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Conformance of Roll Formed Internal Threads to AS8879

Written by ALMA
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Background

Use of the roll forming process for the creation of internal threads has been and remains a viable method for producing internally threaded fasteners. The roll forming method uses a tool similar to a tap, but one without cutting edges. The geometry of the tool initiates material flow to fill the tool geometry, but typically leaves an incomplete minor diameter. Thread forms exhibiting this condition are typically referred to as having “open crests.”

Historically, in the aerospace fastener industry, the method commonly employed in production of structural products referencing the AS8879 thread specification has been cutting of threads from a prepared hole at the AS8879 specified minor diameter. There are various methods available to create cut threads.

Definitions

Discontinuity

The Industrial Fasteners Institute defines a *discontinuity* as an interruption in the normal physical structure or configuration of a part; such as laps, cracks, seams, inclusions or porosity. Other OEM specifications follow the same definition for discontinuities.

Incomplete thread

The Industrial Fasteners Institute defines an incomplete thread as that portion of a thread not fully formed at the root or the crest.

Tolerance

ASME Y14.5 defines a *tolerance* as the total amount that a feature is permitted to vary from the specified dimension.

Discussion

AS8879 requirements

The AS8879 specification defines the dimensional characteristics and geometry of controlled root radius product threads. The specification does not control the method used to create the threads. This specification also provides the design of the thread profile and inspection criteria. See Figure 2 extracted from AS8879. As defined in Table 8 of AS8879, Dimensional Design and Conformance Requirements, the minor diameter characteristic states, “The minor diameter shall be within the specified dimensional requirements.” See Appendix.

