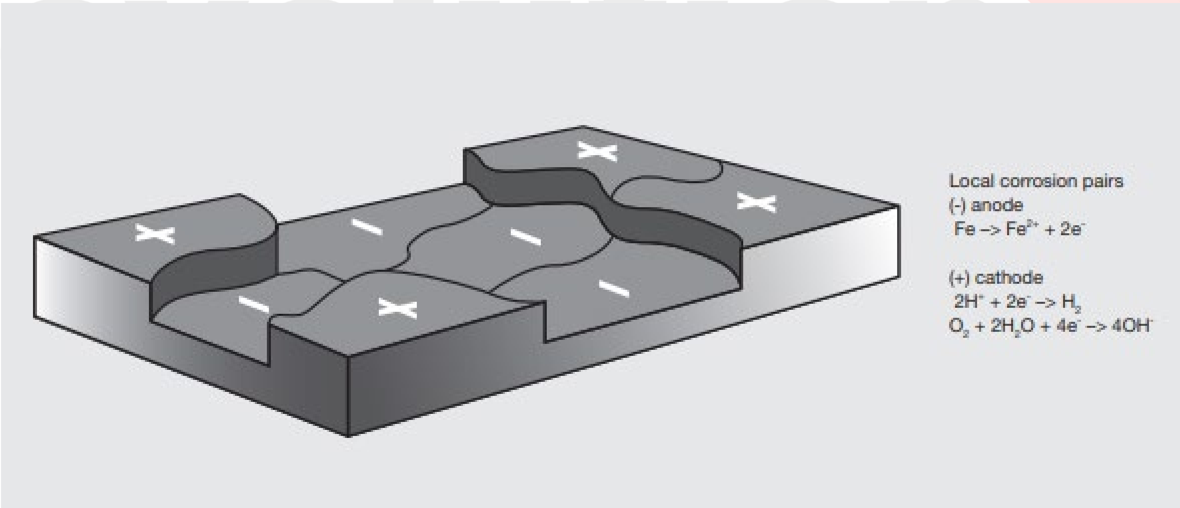

Figure A.II-1 – The formation of electrode pairs on a metal surface and the anodic and cathodic reactions

[64] "*Rust*" is specifically the name for formation of Iron (III) Oxide (Chemical formula = Fe_2O_3), the oxidation product of steels due to their high Iron content,

Knowing the mechanism of corrosion, tests have been derived to evaluate the integrity and resistance to corrosion of coatings, the three primary tests utilised by Evolution Fasteners are

BS EN ISO 9227: 2017 *"Corrosion tests in artificial atmospheres. Salt spray tests.",*

ASTM B117 – 18 *"Standard practice for operating salt spray (fog) apparatus.",*

ISO 22479: 2019 *"Corrosion of metals and alloys. Sulphur dioxide test in a humid atmosphere (fixed gas method).".*

The two former tests are known as neutral salt spray tests and the latter is known as the Kesternich test. Performing these tests in our UKAS accredited laboratory, we are able to determine a reasonable life expectancy for our fasteners and their coatings.

Combining this with a corrosivity category allows us to provide a warranted period which is dependent on both the coating/ material and the environmental conditions the screws will face in reality. Tables A.II – 01 and A.II – 02 show these parameters:

Table A.II – 01: Atmospheric corrosivity categories and examples of typical environments

Corrosivity category[65]	Risk Level	Estimated Steel Thickness Loss[66] (µm/yr)	Examples of typical environmental conditions[67]	
			Exterior	Interior
C1	Very low	≤ 1.3	Not applicable.	Home, school, office, etc.
C2	Low	> 1.3 ≤ 25.0	Rural area with no pollution.	Sport hall, etc.
C3	Medium	≥ 25.0 ≤ 50.0	Urban area with low pollution.	Area with humidity, laundry, etc.
C4	High	≥ 50.0 ≤ 80.0	Industrial area with moderate pollution.	Chemical plants, etc.
C5	Very high	≥ 80.0 ≤ 200.0	Area with high humidity or saline presence	Coastal building, swimming pool, etc.
CX	Extreme	≥ 200.0 ≤ 700.0	Marine.	Marine.

