

Training Manual Drywall Screws and Tek Screws



Training Manual

Drywall Screws and Tek Screws



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1.0 -Introduction

Evolution Fasteners (U.K.) Ltd (herein with referred to as Evolution) are distributors and manufacturers of premium construction products. One of our core ranges is drywall screws, both in their collated and loose forms.

Drywall screws come in a large variety of designs due to the varied materials and construction scenarios they are commonly used in. As such this training manual will cover the whole Evolution drywall screw range (as of 29th May 2012) which is comprised of standard and specialised screw designs delivered in loose or collated form.

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2.0 – Design of Drywall Screws

The actual design of the drywall screws is largely dependent on a number of criteria which govern the performance requirements of the screws. These criteria include (but are not limited to):

1. Fixture material which is being fastened through. This can range from standard drywall to specialised boards for lining and rendering, as well as plywood and other materials.
2. Fixing material which is being fastened into. As per the fixture material this can range from standard drywall to timber or mild steel sections,
3. Environmental conditions. This can range from dry internal to wet external, but is influenced by other considerations such as industrial vapours, effluents, steam, humidity, proximity to the sea and a wide array of factors which are specific to the actual application (usually determined during correspondence with the Specifier),
4. Health and safety conditions. These include and are related to environmental conditions but could take the form as snagging objects, sharp edges and protrusions as well as handling by operators. Secondary factors arise from fatigue caused to the installer from continued use.

All of these points can have a substantial effect on the following design criteria:

- a. Point selection (i.e. sharp, tek, type 17, etc),
- b. Thread form selection (i.e. normal or hi-lo as well as coarse or fine),
- c. Fastener material selection (i.e. carbon steel, stainless steel, titanium, etc),
- d. Coating selection (i.e. zinc, passivation, phosphating, organic coating, etc),
- e. Head style selection (i.e. flat, pan, truss, countersunk, hexagonal, etc),
- f. Recess type selection (i.e. Phillips, pozi, quadrex, etc).

All of the aforementioned conditions and criteria will be explored in depth in the following sections of this training manual.

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3.0 – Common Fixture Materials

In this section we will identify and explore the most common fixture materials which you will encounter on construction sites in the United Kingdom and where possible identify which fixings Evolution produce that might be effective for use in this material.

It is important to remember that “fixture material” refers to the board or material that is being fixed or fastened through (i.e. is on top of the substrate).

3.1 – Standard Plasterboard

The vast majority of drywall screws will simply be used fixing through standard plasterboard. Standard plasterboard is also widely referred to as “drywall”, “drywall board”, “wall board” or “gypsum board”.

3.1.1 – What is Standard Plasterboard?

Standard plasterboard is a panel of plaster material that is pressed between two sheets of thick paper.

The paper component is normally grey or brown, but is available in almost any colour and largely depends on the manufacturer.

3.1.2 – What is it made of?

Standard plasterboard is made of a plaster component and a paper component.

The plaster component is normally made of either gypsum plaster, lime plaster or cement plaster.

The paper component is normally made of standard thick paper made from cellulose pulp. Different materials or additives may be added to help in moisture resistance or fire resistance, but mostly remain cellulose paper with additional thicknesses.

3.1.2.1 – Gypsum plaster

3.1.2.1.1 – Gypsum

Gypsum plaster is made from the material gypsum. Gypsum is an incredibly soft material, which is indeed the second softest material on the Mohr’s hardness scale (for comparison the lowest on the scale is Magnesium Silicate Hydrate, also known as Talc; which has a hardness of 1.00 and the highest on the scale is Carbon in the form of Diamond; which has a hardness of 10.00).

The chemical name of Gypsum is Calcium Sulphate Dihydrate and has the chemical formula $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$.

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Where: Ca = Calcium
S = Sulphur
O = Oxygen
H = Hydrogen

The physical properties of gypsum plaster are:

Mohr's Hardness = 1.5-2.0

Specific Gravity = 2.31 – 2.33

Gypsum is normally produced through natural or synthetic techniques. Naturally gypsum occurs in sedimentary rocks and is mechanically mined and extracted. Synthetic gypsum occurs through the flue gas desulphurisation process at coal fired power stations and is a by-product of the scrubbing process.

3.1.2.1.2 – Gypsum plaster

The gypsum is then made into a plaster by heating the gypsum to around 150°C to evolve water from the molecular compound of Calcium Sulphate Dihydrate in the form of steam to produce Calcium Sulphate Hemihydrate, which has the chemical formula $\text{CaSO}_4 \cdot 0.5\text{H}_2\text{O}$.

Where: Ca = Calcium
S = Sulphur
O = Oxygen
H = Hydrogen

3.1.2.1.3 – Effect on fasteners

The primary effects of gypsum plaster on the design of screws are primarily due to the corrosive properties of the calcium present in the molecular compound.

