INTERNATIONAL STANDARD

ISO 12996

First edition
2013-07-15

Mechanical joining — Destructive testing of joints — Specimen dimensions and test procedure for tensile shear testing of single joints

Assemblage mécanique — Essais destructifs des assemblages — Dimensions des éprouvettes et procédures d'essai pour essais de traction-cisaillement des jonctions uniques

Reference number
ISO 12996:2013(E)

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2, www.iso.org/directives.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received, www.iso.org/patents.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

The committee responsible for this document is ISO/TC 44, *Welding and allied processes*, Subcommittee SC 6, *Resistance welding and allied mechanical joining*.

Requests for official interpretations of any aspect of this International Standard should be directed to the Secretariat of ISO/TC 44/SC 6 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

Mechanical joining — Destructive testing of joints — Specimen dimensions and test procedure for tensile shear testing of single joints

1 Scope

This International Standard specifies the geometry of the test specimens and the procedure for the tensile shear testing of single mechanical joints on single and multilayer specimens up to a single sheet thickness of 4,5 mm.

The term sheet, as used in this International Standard, includes extrusions and cast materials.

The purpose of the tensile shear test is to determine the mechanical characteristics and failure modes of the joints made with the different methods.

This International Standard does not apply to civil engineering applications such as metal building and steel construction which are covered by other applicable standards.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2768-1, *General tolerances — Part 1: Tolerances for linear and angular dimensions without individual tolerance indications*

ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

3.1
tensile shear force
F_{max}
maximum force recorded in the test

Note 1 to entry: If required, further characteristic data, e.g. $F_{p0,2}$ (see 3.2), stiffness of the specimen *c* (see 3.7) or slope of the force curve, energy dissipation *W* (see 3.8), can be determined according to the shear diagram given in Figure 4.

3.2
elastic force limit
F_e
force where predetermined plastic or permanent displacement of the test specimen occurs

3.3
slippage force
F_s
force at which a relative movement of the joined parts is registered

3.4
displacement
s
change in the length of a specimen due to the application of a force

[SOURCE: ISO 18592:2009,[1] 3.15 modified — symbol changed; “force” replaces “load”]

3.5
displacement at the tensile shear force F_{max}
$s_{F_{max}}$
amount of displacement measured at tensile shear force F_{max}

3.6
displacement at $0{,}3F_{max}$
$s_{0{,}3F_{max}}$
amount of displacement measured at $0{,}3F_{max}$

3.7
stiffness in elastic range
c
ratio of increase of force to the increase of elongation in the elastic range ($c = \Delta F/\Delta s$)

3.8
dissipated energy
W
work or area under the force curve

3.9
dissipated energy up to F_{max}
$W_{F_{max}}$
area under the force curve up to the point of maximum tensile shear force F_{max}

$$W_{F_{max}} = \int_{s=0}^{s_{F_{max}}} F.\mathrm{d}s$$

3.10
dissipated energy up to $0{,}3F_{max}$
$W_{0{,}3F_{max}}$
area under the force curve up to the point where the tensile shear force drops to 30 % of F_{max}

$$W_{0{,}3F_{max}} = \int_{s=0}^{s_{0{,}3F_{max}}} F.\mathrm{d}s$$

Note 1 to entry: The $0{,}3F_{max}$ limit was introduced in order to reduce the time for carrying out the tensile shear test, because generally the area under the force curve after $0{,}3F_{max}$ does not contribute significantly to the dissipated energy.

3.11
dissipated energy up to fracture
$W_{fracture}$
total area under the force curve

$$W_{fracture} = \int_{s=0}^{s_{fracture}} F.\mathrm{d}s$$

3.12
interference fit joint
form fit joint
property of a joint in which the transmission of external forces, in particular shear forces, is effected by geometrical elements which prevent the movement of the components relative to one another

Note 1 to entry: This condition is frequently achieved by the fastener's outer diameter surface having complete contact with the joint's component holes.

Note 2 to entry: Compare *clearance fit joint* (3.13).

