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*CFA: Guidance Note*

# SELF-DRILLING AND SELF-TAPPING FASTENERS AND FIXINGS

**INTRODUCTION**

This guidance document for "Fasteners and Fixings" is designed to give an overview of construction fasteners designed to secure elements and components to a building structure or to each other.
The document will look at primarily screw fasteners covering self-tapping, self-drilling and self-piercing fasteners, looking at their varying forms, characteristics and performance requirements. We will discuss primary and secondary fasteners as well as general guidance on choice of fasteners with respect of the application and the material and performance criteria required to, make an effective connection.

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**1.1 Definitions**

"Fastener" is the term used to describe a mechanical device used to secure an individual or number of component to a structure or to each another.

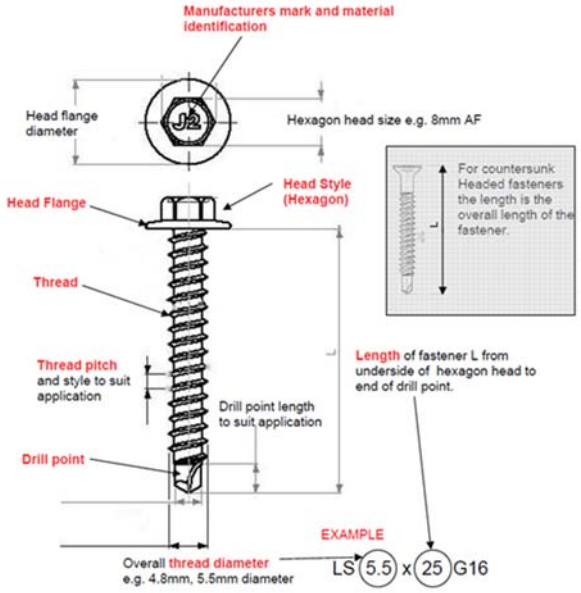
"Fixing" describes the resultant connection achieved from using a fastener.

"Self-Tapping" describes a fastener that requires a pilot home in the materials so that the fastener taps its own mating thread in the components/structure: producing a two operation fixing method.

"Self-Drilling" describes a fastener that performs the drilling of the installation hole through its integral drill point before the fastener taps the mating thread: producing a single operation fixing method.

"Self-Piercing" describes a fastener that does not require a pilot hole in the base material, and does not have a formed drill point. The fasteners pierce point penetrates the material, cutting through the fibres in the case of timber or timber based products or piercing and displacing the material in respect of metal substrates.

"Thread diameter" the overall diameter of the fastener at the outermost point of the threads.




"Core diameter" the diameter of the core, at the base or root of the threads.

"Cold rolled Steel/Light Section" steel sections that are formed by cold forming therefore the section thickness generally ranges from 1.2mm to 3.5mm in thickness.

"Hot Rolled/Heavy Section" steel sections that are too thick to be cold formed therefore the steel requires to be heated so that it can be formed in a rolling mill.

### 1.2 Self-tapping Fasteners

Self-tapping fasteners require a pre-drilled pilot hole in the component to be fixed and the component/substrate that it is being fixed to. The function of the thread is to tap or thread forming (not thread cutting), producing its own mating threads by forcing the metal to flow round the screw threads.

This type of fastener as a typically thread diameter of 6.3mm and 6.5mm in diameter as well as larger 7.2mm and 8.0mm diameter; where higher shear loading is required.
Self-tapping fasteners are generally used as primary fasteners for securing a component to the substrate, however in some instances they can also be used as a secondary fastener to secure two components together.

There are two basic forms:

- Fine pitch thread with a dog point for use in steel sections from 2mm and above or aluminium sections from 3.0mm and above, and are generally have a thread diameter of 6.3mm.

- Course pitch thread with a point or gimlet point for use in thinner cold rolled steel sections up to 2.0mm and aluminium sections up to 3.0mm. Also suitable for timber and timber based substrates; a pilot hole is not always required depending upon the timber/timber based materials characteristics.

