Surface Discontinuities on Bolts, Screws, and Studs —SAE J123b

SAE Recommended Practice
Approved September 1973
Metric Products Added July 1975

THIS IS A PREPRINT AND WILL
APPEAR IN THE NEXT EDITION
OF THE SAE HANDBOOK

Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

LAND
SEA
AIR
SPACE

PREPRINT

SURFACE DISCONTINUITIES ON BOLTS, SCREWS, AND STUDS—SAE J123b

SAE Recommended Practice

Report of Iron and Steel Technical Committee approved September 1973. Editorial change; metric products added July 1975.

1. Scope—This recommended practice defines, illustrates, and specifies allowable limits for various types of surface discontinuities that may occur or become apparent during the manufacture and processing of bolts, screws, and studs which are primarily intended for use in automotive assemblies subjected to severe dynamic stresses and necessitating use of high strength fasteners having appropriate fatigue resistant properties.

1.1 The basic recommended practice does not include inspection sampling requirements. It is intended that the purchaser shall specify, in the original inquiry and purchase order, the inspection sampling requirements which the producer must satisfy to demonstrate the acceptability of bolts and screws with respect to surface discontinuities. Appendix outlines inspection sampling plans applicable when such requirements are not specified by the purchaser in the original inquiry, purchase order, or in related specifications.

2. Types of Surface Discontinuities—For the purpose of this recommended practice, surface discontinuities on bolts, screws, and studs are divided into 10 "types," defined as follows:

2.1 Crack—A crack is a clean (crystalline) fracture passing through or across the grain boundaries without inclusion of foreign elements. Cracks are normally caused by overstressing the metal during forging or other forming operation, or during heat treatment. Where parts are subjected to significant reheating, cracks usually are discolored by scale.

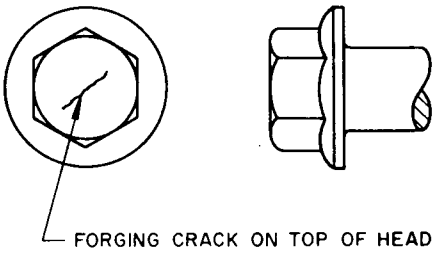
2.1.1 Quench Cracks—Quench cracks may occur during heat treatment due to excessively high thermal and transformation stresses. They usually traverse an irregular and erratic course on the surface of the fastener. Typical quench cracks are shown in Fig. 1.

2.1.2 Forging Cracks—Forging cracks may occur during the cutoff or forging operations and are located on the top of the heads of screws and bolts. Typical forging cracks are shown in Fig. 2.

2.2 Seam—Seams are generally inherent in the raw material from which fasteners are manufactured. They are narrow, generally straight or smooth-curved line discontinuities, running longitudinally on the shank and/or thread. Seams may extend onto the tops of the heads of circular head products as well as being present at the periphery of the head. Seams may also extend into the chamfer circle, washer face, and wrenching flats of hex head products. Typical seams are shown in Fig. 3.

2.3 Burst—A burst is an open break in the metal (material). Bursts may occur on the flats or corners of the heads of bolts and screws, at the periphery of flanged or circular head products, or on the raised periphery of indented head bolts and screws. Typical bursts are shown in Fig. 4.

2.4 Shear Burst—A shear burst is an open break in the metal, occurring most frequently at the periphery of products having circular or flanged heads and are generally located at approximately 45 deg to the product axis. Shear bursts may also occur on the sides of hex head products. Typical discontinuities of this type are shown in Fig. 4.



NOTE: Forging cracks are permissible discontinuities if within the limits specified in paragraph 3.5.

FIG. 2—TYPICAL FORGING CRACKS

2.5 Void—A void is a shallow pocket or hollow on the surface of the bolt or screw due to nonfilling of metal during forging or upsetting. Typical voids are shown in Fig. 5.

2.6 Lap—A lap is a fold-over of metal in the threads of screws, bolts, and studs. If laps occur, they generally show a pattern of consistency between the product, that is, laps will be identically located and with the same direction of traverse between all product. Typical laps in external threads are shown in Fig. 6.