3.13
clearance fit joint
force fit joint
non-interference fit joint
property of a joint in which external forces, in particular shear forces, are transmitted through friction and if the force to be transmitted is greater than the frictional force, then frictional locking is overcome and the components move relative to one another

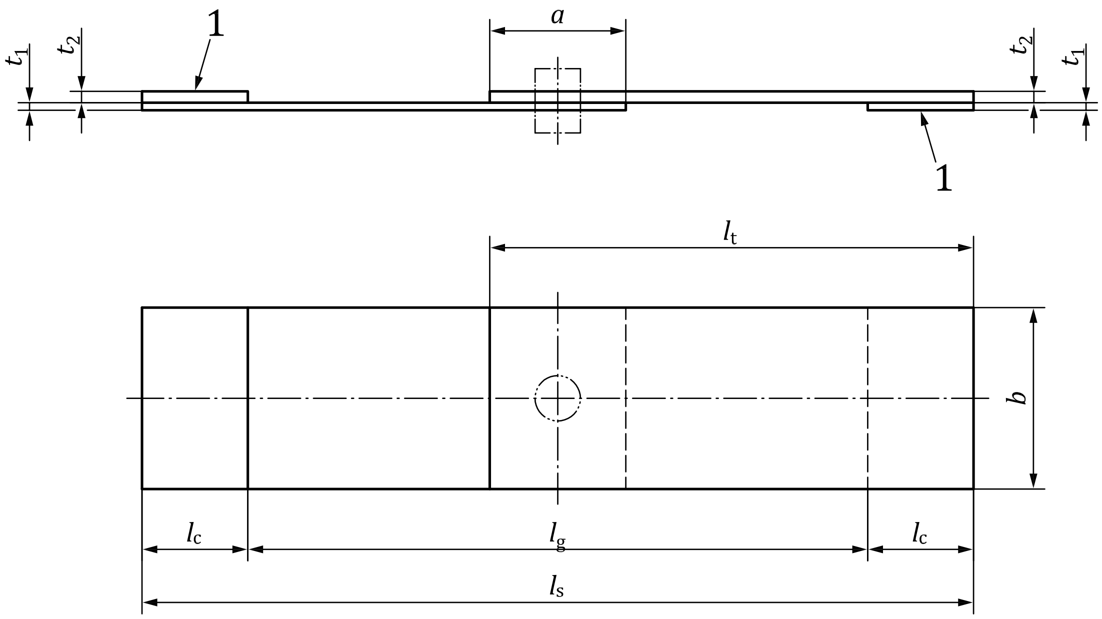
Note 1 to entry: This condition is frequently achieved by the fastener's outer diameter surface having incomplete contact with the joint's component holes.

Note 2 to entry: Compare *interference fit joint* (3.12).

4 Test specimens and types of tests

See Figures 1 and 2.

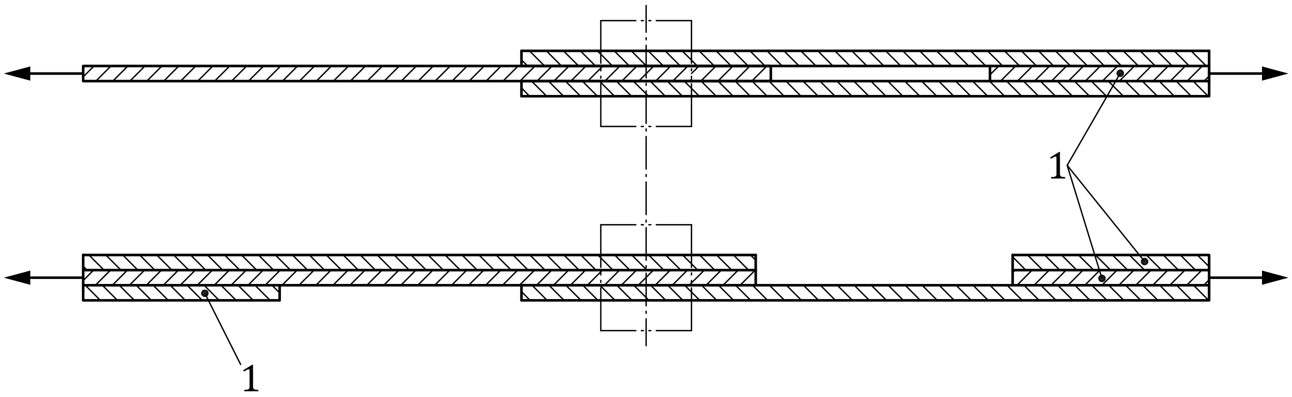
Tolerances according to ISO 2768-1 are applicable to the dimensions of the specimens given in Table 1.



Key

a	overlap	l_s	total length of specimen	t_1, t_2	sheet thickness
b	coupon width	l_g	specimen length between clamps	1	shim plates
l_c	length of clamped area	l_t	coupon length	2	mechanical joint

Figure 1 — Single-lap tensile shear test specimens



Key

1 shim plates

Figure 2 — Examples of different sheet testing arrangements for tensile shear test specimens

Alternative specimen size, stacking order of the sheets, the joining direction shall be agreed upon between the contracting parties and indicated in the test report.

The appropriate size and tolerance of the hole is determined based on the selected fastener.