The diameter of the pilot hole needs to be considered carefully taking into account the diameter of the fastener and the substrate and material type and thickness to be secured. It is also important that the drill bit used is of the correct diameter and that work or damaged drill bits are not used as this may produce an undersized pilot hole. The correct drilling technique should also be maintained making sure that the drill bit does not wobble during the drilling operation as this may cause an oversized pilot hole.

The fastener manufacturer's guidelines should be followed or guidance sort form their technical department.

### 1.2 Self-drilling Fasteners

Self-drilling fasteners are in the majority of application the first choice for the installer/contractor. The fasteners integral drill point takes away the need for pre-drilling taking out one operation, with the self-drilling fastener drilling, tapping and setting/tightening in one single operation. The self-drilling fastener also ensures that the component parts are aligned during the installation of the fastener rather than having to align the materials to drill the pilot hole and then hold all the component parts together in the installation process for a self-tapping fastener.

The choice of self-drilling fastener is dependent upon several factors including:

- The thickness and type of material being drilled
- The material type and thickness being clamped

These factors will affect the choice of fastener which will take into account: -

- The thread form needs to be chosen to match the material it is being installed into and for the required pullout performance.
- The drill point needs to be of sufficient length to drill the components/substrate this is referred to as the fasteners *drilling capacity*.
- The fasteners to be a diameter suitable for the thread type required for the application type and shear performance required.
- The fastener length will also have to be suitable for the effective clamping range of the application this being the overall thickness of the substrate and the components to be installed added together.

The lead threads must fully penetrate the substrate ensuring that in thin gauge material that there is a supporting thread below the material and in thicker sections to ensure that the mating thread has been fully formed within the substrate which ensures full thread engagement within the material.

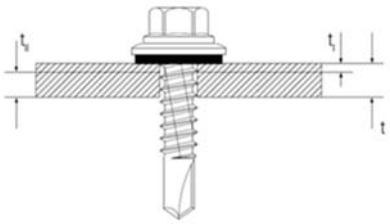
Where there are additional materials/components between the sheet and support (e.g. sealant strips or a thermal break on wall cladding applications), fasteners with 'pilot points' are available to prevent jacking by drilling through all the components/materials before the thread engages in the lead material which in turn provides a good clamping action to the full application.

a. B.

a. Fastener with pilot point. To allow for drilling of full build-up and substrate prior to threads engaging
b. Wing driller, wings cut clearance hole in timber to allow drill point to drill into steel substrate, wings designed to break off when in contact with face of the substrate.

An extensive range of drill-point lengths and diameters and thread forms are available, designed to give optimum pull-out, pull-over, shear and strip-out performance in various thicknesses and material substrates therefore understanding the requirements and performance of the application dictates the choice of fastener.

To determine the correct thread length, and thus the fastener length, the thickness of each material in the build-up must be added together including the substrate to which the components are being fixed ($t = t_I + t_{II}$); this is referred to as the "effective clamping range" of the fastener.



For fastener length to applications where the fastener is being fixed into a timber substrate the embedment depth required is added to the thickness of all the components to be clamped

Self-drilling fasteners can be manufactured in a wide range of materials including carbon steel which are generally manufactured with a protective corrosion resistant coating and Stainless steel in various austenitic grades and aluminium.

Fully Austenitic stainless steel fasteners are suitable for drilling into aluminium and timber based substrates, however to be able to drill into mild steel and galvanised steel sections the Austenitic stainless steel needs to be combined with an integral hardened carbon steel drill point and lead threads, these are known as bi-metal fasteners which are readily available.

The drill point's purpose is to drill the substrate and the carbon steel lead threads to tap the material to allow the following stainless steel threads to hole securely in the substrate.

These bi-metal fasteners should be installed so that only the stainless steel portion of the fastener is within the application and within and below the substrate, the carbon steel drill point and lead threads should be clear of the supporting structure and thus not relied upon for any structural performance.

Selection of the correct fastener is imperative in affecting a positive fixing and that the type chosen is correct for the drilling/tapping and structural performance required for the specific application.

Individual manufacturer's literature will give guidance on the fasteners drilling capacity, effective clamping range, material and suitable applications and guidance on fastener performance.