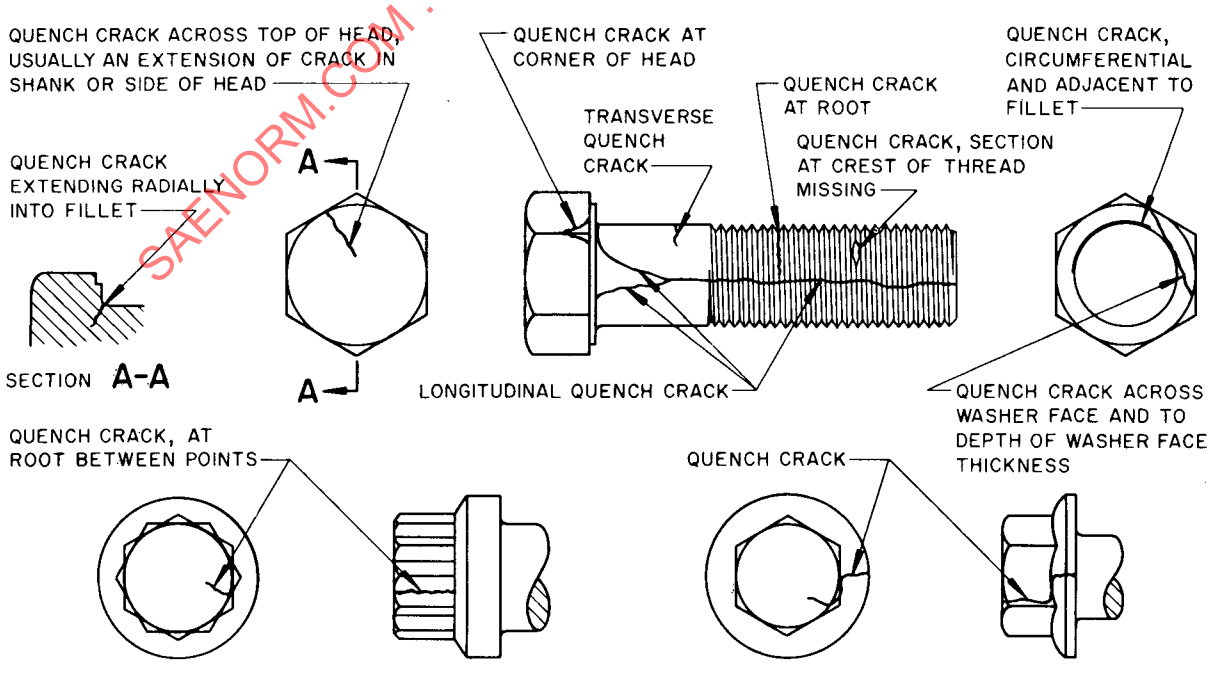
2.7 Fold—A fold is a doubling over of metal which may occur during the forging operation. Folds may occur at or near the intersection of diameter changes and are especially prevalent with noncircular necks, shoulders, and heads. Typical folds are shown in Fig. 7.

2.8 Tool Marks—Tool marks are longitudinal or circumferential grooves of shallow depth produced by the movement of manufacturing tools over the surface of the fastener. Typical tool marks are shown in Fig. 8.

2.9 Nick or Gouge—A nick or gouge is an indentation on the surface of the fastener, produced by forceful abrasion or the impact of product coming into contact with other product or manufacturing equipment during manufacture.

