"Drilling Down"-

The Basics of Drill Screws

by Laurence Claus

Fastening thin metal sheets has presented challenges since screws were first used to connect things. If the metal sheet is very thin the connection is challenging because there isn't enough thickness to provide sufficient thread engagement, and, thus the ability to withstand stripping. On the other hand, as sheet or gauge thickness increases self-piercing is no longer an option and either a pilot hole is required to accommodate a thread forming or cutting screw or a tapped hole must be prepared to accept a machine screw. In many instances, particularly in construction, the time it would take to prepare each joint to accept such designs is prohibitively long. What, therefore, is the solution to this dilemma?

The simple solution is to combine a drilling feature to a thread forming or cutting screw to create what the industry refers to as "Drill Screws". These fasteners have a specially designed point that functions in an equivalent manner as a drill bit. This drill point bores a pilot hole and clears the chips allowing the subsequent threads to form mating internal threads.

Although Drill Screws can be used in any market or application that requires a pilot hole prior to thread forming or cutting, they are most often utilized as construction fasteners in the building trades. They are especially favored here because the location of the fastened joint can rarely be pinpointed prior to the panel, board, or clamped item being set into place. Drill Screws, therefore, allow installers the ease of one-sided installation wherever parts are needed without expending a lot of time preparing the joint. Naturally other markets utilize drill screws as well, including automotive and industrial applications, but none to the extent that they are used in construction.

Unlike drill bits which have many different sizes and configurations, Drill Screws are relatively straight forward in comparison. The dimensional information is given in SAE J78 and IFI-113. Although these standards only define two different point styles, #2 and #3, they do leave the details of the point taper and flute design to the manufacturer provided that the design meets the performance requirements laid out in the standard. Drill Screw points come in four (4) different size variants; #2, #3, #4, and #5. Each of these sizes corresponds to several different screw thread diameters. **Table 1** illustrates the relevant sizes.

Table Nr. 1

Drill Screw Size	Basic Thread Diameter
#2	#6, #8, #10
#3	#8, #10, #12, #14
#4	#12, #14
#5	#12

On the surface, the way a drill screw works appears pretty simple. The drill point bores a hole and the threads which follow it either cut or form mating threads. Although this description generally captures the essence of the process there are several very important nuances that must be maintained. First among these is that the drill flutes must be longer than the material being drilled. This is important because the flutes must provide an unencumbered path to freely expel the chips. If the tip is totally embedded in the material it is boring a hole in, the chips will become trapped in the flutes and the point will likely burn-up or break. Secondly the point length or, more specifically, the length from the tip to the first thread, is extremely important. The drill point must be long enough to assure that the drilling action is complete before the first thread engages. The reason for this is simple, the threads will advance faster (up to ten times) than the drill speed in boring the hole. If the thread should engage before drilling is complete it will move the screw in faster than the point is able to advance in drilling mode and the screw will break. The last consideration is regarding Drill Screws that are passing through wood to metal. If the thickness of the wood element is greater than ½” then a clearance hole is required to prevent the drill speed problem described immediately above. In these cases, either a pilot hole is required to be drilled in the wood element prior to installation of the Drill Screw or a special Drill Screw variant with break-away wings must be used. These wings act like a reamer and enlarge the hole bored by the drill point to provide sufficient clearance for the threads behind them and, thus, eliminate the speed variation problem. Once they contact the metal surface they will break away allowing the subsequent threads to engage the pilot hole and form or cut the mating threads.

Drill Screws are most commonly made of carbon steel and case hardened. For screw sizes #8 to #12 the case depth may range from .004” to .009” and for ¼” diameter screws the case will range from .005”-.011”. The case hardening provides the strong and hard outer surface needed to facilitate drilling and thread forming or cutting. The standards that address performance of these screws are ASTM C1513 and ASTM C954.

In cases where the fastener is likely to be exposed to a harsher environment it may be prudent to choose a Drill Screw made of a corrosion resistant material. Although stainless steel provides the answer to the corrosion protection question it introduces a new problem. These materials, in general, do not provide adequate performance as a drill point. Therefore, several manufacturers offer a clever bi-metal alternative, where a short length of carbon steel is welded to the stainless steel shank. This carbon steel portion is formed into the drill point, hardened, and provides the requisite drilling performance while the remainder of the body is stainless steel and provides the requisite corrosion protection.

The environment that drill screws are exposed to is an important consideration when choosing the right drill screw. Environmental exposure is broken into three different classification levels; low, moderate, and severe (some suppliers may use terms like low, medium, and high). A low level environment is one that is indoors and dry. A moderate (medium) level environment is one that is indoors or outdoors and exposed to minimal moisture. A severe (high) level environment is one that is indoors or outdoors and in a wet environment. This severe case would also include screws in coastal areas, heavy industrial exposure, and areas that receive prolonged exposure to moisture.

If there is any doubt as to the proper choice of screw material based on exposure and joint parameters, it is best to speak with the manufacturer or supplier for expert guidance. As a general rule, however, screws that are connecting untreated lumber to steel, steel to steel, and gypsum to steel in low level environments are usually case hardened and zinc plated. These same applications in a moderate level environment are case hardened but with a special coating (higher corrosion protection and less risk of hydrogen embrittlement) and in severe level environments of 300 series stainless steel. When the applications are pressure treated or flame retardant materials to steel, aluminum to steel, or other dissimilar metal connections, both low and moderate level environments use special coated screws, often with special heat treating and the severe level environments use 300 series stainless steel.

Drill Screws may come in a variety of head styles which will, again, be a function of the application. Most of these screws, however, come in a hex head variety, since the hex shape will allow good torque transmission. Other applications, however, such as attaching gypsum board to metal studs will use a recessed or bugle head style screws with an internal recess.

Another consideration that must be taken into account for installation is the type of joint formed (or application). Some joints will be considered “hard” joints while others are considered “soft”, and this designation will dictate the level of torque control that must be exerted during installation. Examples of “soft” joints include applications such as interior drywall, exterior sheathing, and attaching plywood to metal. In general, these applications are non-structural and can sufficiently accommodate some “over driving”. Therefore, these applications usually do not require precise torque control or depth gauging. On the other hand, “hard” joints such as metal siding, exterior facades, and window glazing cannot accommodate “over driving” without negative consequences and usually require special installation equipment that exerts torque control or depth gaging.

One can see that Drill Screws require more engineering than may originally meet the eye. The point and flute lengths are critical to assuring that the drilling process these screws are intended to accomplish occurs without damage to the point or breakage of the screw. In addition to getting that right, the designer or installer must make sure they properly understand the environment that the screw will be used in so that the proper material and coating choices may be made. Finally, the installer must often take care to control the execution of the installation to prevent screw breakage or joint damage. All-in-all these “simple” screws must be fully understood for proper performance and usage. ■