

A MANUFACTURING METHOD FOR IMPROVEMENT IN DURABILITY OF PLASTIC MOULDED PARTS BY INSERTING METALS IN PLASTICS

Mr.M.S.Dukale¹, Mr.D.S.Zalte², Mrs.B.N.Gaikwad³

^{1,2}*Mechanical Engineering Department, K.K.Wagh Polytechnic, Nashik, Maharashtra, India*

³*Science Department (Chemistry), K.K.Wagh Polytechnic, Chandori, Nashik, Maharashtra, India*

ABSTRACT

Every year your industry grows more competitive. Products are manufactured faster, cheaper, better. Demands are greater, and your customers' requirements are continually changing. What doesn't change is your need for a reliable, competent source for threaded inserts and precision machined products. Threaded inserts (available in brass, stainless steel and low carbon steel) are ideal for plastics, alloys and composite materials. They are designed to provide strong metal threads for machine screws. These inserts are available in various knurled and undercut patterns to suit almost any assembly application. They are designed to provide the high performance strength values of molded-in inserts whilst still retaining all of the economic advantages of insert installation after molding. Inserts can be installed in a variety of ways. These include ultrasonic welding, hot or cold press-in, mold-in and self-threading. Applications include mobile handset, tablet, notebook, consumer electronics and medical / health applications. Due to an increasing cost pressure and new procedural possibilities, hybrid injection molding has become an established and frequently applied procedure these days. The aim of the hybrid technology is to use the property profiles of the involved composite partners in a synergetic way. Hence, multifunctional and highly rigid components with low weight are produced. In this context, sheet-metal structures are reinforced, stabilized geometrically, their energy-absorbing capacity is improved and supplementary functions such as thread inserts snap-in joints and guide elements are added.

Keywords- materials like plastics, alloys, etc, hybrid technology, low weight, moulding machine, etc.

I. LITERATURE REVIEW

Plastic parts and assemblies are becoming more common as engineers work to reduce costs and weight in their designs. But plastics often aren't strong enough to support fasteners such as screws or bolts. Using screws to attach parts to plastic housings, for example, often ends with stripped threads, failed housings, and assemblies that fall apart. To get around this limitation, engineers first install threaded metal inserts into plastic parts. They

give screws and bolts stronger metal threads to mate with, letting plastic parts be easily assembled, taken apart, and repeatedly reassembled. Two of the most common methods for installing inserts into thermoplastic parts are heat and ultrasonic's. (Thermoplastics can be remelted a number of times. Thermo sets, on the other hand, have a onetime reaction and cannot be remelted, making them unsuitable for heat or ultrasonic's.)

Many companies have already been replacing components of their products with materials offering low-cost, weight-reduction options and also to supplement their green footprint on environment. This paper gives a systems approach to the whole metal to plastic replacement process that is common today in fields like automotive, medical, electrical electronics among others. This work clearly shows how a metal to plastic conversion project, right from the concept to the production stage, can be seen as a system with discrete inputs influencing the process due to their interdependency and how it leads to the desired output based on specific requirements. This paper would assist any project taken up in an industry or as a research study, aiming to replace a metal with a plastic component successfully.

II. INTRODUCTION

Every year your industry grows more competitive. Products are manufactured faster, cheaper, better. Demands are greater, and your customers' requirements are continually changing. What doesn't change is your need for a reliable, competent source for threaded inserts and precision machined products. One of the most common uses for induction heating is the heat staking of threaded metal inserts into plastic. Most thermo-plastics are too soft to sufficiently hold a thread, so brass or steel threaded inserts are added. Post-molded installation is more cost-effective than molding in place and induction is a proven way to pre-heat the inserts prior to installation. For heat staking, the insert is preheated with induction and then pressed into a hole in the plastic part. This is accomplished by positioning the induction coil over the hole and then holding the insert in the coil for a short period of time. When the correct temperature is achieved, the insert is pressed into the plastic. A narrow zone of plastic then melts and flows into the knurls of the insert. The plastic re-solidifies, resulting in a complete assembly with much better mechanical properties than inserts implanted with other techniques. The insert material is usually brass or steel; each has advantages and disadvantages. Brass is non-magnetic and will not corrode as easily as steel. However, brass is a softer material and will anneal at temperatures as low as 450°F, whereas steel starts to anneal at 1200°F. Some glass-filled plastics require inserts to be heated to 700°F for correct installation, so the brass inserts must be heated and inserted quickly to prevent annealing. Brass has low electrical resistivity and therefore requires more power to heat with induction than steel. Thread inserts are of the self tapping type installed into either cast or pilot drilled holes to suit customer's product manufacturing processes.

3. What Is "Metal Inserts"?

Inserts are used to strengthen plastic parts in which screws are to be installed and removed more than once. Most are made of brass, which provides long thread life as well as a solid, secure fastening base. Ours are also available in aluminum, stainless steel and free-machining steel by special order. Inserts are commonly used to

reinforce two types of plastic: Thermoplastic or Thermoset Plastic. Thermoplastics are like wax. At usable temperatures they are solid, but at elevated temperatures they get soft and melt. In contrast, thermoset plastics have a molecularly cross-linked structure which is permanently “set” into shape during the manufacturing process. Thermoplastic compounds are generally more resilient than thermosets and respond well to the ultrasonic or thermal installation of inserts. Thermoset compounds, however, are often brittle and less resilient than thermoplastics. They respond better to molding or post-molding cold insertion. Our inserts come in a variety of styles and sizes to meet a variety of applications. They are manufactured to the following thread specifications: UNC-2B and UNF-2B for inch threads and ISO-6H for metric threads



fig 3.1:- metal inserts

IV. INSTALLATION METHODS FOR “METAL INSERTS”

Insert Molding: Molding an insert into an assembly increases the total molding time because extra time is needed to load the insert. Molded-in inserts may also cause sink marks. They are widely used with thermoset (non-meltable) plastics.

Post-molded: Post-molded inserts eliminate the downtime associated with molding a thread or an insert into a plastic part, such as die damage caused by improper placement. Advantages include faster assembly, reduced open press time and no sink marks.

Ultrasonic: The most common method for installing inserts into thermoplastic materials, it provides fast, positive anchoring. An insert is placed in a molded or drilled hole which guides it and provides resistance. An ultrasonic horn contacts the insert and delivers ultrasonic vibrations which travel through the insert during the “weld cycle.” Frictional heat is immediately developed which melts the plastic as the horn drives the insert into

position. After the vibrations cease, the equipment applies clamp pressure until the plastic cools, preventing back-out.