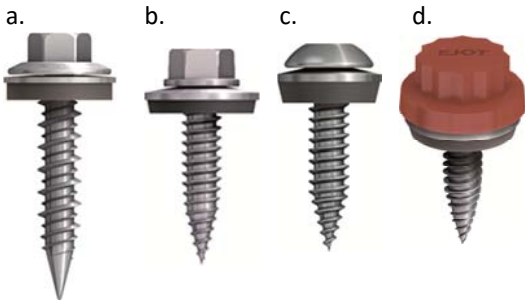

**Typical fastener types.**

1. Hexagon head self-drilling for light sections 1.2mm to 3.0mm
2. Hexagon head self-drilling for heavy section 4.0mm to 12.0mm (versions available for drilling up to 18mm.
3. Integral nylon coloured head available on a wide range of fastener options from stitchers, light section heavy section and composite panel fasteners
4. Stainless steel Low profile headed fasteners that can be powder coated to BS and RAL colours to match cladding, rainscreen facades and flashing details.
5. Clip fixing for installing standing seam clips where a low profile head is required and locating section to underside of the head
6. Low profile flat head fastener for installation of light steel framing systems where a low head is required for sheathing boards applied to the stud.
7. Composite panel "high Thread" fasteners, upper larger diameter thread engages in outer skin of composite panel to minimise dimpling and to ensure washer is compressed on the face of the panel to effect a seal.
8. Fibre Cement fastener with BAZ, fastener designed with wings to provide a clearance hole in the Fibre Cement sheet and washer designed to follow the curvature of the crown of this sinusoidal profiled sheet.

### 1.3 Self-piercing fasteners

These are available as 'S' (Schneidkante) pointed and are normally limited in use to fastening into timber or laminated timber based products, or specialist pierce point stitchers for thin gauge steel and aluminium materials . For timber based applications these fasteners have a flute/cutting edge at the tip to provide cutting edges on the first few threads to allow the fastener to cut into the timber fibres rather than pushing between them to minimise splitting.

The new generation "piece point" stitcher has a thread rolled down to the point of the fastener providing a sharp point that pieces the thin gauge material creating a through draft minimising swarf generation and maximising radial thread contact in the thin substrate.




**a. Self-piecing gimlet pointed timber screw.**
**b. Self-piecing stitcher with plain hexagon head**
**c. Self-piecing stitcher with low profile head**
**d. Self-piecing stitcher with integral nylon head**

**2. MODES OF PERFORMANCE**

**2.1 Material.**

The choice of fastener material is critical to meet the performance of the application with regards to its installation, resistance to atmospheric and bi-metallic corrosion with the components and substrate that the fastener is securing.
The main materials for self-tapping and self-drilling fasteners used for metal roofing and cladding and envelope solutions are carbon steel, with a corrosion resistant finish and 300 series austenitic stainless steels.

Carbon steel fasteners require a corrosion resistant coating this can range for a zinc coating that gives limited corrosion performance so are generally used in internal environments and where corrosion risk is minimal. Other coatings include organic corrosion resistant coatings that are applied to a zinc base coat.

Stainless steel fasteners can be manufactured from wholly from stainless steel self-tappers or self-drillers that allow them to drill into substrates such aluminium and timber: or stainless steel Bi-met fasteners with integral carbon steel drill points to allow the fastener to drill and tap into mild steel and galvanised steel sections. Bi-met fasteners have a zinc based coating to protect and lubricate the dill point.

The main austenitic grade available: -

ISO group A2 (304) Din Werkstoff 1.4301.
ISO group A4 (316) Din Werkstoff 1.4401.