On the periodic table of elements, calcium is an alkaline earth metal. As such the metal itself has a pH in the alkaline range. This means that it has a corrosive property and will actively attack the metallic screws. This corrosive effect is reinforced when an electrolyte (electricity conducting fluid) bridge is provided and allows the metallic material to suffer from bi-metallic (electrogalvanic) corrosion.

As such the design of the coating or materials used in the fastener should reflect the base material. However in the case of gypsum plaster the effect of the calcium is inhibited by the compounds molecular structure, thus has a lesser effect than a lime plaster would.

Since gypsum plaster is very low in terms of hardness, it's abrasion characteristics can almost be ignored.

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3.1.2.2 – Lime Plaster

3.1.2.2.1 – Composition

Lime plaster is made of a combination of hydrated lime and sand.

3.1.2.2.1.1 – Hydrated lime

Hydrated lime is formed when standard lime (Calcium Oxide – CaO) is slaked with water (H₂O) in order to hydrate the compound to Calcium Hydroxide – Ca(OH)₂.

The calcium oxide base used for the production of hydrated lime is manufactured through the thermal decomposition of Calcium Carbonate – CaCO₃, which is found naturally as limestone and is mechanically mined.

The physical properties of Calcium Hydroxide are:

Mohr's Hardness = 1.75-2.0

Specific Gravity = 2.21

It should be noted that Calcium Hydroxide (lime), like Calcium Sulphate Hemihydrate (gypsum) is alkaline due to the presence of the element, calcium. However the calcium content in Calcium Hydroxide is much greater per molar weight than Calcium Sulphate Hemihydrate and its' alkalinity is not prohibited. As such the pH of lime is 12 and lime will readily attack metals through its' corrosive action.

This high alkalinity is dangerous for operators and handlers as it may cause chemical burns on unprotected skin. Calcium Hydroxide also causes blindness when particles make contact with eyes (and protection must always be worn).

Calcium Hydroxide also reacts exothermically when introduced to water, and the temperature of the mixture may increase to unexpectedly high levels. As such protection is always advised.

3.1.2.2.1.2 – Sand

The sand used in construction (and is indeed the highest occurring sand in the world) is Silicon Dioxide – SiO₂ (also known as Silica).

Where:

Si = Silicon

O = Oxygen

Silicon dioxide is a naturally occurring material and is mechanically mined and then purified.

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The physical properties of Silicon Dioxide are:

Mohr's Hardness = 6.0-7.0

Specific Gravity = 2.65

3.1.2.2.2 – Effect on fasteners

As with gypsum plaster, the lime plaster's biggest effect on the fasteners would be from the calcium's inherent alkalinity which would attack metallic elements. Again this corrosive effect is reinforced when an electrolyte (electricity conducting fluid) bridge is provided and allows the metallic material to suffer from bi-metallic (electrogalvanic) corrosion.

As such the design of the coating or materials used in the fastener should reflect the base material. In the case of lime plaster, the corrosive action is far greater than in gypsum plaster, thus a coating of greater resistance is required.

Lime plaster has a much higher abrasion factor due to the inclusion of sand in the mixture. Sand has a high hardness value and as such will be much more damaging to threads and coatings. Therefore the fastener and coating should be designed with an adequate resistance to abrasion.

3.1.2.3 – Cement plaster

Cement plaster can either comprise of:

1. Gypsum plaster, sand and ordinary Portland cement, or,
2. Lime plaster, sand and ordinary Portland cement.

The purpose of cement plaster is twofold:

1. To increase fire resistance,
2. To increase strength and toughness.

It should be noted however that standard drywall boards containing cement plaster should not be confused with a cementitious board, which will be covered later in this manual.

3.1.2.3.1 – Ordinary Portland cement

Ordinary Portland cement is produced by the fine grinding of cement clinker with the addition of Calcium Sulphate (to control the flash setting properties of cement) and Magnesium Oxide (MgO).

Cement clinker is produced by sintering limestone and alumina-silicate (clay) in a cement kiln.

Cement clinker is primarily constituted of calcium silicates Alite ($3 \text{ CaO} \cdot \text{SiO}_2$) and Belite ($2 \text{ CaO} \cdot \text{SiO}_2$) respectively.

The clinker will also contain very small quantities of metallic elements such as iron and aluminium.

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Therefore the main components of ordinary Portland cement are:

1. Calcium Silicates:
 - a. Alite = $3 \text{ CaO} \cdot \text{SiO}_2$,
 - b. Belite = $2 \text{ CaO} \cdot \text{SiO}_2$,
2. Calcium Oxide = CaO ,
3. Silicon Dioxide = SiO_2 ,
4. Magnesium Oxide = MgO ,
5. Calcium Sulphate = CaSO_4 .

Where:

Ca = Calcium,
Mg = Magnesium,
O = Oxygen,
S = Sulphur,
Si = Silicon.