Thermal: During thermal/heat insertion, the insert is placed into a molded or drilled hole. Pressure is applied with a heated probe that contacts the top surface and minor thread diameter of the insert. Localized melting takes place, and plastic flows in and around the knurls and serrations. When the proper depth is reached, the probe is removed and the plastic re-solidifies, locking the insert in place. Upon removal of the probe, a minimal amount of withdrawal (back-out) of the insert may occur. Thermal/heat insertion provides a good alternative to the ultrasonic method, but it is a slower process. Some benefits include:

- Multiple inserts can be installed simultaneously, even on different levels
- Quiet when compared to ultrasonic
- Thermal equipment is less expensive than ultrasonic equipment
- Excellent for larger inserts

Cold Insertion: Some inserts can simply be pressed in after molding. However, pressing inserts into cold plastic may create unwanted stress. Larger boss (or wall thicknesses) is required to prevent stress fracture. Pull, torque and jack-out strengths are significantly lower compared to thermal or ultrasonic installation.

Variables to consider Lubricants, Fillers or Glass in the Plastic: If the plastic's filler or glass content exceeds 40%, assembly or performance problems may result.

Molded Versus Drilled Holes: Molded holes provide better performance than drilled holes because a strong skin of denser material is formed around them during molding. This is particularly true with structural foam plastics which are porous under the skin.
Plating and Color-coding: We offer a full range of plating and/or color-coding services. The most common metal finishes include nickel, tin and zinc. Inserts of similar size and configuration are often color-coded to prevent inadvertent mixing (inch threads vs. metric threads).

V. INSERT SELECTION

5.1 H Series Tapered Inserts – The leading insert for ultrasonic or thermal installation into thermoplastic or structural foam. A row of unique “knuckle knurls” reduces residual stress and increases strength. The tapered design reduces installation time, making alignment faster and more accurate.

5.2 C Series Chevron Inserts – Designed for straight holes using ultrasonic or thermal processes. This series features two opposing bands of sharp diagonal knurls of different diameters for maximum gripping power. A lead-in pilot diameter assures true perpendicular alignment.

5.3 S Series Symmetrical Inserts – For fast, high-volume applications, symmetrical inserts install without orientation using ultrasonic or thermal equipment. They are designed for straight holes and are ideal for thin-wall applications because little stress is applied to the walls of the part.

5.4 Specials & Custom Designed Parts – Our design engineers will be happy to adapt an existing insert or custom design one specifically for your application. And you'll be surprised how quickly we get back to you.

5.5 P & HP Series Press-in Inserts – Straight-hole inserts install easily in hard or thermoset plastics without heat or special equipment. Three bands of helical knurls anchor the insert firmly into place and provide excellent torque-out resistance.

5.6 HC Series Headed Chevron Inserts – The HC Series features a flange for a greater load-bearing surface in weaker plastics. The flange provides a large contact area for electrical connections. Used in reverse-entry applications, the HC Series offers exceptional pull-out strengths.

5.7 SH & SC Series Threaded Studs – Available in H or C Series body designs. Studs are commonly used to fulfill specific design functions, to save money in production costs, to function as electrical contacts or to replace self-tapping or removable screws. Thread lengths are variable to meet your specific requirements. Special studs without threads can be used as axles, pivots, pins, locating points or solder terminals.

5.8 MB Series Mold-in Blind Inserts & RM Series Rotational Mold-in Blind Inserts – Designed for mold-in applications. The inserts feature a blind thread (closed bottom) that prevents plastic from entering the bottom of the insert. The hex design of the rotational molded insert provides greater holding power in softer materials.

5.9 KS Series Knurled Spacers, Threaded – Designed for a wide variety of applications, these inserts are commonly used for stacking printed circuit boards or when a threaded spacer is required. They can also be molded into a plastic component.

5.10 E & HE Series Expansion Inserts – Designed to provide strong, usable threads in thermoset and other hard plastics. The inserts are pressed into the plastic and expand when the assembly screw is installed. The sharp diamond knurls secure them into the plastic. Inserts are available with or without a flange.

5.11 CL Series Compression Limiters – Unthreaded spacers (bushings) used to strengthen plastics during compression loads

VI. DESIGN OF METAL INSERT

When designing a mating component clearance hole, it is very important that the insert, not the plastic, carries the load. The hole in the mating component should be larger than the outside thread diameter of the screw and smaller than the insert diameter. This prevents the insert from jacking out (Figure 2). When the mating component hole is larger than the insert diameter, a jack-out condition exists (Figure 3).

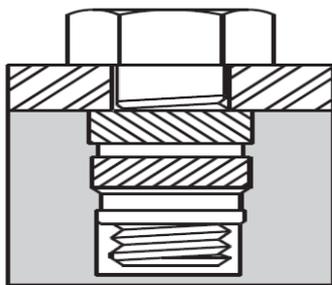


Fig 6.1 Correct

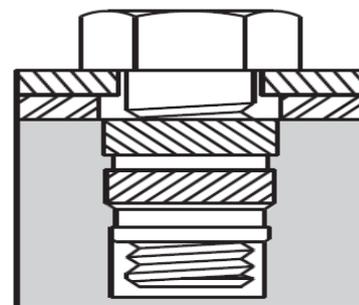


Fig 6.2 Incorrect

6.1 Design considerations

- Hole sizes are not core pin sizes.
- Core pins should be designed to allow for the shrinking of plastic.
- For solid (blind) inserts and threaded studs, we recommend adding a small vent at the bottom of the hole to allow trapped air and other gasses to escape.
- Expect your inserts to seat flush with or .005" above the plastic surface.

6.2 Boss diameter /wall thickness

The performance value of an insert is proportional to the wall thickness (boss diameter) surrounding it. When an increase in wall thickness does not produce an increase in performance, optimum thickness has been reached. Optimum thickness, on average, is two times the hole diameter. If a boss is too large, a sharp drop in performance may result because the hole may become oversized as the molded plastic shrinks. When the hole diameter is larger than recommended, less material is displaced and the insert does not become fully encapsulated in the plastic part – resulting in lower performance values.

6.3 Hole specifications

Hole depth is the key to achieving a flush installation and preventing excess plastic from forming on the threads at the bottom of the insert. Countersinks should not be molded into a hole where an insert is to be installed. All of our inserts have a pilot or “lead-in” diameter that assures proper alignment of the insert during installation, as well as a counter bore or countersink at each end of the insert for easy installation of the mating screw. Should alterations in hole sizes be necessary, please contact our Engineering Department for technical assistance. Remember, there are two types of molded holes referred to in this catalog. The “straight hole” has a maximum of a 1° taper or 1/2° per side. The “tapered hole” has an approximate 8° included angle.

