Inserts – Lowering Your "Installed Cost"

Christopher Doll
Bulten North America
www.bulten.com

The application of plastics to engineering design remains high. To make full use of a wide range of plastic materials available, designers need a similarly wide range of fastening systems. Many fastening systems are available, but for the majority of engineering assemblies, provisions must be made to allow for dismantling for adjustment, servicing or repair. This usually means that a mechanical fastening system is essential.

For use with plastics, there are a variety of insert designs that are available, for either post-mold installation or over-mold installation and for installation into both thermoplastics (which can be softened by heat) as well as thermoset plastics (which cannot be softened by heat).

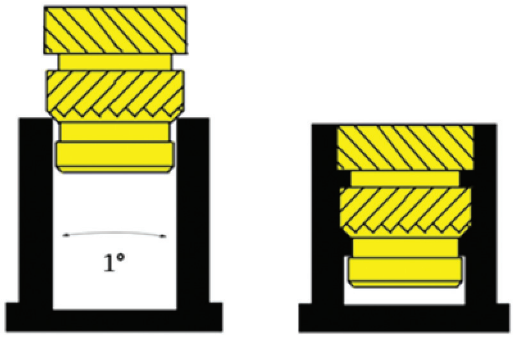
In our experience, 90% of the inserts we sell are for post-mold installation, and almost all of those are used with thermoplastics. With post-mold installation, a hole (known as a "boss") is created in the plastic assembly. The insert would then be installed into the boss via secondary process installation. While there are a few insert designs that are simply cold-pressed into the plastic, the overwhelming majority of inserts would be installed via heat or ultrasonic.

There are many benefits to post-mold installation. The inserts can be installed remote from the molding operation, reducing "press-open" time and therefore increasing production. There are reduced scrap rates and no displaced inserts or damaged molds.

Traditional Insert Designs

When selecting the appropriate insert, the prime consideration will be the type of plastic used. The installation method at the point of assembly will also be a determining factor in the insert style. Historically the most commonly used inserts are known as parallel inserts, which feature opposing helical knurl bands for retention, along with a pilot end point for location and alignment. To assist with installation, parallel inserts are installed into a boss with a 1° inclusive taper, from the point of insertion. Therefore, the specified hole size for a parallel insert is the diameter of the hole at the installed depth of the insert, with the diameter being slightly larger at the top of the boss. Parallel inserts provide excellent pullout and torque performance. The only drawback to this design is that parallel inserts have a relatively long installation stroke.

Occasionally engineers will specify a tapered insert



A parallel insert is installed into a hole with a 1° inclusive taper. The insert will locate via the pilot, as per the image on the left. While providing excellent performance, a parallel insert will have a relatively long installation stroke.

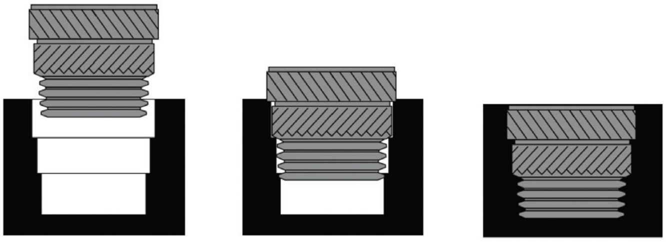
instead of a parallel insert. A tapered insert is installed into a hole with an 8° inclusive taper. Because of the increased taper dimension, tapered inserts will freely locate further into the mating hole than a parallel insert, providing improved ease-of-location and hole-centering benefits. However, there are also potential drawbacks to traditional tapered designs. Tapered inserts often require a dwell time, whereby the installation tool dwells (pauses) at the bottom of the installation stroke. Without the dwell time, the insert is subject to "spring back" in which the insert would cease to remain flush and would become alarmingly proud in relation to the top surface of the boss. Further, traditional tapered inserts often produce plastic flash, where the plastic bubbles up around the top surface of the insert. This often requires a secondary deburring process to remove the plastic flash, adding to the overall manufacturing costs. Therefore, while traditional tapered inserts are somewhat common in the marketplace, they have never been one of our recommended designs.

Creating a New Insert Design

Our goal was to create a new insert design that featured the location and alignment properties of a tapered insert, but with all of the benefits associated with parallel hole technology. As an added measure, we wanted the

A traditional tapered insert is installed into a hole with an 8° inclusive taper. In the image on the left, you can see that a tapered insert will locate further into the mating hole than a parallel insert. However, tapered inserts will often produce plastic flash, and also require a dwell time to eliminate "spring back," adding to the overall "installed cost" of the insert.

Tri-Step® inserts are installed into a corresponding stepped hole. The inserts will freely locate more than two-thirds of the way into the hole. Tri-Step inserts produce no plastic flash and require little-to-no dwell time, resulting in quicker installation and a lower "installed cost."



new insert to be available in lighter weight options, for those applications where light-weighting was a desired criteria.