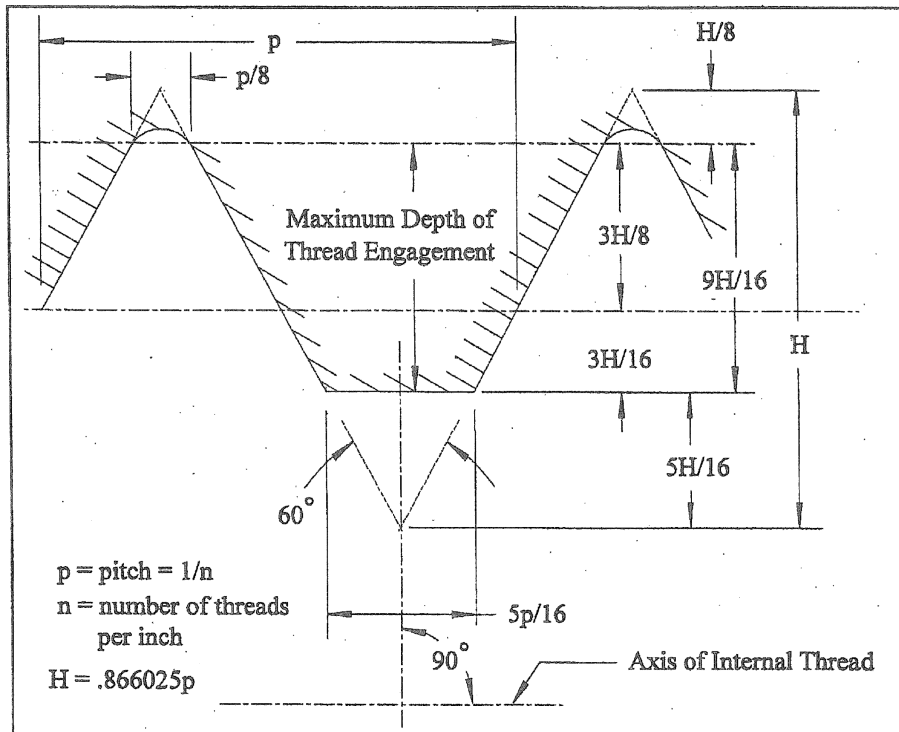


FIGURE 2 - Internal Thread Maximum Material Condition

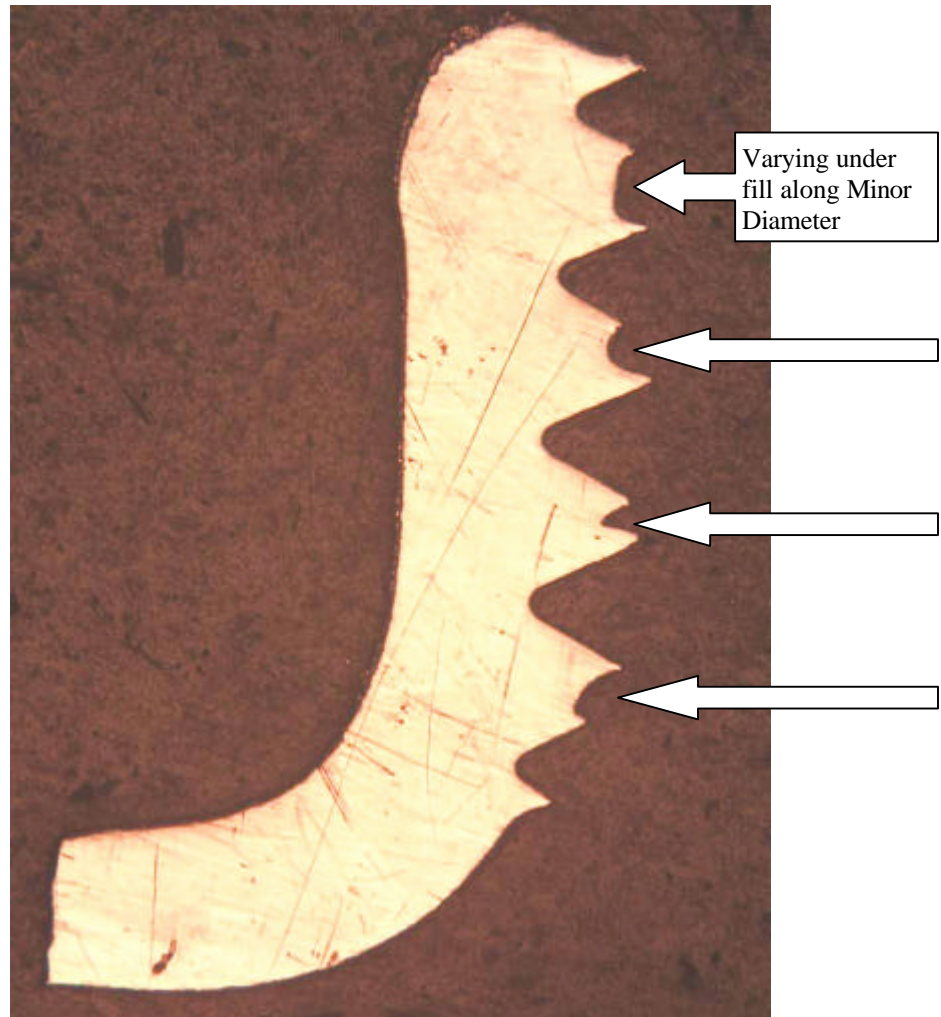
AS8879 does allow for incomplete threads in the run-out and lead-in of the part. The lead-in is inclusive of the countersink/thread relief. The expectation is that, outside of these zones of incomplete thread allowance, the thread form will meet the dimensional requirements of the specification.

Subject parts

The photomicrographs below are of internal threads produced by roll forming. Allowing that the permitted incomplete threads at the top and bottom of the part would consume four pitches, or 0.125", the resulting length over which the threads must conform to AS8879 is 0.065" (0.190" - 0.125" = 0.065"). By design, the innermost two threads shall be required to conform to AS8879.

The photomicrograph represents parts taken from sheet metal product using the roll formed thread process. The sample was prepared without etching and is shown at 2.5X magnification.