[65] Pursuant to BS EN ISO 12944-2 and BS EN ISO 9223,
[66] Values taken from BS EN ISO 9223 and are based on steel being a low-carbon steel alloy,
[67] Informative only,

Table A.II – 02: Warranty periods for differing coatings or materials in differing corrosivity categories.					
Coating/ Material	**NSST Rating (hours)**	**CCT Rating (cycles)**	**Corrosivity Category**	**Warranty Period (Years)**	
				Internal	**External**
EvoShield® 500	≥ 500	≥ 30	C1	50	50
			C2	50	25
			C3	25	25
			C4	Prohibited	Prohibited
			C5	Prohibited	Prohibited
			CX	Prohibited	Prohibited
EvoShield® 1000	≥ 1,000	≥ 100	C1	50	50
			C2	50	50
			C3	50	25
			C4	25	25
			C5	Prohibited	Prohibited
			CX	Prohibited	Prohibited
EvoShield® 2000	≥ 2,000	≥ 200	C1	50	50
			C2	50	50
			C3	50	50
			C4	50	25
			C5	Prohibited	Prohibited
			CX	Prohibited	Prohibited
Stainless Steel A2-80 (EN 1.4301)	≥ 2,000	≥ 200	C1	50	50
			C2	50	50
			C3	50	25
			C4	50	25
			C5	Prohibited	Prohibited
			CX	Prohibited	Prohibited
Stainless Steel A4-50 (EN 1.4401)	≥ 3,000	≥ 300	C1	50	50
			C2	50	50
			C3	50	50
			C4	50	50
			C5	25	25
			CX	Prohibited	Prohibited

APPENDIX III Installation troubleshooting

Problem	Cause	Solution
The drilling point is turning but not cutting!	You have the tool in reverse.	Switch direction of tool rotation to clockwise.
The drilling point isn't cutting and when I look at it: it's turning flat or mushroom shaped!	You're leaning on the tool too hard or you're using an impact tool.	It only takes a few kilograms of weight on the back of the tool to provide enough force for cutting, just relax and let the drilling point do its' work.
The drilling point isn't cutting and when I look at it: it's melted or turned a purple colour!	You're turning the screw too fast or you're using an impact tool.	Your screwdriver can go 2,500 RPM but it only takes about 750 RPM to cut steel. Back off the trigger to half revs and let the drilling point do its' work.
The screw isn't drilling the entire way through!	You're probably trying to drill too thick a thickness of steel.	Ensure you're using the right screw for the job and that your screws are being used within the limits outlined in Appendix IV.
The fixture is moving up the screw thread instead of drilling continuing!	You didn't adequately clamp or restrain the substrate or there is a gap between the fixture and substrate.	Clamp the fixture to the substrate. Check that the drilling point is longer than the combined thickness of your fixture and substrate (including any air gap or void between them). If it is not long enough then you will need to call our Technical Support Team to consider your option.
The screw isn't tapping and is getting stuck!	You're probably using the wrong screw type for your substrate.	Ensure you're using the right screw for the job and that your screws are being used within the limits outlined in Appendix IV.
The screw isn't tapping and is snapping!	If you've selected the right screw for the thickness of steel, this only happens when you're using an impact tool. Otherwise you're using the wrong screw type for your substrate.	Ensure you're using the right screw for the job and that your screws are being used within the limits outlined in Appendix IV.

APPENDIX IV Limitations of self-drilling screws (drilling capacity, tapping capacity, etc)

In self-drilling screws there are limitations on the self-drilling capacity and tapping capacity. These limitations are caused by the physical characteristics of the screws as well as their metallurgical properties and the properties of the substrates that they are being used in.

Limitation on self-drilling capacity

Nominally, the biggest limitation is on the length of the self drilling point itself. The point has to be long enough so that it can drill through both the fixture and the substrate before the threads contact the fixture. If drilling is not completed before the threads start to engage this will cause the fixture to start riding up the thread of the screw in a phenomenon called "*jacking*" as shown in Figure A.IV - 1.

This happens because drilling is a low-torque-high-speed action and tapping is a high-torque-low-speed action, so when the drill can no longer spin fast enough to drill, it acts as a bearing face in the partially cut hole, the free rotation of which will cause the thread to proceed in the fixture.

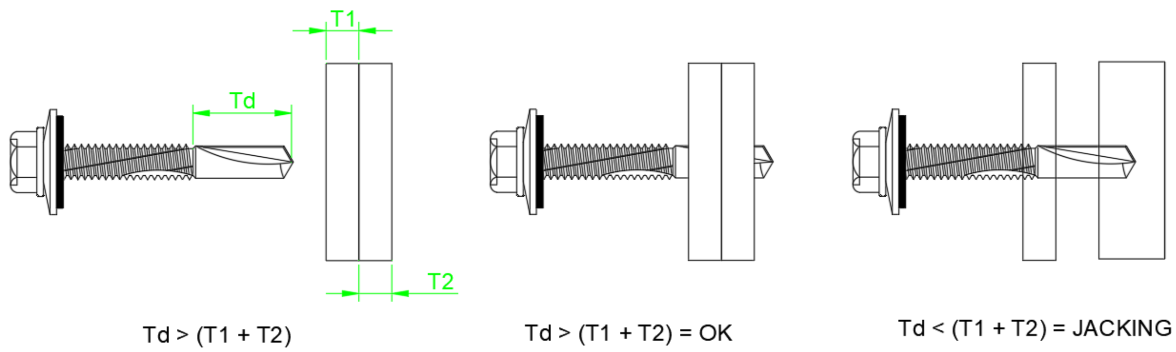

Figure A.IV – 1: Schematic of jacking phenomenon

TEK Screws® are generally made of carbon steel, most commonly grades such as SAE C1020, SAE C1022 and JIS G4105 SCM 435. They are also heat treated to raise the tensile strength of the screws as well as the hardness as the hardness of the screw has to be several times more than the hardness of the substrate to stop the drilling point from blunting before successfully drilling the substrate materials.