The predominate grade, over the last 25-30 years has been, A2 which offers good resistance to corrosion in a wide range of applications and environments. Where integral Nylon coloured heads are incorporated on the head of the fastener, additional protection from the environment can be made, the fastener may then be suitable for coastal environments depending upon the specific application. For buildings with high humidity, swimming pools, anaerobic digesters buildings and/or coastal, industrial, commercial or leisure environments and tunnel linings may contain corrosive or chemical laden conditions either internally or externally (or both). In these circumstances there is a need to check suitability and compatibility of component parts with the manufacturer or system supplier and obtain specific project guidance. Higher grade Austenitic stainless steel EN numbers
1.4547 & 1.4529 (A5) are now available, which are resistance to Chlorine Induced Stress corrosion, and are resistance to sulphur dioxide as well as concentrated pollutants. These fasteners are restricted to the self-tapping type as a carbon steel drill point of a bi-met would be susceptible to corrosion.

## Life Expectancy Guide

| **Fastener Material** | **Environment** | | **Life Expectancy (years)** (see note 3) | **Sheet Material** (See Note 1) | | | |
|---|---|---|---|---|---|---|---|
| | Internal Humidity Grade | External Exposure | | Aluminium | Coated Steel | Stainless Steel | GRP / PVC Fibre cement |
| Min Washer Dia. | | | | 15 mm | 15 mm | 15 mm | 29 mm |
| Coated Carbon Steel & Push-on caps | Dry/low humidity | Urban/Rural | 10 / 20 | NR | ✓ | ✘ | ✓ |
| | | Industrial * | 10 / 15 | NR | C | ✘ | ✓ |
| | | Coastal/Marine | - | ✘ | ✘ | ✘ | ✘ |
| | High humidity | Urban/Rural | 10 / 15 | NR | C | ✘ | C |
| | | Industrial * | 10 | NR | C | ✘ | C |
| | | Coastal/Marine | - | ✘ | ✘ | ✘ | ✘ |
| Coated Carbon Steel with integral coloured head | Dry/low humidity | Urban/Rural | 15 / 25 | NR | ✓ | ✘ | ✓ |
| | | Industrial * | 15 / 25 | NR | ✓ | ✘ | ✓ |
| | | Coastal/Marine | - | ✘ | ✘ | ✘ | ✘ |
| | High humidity | Urban/Rural | 10 / 15 | NR | ✓ | ✘ | ✓ |
| | | Industrial * | 10 | NR | C | ✘ | C |
| | | Coastal/Marine | 10 | ✘ | C | ✘ | C |
| Austenitic Stainless Steel | All humidity grades | Urban/Rural | 25 + | ✓ | ✓ | ✓ | ✓ |
| | | Industrial * | 25 + | ✓ | ✓ | ✓ | ✓ |
| | | Coastal/Marine | 15/20 | ✓ | ✓ | ✓ | ✓ |
| Austenitic Stainless Steel with Nylon integral coloured head | All humidity grades | Urban/Rural | 25 + | ✓ | ✓ | ✓ | ✓ |
| | | Industrial * | 25 + | ✓ | ✓ | ✓ | ✓ |
| | | Coastal/Marine | 20/25+ | ✓ | ✓ | ✓ | ✓ |
| Austenitic Stainless Steel 1.4547 & 1.4529 (A5) | High Humidity | Chlorinated environment | 25 | ✓ | ✓ | ✓ | ✓ |
| Aluminium secondary fasteners e.g. rivets | All humidity grades | Urban/Rural | 20 / 25 | ✓ | ✓ | ✘ | C |
| | | Industrial * | 15 / 20 | ✓ | ✓ | ✘ | C |
| | | Coastal/Marine | 15 / 20 | C | C | ✘ | C |

**KEY:**

✓ Recommended suitable for use in these environments

✘ Unsuitable for use in these conditions

**C** Check suitability of both sheet system and fastener with manufacturer

**NR** Not recommended for use with aluminium sheets by some profile manufacturers

* Subject to non-polluted environment, may not be suitable in corrosive or other chemical laden conditions

**Note 1**

This table gives guidance on the selection and functional life **of the fastener** in various sheet materials. Consult the sheet manufacturer, regarding the most appropriate sheet material and coating and its functional life in the particular environment.

**Note 2**

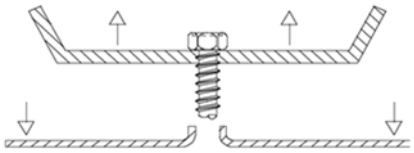
Carbon steel fasteners which are ***not exposed*** to the external environment, the functional life would be similar to those tabled above for carbon steel with integral colour heads, check with the fastener manufacturer for specific requirements.