Ordinary Portland cement itself is an alkaline mixture of chemical compounds. The alkalinity of the cement is as per lime plaster, however the introduction of Magnesium reinforces the bi-metallic corrosion element further due to the incorporation of a further dissimilar metal that is also a alkaline earth metal.

3.1.2.3.2 – Effect on fasteners

Cement plaster is slightly more corrosive than gypsum plaster or lime plaster respectively due to the addition of a further alkaline earth metal. The main increase in corrosive properties lies within bimetallic (electrogalvanic) phenomenon.

The set cement plaster will also have a slightly higher abrasive property when compared to gypsum or lime plasters.

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3.1.3 – How does their performance differ?

Performance Differences – Standard Plasterboard(s)			
Factor	Standard Plasterboard Sub-Type		
	Gypsum based	Lime based	Cement based
Toughness	Standard	Good	Best
Fire Resistance	Good	Good	Best
Workability	Best	Good	Good
Cost	Best	Good	Good
Load Capacity	Standard	Good	Best
Wear on Fastener (Corrosion)	Lowest	Some	Some
Wear on Fastener (Abrasion)	Lowest	Medium	Medium

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3.1.4 – How do I fix it (drywall range selector)?

DRYWALL RANGE SELECTOR	Fixture Material (being fastened through)			
		Gypsum plaster	Lime Plaster	Cement Plaster
Fixing Material (Substrate being fixed into)	Drywall Track (up to 1.2mm thick)	DWSZ,DWSP, CDWFZ.	DWSZ,CDWFZ.	DWSZ,CDWFZ,F, WHL.
	Steel Studding (up to 2.5mm thick)	DWSDZ,CDWFDZ.	DWSZ,CDWFZ, SSDW.	DWSZ,CDWFZ, F WHP,SSDW.
	Steel Studding (up to 5.0mm thick)	TSTF-3.	TSTF-3,BMWD-3	TSTF-3,BMWD-3.
	Steel Section (up to 12.5mm thick)	TSTF-5.	TSTF-3,BMWD-5.	TSTF-3, BMWD-5.
	Structural Timber	DWSC,CDWCP.	DWSC,CDWCP, WHL,SSDW.	DWSC,CDWCP, WHL,SSDW.
	Joists	DWSC,CDWCP.	WHL,SSDW.	WHL,SSDW.

3.2 – Specialist drywall boards

The next most popular fixture materials our screws will be used in are specialist drywall boards. These boards generally are referred to as “cement boards”, “cementitious boards”, or “composite boards”.

3.2.1 – What are specialist drywall boards?

Just like standard plasterboards, specialist boards are a panel of material that is pressed between two sheets of thick paper.

The material itself is dependent on the manufacturer of the board and the purpose of the board itself.

3.2.2 – What is it made of?

Specialist board are normally composite in nature. This means that there is more than one material that makes up the filling material between the two cellulose sheets.

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Here we will examine the most common types of composite material used:

Woodchip and cement combination:

The composite material makes us of fairly inexpensive wood chippings which are bound by cement. As we have already covered what cement is in previous chapters, we know that it becomes an incredibly strong binding material. This is enhanced by the wood; which is a water retaining material and will allow for full pozzolanic reaction with the cement that binds it.

In short this creates a very tough board material that proves very resistant to impacts. As such it has a high abrasion property as well as hardness. These factors make drilling and tapping through this material more difficult than the standard drywall boards.

Polymer and cement combinations:

The composite material is still made of a cellulose type base (such as wood or paper pulp, etc) but has differing polymers added to it for increased physical or chemical properties such as GRP (Glass Reinforced Polyamide). Again this composite contains cement as a binder, but can also in some cases be epoxy bound.

Again, this is a very tough board material and has the same effect on fasteners as the aforementioned composite material.

There are other composite materials used in the manufacture of these boards, but exact make ups are generally not provided as they are regarded “trade secrets” by their respective manufacturers.

3.2.3 – Effects on Fasteners

Again due to the inclusion of cement in the material, the corrosive property of the board will be increased; which will manifest more in bi-metallic (electro galvanic) corrosion.

The boards will also have a significantly increased abrasion property.

3.2.4 – Purpose of these boards?

These boards are used for a multitude of purposes. Due to the resilient nature of the boards they are used in:

Hospitals, factories, schools, etc:

Where there is a high flow of traffic or the movement of heavy equipment, etc that might bump or collide with walls. Therefore a tough board with significant anti-damage properties would be desired.

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Fire case scenario:

The board by its own nature is extremely resistant to heat and smoke transfer, thus the temperature transfer is limited only to the lowest boiling point in the material mixture (which in this instance would be entrained water at approximately 100°C). The material would therefore act in an ablative manner until its complete disintegration after a long period of time.

3.2.5- How do I fix it?