As such the materials and their mechanical properties which are used by Evolution Fasteners are summarised in Table A.IV - 01:

Table A.IV - 01: Typical mechanical properties of Evolution Fasteners product wire/ blanks

Grade	Pre-Hardening & Quenching			Post-Hardening, Quenching & Tempering		
	Tensile Strength, R_m (N/mm^2)	Yield Strength, R_{eH} (N/mm^2)	Hardness (HB)	Tensile Strength, R_m (N/mm^2)	Yield Strength, R_{eH} (N/mm^2)	Hardness (HB)
SAE C1020/ C1022	550	330	330	1,220	980	550
JIS G4105 SCM 435	930	785	210	1,300	1,095	600
NOTE: Values provided are for educational purposes only – not for commercial purposes.						

The screws are generally designed for use in the construction market of the United Kingdom and as such are likely to only be used in mild structural steels graded to BS EN 10025-2: 2004. The properties of the most common steels used are shown in Table A.IV - 02[68] below (which is not exhaustive):

Table A.IV - 02: Typical mechanical properties of UK construction sector structural mild steels

Grade	Tensile Strength, R_m (N/mm^2)	Yield Strength, R_{eH} (N/mm^2)	Hardness (HB)	Compatible with TEK Screws®
S185	290	185		
S235	510	235	140 - 290	Yes
S275	560	275		
S355	630	355		
E295	610	295		
E335	710	335		
E360	830	360		No
S450	720	460		Yes
S500	770	500		
S690	940	690	N/A	No
S960	1,150	960		
NOTE: Values provided are for educational purposes only – not for commercial purposes.				

[68] Table derived from BS EN 10025-2: 2004, BS EN 10025-4: 2004 and BS EN 10024-6: 2004.

Generally, as a rule; TEK Screws® cannot be used in substrates which are either too ductile (and will "gum" the blade (specifically become trapped in the tapered honed section of the cutting point blades) thus stopping the cutting point from advancing any further, or; cannot be used in substrates which have too high a hardness or tensile strength.

This can be summarised in a unity factor equation as below:

$$\left(\left(\frac{R_m^{Substrate}}{R_m^{Fastener}}\right)^2 + \left(\frac{H_B^{Substrate}}{H_B^{Fastener}}\right)^2\right) \neq \geq 0.80$$

Where:

Where:	$R_m^{Substrate}$	=	Tensile strength of the substrate material,
	$R_m^{Fastener}$	=	Tensile strength of the fastener material,
	$H_B^{Substrate}$	=	Hardness of the substrate material,
	$H_B^{Fastener}$	=	Hardness of the fastener material.

It is also important to calculate the various parameters effecting cutting and drilling operations, this requires the drilling time to be tested and recorded in various substrates. Fortunately, Evolution Fasteners (UK) Ltd are in the unique position of having a UKAS accredited testing laboratory in-house which has recorded the drilling time performance for various TEK screws in differing substrate thicknesses of the same material properties.

A summarisation of the mean times taken to drill different thicknesses of mild steel substrate are given below in Table A.IV - 03. It should be noted that the figures presented in the table are the mean of 50 tests per variable minus twice the standard deviation of the individual tests per variable, this is in line with standard central limit theorem presentation as recommended by the National Physics Laboratory[69]:

Table A.IV - 03: Typical drilling times (S_d) of Evolution Fasteners product in varying substrate thicknesses (in seconds) – S275 JR mild steel

Point Type	Substrate Thicknesses, t_{sub} (in mm)													
	0.7	**1.2**	**1.5**	**2**	**2.5**	**3**	**4**	**5**	**8**	**10**	**12.5**	**15**	**20**	**25**
1/2	0.3	0.6	1.0	1.2	1.5									
3		1.1	1.2	1.6	2.2	2.8	3.7	4.0						
5							4.0	4.3	6.7	9.8	14.6			
6/7							3.2	3.9	6.1	8.3	10.0	12.1		
8/10							3.6	4.1	7.0	9.2	10.9	12.8	21.9	28.0

NOTES:

1. Values provided are for educational purposes only – not for commercial purposes,
2. Interpolation is forbidden.

From Table A.IV - 03, it is possible now to calculate various other parameters such as drilling speed (v_c), penetration rate (v_f), feed per revolution (f_n), substrate material removal rate (Q) and torque required to drill substrate (τ_c) using the formulae presented below[70]:

Cutting Speed:

$$v_c = \left(\frac{t_{sub}}{S_d}\right) \times 60$$

Where:

v_c = Cutting speed,

t_{sub} = Nominal substrate thickness,

S_d = Typical drilling time.