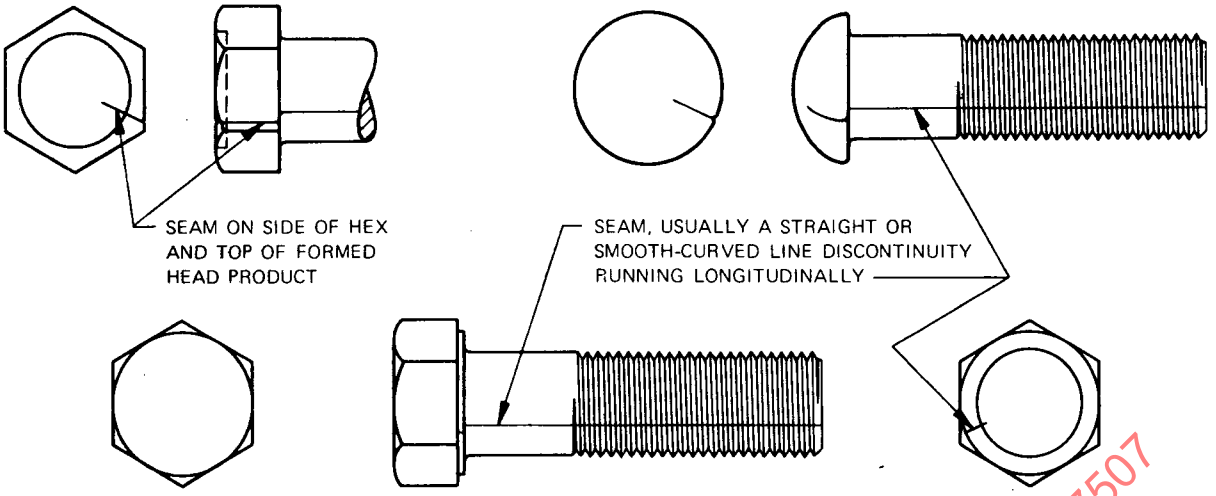
3. Limits for Surface Discontinuities

3.1 Letter Definitions—Throughout the following requirements, D designates the nominal size (basic major diameter of thread) of bolts, screws, and studs, except for bolts and screws with shoulders, in which case D designates



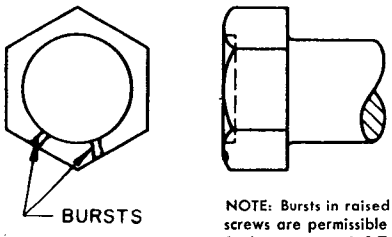
NOTE: Quench cracks of any depth, any length, or in any location are not permissible discontinuities.

FIG. 1—TYPICAL QUENCH CRACKS

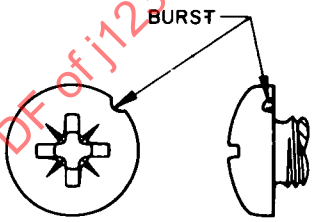


NOTE: Seams are permissible discontinuities if within the limits specified in paragraph 3.6.

FIG. 3—TYPICAL SEAMS



NOTE: Bursts in raised periphery of indented head bolts and screws are permissible discontinuities if within the limits specified in paragraph 3.7.3.



NOTE: Bursts in circular head products, with or without recess, are permissible discontinuities if within the limits specified in paragraph 3.7.2.

NOTE: Bursts and shear bursts are permissible discontinuities if within the limits specified in paragraph 3.7.

FIG. 4—TYPICAL BURSTS AND SHEAR BURSTS

the largest shoulder diameter. F designates the nominal flange diameter or head diameter of products having circular heads. For metric-series products, use millimeter; for inch-series products, use inch.

3.2 Quench Cracks—Quench cracks of any depth, any length, or in any location, are not permitted. (See paragraph 2.1.1 and Fig. 1.)

3.3 Laps in Screw Threads—Laps of any depth and any length which (a) are present in the root of the screw thread, or (b) originate on the flank, traverse toward the interior, and extend in depth below the pitch line of the bolt, screw, or stud, or (c) originate below the pitch line on the pressure flank and traverse toward the major diameter, are not permitted. (This requirement is not applicable to tapping screws having spaced threads.) (See paragraph 2.6 and Fig. 6.)

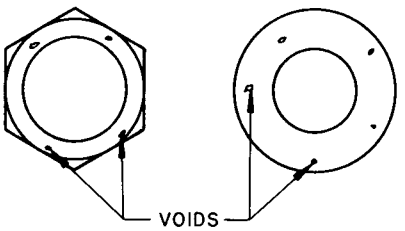
3.4 Folds

3.4.1 Folds located in internal corners at or below the bearing surface, for example, in the fillet at the junction of head and shank, are not permitted.

3.4.2 Folds located at the intersection of the flange periphery and bearing surface, are not permitted. (See paragraph 2.7 and Fig. 7.)

3.5 Forging Cracks—Forging cracks on the top of head bolts and screws shall not exceed a length of 1 D or a width or depth of 0.20 mm (0.008 in.) +0.010 D.