Table 1 — Specimen dimensions

Thickness of sheet	Minimum overlap	Minimum specimen width	Length of clamped area	Specimen length between clamps
t_1; t_2	a	b	l_c	l_g
mm			mm	mm
≤4,5	5d	7d	≥45	95

NOTE Total specimen length, $l_s = l_g + 2l_c$, where the length of the clamped area is to be selected in accordance with the testing machine being used.

d Nominal diameter of the fastener or width or diameter of the clinching die.

5 Test equipment and test procedure

Clamp the test specimen in a tensile testing machine according to ISO 7500-1, in such a manner that the clamps are at the required distance from one another. For sheet thicknesses >1 mm or where the ratio of the thicknesses is >1,4, shim plates shall be used for clamping the test specimen in the grips of the tensile testing machine to ensure force concentricity [see Figure 3 b) and c)]. Shim plates can be joined by suitable joining method, e.g. resistance spot welding, adhesive bonding.

NOTE 1 If identical test results can be achieved by other measures shim plates can be omitted, e.g. by self-aligning clamps.

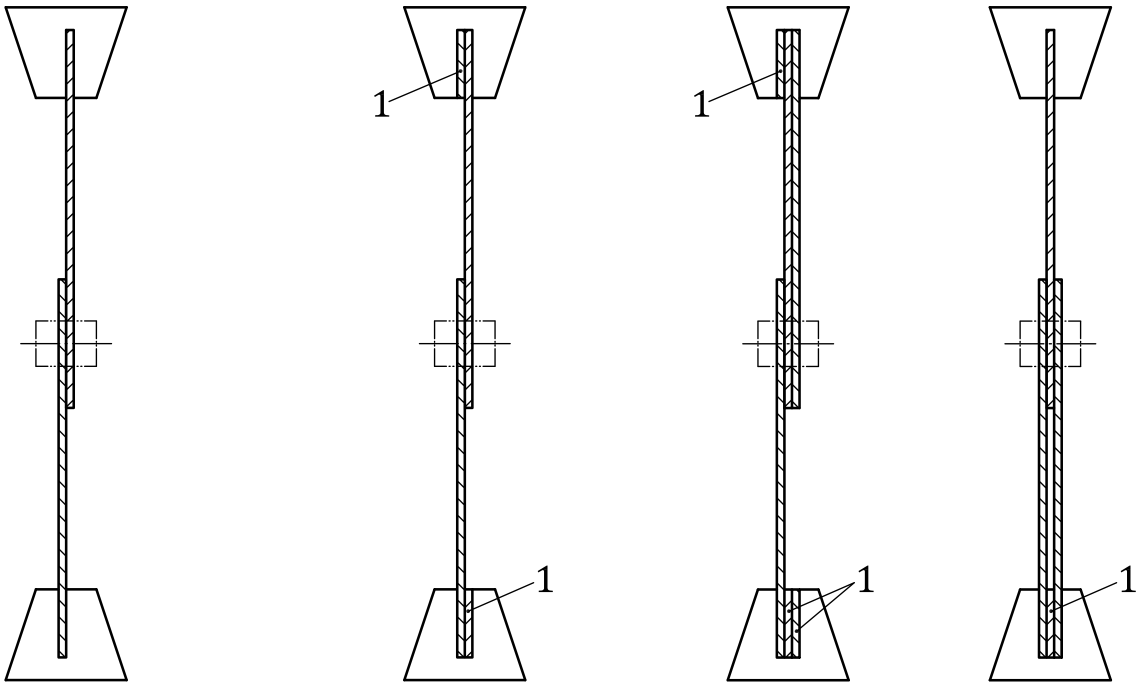
Testing shall be carried out at room temperature, unless otherwise specified.

The speed of testing is 10 mm/min or less.

NOTE 2 If tests at higher speeds show that the higher testing speed has no influence on the test results, then the higher testing speed may be used for the tensile shear tests.

The displacement shall be measured as the travel of the crosshead or by using extension calliper gauges, laser measuring equipment or other suitable extension sensors with a defined length directly on the specimen. Measurements made using signals from the crosshead shall, if necessary, be corrected by taking the stiffness of the machine into consideration. The sensing method used and the defined length of the specimen measured shall be recorded in the test report.

Tests results are comparable only when the tests are carried out under identical boundary conditions.



a) test arrangement without shim plates **b) test arrangement with shim plates (two layers)** **c) test arrangement with shim plates (three layers)**

Key

1 shim plates

Figure 3 — Set-up for tensile shear test specimens

Figure 4 illustrates a typical force elongation diagram for specimens with interference and clearance fit joints showing slippage. Different diagrams can be the result of different combinations of joining methods, sheet materials and thicknesses, as well as specimen geometries.