ROLLED FORM THREAD SPECIMEN



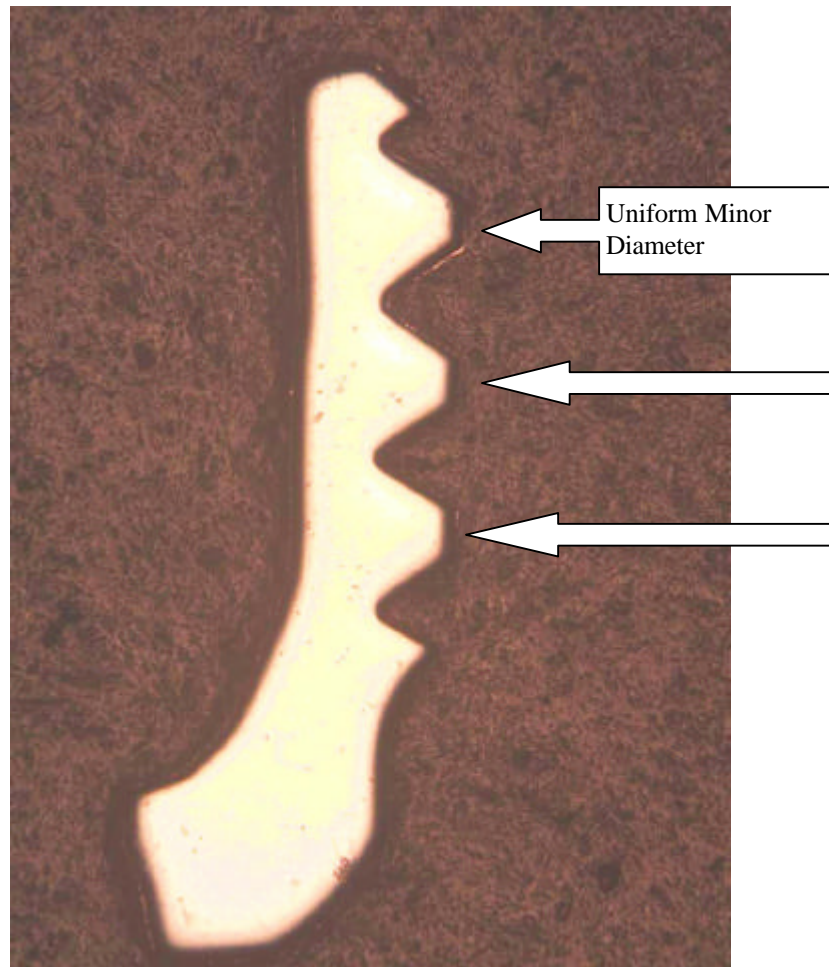
Visual inspection reveals an irregular minor diameter that is not, by definition, a discontinuity. The material volume of the pre-rolled blank is insufficient to completely fill the minor diameter, resulting in irregular threads along the minor diameter. It is assumed that providing a blank with a smaller internal diameter, prior to the roll forming process, will decrease the voids present in the photomicrograph above.

Reference parts

The photomicrograph below represents parts with cut threads and the resulting geometry. The nut element has an overall height of approximately 0.177". The thread requirement is 0.1900"-32 UNJF per AS8879.

The images that follow reflect a random specimen taken of the product using a cut thread manufacturing process, in this case tapping. The sample was prepared without etching and is shown at 2.5X magnification.

TAPPED (CUT THREADS) SPECIMEN



Visual inspection of the cut thread form reveals a uniform minor diameter along the entire thread length. The sample part is also made from sheet metal to show comparable results using the same initial manufacturing process.

Attribute Inspection

Both thread forms satisfied the attribute inspection method as currently specified within AS8779. Without part sectioning and magnification of the two thread forms, the differences would not be detected.

Conformance to AS8879

AS8879 is a dimensional specification and the observed voids along the minor diameter from the roll formed thread process do not conform to the specification. The voids can't be categorized as a discontinuity enabling the interpretation of conformance.