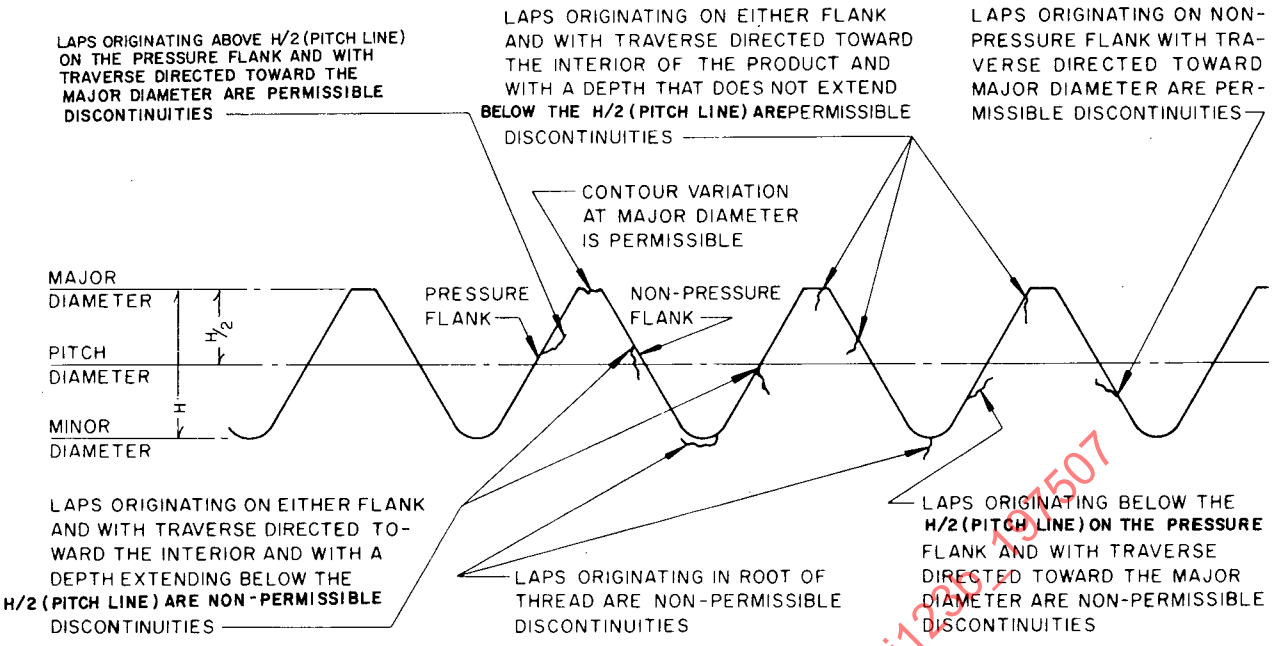
3.6 Seams—For metric-series bolts, screws and studs, seams in the shanks shall not exceed (a) an open width at the surface of 0.13 mm for sizes 6.3 to 12 mm, inclusive, and 0.25 mm for sizes 14 mm and larger, and (b) a depth of 0.015 D +0.10 mm for sizes 6.3 to 16 mm, inclusive, and 0.030 D for sizes over 16 mm. (See paragraph 2.2 and Fig. 3.)



NOTE: Voids are permissible discontinuities if within the limits specified in paragraph 3.8.