6 Failure modes and force-displacement curves

The failure mode after tensile shear testing shall be classified according to Annex A.

Figures A.1 to A.8 show classification of typical failure modes.

Figure A.9 shows some force–displacement curves.

7 Test report

The test report shall contain the information agreed to between the contracting parties. The content may include some or all items listed below:

a) a reference to this International Standard (ISO 12996:2013);

b) name of the examiner and/or the examining body;

c) date and signature of the examiner and/or the examining body;

d) joining technology;

e) joining parameters and joining equipment, fastener used;

f) specimen material and material condition;

g) joining direction, stacking order, location of coated sites;

h) specimen dimensions;

i) testing machine, test speed;

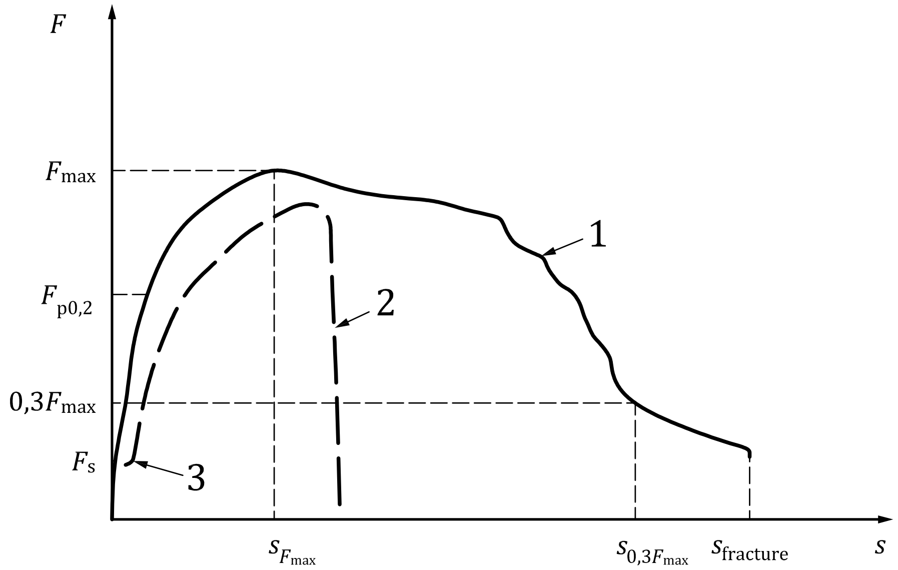
j) defined length on specimen and gauge type used for displacement measurements single values, mean values and standard deviation of the characteristic values;

k) individual test results, standard deviation, Coefficient of variation for the forces and the displacement;

l) force–displacement diagrams;

m) failure mode;

n) any additional remarks and any deviations from this International Standard.



Key

F force

s displacement

1 interference fit joint/form fit joint

2 clearance fit joint/force fit joint

3 slippage

Figure 4 — Characteristic values of a force–displacement diagram for the tensile shear test

Annex A
(normative)

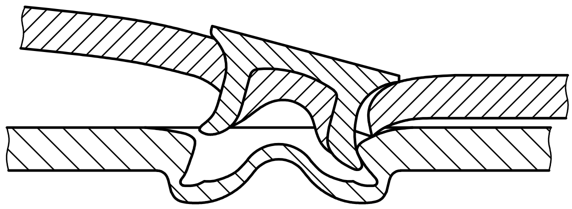
Types of joint failure

A.1 General

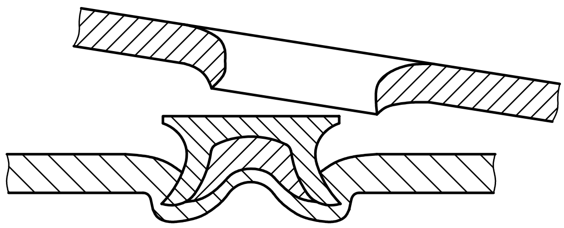
Depending on the joining technology, different types of failure can occur. Some of these are specific to the joining technology employed and should be recorded in the test report. Typical failure modes for various mechanical joints are shown, by way of example, in Figures A.1 to A.8.

Criteria for a failure of a mechanical joint are to be agreed between contracting parties. Figures A.1 to A.8 give typical failure modes at the end of the test. Figure A.9 gives examples of different force–displacement curves.