[69] http://www.npl.co.uk/mathematics-scientific-computing/measurement-uncertainty-evaluation/research/propagation-of-distributions.

[70] https://www.sandvik.coromant.com/en-gb/knowledge/machining-formulas-definitions/pages/drilling.aspx.

<table>
<tr><th colspan="15">Table A.IV - 04: Cutting speed (v_c) in S275JR mild steel</th></tr>
<tr><th rowspan="2">Point Type</th><th colspan="14">Substrate Thicknesses, t_{sub} (in mm)</th></tr>
<tr><th>0.7</th><th>1.2</th><th>1.5</th><th>2</th><th>2.5</th><th>3</th><th>4</th><th>5</th><th>8</th><th>10</th><th>12.5</th><th>15</th><th>20</th><th>25</th></tr>
<tr><td>1/2</td><td colspan="5">36.0 mm/min</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3</td><td></td><td colspan="7">48.0 mm/min</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>5</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="5">51.4 mm/min</td><td></td><td></td><td></td></tr>
<tr><td>6/7</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="6">74.1 mm/min</td><td></td><td></td></tr>
<tr><td>8/10</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="8">53.5 mm/min</td></tr>
<tr><td colspan="15">NOTE: Values provided are for educational purposes only – not for commercial purposes.</td></tr>
</table>

Feed per Revolution:

$$f_n = \frac{v_c}{n}$$

Where: f_n = Feed per resolution.

<table>
<tr><th colspan="4">Table A.IV - 05: Feed per revolution (f_n) in S275JR mild steel</th></tr>
<tr><th>Point Type</th><th>Cutting Speed, v_c (mm/min)</th><th>Rotational Speed, n (RPM)</th><th>Feed per Revolution, f_n (mm/1rpm)</th></tr>
<tr><td>1/2</td><td>36.0</td><td rowspan="5">1,250</td><td>0.0288</td></tr>
<tr><td>3</td><td>48.0</td><td>0.0384</td></tr>
<tr><td>5</td><td>51.4</td><td>0.0411</td></tr>
<tr><td>6/7</td><td>74.1</td><td>0.0593</td></tr>
<tr><td>8/10</td><td>53.5</td><td>0.0428</td></tr>
<tr><td colspan="4">NOTE: Values provided are for educational purposes only – not for commercial purposes.</td></tr>
</table>

Substrate Removal Rate:

$$Q = \left(\frac{d_{nom} \cdot f_n \cdot v_c}{4}\right)$$

Where: Q = Substrate removal rate.

Table A.IV - 06: Substrate removal rate in S275JR mild steel					
Point Type	**Nominal Diameter, d_{nom} (mm)**	**Cutting Speed, v_c (mm/min)**	**Feed per Revolution, f_n (mm/1rpm)**	**Substrate Removal Rate, Q (cm^3/min)**	**Substrate Removal Rate, Q (mm^3/s)**
1/2	4.2	36.0	0.0288	1.0886	18.14
	4.8			1.2442	20.74
3	4.2	48.0	0.0384	1.9354	32.26
	4.8			2.2118	36.86
	5.5			2.5344	42.24
5	5.5	51.4	0.0411	2.9047	48.41
6/ 7	5.5	74.1	0.0593	6.0420	100.70
8/ 10/ X	6.3	53.5	0.0428	4.9968	83.28
NOTE: Values provided are for educational purposes only – not for commercial purposes.					

Net Power Required to Drill Substrate:

$$P_c = \frac{f_n \cdot v_c \cdot d_{nom} \cdot k_c}{240 \times 10^3}$$

Where: P_c = Net power required to drill substrate,

k_c = specific cutting force required to drill substrate[71].

Table A.IV - 07: Net power required to drill substrate in S275JR mild steel					
Point Type	**Nominal Diameter, d_{nom} (mm)**	**Cutting Speed, v_c (mm/min)**	**Feed per Revolution, f_n (mm/1rpm)**	**Specific Cutting Force, k_c (N/mm^2)**	**Net Power Required to Drill, P_c (kW)**
1/2	4.2	36.0	0.0288	3,610	0.07
	4.8				0.08
3	4.2	48.0	0.0384		0.12
	4.8				0.13
	5.5				0.15
5	5.5	51.4	0.0411		0.17
6/ 7	5.5	74.1	0.0593		0.36
8/ 10/ X	6.3	53.5	0.0428		0.22
NOTE: Values provided are for educational purposes only – not for commercial purposes.					

[71]http://www.mitsubishicarbide.net/contents/mhg/ru/html/product/technical_information/information/formula4.html.