Roll Formed Thread applications

There are product lines where roll formed threads provide a viable alternative to cut threads (e.g. internally threaded blind hole product). The requirement to objectively reflect conformance goes without question in the aerospace fastener industry.

Conclusion

Part standards which specify AS8879 should not allow the use of roll formed threads unless authorized within the applicable procurement documents. AS8879 Paragraph 4 is very specific as to thread design requirements. Currently, there are insufficient controls in place to ensure dimensional conformance; thus part standards and procurement specifications contain no means to mitigate the risks of the roll formed thread process. A separate screw thread specification addressing roll formed threads is recommended to ensure that adequate dimensional verification would be provided regarding those applications that would require the use of this thread form.

Appendix

SAE AS8879 Revision D

TABLE 8 - Dimensional Design and Conformance Requirements

| EXTERNAL THREADS | | |
|---------------------------|---|------------------------------|
| CHARACTERISTIC | CATEGORY 1 | CATEGORY 2 |
| Major Diameter | Major Diameter shall be within specified dimensional requirements | |
| Pitch Diameter | Size (Pitch Diameter or Groove Diameter) shall be within the specified dimensional requirements Note: Unless otherwise specified, for products with thread length less than 6 pitches, only the maximum and minimum material limit inspections are required | |
| Functional Diameter | The Functional Diameter shall be less than or equal to the envelope of perfect form at Maximum Pitch Diameter | |
| Minor Diameter | Minor Diameter shall be within the specified dimensional requirements | |
| Root Radius | Root Radius shall be within the specified dimensional requirements. See Para. 3.2.2 | |
| Incomplete Runout Threads | Ref. Para. 3.5.1 | |
| Incomplete Lead Threads | Ref. Para. 3.5.2 | |
| Surface Roughness | For reference only, see 3.6 | Ref. Para. 3.6 |
| Lead | For reference only, see 3.4.1 | Ref. Para. 3.4.2 and 3.4.2.1 |
| Flank Angle | For reference only, see 3.4.1 | Ref. Para. 3.4.2 and 3.4.2.2 |
| Circularity | For reference only, see 3.4.1 | Ref. Para. 3.4.2 and 3.4.2.3 |
| Taper | For reference only, see 3.4.1 | Ref. Para. 3.4.2 and 3.4.2.4 |
| Runout | For reference only, see 3.4.1 | Ref. Para. 3.4.2 and 3.4.2.5 |
| INTERNAL THREADS | | |
| CHARACTERISTIC | CATEGORY 1 | CATEGORY 2 |
| Major Diameter | Major Diameter shall be greater than the specified minimum | |
| Pitch Diameter | Size (Pitch Diameter or Groove Diameter) shall be within the specified dimensional requirements Note: For internal threads of nominal size less than .1900 inch, only the functional diameter limit and minor diameter limit inspections are to be performed. Note: Unless otherwise specified, for products with thread length less than 6 pitches, only the maximum and minimum material limit inspections are required | |
| Functional Diameter | The Functional Diameter shall be greater than or equal to the envelope of perfect form at Minimum Pitch Diameter | |
| Minor Diameter | Minor Diameter shall be within the specified dimensional requirements | |
| Incomplete Lead Threads | Ref. Para. 3.5.2 | |
| Surface Roughness | For reference only, see 3.6 | Ref. Para. 3.6 |
| Lead | For reference only, see 3.4.1 | Ref. Para. 3.4.2 and 3.4.2.1 |
| Flank Angle | For reference only, see 3.4.1 | Ref. Para. 3.4.2 and 3.4.2.2 |
| Circularity | For reference only, see 3.4.1 | Ref. Para. 3.4.2 and 3.4.2.3 |
| Taper | For reference only, see 3.4.1 | Ref. Para. 3.4.2 and 3.4.2.4 |
| Runout | For reference only, see 3.4.1 | Ref. Para. 3.4.2 and 3.4.2.5 |