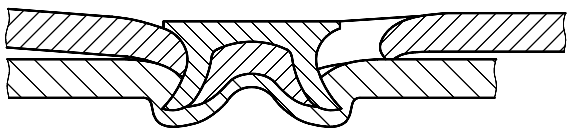
A.2 Typical failure modes of semi-tubular self-piercing rivet joints under shear force



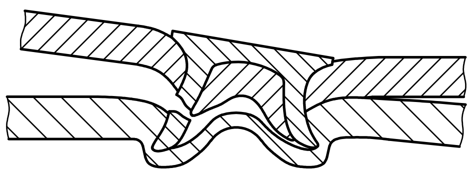
a) Rivet pull-out from bottom sheet



b) Pull-out of rivet head



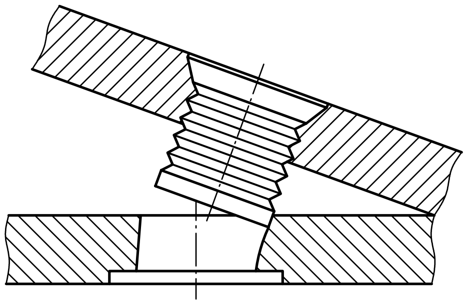
c) Failure of the specimen material



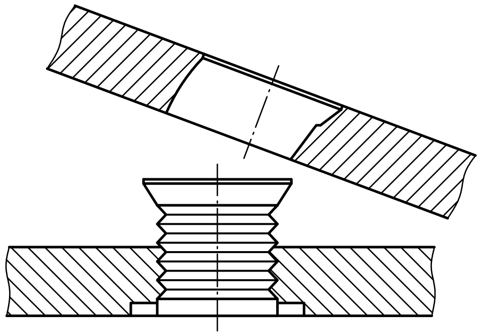
d) Rivet failure

Figure A.1 — Typical failure modes of semi-tubular self-piercing rivet joints under shear force

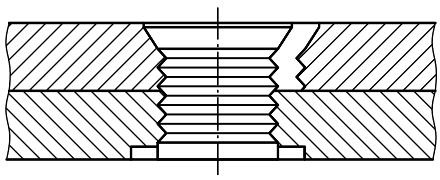
A.3 Typical failure modes of solid self-piercing rivet joints



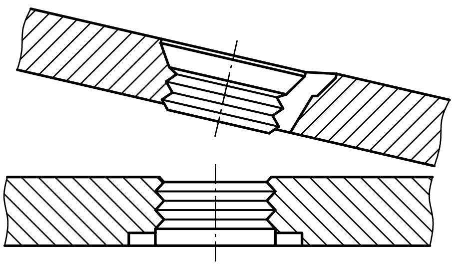
a) Rivet pull-out from bottom sheet



b) Pull-out of rivet head



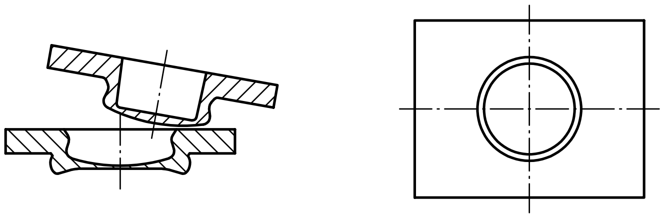
c) Failure of the specimen material



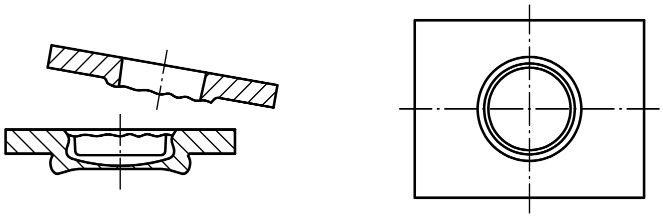
d) Rivet failure

Figure A.2 — Typical failure modes of solid self-piercing rivet joints under shear force

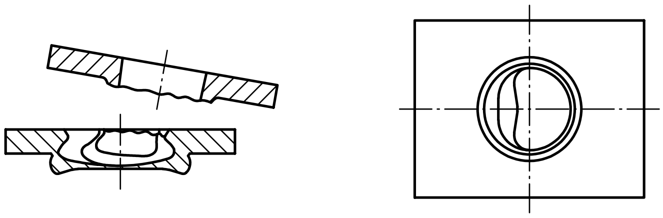
A.4 Typical failure modes of clinch joints



