“METAL INSERTS IN PLASTICS” A MANUFACTURING METHOD FOR IMPROVING THE DURABILITY OF PLASTIC MOULDED PARTS

Nilesh P. Jade[1], Prof. Jitendra G. Patil[2], Prof. Rajesh R. Borse[3], Prof. Sunil S. Raut[4]

[1]*P. G. Student, in Mechanical Engineering Department, Shri. Gulabrao Deokar College of Engineering, Jalgaon, Maharashtra, India*

[2]*Associate Professor, in Mechanical Engineering Department, Shri. Gulabrao Deokar College of Engineering, Jalgaon, Maharashtra, India*

[3]*Associate Professor, in Mechanical Engineering Department, Shri. Gulabrao Deokar College of Engineering, Jalgaon, Maharashtra, India*

[4]*Head of department, in Mechanical Engineering Department, Sandip Institute of Polytechnic, Sandip foundation’s, Nasik, Maharashtra, India.*

ABSTRACT

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*: - knurls, knurl design, molded-in inserts, thread inserts*

1. INTRODUCTION

Plastic engineering is synonymous in almost all modern day industries due to versatility of plastic materials today. We can say that plastic engineering is a mix of mechanical and chemical/polymer engineering with various other facets of science and technology. Several type of plastic moluded parts are used in automobile vehicle for various operations. The plastic parts are mostly used in automobile in metering device as well as in air intake system. Air filter is used to supply fresh and filtered air to the engine for combustion. These parts are mounted on engine frame and connected to intake manifold. These parts are removed at the time of servicing and replaced after the repairing, but these are the plastic parts so they will not be able to maintain their dimensional stability during refitting. The metal screws are fastened in the plastic and these are mounted on engine frame which is also of metal. So these plastic parts are get damaged and will not be able maintain their dimensional stability. Hence the metal inserts are used in the plastic molded parts to provide support to screws which are mounted on engine and provide support to plastic parts. These inserts improves the durability of plastic parts and also provides support to them.

1.1 Benefits of Metal to Plastic Replacements

Typically some of the main merits of plastics over metals are:

1) Weight reduction since all plastic materials including composites are lighter than metals like steel and aluminum.
2) Fewer assembly operations may be achieved.
3) Reduced secondary finishing.
4) Reduction in total system costs.
5) Electrically nonconductive, predominantly.
6) Ability to withstand temperatures to more than 500F and most chemicals and corrosive Environments.
7) Greater design freedom, e.g. part complexity may be worked upon depending upon requirement.
8) Opportunity for parts consolidation.
9) Broad range of properties tailored to meet specific applications.
10) Energy efficient since plastic part production is less energy consuming compared to metal part Production or metal forming like die casting, sand Casting, etc.

2. Design

The objective is to design an Insert with sufficient torque resistance to accommodate the tightening torque necessary to achieve sufficient axial tension load on the threaded joint to keep it together and prevent loosening, while also achieving pull-out values necessary for the load conditions that the Insert will be exposed to while in service. In general, resistance to torque is a function of diameter and resistance to pull-out is a function of length. These functions, however, are interactive and the challenge for the designer is to achieve the optimum combination of both. Basically inserts are classified in two ways, according to the type of knurl and type of fittings or type of fastened in plastic. Knurls are used to increase resistance to torque. Straight knurls, as opposed to diamond knurls, are the preferred design. Coarser knurls increase resistance to torque but they also induce greater stress on the plastic. In addition, the circumference of the Insert determines the knurl pitch so there are practical limitations on knurl design. Helical knurls, in comparison to straight knurls, lower torque resistance but increase axial pull-out resistance. In practice, knurl angles between 30 and 45 degrees have a positive impact on pull-out resistance with a minimal loss of torque value. In some Inserts, different helical knurl bands as well as straight and helical knurls can be combined on the same Insert to achieve an optimum combination of torque and pull-out resistance.