Peak Torque During Drilling Phase:

$$\tau_c = \frac{P_c \cdot 30 \times 10^3}{\pi \cdot n}$$

Where: τ_c = Peak torque required to drill substrate

Table A.IV - 08: Peak torque during drilling phase in S275JR mild steel			
Point Type	**Nominal Diameter, d_{nom} (mm)**	**Substrate Thicknesses, t_{sub} (in mm)**	**Peak Torque, τ_c (Nm)**
1/ 2	4.2	2.5	0.53
	4.8		0.61
3	4.2	5.0	0.92
	4.8		0.99
	5.5		1.15
5	5.5	12.5	1.30
6/ 7	5.5	20.0	2.75
8/ 10/ X	6.3	25.0	1.68
NOTE: Values provided are for educational purposes only – not for commercial purposes.			

Limitation on self-tapping capacity

The self-tapping performance of the fasteners is determined by both the torque capacity of the fasteners and the thickness of substrate material that is required to be tapped by the male thread of the fastener.

In the tapping phase there are two ways a female thread is formed in the substrate, the first way is where a sharp thread will cut the female thread, the second way is where a female thread is formed in the substrate by displacement of the substrate material around the male thread of the fastener.

In practice cut threading is used in fasteners which will have to tap a thread into thicknesses of steel greater than 2.5mm in thickness and as such these fasteners will generally have a thread with an angle of approximately 40˚. This is advantageous as it significantly reduces the torque required to form a thread is thicker substrates or even thinner substrates of a higher tensile strength.

By comparison the thread-forming method by displacing substrate material is only used when fixing together thin substrates (generally of a thickness of 2.5mm or less), with the optimal thickness being between 0.5mm and 1.2mm. This method is preferred as it does not weaken the substrate by removing material and instead locally deforms the substrate over the male threads of the fasteners. This happens when the tensile strength (and hardness) of the fasteners is significantly higher than that of the substrate. This has the additional benefit of significantly mitigating against the possibility of the fastener reaming a clearance hole in the substrate when the torque required to install a screw is greater than the torque capacity of the female thread in the substrate. Generally, these kinds of threads have an angle of approximately 60˚ and a very high (comparatively) thread pitch (the distance between individual thread peaks).

The increasing of distance between threads has the advantage of mitigating against substrate reaming at the cost of heavily reduced pull-out (withdrawal resistance) capacity.

Peak Torque During Tapping Phase[72]:

$$\tau_t = g_P \cdot k_{sub} \cdot t_{sub} \cdot P^2$$

Where:

τ_t	=	Peak torque during tapping phase,
g_P	=	Gravitational constant converted to Power,
k_{sub}	=	Coefficient for work hardening of substrate[73],
t_{sub}	=	Thickness of substrate,
P^2	=	Nominal thread pitch (squared).

Table A.IV - 09: Peak torque during tapping phase, τ_t (in Nm) – S275JR mild steel

Point Type	Substrate Thicknesses, t_{sub} (in mm)													
	0.7	**1.2**	**1.5**	**2**	**2.5**	**3**	**4**	**5**	**8**	**10**	**12.5**	**15**	**20**	**25**
1/2	0.3	0.5	0.6	0.9	1.0									
3		0.6	0.6	0.9	1.1	1.4	1.8	2.3						
5							1.2	1.5	2.4	3.1	4.0			
6/7							1.1	1.3	2.2	2.8	3.4	4.1		
8/10/X							1.4	1.7	2.8	3.7	3.9	4.4	6.2	7.1

NOTES:

1. Values provided are for educational purposes only – not for commercial purposes,
2. Interpolation is forbidden.

[72] http://www.tanoi-mfg.co.jp/us/taflet/main.html,
[73] "Prediction of tapping forces and torque for (sic) alloyed steel" by M. Popovic et al,

Torque capacity of fasteners[74]:

$$\tau_f = \int \left(R_{eH} \cdot \left(k_\tau \cdot \frac{d_{nom}}{2}\right)^2\right)$$

Where: τ_f = Torque capacity of fastener,

R_{eH} = Yield strength of fastener,

d_{nom} = Nominal diameter of fastener,

k_τ = Coefficient of torque (ratio of thread pitch/ diameter).