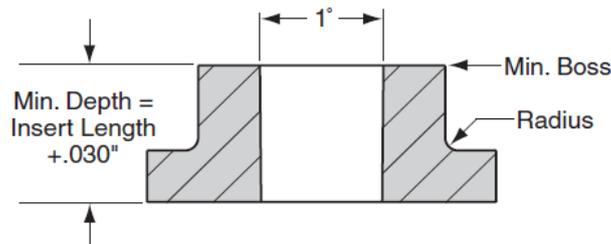


Fig 6.3.1 Boss Diameter

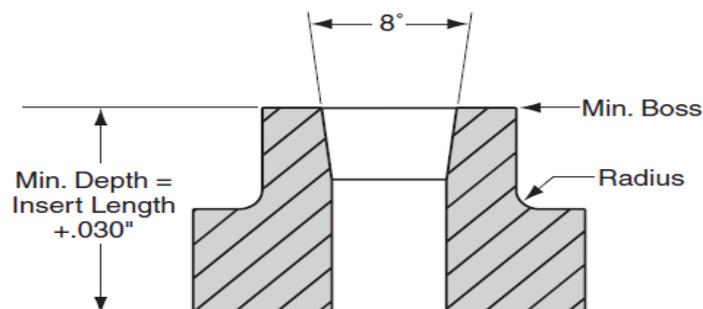


Fig 6.3.2 Hole Specification

VII. DIFFERENT TYPES OF METAL INSERTS

7.1 H Series Tapered Inserts

H Series Tapered Inserts outperform all competitive inserts for ultrasonic and thermal applications. Our customers confirm it. We've eliminated the outward stress that occurs with other insert designs during the installation process. Our proprietary "knuckle knurl" ensures a more uniform flow of material into the diagonal knurls and undercuts, ensuring a complete fill, reducing installation time and increasing holding strengths.

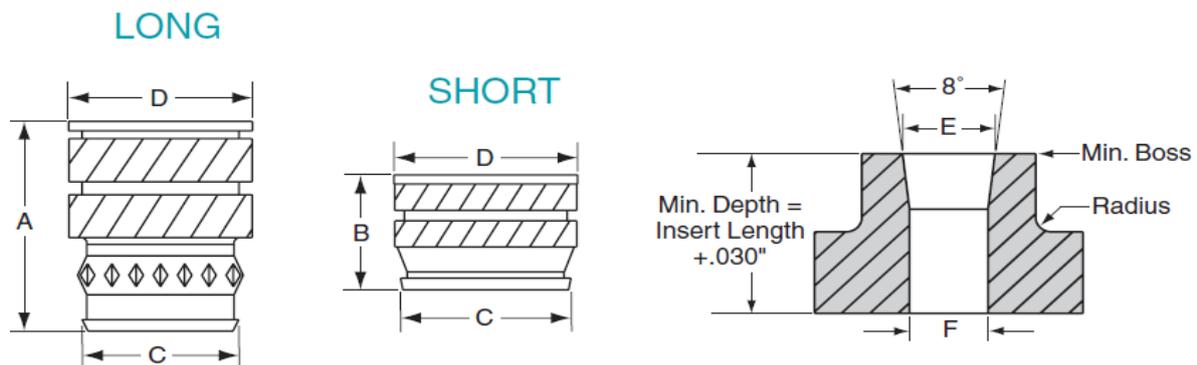


Fig 7.1.1 H Series Tapered Inserts

7.2 C Series Tapered Inserts

Some thermoplastics, like polycarbonates and structural foams, are brittle – especially in thin-wall applications. Our chevron inserts add considerable strength. Two opposing bands of sharp diagonal knurls provide high tensile pull-out load carrying capability. Little or no stress is applied to the walls of the molded holes.

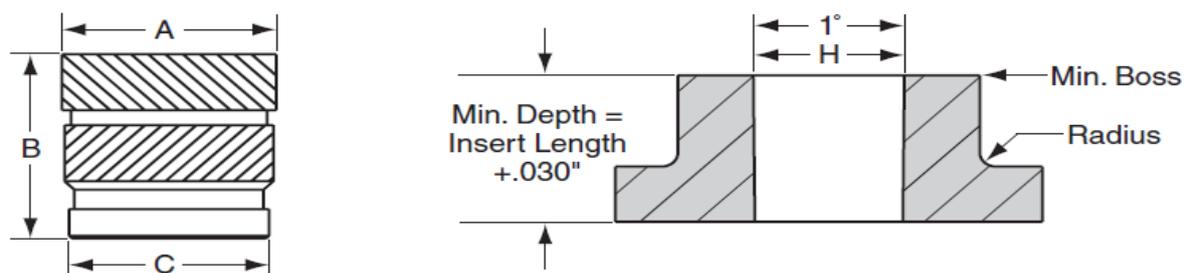


Fig7.2.1 C Series Tapered Inserts

7.3 HC Series Chevron Inserts

HC Series Inserts offer the same benefits as the C Series plus a flanged head. This insert offers a large contact area for electrical connections and greater pullout strengths for reverse entry applications.

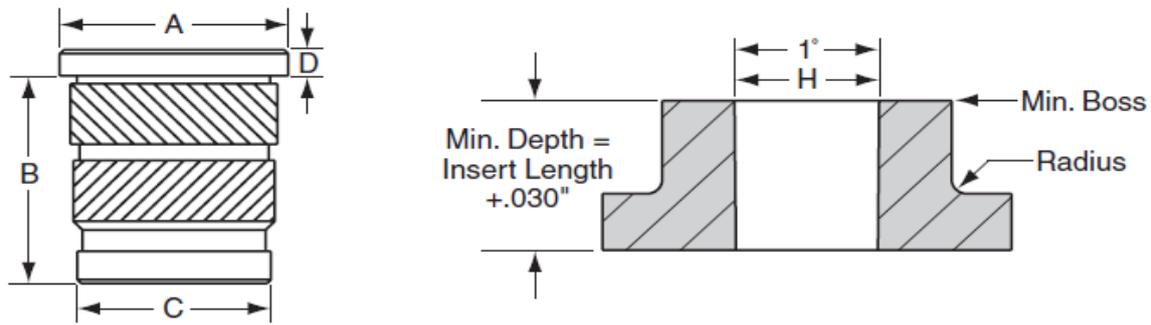


Fig 7.3.1 HC Series Chevron Inserts

7.4 S Series Symmetrical Inserts

Say goodbye to expensive part orientation feeding mechanisms. Our symmetrical inserts can be installed either end first for faster installation and lower costs. By decreasing outward hoop stress, symmetrical inserts decrease cycle times. Their proportionally engineered design ensures that the displaced material is encapsulated by knurls and undercuts. They are designed for straight hole applications.

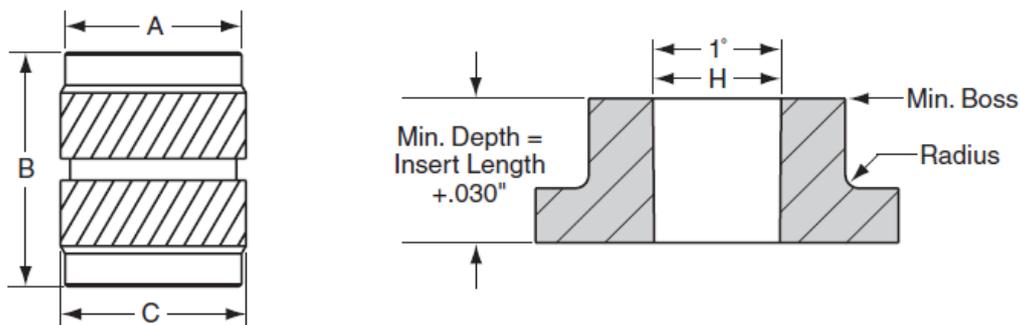


Fig 7.4.1 S Series Symmetrical Inserts

7.5 P & HP Series Press-In Inserts

P & HP Series inserts provide adequate holding strengths without the use of ultrasonic or heat equipment. These inserts are most commonly used in thermoset or other hard plastics. The pilot end provides for fast alignment. The insert is placed in a hole, pressure is applied and the three bands of helical knurls dig down deep and lock the insert in place.