DRYWALL RANGE SELECTOR	Fixture Material (being fastened through)	
Fixing Material (Substrate being fixed into)		Specialist Drywall (Knauf Toughboard, British Gypsum Rigidur H, Euroform Versapanel, etc)
	Drywall Track(up to 1.2mm thick)	F,WHL.
	Steel Studding (up to 2.5mm thick)	F,WHP,SSDW.
	Steel Studding(up to 5.0mm thick)	TSTF-3,BMWD-3.
	Steel Section(up to 12.5mm thick)	TSTF-3,BMWD-5.
	Structural Timber Joists	WHL,SSDW.

3.3 – Insulation

The main type of insulation encountered in construction is rigid foam insulation (commonly known as PIR and PUR insulation).

3.3.1 – What is insulation?

PUR Insulation is made by reacting a polyol component with a polymeric component, isocyanate and Methylene Diphenyl di-Isocyanate (MDI) component in the presence of a blowing agent and other additives. These then react together in an exothermic (produces heat) reaction to form a thermosetting polymer (which becomes rigid when set).

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The heat produced in this reaction causes the blowing agent to evaporate thus leaving a rigid closed cell of low density – i.e. the rigid insulation panel.

This allows for excellent insulation properties as the gas entrapped within this closed cell has low thermal conductivity properties and in turn there is low thermal conductivity through the cell walls due to the low density of the material (approximately 97% of the polymer foam is trapped gas).

PIR Insulation

Differs from PUR insulation in that it is produced using an excess of the MDI component. In the presence of a catalyst, the excess MDI reacts with itself to form Isocyanurate; which is characterised by greater heat stability.

The resultant insulation product has increased fire performance and resistance as well as reduced combustibility and higher working temperature limits compared to PUR insulation. When incorporated into construction products, PIR can meet some of the most demanding fire performance requirements and is sometimes stipulated for applications by the insurance industry.

3.3.2 – How do I fix it?

SCREW RANGE SELECTOR	Fixture Material (being fastened through)	
Fixing Material (Substrate being fixed into)		Insulation Board
	Drywall Track (up to 1.2mm thick)	DWSDZ & RW
	Steel Studding (up to 2.5mm thick)	TSBWHT-3, BMTSBWHT-3
	Steel Studding (up to 5.0mm thick)	TSBWHT-3, BMTSBWHT-3
	Steel Section (upto 12.5mm thick)	TSBWHT-5, BMTSBWHT-5
	Structural Timber Joists	DWSZ & RW

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4.0 – Substrates

Drywall screws and TEK screws are only likely to be used in a small number of substrates. In the previous section using the tables, you can see what fasteners are typically used to join different fixing and fixture materials.

Therefore in this section we will cover points on the most common substrates found in construction applications with drywall and TEK screws.

4.1 – Metallic substrates

The vast majority of applications involve the use of a metallic substrate or the joining of two metallic elements.

In the United Kingdom, steel is delivered to site in two main forms: hot rolled steel and cold rolled steel.

Hot rolled steel is steel that was deformed into its current shape and profile by a series of rollers when the steel was hot (red hot). This imposes the least amount of residual stress as the hot steel is very malleable when red hot – thus there are generally fewer localised hard spots in the material.

Cold rolled steel is steel that was deformed into its current shape and profile by a series of rollers when the steel was cold (room temperature). This imposes the most amount of residual stress as the cold steel is very hard to work, thus the machinery used has to induce folds, etc to bend the material into shape. Simply by nature, cold rolled steel has a lot of localised hard spots caused by work hardening; where the displacement of atoms has caused some spots to be weaker when adjacent spots have been made stronger through hardening.

From a scientific point of view it is simply the logical transformation of the functions of work, force and energy.

Both methods have their advantages and weaknesses. Hot rolling steel produces very large section profiles and thicknesses; however the heating and annealing process is very energy intensive – as such the cost of the product is increased. Inversely, the cold rolled steel is formed by mechanical process, and therefore the profile size is limited by the mechanical force capacity of the system forming it. As these systems are expensive, they tend to limit the thickness of cold rolled steel to less than 6.0mm in thickness (as opposed to hot rolled thicknesses of 50.0mm and greater).

The main difference for specifiers is the yield strength of the material. Hot rolled steel is typically supplied in two strength classes; 275 N/mm² and 355 N/mm² respectively. Cold rolled steel is available in much lower ranges. For example cold rolled drywall track may have a yield strength as low as 120 N/mm² or as high as 220 N/mm².

Cold rolled steel has found its' main use in secondary steel framing and is typically 220 – 280 N/mm². Hot rolled steel has found its' main use in primary steel framing.

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Evolution Fasteners (U.K.) Ltd has gained extensive specifications in cold rolled steel and most prominently with Metsec plc.

As such, refer to the Evolution Fasteners (U.K.) Ltd “Fixings Application Guide for Metal Framing” as this covers the vast majority of TEK screw applications into metallic substrates (which have not already been covered by this training manual).