**Note 3**

The above periods are for the fasteners' **functional life expectancy**. Where a warranty is required then this may be typically up to

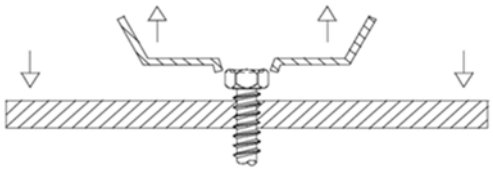
10 years for carbon steel and up to 25 years for stainless steel, check with individual fastener manufacturers for specific requirements.

**2.2 Pullout**



One primary performance function of fasteners is to resist being pulled out of the substrate or support member resisting the applied loads for the component or material being clamped. The correct choice of fastener for the substrate material is required to resist these tensile forces. The overall application requires the calculation of the correct quantity and locations to resist the loadings on the system. Fastener manufacturer's performance tables based upon laboratory testing to BS 5427: 1996[1] should be used with the engineer/designer and factored within their design calculations to suit the specific criteria for each individual project.

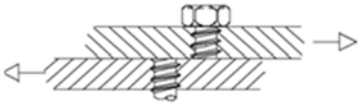
**2.3 Pullover**



Pullover is where the service load causes the installed component, sheet or panel to be pulled over the fastener head. The choice of fastener head style and washer combination appropriate for the roofing/cladding system needs to be considered to resist these applied loads. The position of the fastener within the system will also affect the pullover performance e.g. valley fixing for a roof sheet, Crown Fixing with or without a storm/saddle washer or secret fixed composite panel system with the fastener incorporated in a tongue and grove joint.

Fastener manufacturer's performance tables based upon laboratory testing to BS 5427: 2016 should be used with the engineer/designer and factored within their design calculations to suit the specific criteria for each individual project.

**2.4 Shear**



Fasteners have to resist shear, lateral and differential movement. Performance is derived from the components and material of the installed system as well as the fastener material and diameter. This aspect of the fasteners performance is critical in many roofing and cladding systems and also where high shear loadings are required for brackets and structural cladding systems. Fastener manufacturer's performance tables should be consulted with regards fastener selection.

**2.5 Sealing and clamping**

The fastener must in most applications fully secure and clamp the component to the substrate. Consideration of the fastener type and head design and washer combination is required for the specific application and/or roofing/cladding system to resist "Back-out", where the fastener works loose, often due to cyclic loadings, movement of the structure or by vibration. Correct fastener thread form, drill point and installation method is required to resist these effects. Where thermal movement or differential movement between dissimilar metals the clearance holes in the component being secured may be required this is generally referred to as a "floating point" connection. Specialist fasteners that self-centre into a clearance hole may be required for systems such as ACM (Aluminium Composite Material) or HPL (High Pressure laminates). Where a fastener rigidly fixes the component to the substrate this is generally referred to as a "fixed point" connection, this type of connection will be required in at least one position for ACM and HPL systems, subject to the manufacturer's recommendations.
The choice of washer is determined by the applications exposure and the requirements to seal where the fastener penetrates the component/substrate for moisture and from air leakage as well as providing pullover performance.

Under-Driven Over-Driven Correctly Installed

**2.6 Corrosion**

The material of the component and substrate being fixed, together with the location of the fastener and the internal and external environments is critical in the choice of fastener material and coating in resisting corrosion from weathering and the environment and bimetallic/Galvanic corrosion. Bimetallic corrosion is a complex subject as it is determined by the electrolytic connection of dissimilar metals surface area contact and the presence of an electrolyte e.g. moisture/water. The presence of salts and pollutants in the electrolyte will increase the conduction between the metals. More information is available in the British Standard PD 6484: 1979 Commentary on Corrosion at Bimetallic contact and its alleviation.

For timber applications special care should be taken as preservatives can contain chemicals and levels of copper than can affect some fastener materials therefore consultation with the preservative manufacturer and the fastener manufacture will be required to ascertain the correct fastener.
Some hardwoods such as oak have a high resin content therefore stainless steel fasteners are generally recommended.