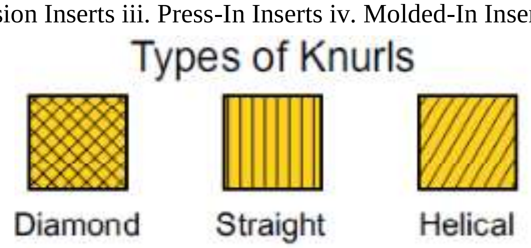
Some Inserts are designed with a slightly larger diameter knurl band between two slightly smaller diameter knurl bands on either side separated from the larger knurl band by grooves. With a properly designed Insert and in a hole manufactured as recommended, the plastic will flow over the larger knurl band into the groove and knurls behind the larger knurl band in the opposite direction of installation, significantly increasing pullout resistance. All the plastic above the larger knurl band in effect becomes a shear plane. A head facilitates plastic flow into the upper grooves of the Insert.

a. Type of Knurl

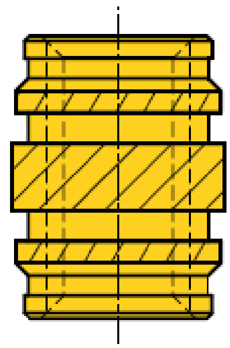
i. Diamond ii. Straight iii. Helical

b. Type of fittings

i. Self-Tapping Inserts ii. Expansion Inserts iii. Press-In Inserts iv. Molded-In Inserts



b. i. Self-Tapping Inserts provide the best pull-out resistance for a post-mold installed Insert. The threads are designed with a thin profile to minimize inducing stress into the plastic and a relative coarse pitch to provide the maximum plastic shear surface to resist pull-out. Installation torque is not a problem in that tightening increases the friction between the plastic and threads, and the larger diameter of the external Insert thread increases the frictional surface. Back-out torque performance relies totally on the greater surface area of the external Insert thread and the tension between the threads and plastic. Thread-Forming Inserts for ductile plastics need a coarse thread to avoid hole reaming. Thread-Cutting Inserts for thermoset plastics and brittle materials need a cutting facet to facilitate the cutting process. Again, to facilitate installation square to the hole, a good pilot is essential.

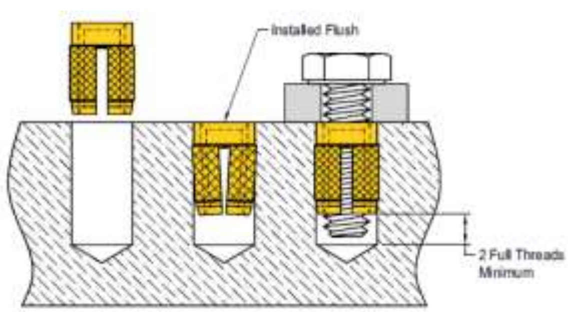


ii. Expansion Inserts

Expansion Inserts are designed for non-critical applications. Ease of installation, not torque and pull-out resistance, is the primary design criteria. Diamond knurls are a cost-effective solution to increase friction enhancing interference between the Insert and the hole wall. Torque is an issue to the extent that the Insert must not spin when the bolt is installed. The Insert diameter is designed slightly larger than the hole diameter and slots are provided to reduce interference during Insertion. A generous lead-in is provided to assure straight insertion. Installation of the screw expands the Insert and forces the diamond knurl into the hole wall providing reasonable torque and pull-out resistance for applications with non-demanding requirement.

iii. Press-In Inserts

These Inserts are designed to reduce installation cost at a sacrifice of torque and pull-out performance. Helical knurls are used to provide both torque and pull-out resistance and to ensure good plastic flow as the Insert rotates into the hole. Installation torque to achieve sufficient tension between the threads is not a problem in that the helical knurls are designed so that the direction of the installation torque will have the tendency to drive the Insert into the hole — which of course is not possible — as the threaded joint is tightened. A pilot only slightly smaller than the hole and of sufficient length is designed to assure straight Insertion into the hole.