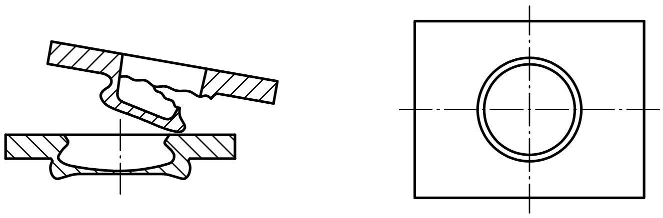
a) Pull-out



b) Neck fracture



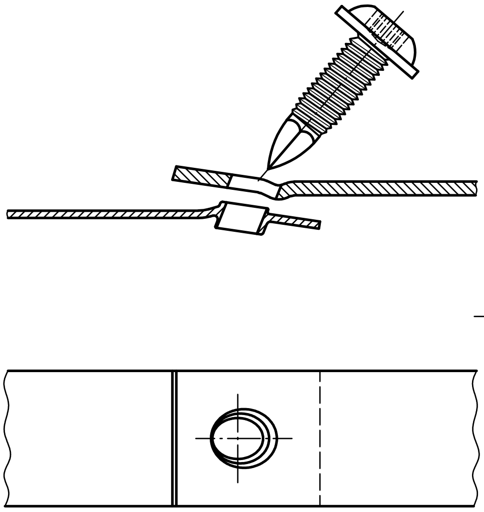
c) Neck fracture with plastic deformation (mixed mode failure)



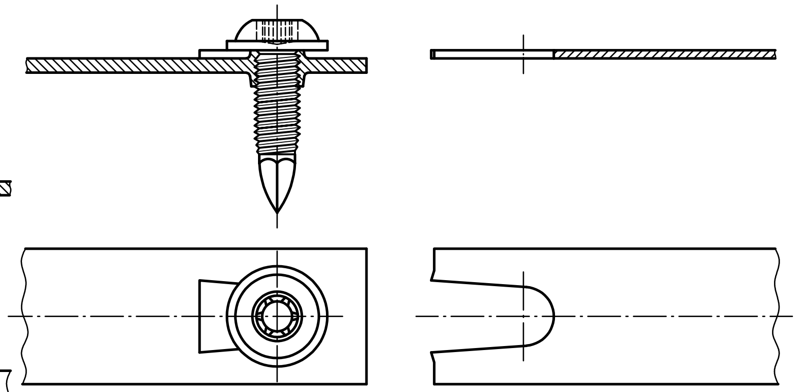
d) Pull-out with neck fracture (mixed failure)

Figure A.3 — Typical failure modes of clinch joints

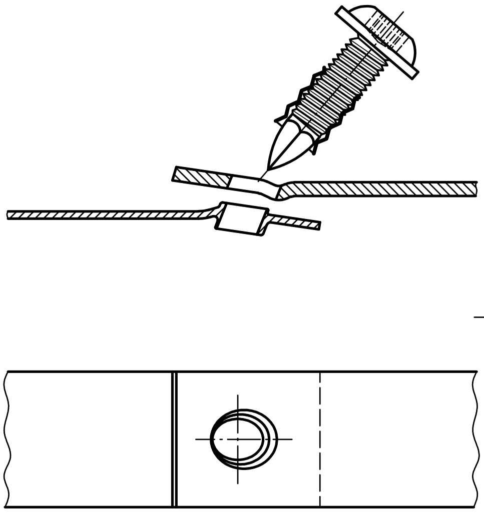
A.5 Typical failure modes of machine screw or tapping screw joints



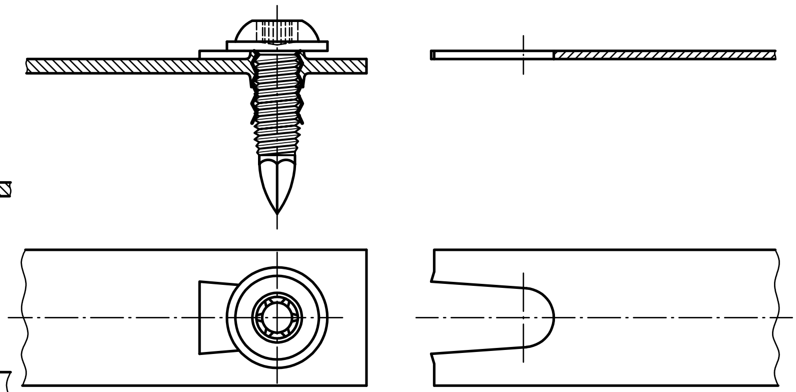
a) Thread in specimen stripped



b) Upper (head side) component failure



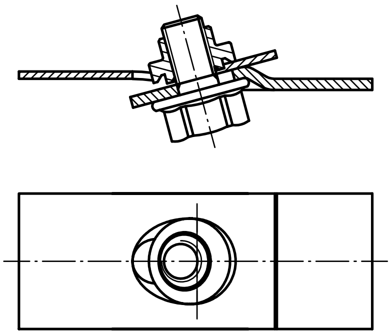
c) Thread in specimen stripped with bushing or extruded hole



