Measurement of Non-Standard Fasteners

by/ Larry Borowski

Quite often we get inquiries from customers asking how to measure a particular feature on a special fastener. The "special" part of the fastener can range from material, to machined surfaces on threads or heads, to a special design resembling a fastener. It can also simply be a modification to size to accommodate a special coating. Whatever it is that makes the fastener deviate from the standards, results in a "Non-Standard" fastener.

Special material can cause performance issues, but in this article we are going to focus on dimensional measurements of non-standard fasteners, specifically screws and bolts. A screw or bolt can be broken down into two fundamental parts, which we will cover individually. These are the head, which includes the recess or drive feature, and the threads or shank.

Measurement of Non-Standard Heads

Many times, engineers or end users cannot find a head that meets their needs for the application at hand, and they are not willing to go through the cost of special tooling and processing to get it. The result is a modified head, in some form or another. In these cases, the heads should be checked for conformance to "standard specifications" prior to the modification. After the modification, the feature that was modified should be checked to insure that it dimensionally meets the new criteria. For example, we can start with a ½-13 Hex bolt and reduce the head height and machine two of the flats narrower for a clearance issue. It would be expected that the head be first checked for standard conformance, and afterward be checked that the new height and new across flats dimensions conformed to the new criteria. If these modifications are controlled by a different engineering drawing, that becomes your new criteria for inspection. If you are the manufacturer, care should be taken that the "standard" bolt you are starting with is capable of meeting the new drawing after modification. For example, if the modified head requires a stricter concentricity callout than the standard head, there may be problems meeting the modified print requirements.

For those applications where the cost of special tooling and processing is warranted, the sky is the limit on what a fastener head can look like. In these cases, the engineering print takes precedence over any "standard".

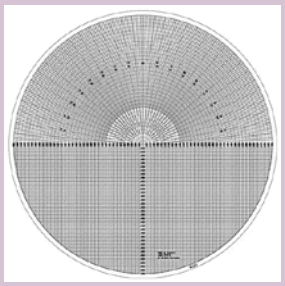
Much of the standard inspection equipment in the marketplace can be used to inspect these non-standard heads, even though the end resultant is different than the standard. For example, an undercut flat head screw can still be measured on a protrusion head height gage to obtain a value to the new protrusion head height value. Most of the time, heads are a feature that can be measured with many different tools that are considered to be multi-functional, such as micrometers, calipers, optical comparators, indicator stands, height gages, etc.

Optical comparators are probably the most versatile piece of inspection equipment used to measure specialty fasteners, simply because there are many options for magnification, work holding, transparent overlays, as well as surface illumination.

Measurement of Special Drives

Non-Standard recesses or drives often give inspectors problems. Again, this can range from a modified drive to a purposely designed special drive. The majority of the time, these require special tooling because we are not only checking the profile, but also checking the depth. A combination drive is a good example that can be found in some standards. Many times these are standard recesses with a slot placed in them. It works great for serviceability, but confuses many inspectors. As an example, it cannot be expected for a cross recess combined with a slot to pass a wobble test. This is because the slot removes most of the material related to that test. Nor can it be expected that the slot be dimensionally accurate across the entire length, as it is missing most of its material over the central portion of the drive.

As a gage designer/manufacturer, we get plenty



of requests for special recess gaging, whether it be a special size to accommodate a "pre-plate" condition or a special configuration containing multiple drive shapes, or multiple drive levels. The criteria may be orientation of shapes, depth of the shapes, or size of the shapes either individually or collectively.

Generally speaking, a non-standard drive will require special measuring tools or gages, that are either designed by the engineer that developed the drive, or designed by an independent gage manufacturer based on the engineering print of the product. There is no simple measuring solution to accommodate all non-standard drive types, as they are specific to the design. This is why it is important to make sure that the screw print completely defines the profile, tolerance, and depth of the recess so that the gage designer can do his job effectively.

Measurement of Non-Standard Threads

Non-standard or special threads can be easy or very difficult to measure, it just depends on the equipment you have, and the thread profile. Special threads can be in the standard 60º thread form with a non-standard pitch diameter, which are probably the easiest threads to measure. If variable thread gaging such as a tri-roll gage is available, these specials can be measured directly based only on the diameter and pitch of a standard thread form. Tri-roll gages are comparative type measuring devices, so the comparison is the known value of a standard set plug to the unknown value of the special thread size. The other option is to have special GO and NOGO thread rings made, but they are specific to the particular non-standard thread being measured, and cannot be used in other applications.

Other thread forms can include asymmetrical threads similar to a Buttress thread with a 45º and 7º thread angle, or some other combination of thread angles that are not equal. These types of threads can either be measured using specially made GO and NOGO thread ring gages, or a lower cost alternative would be to use the 3 wire method. The only problem with the 3 wire method is doing the math involved to calculate the pitch diameter. It can be a long complicated formula if software is not available to aid in the calculation. Some of these thread forms can be measured on a variable thread gage, but it is advisable to check with the manufacturer to see if the geometry is achievable on the rolls or segments. Optical comparators can also be used in conjunction with transparent overlays to measure some special thread forms.

Other non-standard threads that can be found are modifications to standard fasteners in the threaded area. These can be in the form of channels, missing threads, combinations of more than one thread next to the other, flats, notches, deformation for a locking feature, etc. Typically, the pitch diameter of the thread can no longer be accurately measured after the original thread is altered. There is either something in the way, the modification did not leave enough material, or the thread is completely missing. Sometimes a variable type gage can be used because it can be positioned on the thread as to not interfere with the modification, but that is not always the case.

Measuring non-standard fasteners can be challenging, but if the time is taken to understand the requirements though industry standards or engineering drawings, and the correct equipment for the job is chosen, it can be rewarding. Make sure to fully understand the customer's requirements when dealing with non-standard fasteners, because it may require special tooling or gaging that can easily be overlooked. A modified standard fastener cannot be expected to meet all the same dimensional requirements as the original fastener did, either because material is missing, or the modification has made it impossible to re-measure. If an existing fastener is modified, make sure to do a full inspection before the modification, because it may be impossible to do afterward.