For swimming pool environments that contain chlorine the selection of the fastener material is critical as 304 and 316 and 410 grades of stainless steel can suffer from chlorine induced stress corrosion see 2.1.

**3. Primary Fasteners**

Primary fasteners are
Primary fasteners are the fasteners which provide structural performance. Primary fasteners are used for the attachment of a wide range of components such as profiles metal sheeting systems, insulated composite panel systems, rooflight's, secondary supports, bracketry and cladding spacer systems to secure them to the structural elements which can comprise of light section or heavy section steel and timber based substrates such as solid structural timber, Glulam structures and cross laminated timber.

Primary fasteners must be designed so that they safely carry the relevant loads determined in accordance with the Building Regulations (or other relevant legislation). Primary fasteners may need to provide weathering, vapour and air sealing performance in line with these documents as well as the specific design criteria where a specialist system is being installed.

**4 Secondary fasteners**

Secondary fasteners are used to attach secondary components such as flashings and for side lap stitching of profiled metal sheets and composite panels or for the retention of insulation.

Secondary fasteners in a stitching application are not generally relied upon solely to contribute to structural performance except in stressed skin designs but may contribute in transferring loads from sheet to sheet. Secondary fasteners cannot be dismissed as non-load bearing and may need to provide weathering, vapour and air sealing performance and may have to resist thermal and differential movement.

**5 Standards and test methods**

**BS 5427: 2016** defines methods in Annex B for 'Determination of the strength of attachment of a cladding system', together with guidance notes on interpretation of test results. A range of recognised test methods have been adopted by the fastener industry, which have been incorporated into ETAG's CUAP's and EAD's by EOTA (European Organisation for Technical Assessment) in compiling ETA' s (European Technical Approvals) and ETAs (European Technical Assessments). Although self-drilling and self-tapping fasteners are not currently covered by a harmonised European standard (hEN) the ETA/ETAs process allows the fasteners with approvals to be CE marked.

Composite/Sandwich panel fasteners generally recognise ECCS (European Convention for Constructional Steelwork) document No 127 "Preliminary European Recommendations for the testing and design of fastenings for sandwich panels", many of its recommendations have been adopted and incorporated inti the ETA/ETAs process.

Reputable fastener manufacturers product data sheets and load tables giving performance data for the fastener in tensile and shear as well as performance data for pullout and pullover in materials generic for the fasteners design and use. Some manufacturers have the facility to provide additional test data and specific testing of fasteners from materials they may not be incorporated within the published data.

The installation contractor or designer should obtain performance values from the fastener manufacturer before selecting the fastener type and frequency, to ensure they exceed the design loads for the intended use. System suppliers may already incorporate the fastener design within their package where this is the case this design should be adhered too.

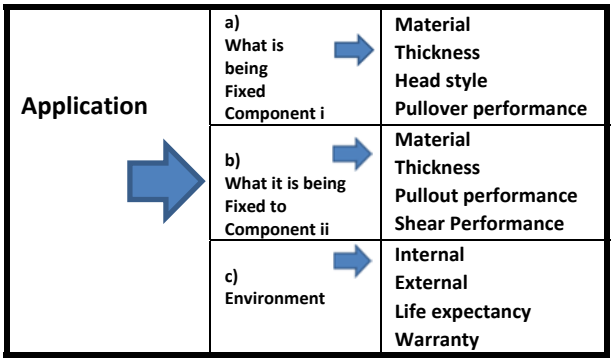
Site pullout testing can be performed however this is limited to the application and the substrate material. This type of testing is destructive testing therefore suitable areas for testing needs to be considered.
NOTE: Proof testing cannot be performed on self-drilling and self-tapping fasteners.
Pullout from timber and sheathing boards can be performed however please consult the fastener manufacturer if this service is required. Consult manufacturers published data for pullout from steel sections.