4.2 – Timber Substrates

Timber is another commonly used construction substrate, however at present Evolution Fasteners (U.K.) Ltd primarily caters to timber flooring through our PAM range of fasteners.

Timber substrates for internal flooring normally come in graded form, which the most common grade being C16 or C18 due to their relatively good performance to cost ratio.

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5.0 - Fasteners

There are many types of fasteners and indeed many differing materials and designs for these fasteners. As such in the subsequent sections we will explore fasteners in more detail.

5.1 - Materials

Fasteners are available from a large array of providers, vendors and manufacturers. Each of these will have their own specification for the material grade used in the construction of the fasteners. As this varies between the companies it is important to highlight the materials used in our own products.

Evolution Fasteners (U.K.) only uses carbon steel and stainless steel in our product range. These steels are further limited to certain grades only. These grades are:

Carbon Steel AISI C1022
 AISI 10B21

Stainless Steel AISI A304 (A2)
 AISI A316 (A4)
 AISI A410

This document will now show the composition and mechanical properties of each of the grades overleaf. Please note that Evolution Fasteners (U.K.) Ltd's entire stainless steel product range (with the exception of AISI A410) is in accordance with BS EN ISO 3506.

5.1.1 – Carbon Steel

This section will give details on the different grades of carbon steel used by Evolution Fasteners (U.K.) Ltd.

5.1.1.1 – AISI C1022 Grade carbon steel

Composition of AISIC 1022			
Weight of Elemental Components (%)			
Carbon (C)	Manganese (Mn)	Phosphorus (P)	Sulphur (S)
0.18–0.23	0.70–1.00	0.04 (Max)	0.05 (Max)

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Mechanical Properties of AISI C1022

Mechanical Properties of AISI C1022			
Properties			
Property	Value	Temperature (°C)	Treatment (s)
Density (x10 ³ kg/m ³)	7.858	25	N/A
Poisson's Ratio	0.27–0.30		
Elastic Modulus (x10 ³ N/mm ²)	190-210		
Tensile Strength (N/mm ²)	429.2		Annealed at 870°C
Yield Strength (N/mm ²)	317.2		
Elongation (%)	35.0		
Reduction in Area (%)	63.6		
Hardness (HB)	137		
Impact + Strength (J)	120.7		

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5.1.1.2 AISI 10B21 carbon (boron) steel

Composition of AISI 10B21			
Weight of Elemental Components (%)			
Carbon (C) (S)	Manganese (Mn)	Phosphorus (P)	Sulphur
0.18-0.23	0.70-1.00	0.03 (Max)	0.035 (Max)

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Mechanical Properties of AISI 0B21

Properties

Property	Value	Temperature(°C)	Treatment(s)
Density(x10 ³ kg/m ³)	7.858	25	N/A
Poisson's Ratio	0.27–0.30		
Elastic Modulus (x10 ³ N/mm ²)	190-210		
Tensile Strength (N/mm ²)	834.0		Annealed at 870°C
Yield Strength (N/mm ²)	803.0		
Elongation(%)	36.5		
Reduction in Area(%)	66.0		
Hardness (HB)	225		
Impact Strength (J)	123.4		

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5.1.2– Stainless Steel

This section will give details on the different grades of stainless steel used by Evolution Fasteners (U.K.)Ltd.

5.1.2.1–AISI A304 (A2) Stainless steel

Composition of AISIA 304 (A2)								
Weight of Elemental Components								
Carbon	Silicon	Manganese	Sulphur	Phosphorus	Chromium	Molybdenum	Nickel	Copper
(C)	(Si)	(Mn)	(S)	(P)	(Cr)	(Mo)	(Ni)	(Cu)
0.10	1.00	2.00	0.03	0.05	15.00–20.00	0.00	8.00–19.00	4.00

Mechanical Properties of AISI A304 (A2)		
Properties		Condition (s) Information
Property	Value	Temperature (°C)
Density ($\times 10^3$ kg/m ³)	8.0	25
Poisson's Ratio	0.27 – 0.30	
Elastic Modulus ($\times 10^3$ N/mm ²)	193	
Tensile Strength (N/mm ²)	515.0	
Yield Strength (N/mm ²)	205.0	
Elongation (%)	40.0	
Reduction in Area (%)	50.0	
Hardness (HB)	88	
Impact Strength (J)	N/A	
		N/A
		Annealed

5.1.2.2 – AISI A316 (A4) Stainless steel

Composition of AISI A316 (A4)								
Weight of Elemental Component (%)								
Carbon	Silicon	Manganese	Sulphur	Phosphorus	Chromium	Molybdenum	Nickel	Copper
(C)	(Si)	(Mn)	(S)	(P)	(Cr)	(Mo)	(Ni)	(Cu)
0.08	1.00	2.00	0.03	0.045	16.00 – 18.50	2.00 – 3.00	10.0 – 15.0	1.00