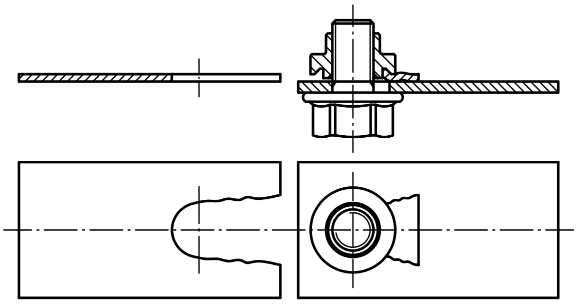
d) Upper (head side) component failure with bushing or extruded hole

Figure A.4 — Typical failure modes of screw joints (machine screw or tapping screws)

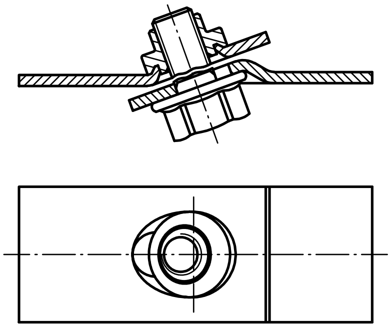
A.6 Typical failure modes of joints made with self-clinching or self-piercing nuts



a) Impermissible specimen deformation or pull-out of the nut



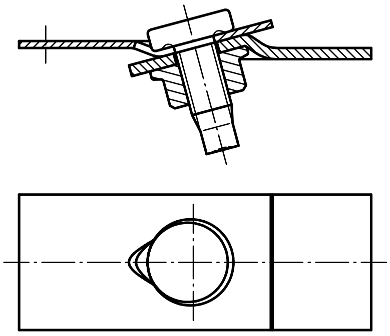
b) Specimen tear-out



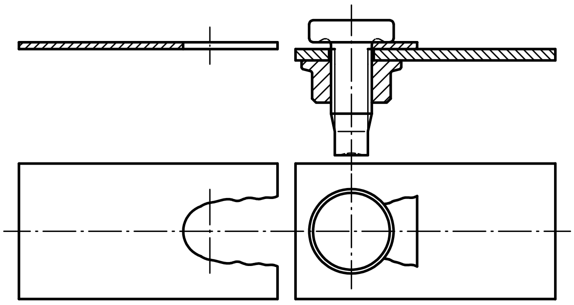
c) Bolt failure

Figure A.5 — Typical failure modes of joints made with self-clinching or self-piercing nuts

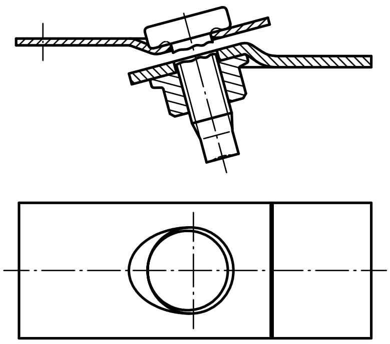
A.7 Typical failure modes of joints made with self-clinching or self-piercing bolts



a) Impermissible specimen deformation or pull-out of the bolt



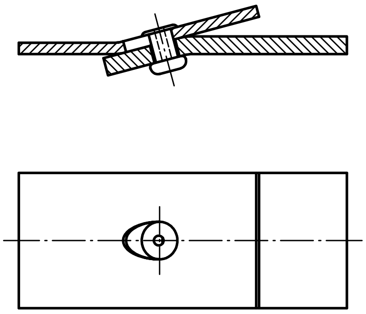
b) Specimen tear-out



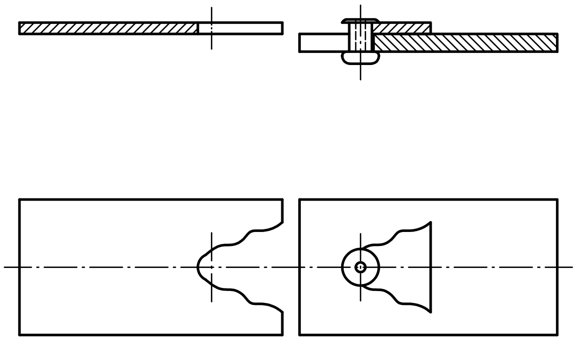
c) Bolt failure

Figure A.6 — Typical failure modes of joints made with self-clinching or self-piercing bolts