The end result was the creation of the Tri-Step® insert, which has become widely accepted, especially for new applications where a running design change is not required. Tri-Step inserts feature opposing helical knurl bands along with a series of annular vanes. The inserts are installed into a corresponding stepped hole, which is easily created via an inexpensive pin within the mold tool. The overall hole depth should ideally exceed the insert length by 0.5mm. As with other insert designs, the specified hole diameters apply at the bottom of each bore, with a tolerance of -0.00 / +0.10mm. For each bore (step), a 1° inclusive molding taper should be used, slightly increasing the hole diameter at the top of each bore. The stepped hole design features 0.6mm clearance between the insert and each bore of the mating hole, with each of the two helical knurl bands engaging with its own hole diameter, thereby creating the necessary interference and captivation during heat installation.

By carefully selecting the difference in diameter between the steps, the small leading insert diameter has a substantial clearance with the large top hole diameter. In fact, both of the two leading insert diameters are a free fit with the top two molded hole diameters, providing excellent location and alignment. As a result, during heat installation the insert travel is less than one third of the total insert length. Compared to a traditional tapered insert, the Tri-Step insert will freely locate further into the hole, thereby reducing installation time and increasing productivity. Additionally, Tri-Step inserts require little-to-no dwell time and produce no plastic flash, further reducing the installed cost of the insert.

Tri-Step inserts are available in two styles: a standard version, produced via machining, and most often made in brass. And a high-strength version, produced via cold forming, and available in steel or aluminum.

The standard brass version will provide the required performance for the majority of insert applications, especially when a smaller body diameter is required for more space-sensitive applications. The high-strength version features a larger body diameter, primarily for the automotive industry where large clearance holes in mating parts are commonly used. The larger body prevents the most common cause of insert failure.

The most common cause of insert failure is during the assembly stage, where the mating screw joins the plastic component to a mating component. The cause is that the clearance hole in the mating part is either larger than the insert diameter or it provides very little contact area between the mating part and the top diameter of the insert. When the force generated by the screw exceeds the pull-out resistance of the insert, the insert will "jack out" unless the force exceeding the pull-out resistance is countered via the contact area with the mating part. As noted, the high-strength Tri-Step version features an oversized body diameter, which is beneficial in guarding against jack out conditions. Even the standard Tri-Step version features a slightly larger body diameter than both traditional parallel inserts and tapered inserts, thereby also providing an increased contact area and a reduced threat of jack out. And when needed, the standard version is also available in a headed/flanged design.

Light-Weighting

One further challenge we wanted to address: with regard to automotive applications, many OEM's are constantly seeking to reduce weight to improve performance, fuel consumption and vehicle range. And with EV's in particular, a lighter overall vehicle weight will equate to greater vehicle range prior to re-charging. In the past the focus has been on large components that offer significant weight reduction. More recently there has been attention to smaller components, including fasteners. This led us to evaluate various alternate materials, ultimately selecting aluminum as one of the material options.

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Standard machined brass Tri-Step® inserts, as well as high-strength cold-formed aluminum Tri-Step inserts.

Historically brass has always been the preferred material for inserts due to its thermal conductivity, corrosion resistance, mechanical properties and ease of machining. In our research, aluminum has been found to be a viable alternative, offering a 66% weight savings, similar mechanical properties and in-place cost benefits due to its higher thermal conductivity. And while aluminum cannot be machined as quickly as brass, we focused on aluminum in relation to the larger-body design, which is produced via cold forming.

The high-strength Tri-Step in aluminum is substantially lighter than the standard Tri-Step in brass, even though the high-strength version has a larger body diameter. As thermoplastic components continue to be used extensively in the automotive and EV industries, when considering the overall number of inserts used on a vehicle, even a small weight savings per part is meaningful.

Summary

Standard Tri-Step inserts are available in metric sizes M2 through M8, along with comparable unified sizes. They are available in two different overall lengths. Moreover, as they are made via machining, they can be produced in special lengths depending on the specific application requirements. Cold formed Tri-Step inserts are available in sizes M4 through M8.

Whether the application is automotive or non-automotive, Tri-Step inserts will provide the ease-of-location and hole-centering benefits of traditional tapered inserts, while eliminating the inherent drawbacks of tapered designs, as well as providing all of the benefits of parallel hole technology. And where required, Tri-Step inserts can also help achieve light-weighting goals.
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Author Profile: Christopher Doll is Account Manager/Business Development Manager for **Bulten North America**. He has worked with captive-style engineered fasteners since 1994, often engaging with OEM engineers from the design concept stage.

Company Profile: Bulten was founded in 1873 and has since developed into a leading manufacturer and supplier of fasteners to the automotive and EV markets, as well as mobile telecommunications, PC and notebooks, white goods & appliance, lawn & garden, and other manufacturing sectors. Core product ranges include inserts for plastics, compression limiters, clinch fasteners, miniature fasteners, externally-threaded parts and various machined and cold formed specials. Bulten acquired PSM International in 2020. **www.bulten.com**