Mechanical Properties of AISI A316(A4)

Properties		Condition (s) (Information)	
Property	Value	Temperature (°C)	Treatment (s)
Density ($\times 10^3$ kg/m ³)	8.1	25	N/A
Poisson's Ratio	0.27 – 0.30		
Elastic Modulus ($\times 10^3$ N/mm ²)	203		
Tensile Strength (N/mm ²)	515.0		Annealed
Yield Strength (N/mm ²)	205.0		
Elongation (%)	40.0		
Reduction in Area (%)	50.0		
Hardness (HB)	95		
Impact Strength (J)	N/A		

5.1.2.3 AISI A410 Stainless Steel

Composition of AISI A410								
Weight of Elemental Components								
($\%$)								
Carbon	Silicon (Si)	Manganese (Mn)	Sulphur (S)	Phosphorus (P)	Chromium (Cr)	Molybdenum (Mo)	Nickel (Ni)	Copper (Cu)
0.15	1.00	1.00	0.03	0.04	11.5 – 13.0	0.00	0.00	0.00

Mechanical Properties of AISI A410		
Properties		Condition(s) Information
Property	Value	Temperature (°C)
Density ($\times 10^3$ kg/m ³)	7.7	N/A
Poisson's Ratio	0.27 – 0.30	
Elastic Modulus ($\times 10^3$ N/mm ²)	212	25
Tensile Strength (N/mm ²)	689.0	
Yield Strength (N/mm ²)	551.0	
Elongation (%)	15.0	
Reduction in Area (%)	40.0	
Hardness (HB)	156	
Impact Strength (J)	N/A	
		Annealed

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5.2 – Corrosion resistance, protection and prevention

Every project our products are used on is different and often unique, this causes problems in that it is impossible for us to determine every use and application of our products throughout the broad spectrum of their use in the construction industry.

From our many years of experience, one problem has emerged above all else that many specifiers and site operatives alike find confusing. That problem is corrosion.

In this guide, we will explore a large number of factors that attribute to the advancement of corrosion, and suggest the adequate coating for each scenario. Please note that this guide deals specifically with normal corrosion only and does not consider bi-metallic corrosion.

Q. What is Corrosion?

A. Corrosion is the natural degradation of materials through chemical reactions. In this instance we are only considering the corrosion of metals specifically. This corrosion is the electrochemical oxidisation of the metal, where the metal is subjected to an oxidising agent such as oxygen (O₂). For example in the electrochemical oxidisation of iron atoms (in solid state) producing iron oxide. This process is commonly known as “rusting”.

Q. Can Corrosion be Stopped Completely?

A. No. All metals will corrode (even stainless steels). Corrosion is a natural process and cannot be stopped completely, it can only be resisted.

Q. What is Corrosion Resistance?

A. Corrosion resistance is literally the resistance of a material (or coating) to corrosion. All metals (and indeed materials) have a natural resistance to corrosion; this can range wildly depending on the metal itself. For example carbon steel has a low resistance to corrosion, stainless steel has a high resistance to corrosion and platinum has the highest resistance to corrosion. This is directly related to the transitional metal series in the periodic table of elements.

Q. Can I Increase the Corrosion Resistance?

A. Yes. You can improve the corrosion resistance of a metal by coating it. This coating can be achieved through various methods; firstly you can coat the original material in another metal that will sacrificially degrade so that the original metal does not, secondly you can coat the original material in a organic or non-organic compound which is typically extremely resistant to corrosion and therefore takes a very long time to degrade to the point where the original material could be effected

Q. What's Best for my Application?

A. On the next page we run through the most popular scenarios and make recommendations for you.

Evolution Testing & Analytical Services Evolution Fasteners (U.K.) Ltd



Recommendations for Corrosion Resistance and Protection			
General Project Type(s)	Application(s)	Application Specific Condition(s)	Recommendation(s)
Initial/ Carcass/ Shell Construction	Temporary fasteners (inc. forms, etc)	Internal or external	Organic/ Non- Organic coated
	Structural fasteners (brackets, beams, columns, etc)	Dry, internal and no water/ condensation present	Zinc plated or Organic/ Non-Organic coated
Damp, interior with some water/ condensation present with high humidity and/or temperature		Organic/ Non-Organic coated or Stainless steel (A2 & A4)	
		Constant exposure to condensation and are subject to humidity and high temperature	
Interior/ Drywall/ Roughing/ Finishing	Concrete fasteners	Protected by concretes inherent alkalinity	Zinc plated or Organic/ Non-Organic coated
	Drywalls, suspended ceilings, doors, windows, etc fasteners	Dry, internal and no water/ condensation present	
Cladding, Roofing and Facades	Profiled metal sheets, curtain wall cladding, insulation, metal framing systems	Rural atmosphere (No emissions)	Internal : zinc plated or organic/ non-organic coated External : Stainless steel (A2 & A4) Insulation : Plastic and stainless steel (A4)
		City atmosphere (High Sulphur Dioxide (SO ₂) and high Nitrogen Oxides (NO _x))	
		Industrial atmosphere (High Sulphur Dioxide (SO ₂) and high acid/ alkaline)	Internal : Stainless steel (A2) External : Stainless steel (A4) Insulation: Stainless steel (A4)
		Coastal atmosphere (High Chlorides)	