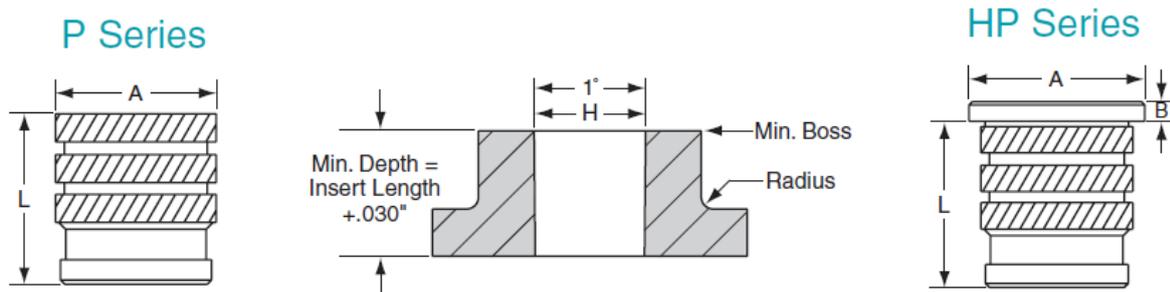


Fig 7.5.1 P & HP Series Press-In Inserts

7.6 E & HE Series Expansion Inserts

The E & HE Series Expansion inserts are designed to provide strong reusable threads in thermoset and other hard plastics. Inserts are pressed into the plastic and expand when the assembly screw is tightened. The sharp diamond knurling provides resistance to tensile and torque loads. The mating screw should be designed for full thread engagement. This will allow the insert to fully expand. For best results, the boss diameters should be approximately 2-1/2 times the recommended hole size. In “through hole” applications, the HE Series flange adds greater strength for tensile pull loads.

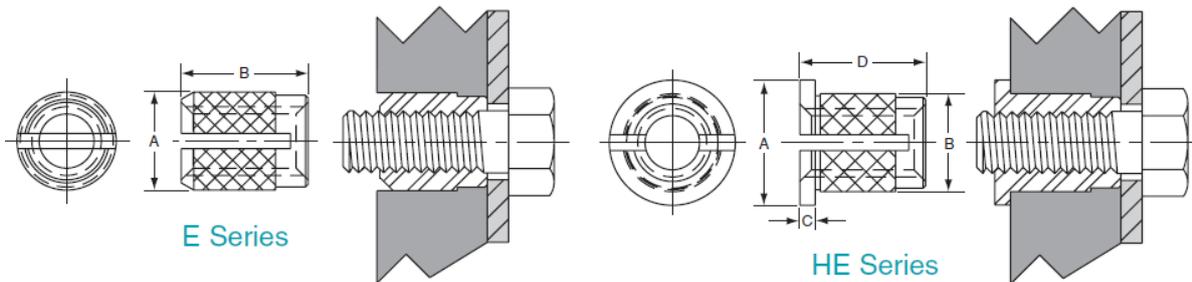


Fig 7.6.1 E & HE Series Expansion Inserts

7.7 SH Series Threaded Studs

The body of this threaded stud is specifically modeled after our H Series Insert. Its key feature is the tapered design, which allows for easy insertion into tapered molded or drilled holes. They may be installed using the thermal or ultrasonic method or can be molded in place.

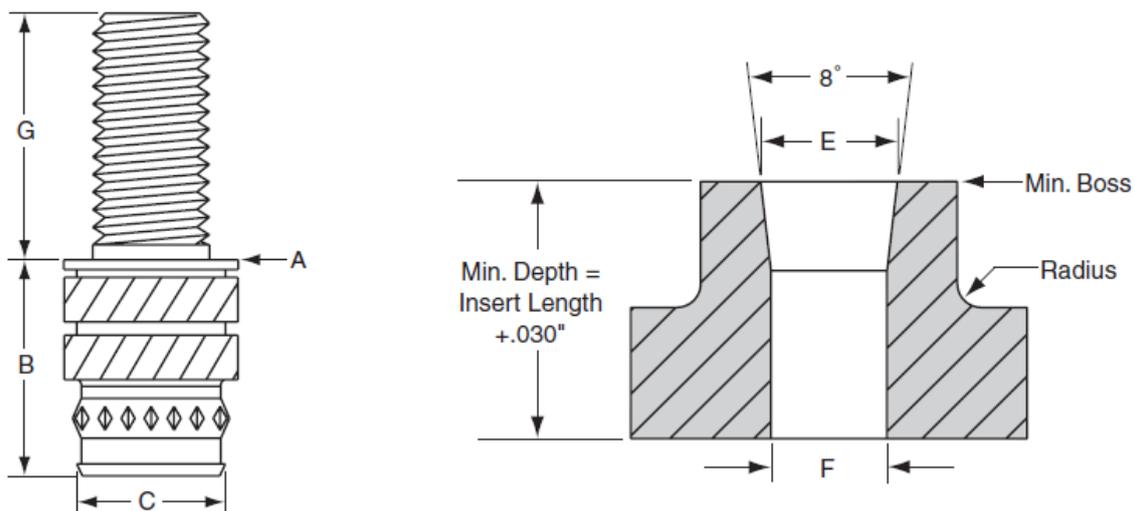


Fig 7.7.1 SH Series Threaded Studs

7.8 SC Series Threaded Studs

The body of this threaded stud is modeled after our C Series Insert. Its key feature is the opposing diagonal knurls, which will provide exceptional rotational and tensile resistance. The SC Series is designed for straight

molded or drilled holes. They may be installed using the thermal or ultrasonic method or can be molded in place.

