(Image source:
Sheh Fung Screws)

Application and Use of Self-Drilling Screws

by Wei-Ming Wang

Introduction

Self-tapping screws are a type of screws which can tap their own threads as they are driven into the material. It's been a long time that self-tapping screws are considered the ideal fasteners for thin sheet metal connection for steel or other metals. They are inexpensive, easy to install, and requires only tooling. They are common and easy to be used everywhere in the mechanical world. Self-tapping screws have a wide range of tips and thread patterns, and are available with almost any possible screw head design. Common features are the screw thread covering the whole length of the screw from tip to head and a pronounced thread hard enough for the intended substrate, often case-hardened. For hard substrates such as metal or hard plastics, the self-tapping ability is often created by cutting a gap in the continuity of the thread on the screw, generating a flute and cutting edge similar to those on a tap. Thus, whereas a regular machine screw cannot tap its own hole in a metal substrate, a self-tapping one can (within reasonable limits of substrate hardness and depth).

Self-tapping screws can be divided into two classes:

Those that displace material (especially plastic and thin metal sheets) without removing it are termed thread-forming self-tapping screws. Self-tappers with sharp cutting surfaces that remove the material as they are inserted are termed self-cutting self-tapping screws. Thread-forming screws may have a non-circular plane view, such as the five-fold symmetry of the pentalobular or three-fold symmetry for Taptite screws. Thread-cutting screws have one or more flutes machined into their threads, giving cutting edges.

Both fastener types required a pre-drilled hole in the assembly in order to be installed. Installation required two tools and often two workers to install the fasteners; one to drill the holes and a second worker to install the fastener. By the late 1960's and early 1970's, a new-technology self-drilling point was introduced to the metal building industry. It was described as a "pinched point" (cold-forged) self-drill. This new point required only one operation to form (pinch) the point on the end of the fastener. That process employed the use of a machine equipped with hardened dies that were configured to match the desired shape of the point. As the fasteners passed into position, the dies were closed and the point was cold-formed on the screw in one operation. This process was faster and more consistent in the production of self-drilling screws. The obvious advantage of using self-drilling fasteners was the reduction in the overall time and cost of installing fasteners. Self-drilling fasteners did not require pre-drilled holes to be installed. They were still a hard sell in the early years because self-drilling screws were considerably more expensive to purchase. Eventually, the economics of a one-man operation to install a fastener became evident. Self-drilling screws save time. It won't take a ton of time prepping for the drilling process. Self-drilling metal screws have a chisel tip that looks like a drill bit which is simple and easy to use. Innovations in the building sector are almost always driven by increased efficiency. Today, self-drilling fasteners are used almost exclusively for securing walls and roof sheeting to girts and purlins in the metal building industry.

Design Features

What are self-drilling screw tips? A self-drilling tip effectively drills its own pilot hole through the material as the screw is being driven in. It has a cutting blade which sends the waste material back up the body of the screw and out of the hole. (see **Figure 1**)

The self-drilling screw has the same tap-like flute in the leading threads as the self-tapping screw, and there is also a preliminary drill-like fluted tip that looks much like the tip of a center drill. These screws combine a thrilling-like action and the fastener installation itself into only one driving motion (instead of separate drilling, tapping, and installing motions). They are thus very efficient in a variety of substrate applications. (See **Figure 2**).