## 6.0 Selection of Fasteners

### 6.1 General

With the selection of any fastener system the first process is to look at the various aspects of the application: -

- Application requirements: - What material is being fixed and what is it being fixed too.
- Materials required in meeting the application requirements.
- Fastener type in meeting the requirements of the substrate with regards its material/thickness and installation and drilling capacity.
- Fastener performance with regards pullout, shear and pullover its ability to provide a weather and air seal and its corrosion resistance for the component and the substrate in meeting the application requirements. There may also be a need to provide a thermal break when used within a system where thermally broken washers are required.
- Installation process this will affect the choice of fastener as well as indicating the specific requirements on-site to ensure that the fastener maintains it performance in the application.
- Appearance, this may be critical where the fastener is visible and even where the fastener is within a secrete fix system the correct choice is required to ensure no deformation in the surface of the material being fixed.




### 6.2 Application

Self-drilling and self-tapping fasteners are used in a wide variety of application and that range of applications is growing and innovative systems and existing systems are being developed to meet the growing technical demands that the construction industry faces.

Primarily when self-tapping and self-drilling fasteners are considered the installation of profiled metal cladding and roofing systems are amongst the first applications that come to mind. The system of installing profiled sheets to steel and timber substrates where fast safe installation is required has made full use of the self-drilling fastener, taking over from self-tapping fasteners; with lighter and lighter steel purlins and larger industrial units being built the labour intensive slower process of installing self-tapping fasteners as made way for self-drilling fasteners. Applications include single skin systems, built up systems where a liner is secured to the purlin/rails followed by a proprietary spacer system to provide a cavity for insulation and a structural support for the outer profiles sheet. Composite/sandwich panels that incorporate the liner insulation core and outer weather sheet in one homogenous unit have become common place in industrial type units and a growing wide range of building types.

***A: What is being fixed:***

The first consideration is what is being fixed e.g.:-

- Bracket to primary structure
- Bracket/rail to bracket/rail
- Profiled sheet to rail/primary structure
- Composite sandwich panel to primary structure
- Profiled sheet or composite sandwich panel side lap stitching
- Flashing to profiled sheet or composite sandwich panel
- Insulation products in rainscreen and flat roofing applications.

In considering what is being fixed you need to consider: -

- **The material** of the component: steel (galvanised or coated), aluminium (mill finish or coated, or ACM: Aluminium Composite Material), fibre cement, high pressure laminate board, etc. The component itself may have the requirements for a clearance hole for thermal movement especially with regards aluminium and some laminated materials. The material of the component being fixed will affect the choice of fastener material, as well as the environment that the application is in.
- **The thickness** of the component: This could range from 0.4mm for a profiled steel liner panel to 250mm+ for a sandwich panel. This will affect the choice of fastener length as well as fastener type.
- **Head style of the fastener**: The factors involving the choice of head style include pullover performance, which will be related to the fastener head and washer where required. For crown fixing of profiled steel and aluminium sheets a saddle or storm washer may be required to minimise compression of the crown so as to maintain the profiles shape and to improve the pullover performance. Where secret fixed assemblies and standing seam fixing clips are used the fastener head will need to be considered in ensuring that it is compatible with the secured over the clip therefore a low profile or wafer headed fastener head may be required. Where a fastener head is exposed additional protection to the fastener head from an over moulded integral nylon head. The benefits of the Nylon head include: prevention of inversion of the washer as the nylon head as a greater surface area contact with the sealing washer: Aesthetics, Colour matching with the profiles or composite panel being secured: corrosion protection of the fastener head. Low profile headed fasteners are used where for details, rainscreen facades or where a more obscure fixing is required.
- These can be powder coated to match the component. Where insulation products are being installed in rainscreen systems or flat roofing application a system specific washer will be required.
- **Pullover:** as well as ensuring that the component is securely clamped to the substrate the pullover performance of the fastener head and washer assemble will need to be considered. The fastener head and washer combination together with the fastener location within the component or system will be critical in needing the design criteria and wind loading of the system. Larger washers and thermally broken washer/fastener combinations for single ply membrane roofing applications