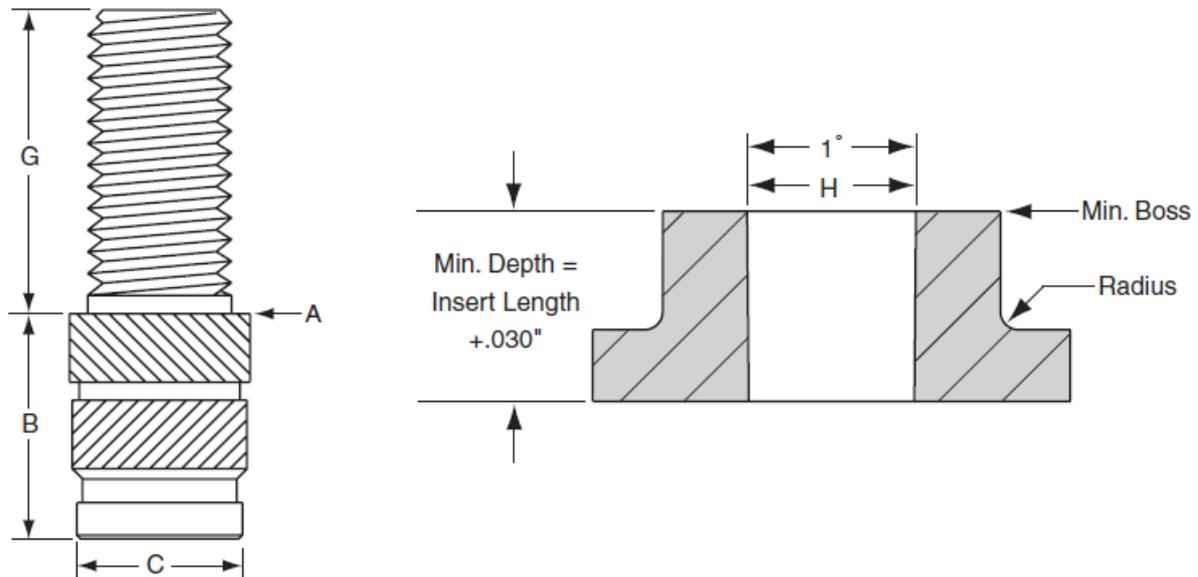


Fig 7.8.1 SC Series Threaded Studs

7.9 Blind Inserts, Spacers & Bushings

7.9.1 MB Series Mould-In Blind Inserts

This threaded insert is designed to be molded into the plastic component during the molding cycle. Typically, the insert is placed on a core pin in the mold during the molding cycle. The insert is designed with aggressive knurling and undercuts to resist rotational and tensile pull loads. The part has a closed bottom (blind thread) to eliminate plastic flow into the threads. Although our catalog insert is brass, this product can also be manufactured in stainless steel, steel and aluminum.

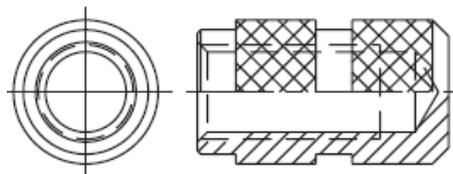


Fig 7.9.1.1 MB Series Mould-In Blind Inserts

7.9.2 RM Series Rotational Mould-In Blind Inserts

Designed primarily for rotational molding, the hex and undercut features provide high resistance to torque and tensile pull loads. The part has a closed bottom (blind thread) to eliminate plastic flow into the threads. Various sizes and lengths can be manufactured to your specifications.

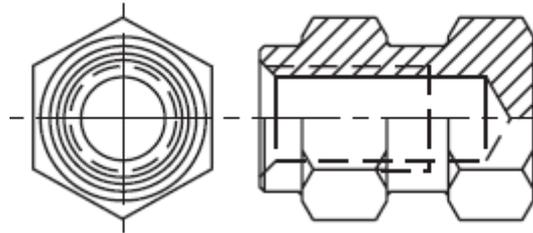


Fig 7.9.2.1 RM Series Rotational Mould-In Blind Inserts

7.9.3 CL Series Compression Limiters

Compression limiters are commonly used in applications where a compressive load is applied to a plastic assembly. The compression limiter strengthens the plastic and resists the load that is applied. The integrity of the plastic, therefore, is not compromised. Generally speaking, compression limiters are made to meet your individual specifications. Various lengths and sizes can be manufactured to accommodate inch and metric bolts.

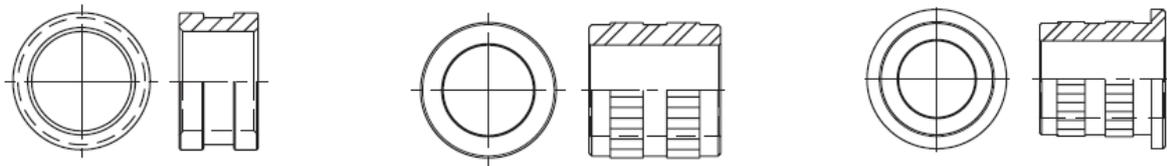


Fig 7.9.3.1 CL Series Compression Limiters

VIII. SIZE GUIDE FOR VARIOUS INSERTS

8.1 H SERIES TAPERED INSERTS

International Conference on Recent Trends in Engineering & Science

Shree Ramchandra College of Engineering, Pune (India)

29th-30th September 2016, www.conferenceworld.in

ICRTES - 16

ISBN : 978-93-86171-06-1

INCH		METRIC		A	B	C	D	E	F	Min. Boss
Thread Size	Part Number	Thread Size	Part Number	±.004 [long]	±.004 [short]	±.004	±.004	+ .002 - .000	+ .002 - .000	
0-80	080 x 115H	M1.6 x 0.35	M16 x 115H		.115	.123	.141	.129	.118	.246
	080 x 188H		M16 x 188H	.188		.112	.141	.123	.107	.246
2-56	256 x 115H	M2.0 x 0.4	M20 x 115H		.115	.123	.141	.129	.118	.246
	256 x 188H		M20 x 188H	.188		.112	.141	.123	.107	.246
4-40	440 x 135H	M2.5 x 0.45	M25 x 135H		.135	.157	.172	.159	.153	.318
	440 x 219H		M25 x 219H	.219		.146	.172	.159	.141	.318
	440 x 285H		M25 x 285H	.285		.146	.172	.159	.141	.318
5-40	540 x 150H	M3.0 x 0.5	M30 x 150H		.150	.203	.219	.206	.199	.412
	540 x 250H		M30 x 250H	.250		.190	.219	.206	.185	.412
6-32	632 x 150H	M3.5 x 0.6	M35 x 150H		.150	.203	.219	.206	.199	.412
	632 x 250H		M35 x 250H	.250		.190	.219	.206	.185	.412
8-32	832 x 185H	M4.0 x 0.7	M40 x 185H		.185	.230	.250	.234	.226	.468
	832 x 312H		M40 x 312H	.312		.213	.250	.234	.208	.468
	832 x 375H		M40 x 375H	.375		.213	.250	.234	.208	.468