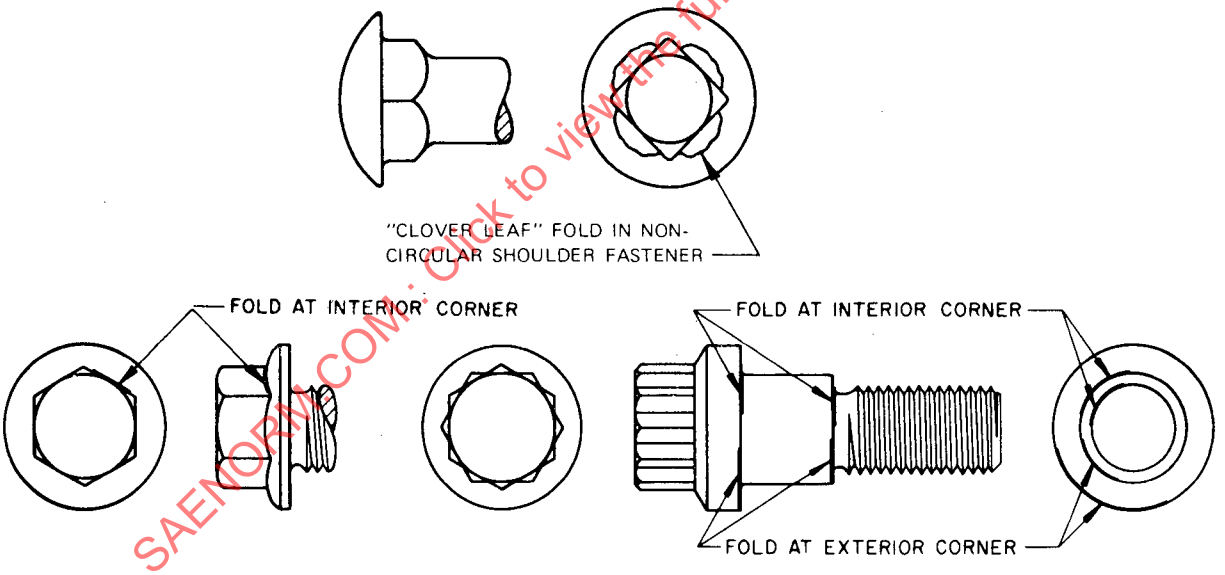
FIG. 5—TYPICAL VOIDS ON BEARING SURFACE

For inch-series bolts, screws and studs, seams in the shanks shall not exceed (a) an open width at the surface of 0.005 in. for sizes $\frac{1}{4}$ to $\frac{7}{16}$ in., inclusive, and 0.010 in. for sizes $\frac{1}{2}$ in. and larger, and (b) a depth of 0.015 D +0.004 in. for sizes $\frac{1}{4}$ to $\frac{5}{8}$ in., inclusive, and 0.030 D for sizes over $\frac{5}{8}$ in. (See paragraph 2.2 and Fig. 3.)



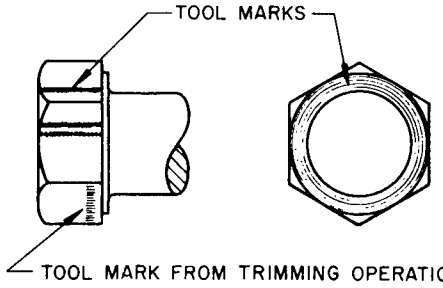
NOTE: These requirements apply to all bolts and screws except tapping screws with spaced threads.

FIG. 6—SURFACE DISCONTINUITIES IN EXTERNAL SCREW THREADS



NOTE: Folds in interior corners at or below the bearing surface are not permissible discontinuities. Folds at exterior corners are permissible discontinuities if within the limits specified in paragraph 3.4

FIG. 7—TYPICAL FOLDS



NOTE: Tool marks are permissible discontinuities if within the limits specified in paragraph 3.9.

FIG. 8—TYPICAL TOOL MARKS

Seams extending into the heads and flanges of fasteners which do not open beyond the limits specified for bursts are acceptable.

3.7 Bursts and Shear Bursts

3.7.1 Bursts in the flats of hex bolts and screws shall not exceed a width or an open depth of 0.25 mm (0.010 in.) +0.025 D. In addition, no burst shall extend into the bearing surface, nor shall any burst occurring at the intersection of two wrenching flats reduce the width across corners below the specified minimum. (See paragraphs 2.3 and 2.4 and Fig. 4.)

3.7.2 Flanges of bolts and screws and peripheries of circular head products may have two or more bursts or shear bursts providing that only one has a width greater than 0.13 mm (0.005 in.) +0.020 F or an open depth greater than 0.08 mm (0.003 in.) +0.012 F; in addition, this one burst shall not have a width exceeding 0.25 mm (0.010 in.) +0.040 F or an open depth of 0.15 mm (0.006 in.) +0.024 F.

3.7.3 Bursts in the raised periphery of indented head bolts and screws shall