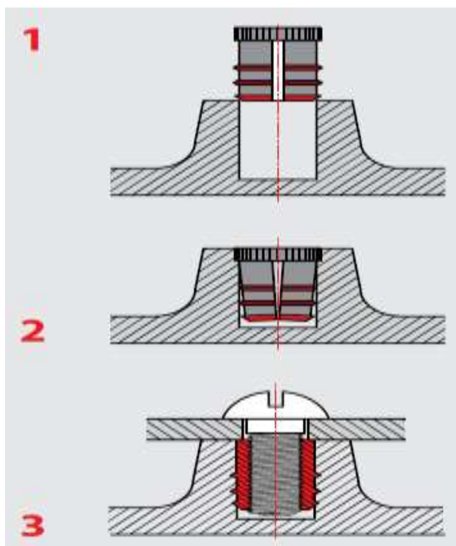
iv. Molded-In Inserts

This process, although generally more costly in getting the Insert into place than the post-mold installation process, provides the best performance. Both length and diameter have an impact on pull-out resistance and torque. The challenge is to find the most cost-effective solution that provides/meets the installation torque requirements to achieve a good threaded joint, and the pull-out values that meet the application load requirements. A hexagonal exterior is the designer's choice to maximize the torque resistance for a given diameter. The length of the hexagonal shape of the Insert needs to be long enough to meet the installation torque requirements for a good threaded joint. The length of the Insert above the hexagonal section must be sufficient to achieve the pull-out resistance to which the Insert is subjected while in service. The design also needs to consider material usage to provide the lowest cost solution. In order to facilitate installation square to the hole, the tolerance of the minor thread diameter is reduced for a good fit between the Insert and mold guide pins. Countersinks are designed to simplify the placing of the Insert on the pin.

3. Material and Installation

Metal inserts are fastened to improve the strength of plastic parts as well as to improve the durability. So the material of inserts should be stiff, hard, durable, brittle and should maintain dimensional stability. Some of the hard metals are used for the manufacturing of metal inserts. Special materials like 300 Series Austenitic Stainless Steel, 12L14 Steel, Aluminum are used. These inserts are used in hard plastic.

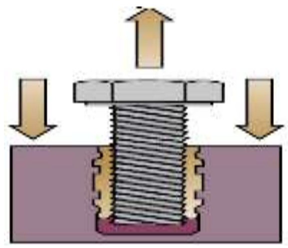
These inserts are fitted in the plastic, so there are some chances of corrosion between two metals. The inserts are already made up stainless steel material but at the time of reuse the steel coating will not be able provide better support. Hence to improve the durability of insert, coating is applied. There are several type of metal coatings are available but for these inserts nickel, zinc and black zinc plate is used. The position of the insert must be flush with the assembly surface (1); the hole (2) on the item to be connected must be the correct dimension so that a contrast is created with the head of the bush, preventing its extraction due to lever action. The length of the screw must be calculated so that the entire length of the thread of the bush is used to obtain maximum expansion. Make sure the screw does not come into contact with the bottom of the hole (3) to prevent the bush from coming out. The design of the seat, hole size and wall thickness depend on the material used. Flared or bevelled shapes are not recommended. Refer to the technical specifications for the measurements. To safeguard correct use of the product, we recommend assembly testing in order to establish the exact diameter of the hole. The depth of the hole must be greater than the length of the bush.



The seat should be prepared during moulding. Insert the bush by pressing it in with a suitable punch. Do not use punches with guide pins so that the bush is able to contract during insertion. 3 When the screw is inserted, the bush will expand so it is anchored to the walls of the hole. The residual tension creates a slight self-locking effect on the screw

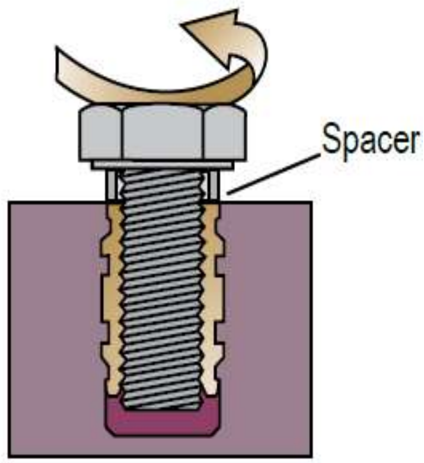
4. Testing Methods

4.1 Tensile (Pull-Out) Strength



The axial force required to pull the Insert out of the plastic material. This test is performed using a qualified tensile testing machine. A load curve is recommended for analysis purposes.