INCH		METRIC		A	B	C	D	E	F	Min. Boss
Thread Size	Part Number	Thread Size	Part Number	±.004 [long]	±.004 [short]	±.004	±.004	+ .002 - .000	+ .002 - .000	
10-24	1024 x 150H				.150	.267	.297	.277	.267	.554
	1024 x 225H				.225	.272	.297	.277	.267	.554
	1024 x 375H			.375		.251	.297	.277	.246	.554
10-32	1032 x 150H				.150	.267	.297	.277	.267	.554
	1032 x 225H				.225	.272	.297	.277	.267	.554
	1032 x 375H			.375		.251	.297	.277	.246	.554
		M5.0 x 0.8	M50 x 265H		.265	.308	.328	.315	.303	.630
			M50 x 438H	.438		.283	.328	.315	.278	.630
1/4-20	2520 x 300H				.300	.354	.375	.363	.349	.726
	2520 x 500H			.500		.332	.375	.363	.321	.726
1/4-28	2528 x 300H	M6.0 x 1.0	M60 x 300H		.300	.354	.375	.363	.349	.726
	2528 x 500H		M60 x 500H	.500		.332	.375	.363	.321	.726
5/16-18	3118 x 335H				.335	.439	.469	.448	.431	.896
	3118 x 562H			.562		.406	.469	.448	.401	.896
5/16-24	3124 x 335H	M8.0 x 1.25	M80 x 335H		.335	.439	.469	.448	.431	.896
	3124 x 562H		M80 x 562H	.562		.406	.469	.448	.401	.896
3/8-16	3816 x 375H				.375	.532	.563	.540	.523	1.080
	3816 x 625H			.625		.493	.563	.540	.488	1.080
3/8-24	3824 x 375H	M10.0 x 1.5	M100 x 375H		.375	.532	.563	.540	.523	1.080
	3824 x 625H		M100 x 625H	.625		.493	.563	.540	.488	1.080

8.2 C SERIES CHEVRON INSERTS

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ISBN : 978-93-86171-06-1

INCH		METRIC		A	B	C	Hole H	Min. Boss
Thread Size	Part Number	Thread Size	Part Number	±.004	±.004	±.004	+ .003 – .000	
2-56	256 x 100C	M2.0 x 0.4	M20 x 100C	.143	.100	.123	.126	.252
	256 x 125C	M2.0 x 0.4	M20 x 125C	.143	.125	.123	.126	.252
	256 x 157C	M2.0 x 0.4	M20 x 157C	.143	.157	.123	.126	.252
4-40	440 x 135C	M2.5 x 0.45	M25 x 135C	.186	.135	.154	.157	.314
		M3.0 x 0.5	M30 x 135C	.186	.135	.154	.157	.314
	440 x 157C	M2.5 x 0.45	M25 x 157C	.186	.157	.154	.157	.314
		M3.0 x 0.5	M30 x 157C	.186	.157	.154	.157	.314
	440 x 170C	M2.5 x 0.45	M25 x 170C	.186	.170	.154	.157	.314
		M3.0 x 0.5	M30 x 170C	.186	.170	.154	.157	.314
	440 x 226C	M3.0 x 0.5	M30 x 197C	.186	.197	.154	.157	.314
		M2.5 x 0.45	M25 x 226C	.186	.226	.154	.157	.314
	M3.0 x 0.5	M30 x 226C	.186	.226	.154	.157	.314	
6-32	632 x 125C			.218	.125	.185	.188	.376
	632 x 150C	M3.0 x 0.5	M30 x 150C	.218	.150	.185	.188	.376
		M3.5 x 0.6	M35 x 150C	.218	.150	.185	.188	.376
	632 x 226C			.218	.226	.185	.188	.376
	632 x 250C	M3.0 x 0.5	M30 x 250C	.218	.250	.185	.188	.376
		M3.5 x 0.6	M35 x 250C	.218	.250	.185	.188	.376
632 x 281C	M3.5 x 0.6	M35 x 281C	.218	.281	.185	.188	.376	

INCH		METRIC		A	B	C	Hole H	Min. Boss
Thread Size	Part Number	Thread Size	Part Number	±.004	±.004	±.004	+ .003 – .000	
8-32	832 x 185C	M4.0 x 0.7	M40 x 185C	.249	.185	.218	.221	.442
	832 x 250C		M40 x 250C	.249	.250	.218	.221	.442
	832 x 321C		M40 x 321C	.249	.321	.218	.221	.442
10-24	1024 x 185C	M5.0 x 0.8	M50 x 185C	.280	.185	.249	.252	.504
	1024 x 225C		M50 x 225C	.280	.225	.249	.252	.504
	1024 x 250C		M50 x 250C	.280	.250	.249	.252	.504
	1024 x 310C		M50 x 310C	.280	.310	.249	.252	.504
	1024 x 375C		M50 x 375C	.280	.375	.249	.252	.504
10-32	1032 x 185C			.280	.185	.249	.252	.504
	1032 x 225C			.280	.225	.249	.252	.504
	1032 x 250C			.280	.250	.249	.252	.504
	1032 x 310C			.280	.310	.249	.252	.504
	1032 x 375C			.280	.375	.249	.252	.504
1/4-20	2520 x 226C	M6.0 x 1.0	M60 x 226C	.342	.226	.312	.315	.630
	2520 x 250C		M60 x 250C	.342	.250	.312	.315	.630
	2520 x 312C		M60 x 312C	.342	.312	.312	.315	.630
	2520 x 375C		M60 x 375C	.342	.375	.312	.315	.630
	2520 x 500C		M60 x 500C	.342	.500	.312	.315	.630

8.3 S SERIES SYMMETRICAL INSERTS

INCH		METRIC		A	B	C	Hole H	Min. Boss
Thread Size	Part Number	Thread Size	Part Number	±.004	±.004	±.004	+0.003 –.000	
2-56	256 x 115S	M2.0 x 0.4	M20 x 115S	.123	.115	.138	.126	.252
	256 x 157S	M2.0 x 0.4	M20 x 157S	.123	.157	.138	.126	.252
4-40	440 x 226S	M2.5 x 0.45	M25 x 226S	.154	.226	.175	.157	.314
		M3.0 x 0.5	M30 x 226S	.154	.226	.175	.157	.314
6-32	632 x 281S	M3.5 x 0.6	M35 x 281S	.185	.281	.206	.188	.376
8-32	832 x 321S	M4.0 x 0.7	M40 x 321S	.218	.321	.239	.221	.442
10-24	1024 x 375S	M5.0 x 0.8	M50 x 375S	.249	.375	.270	.252	.504
10-32	1032 x 375S			.249	.375	.270	.252	.504
1/4-20	2520 x 500S	M6.0 x 1.0	M60 x 500S	.312	.500	.333	.315	.630
1/4-28	2528 x 500S			.312	.500	.333	.315	.630
5/16-18	3118 x 500S	M8.0 x 1.25	M80 x 500S	.374	.500	.393	.377	.754
5/16-24	3124 x 500S			.374	.500	.393	.377	.754
3/8-16	3816 x 500S	M10 x 1.5	M100 x 500S	.465	.500	.484	.468	.936
3/8-24	3824 x 500S			.465	.500	.484	.468	.936