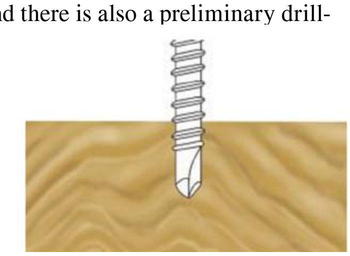


Figure 1. A cutting blade sends the waste material back up the body of the screw

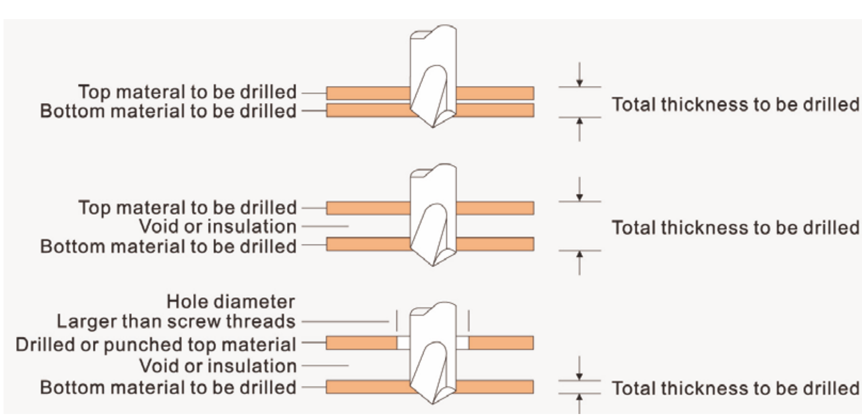


Figure 2. Preliminary drill-like fluted tip of Self-drilling screw during installing motions

(Source: Product Catalogue of Sheh Fung Screws Co., Ltd.)

The cutting point feature of self-drilling screw tips is originated from the drill bit. The best geometry to use depends upon the properties of the material being drilled. The following geometries of drill bit point angle, helix angle, and lip relief angle shall be taken into account for some commonly drilled materials. (see **Figure 3**) The recommended detail is dominated by the materials to be drilled. Thus, key design features to consider for self-drilling screw fasteners are listed in **Table 1**. The drill flute and point length of self-drilling screw tip should be taking into account if metal materials are to be drilled only. The drill bit with winged reamer may be the feature for wood-to-metal connection.

When selecting a self-drilling screw, consider the material thicknesses and types of materials to be joined. Table 1 shows some key design features to look for when selecting suitable fasteners.

Drill flutes allow drilled material to exit the hole. Completely embedded flutes can no longer remove these chips, which contain approximately 80% of the heat created by the drilling process. A buildup of this material can cause the point to over-heat and fail.

Point length determines the material thickness which the screw can reliably penetrate. The unthreaded portion of the point, (pilot section) must be able to completely drill through the material before the threads engage. If the threads engage before drilling is complete, the fastener can bind and break.

The jacking may occur when some screws fasten thicker materials, such as wood, to metal.. (see **Figure 4**). The solution against jacking may consider the requirements of point length factor or pilot point. Point wings are used against thicker wood materials to metal connection. The wings enlarge the hole in the fastened material, allowing the threads to pass through without contacting the fastened material. The wings will break away in contact with the metal before the threads engage in the metal. (see **Figure 5**)

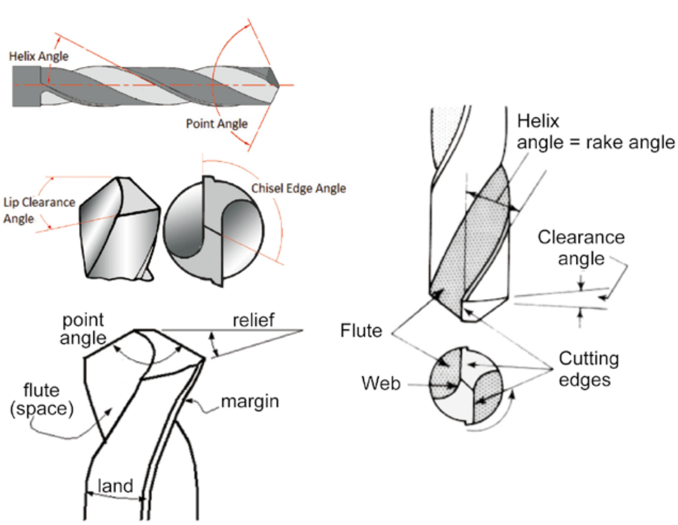


Figure 3. key feature of drill bit

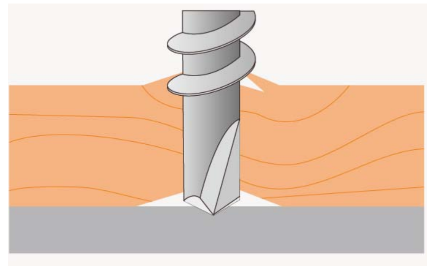


Figure 4.
The jacking occurs when self-drilling screws are used for thicker materials
(Source: Product Catalogue of Sheh Fung Screws Co., Ltd.)