<table>
<tr><th colspan="4">Table A.IV - 10: Torque capacity of fasteners (made of SAE C1022 carbon steel)</th></tr>
<tr><th>Point Type</th><th>Nominal Diameter, d_{nom} (mm)</th><th>Yield Strength, R_{eH} (N/mm^2)</th><th>Torque Capacity, τ_f (Nm)</th></tr>
<tr><td rowspan="2">1/ 2</td><td>4.2</td><td rowspan="8">980</td><td>3.2</td></tr>
<tr><td>4.8</td><td>4.2</td></tr>
<tr><td rowspan="3">3</td><td>4.2</td><td>4.1</td></tr>
<tr><td>4.8</td><td>5.3</td></tr>
<tr><td>5.5</td><td rowspan="3">8.0</td></tr>
<tr><td>5</td><td>5.5</td></tr>
<tr><td>6/ 7</td><td>5.5</td></tr>
<tr><td>8/ 10/ X</td><td>6.3</td><td>9.2</td></tr>
<tr><td colspan="4">NOTE: Values provided are for educational purposes only – not for commercial purposes.</td></tr>
</table>

[74] https://www.colorado.edu/engineering/CAS/courses.d/Structures.d/IAST.Lect07.d/IAST.Lect07.pdf.

Torque Capacity of Substrate:

This equation is derived from the theory of von Mises yield criterion[75]:

$$\tau_{sub} = (k_{ts} \cdot (\pi \cdot r^2) \cdot R_{eh}) \cdot t_{sub}$$

Where:

Where:	τ_{sub}	=	Torque capacity of the (female thread) substrate,
	π	=	Ratio of a circles circumference to its diameter,
	r^2	=	Radius of fastener nominal diameter (squared),
	R_{eH}	=	Yield strength of substrate material,
	k_{ts}	=	Reduction factor due to thread diameter min-max ratio,
	t_{sub}	=	Thickness of substrate material.

Table A.IV - 11: Ultimate torque capacity of substrate (Nm) – S275JR mild steel

Point	d_{nom}	Substrate Thicknesses, t_{sub} (in mm)													
		0.7	**1.2**	**1.5**	**2**	**2.5**	**3**	**4**	**5**	**8**	**10**	**12.5**	**15**	**20**	**25**
1/2	4.2	1.5	2.6	3.3	4.4	5.5									
	4.8	2.0	3.4	4.3	5.7	7.1									
3	4.2		3.0	3.8	5.0	6.3	7.6	10.1	12.7						
	4.8		4.0	5.0	6.6	8.2	10.0	13.2	16.6						
	5.5		5.2	6.5	8.7	10.9	13.0	17.4	21.8						
5	5.5							15.1	18.8	30.1	37.7	47.1			
6/7	5.5							15.1	18.8	30.1	37.7	47.1	56.5		
8/10	6.3							19.8	24.7	39.6	49.4	61.8	74.1	98.9	123.7

NOTES:

1. Values provided are for educational purposes only – not for commercial purposes,
2. Interpolation is forbidden.

[75] https://en.wikipedia.org/wiki/Von_Mises_yield_criterion.

APPENDIX V Axis and planes in three dimensional objects

For the purposes of this document, the terminology used is consistent with that which is shown in Figure A.V – 1.

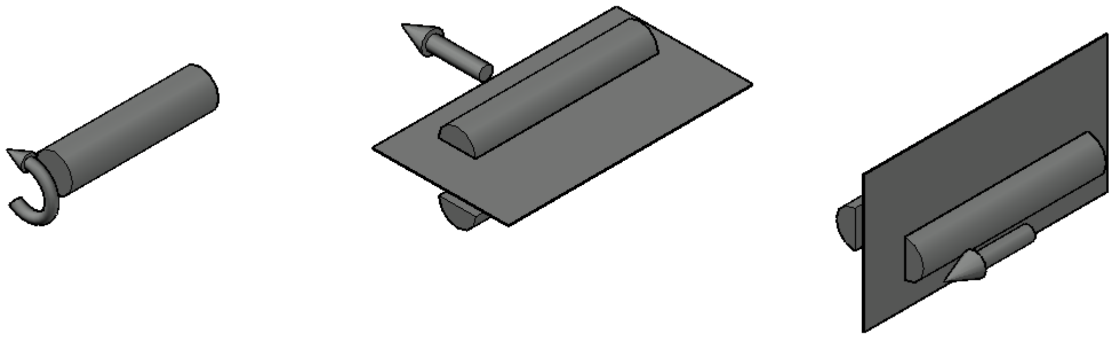

Figure A.V – 1 – Schematic showing direction of planes in 3D space: the radial plane (left), the tangential plane (middle) and the axial plane (right)

APPENDIX VI Explanation of elastic and plastic deformation in screws and substrates

First, you must understand that when load (force) is applied to a body, it causes the body to deform in relation to both the magnitude and the vector of such load, for example:

1. A body in tension will deform axially by extension and tangentially by reduction, and,

2. A body in compression will deform axially by contraction and tangentially by expansion.

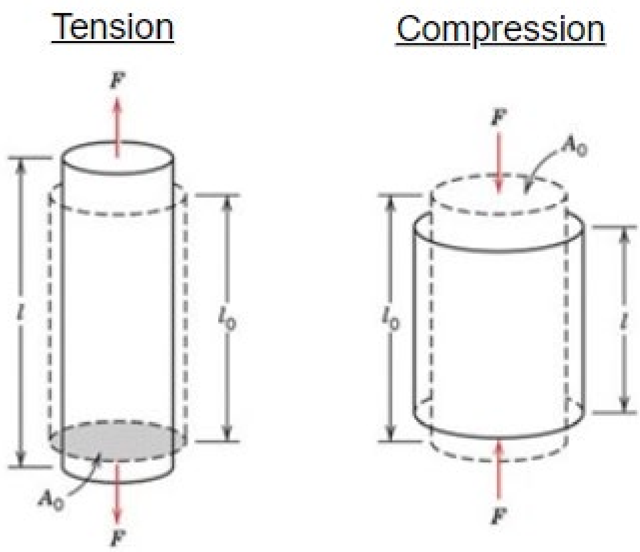

Figure A.VI – 1 – Diagram showing deformation of a body in tension and in compression.

You must also understand the way these bodies deform is not only in relation to their metrological properties but also their metallurgical properties. This is why different materials such as (but not limited to) steel, stainless steel, aluminium, copper, polymers, etc; behave differently. Even materials in the same broad group behave differently, for example SAE C1022 and S275 JR are both steels but their behaviour is wildly different due to the fact that SAE C1022 is a carbon steel and S275 JR is a mild steel.

The differences in behaviour are clearly shown in a stress-strain diagram such as Figure A.VI – 2 on the next page.

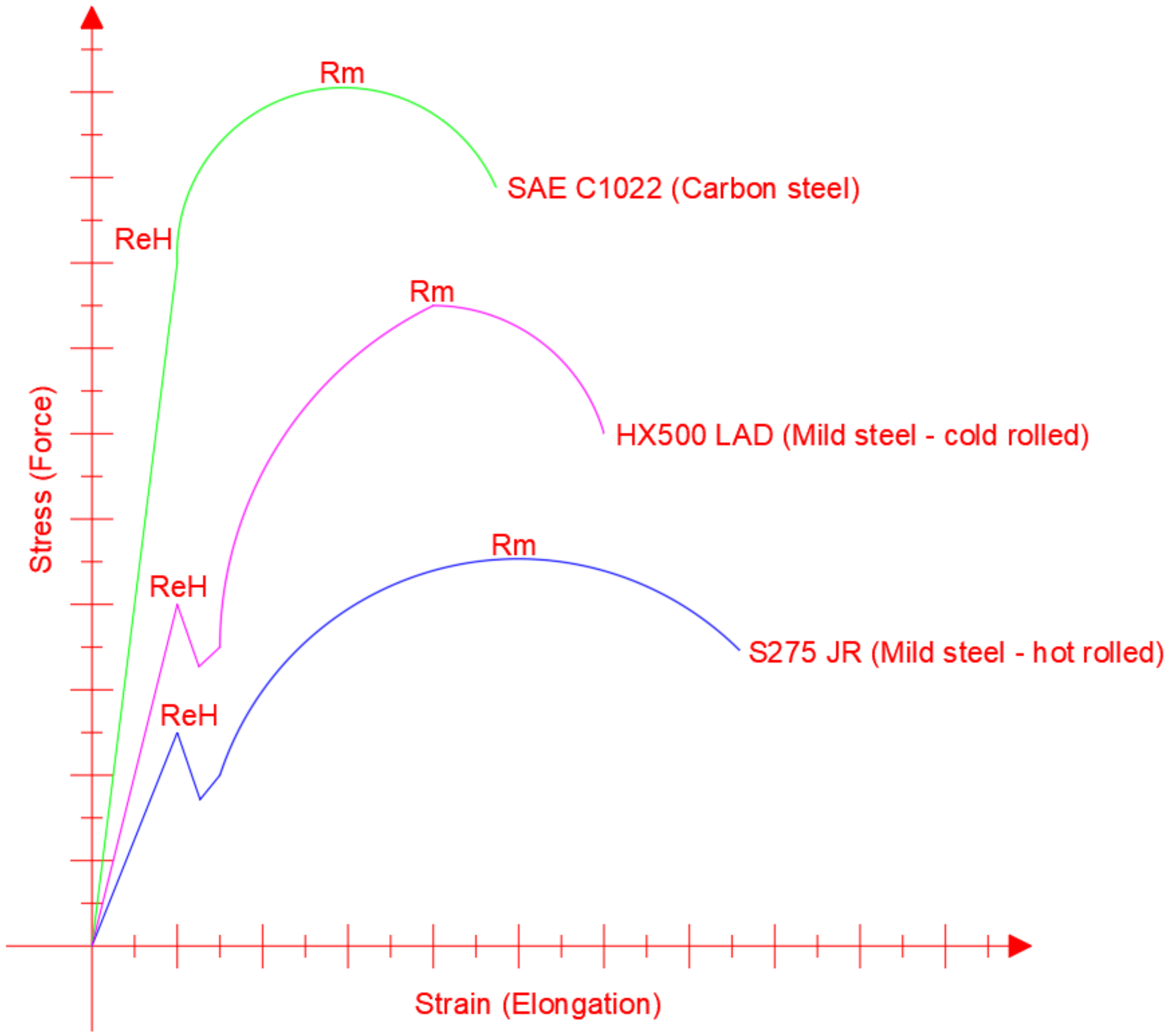

Figure A.VI – 2 – Example stress-strain graph showing differing behaviour between types and grades of steels.