8.4 P & HP SERIES PRESS-IN INSERTS

P Series Inserts

INCH		METRIC		A	L	Hole H	Min. Boss
Thread Size	Part Number	Thread Size	Part Number	±.004	±.004	+0.003 –.000	
2-56	256 x 157P	M2.0 x 0.4	M20 x 157P	.134	.157	.121	.242
4-40	440 x 208P	M3.0 x 0.5	M30 x 208P	.165	.208	.150	.300
6-32	632 x 247P	M3.5 x 0.6	M35 x 247P	.197	.247	.182	.364
8-32	832 x 292P	M4.0 x 0.7	M40 x 292P	.228	.292	.213	.426
10-24	1024 x 328P	M5.0 x 0.8	M50 x 328P	.259	.328	.244	.488
10-32	1032 x 328P			.259	.328	.244	.488
1/4-20	2520 x 364P	M6.0 x 1.0	M60 x 364P	.322	.364	.307	.614
1/4-28	2528 x 364P			.322	.364	.307	.614
5/16-18	3118 x 364P	M8.0 x 1.25	M80 x 364P	.383	.364	.368	.736
5/16-24	3124 x 364P			.383	.364	.368	.736

IX. INSTALLATION METHOD

Ultrasonic Installation - The basic principle of ultrasonic assembly involves conversion of high-frequency electrical energy to high-frequency mechanical energy in the form of reciprocating longitudinal motion which, when applied to a thermoplastic, generates frictional heat at the plastic/plastic or plastic/metal interface. In

ultrasonic insertion, a metal insert is placed in a cored or drilled hole which is slightly smaller than the insert. This hole provides a certain degree of interference and also serves to guide the insert into place. The vibrating ultrasonic horn contacts the insert and the ultrasonic vibrations travel through the insert to the interface of the metal and plastic. Heat, generated by the insert vibrating against the plastic, causes the plastic to melt, and as the horn advances, the insert is imbedded into the component. The molten plastic flows into the serrations, flutes, or undercuts of the insert and, when the vibrations terminate, the plastic resolidifies and the insert is securely encapsulated in place. In ultrasonic insertion, a slow horn approach, allowing the horn to develop a homogeneous melt phase, is preferable to “pressing” the insert. Ultrasonic insertion provides the high performance strength values of a molded-in insert while retaining all of the advantages of post-molded installation. Inserts can be ultrasonically installed in most thermoplastics. Some of the advantages of ultrasonic inserting over other methods include rapid installation, minimal residual stresses in the component following insertion, elimination of potential mold damage, reduced mold fabrication costs and increased productivity as a result of reduced mold cycle times. In some applications, multiple inserts can be imbedded simultaneously with special horns, increasing productivity and further reducing assembly and manufacturing costs. Ultrasonic insertion is not restricted to standard-type threaded inserts. Inserts that can be installed ultrasonically include a variety of bushings, terminals, ferrules, hubs, pivots, retainers, feed-through fittings, fasteners, hinge plates, binding posts, handle-locating pins and decorative attachments. Typically, the plastic component is fixtured and the insert is driven in place by the horn (Figure 1). However, in some cases, the part configuration might prohibit insert contact by the horn, and the horn is made to contact the plastic component instead of the insert (Figure 2). The functional characteristics or requirements of an application actually determine the insert and hole configuration. In all cases, a sufficient volume of plastic must be displaced to fill the under cuts, flutes, knurls, threads and/or contoured areas of the insert. Care should be exercised in selecting the proper inserts. Inserts are designed for maximum pull-out strengths, torque retention or some combination of both. Inserts with horizontal protrusions, grooves, or indents are usually recommended for high pull-out strength requirements. Inserts with vertical grooves, or knurls, are usually recommended for high torque retention.

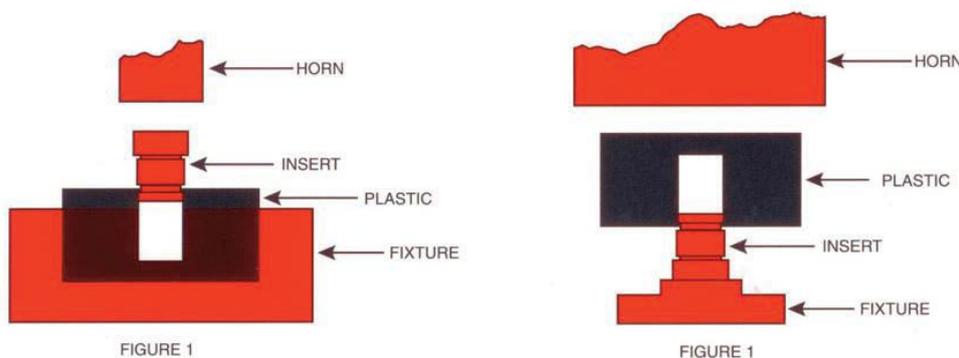


Fig 9 Installation Method

In regard to the hole configuration or insert selection, the recommendations provided by the insert manufacturer should always be observed. Because the horn contacts the metallic insert, it is subjected to some wear. As a result, horns used for insertion are usually made of hardened steel or titanium. Carbide coating of titanium horns

is also available. for low volume applications, titanium horns with replaceable tips can be utilized. Ideally, the diameter of the horn should be twice the diameter of the insert. To prevent a “jack-out” condition, the top of the seated insert should be flush or slightly above the surface of the part. Rigid fixturing should be placed directly under the insert. In most instances, it is necessary to initiate ultrasonic vibrations prior to horn contact with the insert. To maintain an accurate depth of insertion, the total distance the horn travels should be limited either mechanically by a positive stop, or electrically by a lower-limit linear encoder, or both.

X. MOLDED IN INSERT PRECAUTION AND GUIDELINE

When end use considerations preclude complete utilization of the multifunctional design capabilities of DuPont engineering plastics, components can be joined through a variety of relatively quick and inexpensive assembly techniques. Among them press and snap fits, cold heading cementing self-tapping screws, heat staking and spin, vibration and sonic welding. There is still another method of joining engineering plastic components to a final assembly that can solve critical problems. Molding metal inserts into a part, often considered a last resort because of the difficulties associated with it, may pay off in some outstanding advantages when adequate safeguards are taken in the design stage. It is the purpose of this article to suggest some of those precautions and some guidelines for successful insert molding. The three principal reasons for using metal inserts are:

- 1.) To provide threads that will be serviceable under continuous stress or permit frequent part Dis-assembly.
- 2.) To meet close tolerances on female threads.
- 3.) To provide a permanent means of attaching two high-load-bearing parts, such as a gear to a shaft.

In most cases, it should prove possible to secure the insert in a pre-molded part via press or snap fitting or ultrasonic insertion. These and other options, as well as the possible disadvantages of insert molding listed below, should be carefully considered before the final design decision is made.

Disadvantages

- Inserts can “float” or be dislocated in the mold, or cause damage to it.
- Plastic may flash internal threads of an insert and require cleaning.
- Inserts are often difficult to load and can prolong the molding cycle.
- Inserts require preheating to expand them.
- Inserts in rejected parts are costly to salvage.
- When plastic shrinks around the insert, hoop stress is molded into the part and cracking may result.