4.2 Rotational Torque



The rotational force required to rotate the Insert in the plastic material. In practice, the friction between the screw head and mating component comes into play providing an additional safety factor. A calibrated torque wrench can be used for this test.

4.3 ROTATIONAL & TENSILE APPLIED OPPOSITE HEADED END (PULL-THROUGH)

This is recommended for high tensile load applications. Appropriate consideration has to be given to friction between the screw head and mating part.

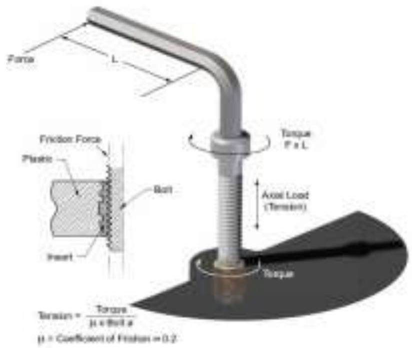
5. Findings

5.1 Unlimited Reuse

The primary and most obvious benefit of an Insert is the unlimited reusable thread. However, and perhaps even more important, the use of an Insert assures that the threaded joint integrity is preserved for the life of the application.

5.2 Proper Seating Torque

During the assembly process of a mating component, the screw has to be tightened with sufficient torque to introduce the recommended axial tension in order to achieve the required load between the screw and Insert threads to prevent loosening. The larger body diameter and body design of the Insert allow the appropriate installation torque to be applied to the screw.



5.3 Unaffected by stress relaxation

A common problem with bolted joints in plastic applications is that plastic is susceptible to creep or stress relaxation. Under loads well below the elastic limit, plastics will lose their ability to maintain a load. When this occurs, the threaded connection becomes loose. The brass thread provides permanent creep resistance for the entire load path of the thread.

5.4 Enhance Load carrying

The load carrying ability of the joint is enhanced by the larger diameter of the Insert as compared to the screw. Inserts are generally twice the diameter of the screw and that increases the shear surface fourfold. Pull-out resistance can further be enhanced by increased Insert length.

6. 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 [10]. Generally, metal replacement is made when plastics offer equal or better performance at a saving of at least 20 percent in finished part cost [3]. 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

7.Referances

1. Prasad balan iyer, “a generalized systems approach to metal to plastic replacements” International Journal of Applied Research in Mechanical Engineering (IJARME) ISSN: 2231 –5950, Volume-3, Issue-1.

2. G. Barber, (2010), “ New applications in food processing,” DuPont Engineering Design Electronic Magazine, USA, http://www2.dupont.com/Plastics/en_US/ Knowledge_Center/engg_design_mag/ed101/ed10107.html

3. Z. . Smith, C. McChesney and K. Fletcher, “Switching from Metals to Plastics,” Ticona LLC Summit, N.J., 2012.

4. C. W. Churchman, “The Systems Approach,” New York, USA: Dell Publishing, 1968

5. L. von. Bertalanffy, “General System Theory: Foundations, Development, Applications,” Rev. Ed., New York, USA: George Braziller, 1968.

6. P. B. Iyer, V. R. Gaval, “Metal to Plastic Conversion in Automotive Industry: Design & Development,” unpublished.

7. D. Rosato, (2009, Sept.), "Advances in the Art and Science of Metal to Plastic Replacement," SpecialChem–Omnexus [Online].Available:http://www.omnexus.com/resources/editorials.aspx?id=23811

BIOGRAPHIES

	Mr. Nilesh P Jade is completed Bachelor of Engineering in Mechanical Engineering Department from Shri Gulabrao Deokar College of Engineering, (North Maharashtra University).Now doing the Master of Engineering in Shri Gulabrao Deokar College of Engineering, (North Maharashtra University), Maharashtra, India. Also Working as Lecturer in Sandip institute, Sandip foundation's, Nashik,422213.Maharashtra India