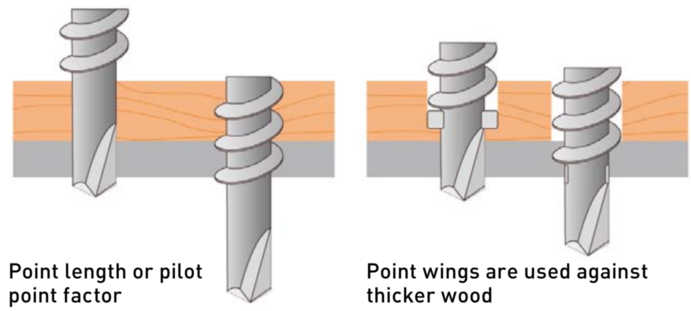
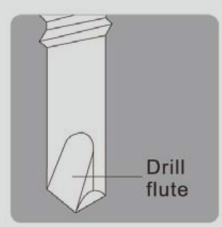
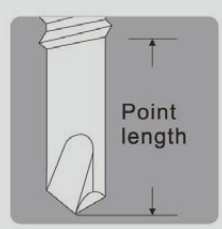


Figure 5. Solution against jacking for self-drilling screw used for thicker materials
(Source: Product Catalogue of Sheh Fung Screws Co., Ltd.)

Table 1. **Key design features to consider for self-drilling screws**

	**Drill Flute** The length of the drill flute determines the metal thickness that can be drilled. The flute itself provides a channel for chip removal during drilling action. If it becomes completely embedded in material, drill chips will be trapped in the flute and cutting action will cease. This will cause the point to burn up or break.
	**Point Length** The drill point is the unthreaded section from the drill point to the first thread. This length must be long enough to completely drill through the material before the threads engage. If the threads engage too early, they can cause the fastener to bind and break.
	**Screw Winged reamer** It is necessary to use fasteners with wings when fastening wood, over ½" thick, to metal. The wings will ream a clearance hole and keep the threads from engaging too early. If the threads engage too early, this could cause a separation of the fastened material from the base material (jacking). Once the wings hit the metal material, they will break off allowing the threads to engage.

(Source: Product Catalogue of Sheh Fung Screws Co., Ltd.)

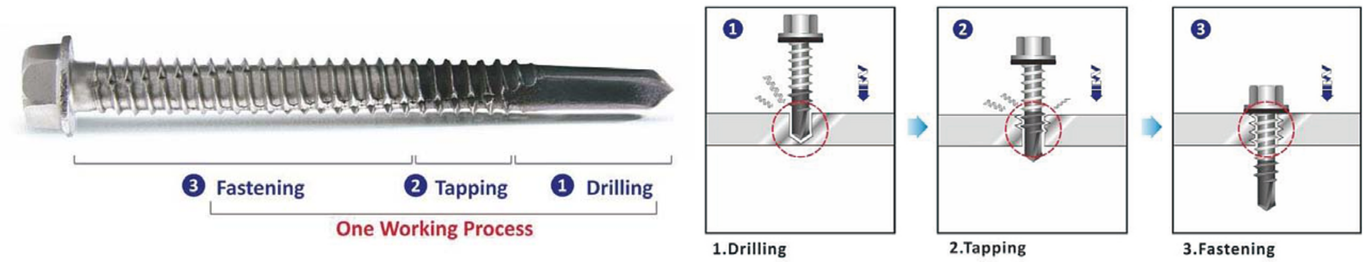


Figure 6. **High quality stainless bi-metal self-drilling screw** (Source: Product Catalogue of Sheh Kai Precision Co., Ltd.)