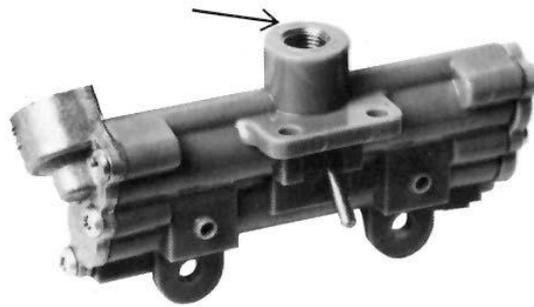


Fig 10.1 Windshield wiper valve in Delrin 500 F has threaded brass fitting in place when it emerges from mold.

Of all the complaints associated with molding inserts, delayed cracking of the surrounding plastic because of molded-in hoop stress is the most common. In order to estimate hoop stress, assume that the strain in the material surrounding the insert is equivalent to the mold shrinkage. An indication of the stress can be gained by checking a stress-strain chart for the specific material. If that data is not readily available, multiply the mold shrinkage by the flexural modulus of the material (shrinkage x modulus = stress). All DuPont engineering plastics can be used in insert molding, as evidenced by the accompanying photos of some current applications in Delrin® acetal resin, Zytel® nylon resin, Minlon® mineral-reinforced nylon resin, and Rynite® thermoplastic polyester resin. A quick comparison of shrinkage rates for these materials, however, puts things in better perspective. Were Zytel® 101 nylon resin, with a mold shrinkage rate of 0.016 mm per mm (in per in), and Delrin® 500 acetal resin, with a mold shrinkage rate of 0.025 mm per mm, otherwise equally well suited for an application requiring a molded-in insert, Zytel® 101 would have a clear advantage.

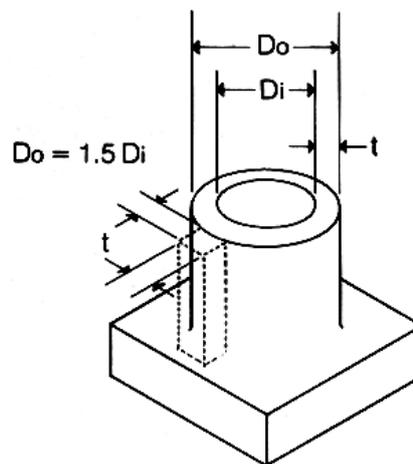


Fig 10.2 Boss diameter should be 1.5 times the insert diameter. Rib at weld line can increase support.

The higher shrinkage for Delrin® yields a stress of approximately 52.4 MPA (7600 psi), which is about 75 percent of the ultimate tensile strength of the material. The thickness of the boss material surrounding an insert must be adequate to withstand this stress, however, and as thickness is increased, mold shrinkage goes up. If we assume part life of 100,000 hours, the 52.4 MPA stress will relax to approximately 14.8 MPA (2150 psi). Not bad, but long term creep rupture data (derived from data for plastic pipe, a natural example of hoop stress)

suggests the possibility that a constant stress of 17.9 MPA (2,600 psi) for 100,000 hours will lead to a creep rupture failure. A part exposed to elevated temperatures, additional stress, stress risers, or an adverse environment could easily fracture under such conditions. Where such outstanding properties as stiffness, low coefficient of friction or spring-like attributes make Delrin® a clear choice over other materials, designers would do well to consider Delrin® 100, the toughest acetal resin yet commercialized. The higher elongation of Delrin® 100 and its resistance to notches have made it superior to other grades for use in a variety of gears. As previously indicated, unreinforced Zytel® 101 nylon is a very “forgiving” resin due to its lower mold shrinkage and high elongation. Its many successful gear type applications include the automotive cam shaft drive sprocket shown.

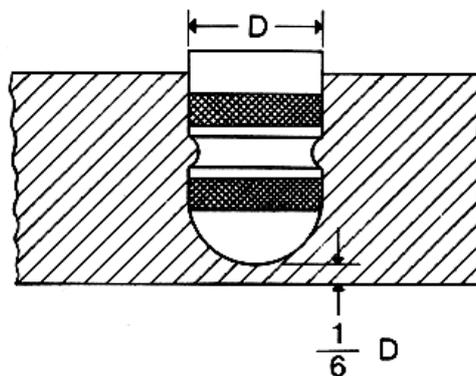


Fig 10.3 Improper depth under the insert can cause poor weld lines and sinks.

Because glass- and mineral-reinforced resins have the advantage of even lower mold shrinkages than their base resins, they too have been used with success. Their lower elongation is offset by a typical mold shrinkage range of from 0.005 to 0.010 mm per mm (in per in). Though weld lines of heavily loaded glass or mineral resins may have only 60 percent of the strength of the unreinforced material, addition of a rib at that point can substantially increase the support provided by the insert boss. (Fig.19).

Guidelines for Molded Inserts:

- Inserts should be rounded or have rounded knurling and there should be no sharp corners. An undercut should be provided for pull out strength.
- The insert should protrude at least 0.4 mm (0.016 in) into the mold cavity. Depth of molding beneath it should equal at least one sixth of the insert's diameter to avoid sink marks .
- Boss diameter should be 1.5 times the insert diameter except for inserts with a diameter greater than 12.9 mm (0.5 in). For the latter, the boss wall should be derived with the overall part thickness and specific grade of material in mind. Keep the metal insert small relative to the plastic surrounding it.
- Toughened grades of resin should be considered (e.g., Delrin® 100, Zytel® ST- 801, Zytel® 80G-33, Minlon® 12T, Rynite® 4004 and Rynite® 4005). These 6 have higher elongation than standard grades and a greater resistance to cracking.
- Inserts should be preheated before molding (200 ° F for Delrin®, 250° F for Zytel®, Minlon® and Rynite®). This minimizes post mold shrinkage, pre-expands the insert and improves the weld line strength.

- Conduct a thorough end-use test program to detect problems in the prototype stage of your development. Testing should include temperature cycling over the range to which the application may be exposed.

XI. CONCLUSION

A systems approach to metal to plastic replacement brings to forth a concrete road map for any industry or any product without getting lost, in the quest for achieving better. As mentioned earlier, the boundary for this system can be set depending on the application of the product, its functionality, strength and mouldability. The three factors that drive metal replacement today are: (i) Cost Out (ii) Performance Enhancement (iii) Product differentiation or a combination of the three. Importance of each driver is highly dependent on the market segment. Generally, metal replacement is made when plastics offer equal or better performance at a saving of at least 20 percent in finished part cost. To find the saving, the company needs to define improvements in part performance and costs. Doing so means evaluating the materials, the assembly and manufacturing practices, and the application. In comparing an existing metal part with one of plastic, accounts for all real costs, including finishing and operating costs buried in overhead. Although plastics may cost more per pound than metal they often are less expensive in the finished part due to parts consolidation and elimination of machining operations, among others factors. In addition they also reduce carbon footprint of a company, since plastic part production effectively reduces energy utilization than a metal part production.

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