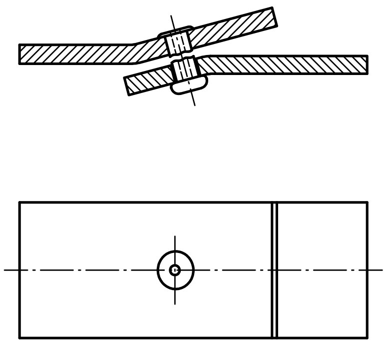
A.8 Typical failure modes of blind rivet joints



a) Impermissible specimen deformation or rivet pull



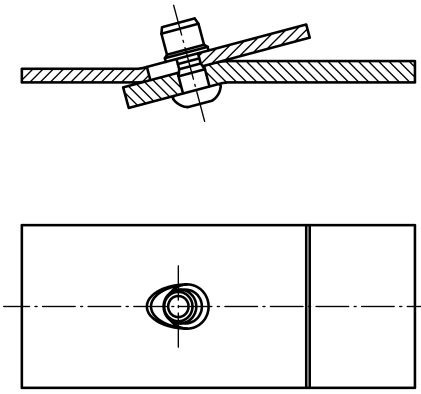
b) Specimen tear out



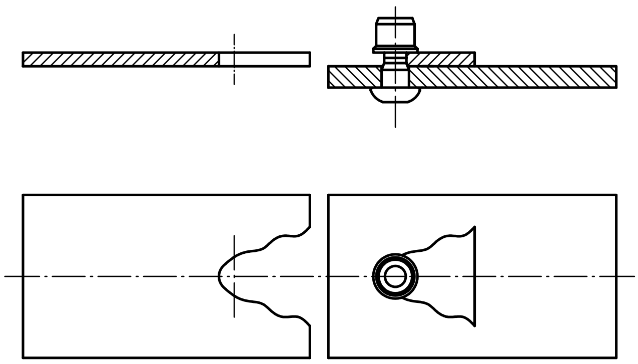
c) Blind rivet failure

Figure A.7 — Typical failure modes of blind rivet joints

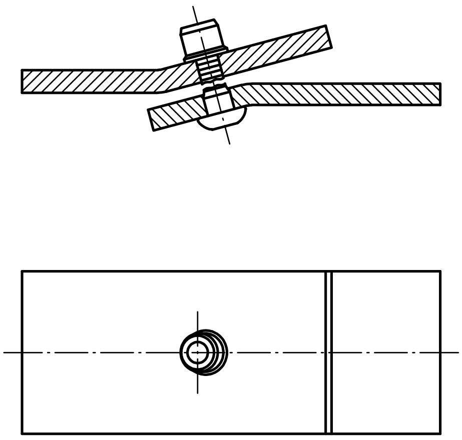
A.9 Typical failure modes of lock bolt joints



a) Impermissible specimen deformation or pull-out of the bolt



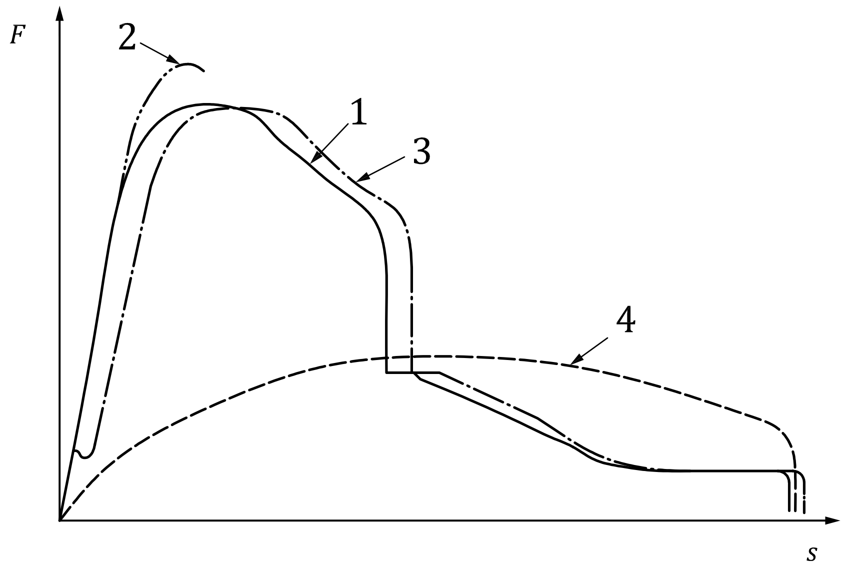
b) Specimen tear out



c) Lock bolt failure

Figure A.8 — Typical failure modes of lock bolt joints

A.10 Different force–displacement curves for the tensile shear test



Key

F	force	1	interference fit joint/form fit joint	3	clearance fit joint/force fit joint
s	displacement	2	brittle joint	4	joint with low stiffness

Figure A.9 — Different force–displacement curves for the tensile shear test

Bibliography

[1] ISO 18592:2009, *Resistance welding — Destructive testing of welds — Method for the fatigue testing of multi-spot-welded specimens*

ICS 25.160.40;25.160.10

Price based on 16 pages