Common Questions for Use of Self-Drilling Screws

The most common materials of self-drilling screws are carbon steel, stainless steel or stainless bimetal material. It depends on the application and intended use of fasteners. Self-drilling screws should offer a balanced combination of strength, durability and resistance to rust/corrosion. Some self-drilling screws, however, made of carbon steel are with heat treatment, surface treatment and also coated with other metals like zinc for enhanced strength or resistance to rust/corrosion. The stainless bi-metal self-drilling screws are made of strengthened carbon steel drill points welded onto A2/A4 of ISO 3506 stainless steel shanks for high quality of drilling capacity and resistance to corrosion. This bi-metal design enables the dual advantages of self-drilling through hard metal and corrosion resistance on the stainless shank when drilling, tapping and fastening in one shot. (See **Figure 6**).

As their name implies, self-drilling screws operate on the same principles as drill bits and other cutting tools. For any cutting tool, performance is governed by cutting speed, feed rate, depth of cut and the work material itself. Then, installation performance of self-drilling screws can be linked to the basic cutting tool parameters where suggested optimal parameter values are dependent on nominal screw size of intended use.

RPM is the speed at which the driver motor runs while the screw is installed with power tool. This is often adjustable using a variable pull trigger or different driver motor. Applied force is a measure of the user's applied force as the screw is installed. More force is not necessarily better. Work material hardness can be viewed as a material's resistance to drilling or cutting. In most instances, the harder the work material, the more difficult it is to cut. Depending on the application, this may be out of the user's control. Drill bits are cutting tools used to remove material to create holes, almost always of circular cross-section. Drill bits come in many sizes and shapes and can create different kinds of holes in many different materials. In order to create holes, drill bits are usually attached to a drill, which powers them to cut through the workpiece, typically by rotation. Drill bits come in standard sizes that can create holes with required screw tap sizes.

Self-drilling screws are susceptible to the same forces as drill bits. Cutting performance is impacted by the speed and depth of the cut made. The common suggestion for solution in use of self-drilling screw is given in **Table 2**.

Make sure that you select the correct sized screw for your application so you can avoid the drill head melting if too much RPM is applied or snapping if too much pressure is applied. A simple rule of thumb is that small diameter screws can take higher RPM's but less force can be applied. Transversely the larger the diameter the lower the RPM but higher force can be applied.

No matter what drill or tool you use to set a self-drilling screw. Turn the screw at a moderate to slow speed through the entire process. Once the self-tap "drills" through the metal the screw then begins to screw in. After only a few reotations the screw will be set.

Table 2. **The common suggestion for solution in use of self-drilling screw**

Issue Item	Description of Failure	Suggestion for Solution
 Split at point	Excessive force (feed) applied while drilling	Reduce application force
	Brittle failure because of higher hardness of screw tips	Control of screw heat-treated by manufacturer
 Outer corners worn or melted	Drill RPM (cutting speed) too high	Use slower motor or partial trigger pull
	Drill snapping is not ok	Drill feature design is not for material to be drilled Control of Nonconformance during drilling bit manufacturing
	Too much drilling pressure is applied	Reduce application force
 Point melted or diameter significantly reduced	Work material too hard	Confirm work material specs and use appropriate self-drilling screw
	Insufficient chip clearance	Choose screw with longer pilot section
	Excessive force (feed) applied while drilling	Reduce application force
 Screw spins without drilling a hole	Drill motor set on reverse	Check motor direction
	Work material too hard	Confirm work material specs and use appropriate self-drilling screw
	Drill point blunted by handling	Inspect unused drill points for possible damage (from handling)

Acknowledgement

This is to express special thanks to SHEH FUNG SCREWS CO., LTD. and SHEH KAI PRECISION CO., LTD. for wonderful integral information on the topic. It helps in doing a lot of study to know about application and use of self-drilling screws.