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Recommendations for Corrosion Resistance and Protection			
General Project Type(s)	Application(s)	Application Specific Condition(s)	Recommendation(s)
Installations	Ducting, piping, cable trays, lighting support, machinery, etc	Dry, internal with no water/ condensation present	Zinc plated or organic/ non-organic coated
		Damp, interior with some water/ condensation present with high humidity and/or temperature	Organic/ Non-Organic coated or Stainless steel (A2 & A4)
		Constant exposure to condensation and are subject to humidity and high temperature	
Roads and Bridges	Signage, insulation, connections, cabling, etc	Not exposed to weathering	Organic/ Non-Organic coated or Stainless steel (A2)
		Frequently exposed to weathering	Stainless Steel (A2)
		Constantly exposed to weathering	Stainless Steel (A4) or greater
Tunnels		Low relevance to safety	Stainless Steel (A2)
		High relevance to safety	Stainless Steel (A4) or greater
		Temporary fixings	Organic/ Non-organic coated or Stainless steel (A2 & A4)
Docks, Harbours, Rigs and Maritime	General fastenings, etc	Permanent fixings	Stainless steel (A2 & A4)
		Oil Rigs	Stainless steel (A2 & A4) or greater

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Recommendations for Corrosion Resistance and Protection			
General Project Type(s)	Application(s)	Application Specific Condition(s)	Recommendation(s)
Industrial/ Chemical (including Hospitals and Healthcare)	Ducting, piping, cable trays, lighting support, machinery, signage, insulation, connections, cabling, etc	Dry, internal with no water/condensation present	Zinc plated or organic/ non-organic coated
		Internal Industrial atmosphere (High Sulphur Dioxide (SO ₂) and high acid/alkaline)	Stainless steel (A2) or greater
		External Industrial atmosphere (High Sulphur Dioxide (SO ₂) and high acid/alkaline)	Stainless steel (A2 & A4) or greater
Nuclear, Oil or Gas Fired Power Plants	General fastenings, fasteners relevant to safety	Dry, internal with no water/ condensation present	Zinc plated or organic/ non-organic coated
		Internal Industrial atmosphere (High Sulphur Dioxide (SO ₂) and high acid alkaline)	Stainless steel (A2) or greater
		External Industrial atmosphere (High Sulphur Dioxide (SO ₂) and high acid/alkaline)	Stainless steel (A2 & A4) or greater
Warm Industrial (Incinerators, etc)		Dry, internal with no water/ condensation present	Zinc plated or organic/ non-organic coated
		Industrial atmosphere (High Sulphur Dioxide (SO ₂) and high acid alkaline)	Stainless steel (A2 & A4) or greater

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Recommendations for Corrosion Resistance and Protection			
General Project Type(s)	Application(s)	Application Specific Condition(s)	Recommendation(s)
Water, sewage and waste industrial	Ducting, piping, cable trays, lighting support, machinery, signage, insulation, connections, cabling, etc	Dry, internal with no water/ condensation present	Zinc plated or organic/ non-organic coated
		Internal Industrial atmosphere (High Sulphur Dioxide (SO ₂) and high acid/ alkaline)	Stainless steel (A2) or greater
		External Industrial atmosphere (High Sulphur Dioxide (SO ₂) and high acid alkaline)	Stainless steel (A2 & A4) or greater
Multi-storey car parks and underground car parks	Ducting, piping, cable trays, lighting support, machinery, signage, insulation, connections, cabling, etc	Dry, internal with no water/ condensation present	Zinc plated or organic/ non-organic coated
		Internal Industrial atmosphere (High Sulphur Dioxide (SO ₂) and high acid/ alkaline)	Stainless steel (A2) or greater
		External Industrial atmosphere (High Sulphur Dioxide (SO ₂) and high acid alkaline)	Stainless steel (A2 & A4) or greater
Swimming Pools	General fastenings, fasteners relevant to safety	Low relevance to safety	Stainless Steel (A2)
		High relevance to safety	Stainless Steel (A4) or greater