***B: What it is being fixed to:***

- **Material/Thickness:** Consideration should be made to what the components are being fixed to. Substrates can range from: -
  - Light section steel (cold rolled) 1.2mm to 3.0mm in thickness
  - Heavy section steel (Hot rolled) 4.0mm to 12mm in thickness for self-drilling fasteners, with some new generation self-drillers with a drilling capacity of 18mm. Self-tapping fasteners for steel up to and above 12mm in thickness.
  - Aluminium sections ranging from 1.5mm and above.
  - Timber both softwood (C14 to C24 grades) and hardwood timber sections.
  - Timber based products ranging from
    - Plywood,
    - OSB (Orientated Strand Board)
    - Glulam beams
    - Cross laminated timber
    -
  - Backing walls which may consist of
    - Composite products such as Metal skinned sandwich panels,
    - OSB faced SIP(structural Insulated Panels)
    - Cement particle boards (depending upon grade, generally fixed to a steel stud frame)

The correct drill point geometry is required depending upon the thickness and material type to be drilled/fixed into. Manufacturer's literature and/or websites offer guidance on the most suitable fastener.

- **Pullout performance:** The load to which the fastener will pull out of the material it is being fixed into is a critical part of the overall design of the application.
  The project/structural engineer will use the figures supplied by the fastener manufacturer to determine the number of fasteners required to achieve the require performance to meet the specific projects design criteria.
  Generally performance is specified as the Ultimate (failure) pullout load, these figures are then factored down by the engineer to take into account variations in substrate performance and installation and safety factors to generate a working or allowable load for each fastener or series of fasteners. Specific pullout testing performed in the laboratory or on-site can be performed to provide application/material specific data. Pullout in hot rolled/heavy section may be limited to the tensile strength of the fastener component; this information will be clearly shown on the manufacturer's data sheets.
- **Shear performance:** The diameter and thread design together with the fastener materials performance will determine the fasteners ultimate Shear performance. The shear performance of the fastener may be higher than the shear performance of the components and the substrate therefore the overall performance of the connection with regards shear needs to be considered by the designer. For applications where longer fasteners are required the bending moment/ performance of the fastener will also need to be considered.

***C: Environment:***

The internal and external environment of the application is important in selecting the correct fastener option.

The internal humidity of the building can be classified as

- Normal/low humidity: This may cover factories and warehouses where the processes and occupants within the building do not add significant moisture and water vapour to the atmosphere.
- Medium humidity: This may cover buildings with high occupancy levels such as supper markets, public meeting halls and offices. Or buildings that are used for short periods of time where exercise e.g. gyms and sports halls, churches and youth clubs.
- High humidity: Buildings where processors add significant moisture and water vapour to the environment. Some high humidity, swimming pools, anaerobic digesters buildings and/or coastal, industrial, commercial or leisure environments may contain corrosive or chemical laden conditions either internally or externally (or both).

The external environment will affect exposed fasteners and fastener heads and washers especially in coastal areas. Coastal environments extend a minimum of 1km from the shore or edge of tidal water. This may extend significantly further (up to 5km) depending on the topography and prevailing wind. Industrial area where corrosive pollutants are present in the environment, In these circumstances there is a need to check suitability and compatibility of component parts with the fastener manufacturer or system supplier and obtain specific project guidance and section 2.1 above regarding swimming pool environments.

BS 5427-1:1996 goes some way to define internal and external environments but more specific advice and guidance is being considered. For more information about environmental classifications, see ISO 9223 and BS EN ISO 12944. For coil coated metal see BS EN 10169.

Life expectancy guidance is detailed in section 2, however where a warranty is required this period will be dependent upon the internal and external environments, building usage and the materials of the components being secured, substrate and the fastener material and any coating or protective nylon head.

General warranty periods may range from 10 to 15 years for nylon headed coated carbon steel fasteners and 20 to 25 years for stainless steel fasteners Fastener manufacturers will give specific and additional guidance on warranty periods based on the criteria detailed within this document.

The overall selection of the fastener is based upon the criteria described above. It can be a simple process of selection from the manufacturer's literature or may require consultation with the system supplier/manufacturer or with the fastener manufacturer's specialist advisers/engineers.