You should be able to see from this graph that:

1. Carbon steels are vastly stronger than a mild steel at a similar stage of elongation,

2. Carbon steels have a much faster transition between plastic and elastic phases of deformation than mild steels,

3. Carbon steels don't elongate as much as mild steels, meaning carbon steels are brittle in nature while mild steels are ductile in nature.

Knowing the differences in the behaviour of these differing steel grades should provide some insight into why this document gives details for elastic and plastic deformation. Some designers may wish to ensure that their design always remains in its' elastic phase so that no permanent deformation occurs in the lifetime of the product. Other designers may not wish to take such a cautionary approach and instead opt to take a permissible stress approach and allow a certain degree of allowable permanent deformation.

It should be noted that Evolution Fasteners UK Ltd always recommends that designers defer to values for elastic deformation and that allowing the fasteners to be stressed into plastic deformation will invalidate the Warranty.

Readers should take careful note of the differences in elastic deformation in the screw and the substrate and remember that in withdrawal and lap-shearing conditions, the vast majority of cases mean that the substrate itself will fail elastically before the screw fails elastically, this consideration is extant in plastic deformation as well.

We accept that a designer or user of this document should have a minimum level of Engineering knowledge to Degree level (min. BSc level) to have the requisite understanding of materials science and that not all readers of this document may have such a level of understanding. To that end, should the reader not understand this or have any other queries regarding this, they should always defer to contacting the Evolution Technical Support Team for further advice.

APPENDIX VII Explanation of characteristic, design and recommended loadings

It is understandable that some readers may be confused by nomenclature surrounding the type of load value that they are reading. For the avoidance of doubt, all values in this document are to be taken as characteristic loads unless explicitly noted to the contrary.

This is due to the fact that Evolution Fasteners UK Ltd have no control over how specifiers design their systems or end-users use our screws. We have no idea what methodology they are adopting whether it be based on a widely adopted building code/ design guide such as Eurocodes or British Standards (i.e. BS EN 1993 – Eurocode 3 and BS 5950 the old British Standard equivalent), or, the designer may be taking an entirely different approach: perhaps using limit state design theory or perhaps using permissible stress design theory.

To that end, our position is to provide characteristic values and that designers should then apply a factor of safety to that characteristic load to derive their own design and recommended loads.

The types of loadings:

Characteristic Load — is the 5% fractile (or in some cases the 2.5% fractile) of the mean ultimate load which was determined by empirical testing. The 5% fractile is just another way of stating a % confidence level that was discussed earlier in Section 8.0 of this document (specifically, the 5% fractile is the subtraction of 2 standard deviations from the mean).

Design Load — is the characteristic load divided by a factor of safety; most Engineers will adopt one of two common methods:

a) The more conservative method (and method we recommend) is a combination (multiplication) of the factor of safety for permanent actions (dead loads), γ_{Gk}, with the factor of safety for variable actions (live loads), γ_{Qk}. This is the preferred method by anyone designing using ultimate and serviceability limit states (limit state design/ load and resistance factor design),

b) material factor of safety, γ_m, which varies depending on the substrate material, the values for which will be dictated by the design standard the designer is using. This is not recommended by Evolution Fasteners as it is not as conservative as the approach in (a). However, in our experience this approach is favoured by designers using permissible stress design.

Recommended Load — is the characteristic load divided by a global factor of safety. This factor of safety is sometimes dictated by the design guide a designer is working to and other times is dictated at statute level by a country's building regulations. In the absence of the aforementioned, Evolution Fasteners UK Ltd recommends a factor of safety of 4.0.

Table A.VII – 01: Equations for different load[76] types

Load Type	Symbol	Equation
Characteristic Load	N_{Rk} = Tension V_{Rk} = Shearing	$N_{Rk} = \left(\left(\sum x_i / n_x\right) - (2 \cdot \sigma)\right)$
Design Load	N_{Rd} = Tension V_{Rd} = Shearing	$N_{Rd} = N_{Rk} / (\gamma_{Gk} \cdot \gamma_{Qk})$
Recommended Load	N_{Rec} = Tension V_{Rec} = Shearing	$N_{Rec} = \frac{N_{Rk}}{4.0}$

[END OF DOCUMENT]

[76] For the purposes of this document, the terms "resistance" and "load" can be used synonymously.