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Recommendations for Corrosion Resistance and Protection			
General Project Type(s)	Application(s)	Application Specific Condition(s)	Recommendation(s)
Sports Facilities	Ducting, piping, cable trays, lighting support, machinery, signage, insulation, connections, cabling, etc	Rural atmosphere (No emissions)	Internal : zinc plated or organic/ non-organic coated External : Stainless steel (A2 & A4) Insulation : Plastic and stainless steel (A4)
		City atmosphere (High Sulphur Dioxide (SO ₂) and high Nitrogen Oxides (NO _x))	
		Industrial atmosphere (High Sulphur Dioxide (SO ₂) and high acid alkaline)	Internal :Stainless steel (A2) External :Stainless steel (A4) Insulation: Stainless steel(A4)
Nursery, Schools and Educational Facilities		Coastal atmosphere (High Chlorides)	
		Rural atmosphere (No emissions)	Internal : zinc plated or organic/ non-organic coated External : Stainless steel (A2 & A4) Insulation : Plastic and stainless steel (A4)
		City atmosphere (High Sulphur Dioxide (SO ₂) and high Nitrogen Oxides (NO _x))	
		Industrial atmosphere (High Sulphur Dioxide (SO ₂) and high acid alkaline)	Internal : Stainless steel (A2) External : Stainless steel (A4) Insulation: Stainless steel(A4)
		Coastal atmosphere (High Chlorides)	

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6.0 – Design of fasteners

Fasteners by design have the following main components:

1. Head,
2. Recess,
3. Thread,
4. Cutting point.

Therefore we will consider the design of these components.

6.1 – Head style

The main head style designs are:

Hexagonal flanged:

Allows the use of a washer to spread the force subjected to the fastener (and inversely the preloading applied by the fastener (typically referred to as “clamping action”)).

It is also used for its large surface area which can be gripped in the drive; producing good stability characteristics.

Countersunk:

Is generally used on larger screws where a flush finish inside the material is required. It may come in double countersunk form to ease countersinking, or with under head nibs which are designed to ease in the countersinking of harder/ more dense materials (such as cement boards, plywood, etc).

Flat/ Pancake/ Cheese/ etc:

Are used where the profile of the screw needs to be as low as possible, but the material cannot be countersunk easily (i.e. metallic substrates).

Bugle:

The most common drywall type head. Its concave shape allows it to countersink in soft materials such as plasterboard by standard deformation of the plaster material. In this situation it is preferable to a countersunk head as the straight sides of a countersunk screw would tear the material.

6.2 – Recess Type

The recess type is largely dependent on the head style of the screw. Typically in countersunk and low profile screws, the most common recess types are Pozi, Phillips and Torx. Whilst there are literally hundreds of recess types available these three are the most common (next to hexagonal head).

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Evolution Fasteners (U.K.) Ltd tend to prefer Phillips drive in drywall screws and TEK screws as the form of the recess allows the screw driver to “cam out”; which ensures that the product is not overly torque induced.

6.3 – Thread type

The thread is arguably the most important feature of a screw product. It is a common misconception that it is the head of a screw which holds two materials together, this is false. The true joint is in the threading of both articles by the singular screws' thread.

As such it is important to consider the main design types of thread:

Coarse:

Is where the thread pitch is comparatively low. The actual thread pitch is dependent on the actual use of the screw, however, the coarse thread is especially good at achieving high tensile resistance in timber substrates and in thin metallic substrates (as it allows the thin sheet material to deform above and below the thread).

Fine:

Is where the thread pitch is comparatively high. Again the actual thread pitch is dependent on the actual use of the screw; however, the fine thread is especially good at achieving high tensile resistance in thicker metallic substrates as it increases the surface area of the screw in physical contact with the substrate material.

Hi-Lo:

Is a combination of a large thread and smaller thread. The pitch is generally coarse. The rationale behind hi-lo threads is primarily for use in weaker materials for pull out resistance (such as timber), or in materials which contain a lot of fines (such as concrete, block, etc). Hi-lo threads are also used in dense board materials where the thread form inherently reduces the torque resistance to the threading action – thus preventing the screw from snapping when tapping through dense materials.

6.4 – Point Type

The point type of a screw is critical in ensuring that it can adequately self drill through a material. As such the point types used by Evolution Fasteners (U.K.) Ltd are:

Sharp:

Sharp points are the most common point type used in drywall and are adequate for use in timber and very light steel (i.e. less than 1.2mm) as with a sufficient angle, can pierce thin metals.

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6.0 - Conclusion

In close, it is difficult to condense the combined knowledge of the Technical Department on drywall screws and TEK screws into a single, concise document. The metallurgical, physical and chemical knowledge alone would be larger than a typical dissertation. There is then another set of knowledge on the coatings themselves.

Evolution Fasteners (U.K.) Technical department are also knowledgeable in failure analysis, fixing techniques, detailed design of fasteners, manufacturing processes, hydrogen embrittlement, stress corrosion cracking, corrosion and many more fields that alone could be written in far greater detail.

The intent of this document is to provide the base tools to achieve specification of Evolution Fasteners (U.K.) Ltd product, and as such uses tables to give reference to fixing types.

In the case of metal framing, there is a separate application guide that is available on our website in the tech. Support section.

Therefore it is advisable that further advice is sought from the Technical Department on any aspect of our product range.