Designation: A 673/A673M – 07

American Association State Highway
and Transportation Officials
Standard AASHTO No.: T 243

# Standard Specification for Sampling Procedure for Impact Testing of Structural Steel[1]

This standard is issued under the fixed designation A 673/A673M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope*

1.1 This specification covers the procedure for longitudinal Charpy V-notch testing of structural steel and contains two frequencies of testing. The impact properties of steel can vary within the same heat and piece, be it as rolled, control rolled, or heat treated. The purchaser should, therefore, be aware that testing of one plate, bar, or shape does not provide assurance all plates, bars, or shapes of the same heat as processed will be identical in toughness with the product tested. Normalizing or quenching and tempering the product will reduce the degree of variation.

1.2 This specification is intended to supplement specifications for structural steel when so specified.

1.3 This specification does not necessarily apply to all product specifications; therefore, the manufacturer or processor should be consulted for energy absorption levels and minimum testing temperatures that can be expected or supplied.

1.4 Two frequencies of testing (P and H) are prescribed.

1.5 The values stated in either inch-pound units or SI units are to be regarded as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with this specification.

## 2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 6/A 6M Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

## 3. Ordering Information

3.1 The inquiry and order shall indicate the following:

3.1.1 Frequency of testing, (P) or (H),

3.1.2 Test temperature (see 4.5 and 4.6),

3.1.3 Minimum average absorbed energy value (see 4.1 and 4.6),

3.1.4 Transverse impact test orientation for plate widths over 24 in. [600 mm], if desired (see 4.2.2),

3.1.5 Alternate core location (see 4.3), if applicable, and

3.1.6 Condition (as-rolled, stress relieved, normalized, normalized and stress relieved, or quenched and tempered).

## 4. Tests

4.1 Impact testing shall be in accordance with Test Methods and Definitions A 370. An impact test shall consist of testing three specimens taken from a single test coupon or test location, the average result of which shall be not less than the minimum average absorbed energy specified in the purchase order, which in no case shall be less than 7 ft·lbf [10 J] for full size specimens.

4.2 Except as allowed by 4.3, specimens for plates and bars shall be taken from a location adjacent to the location specified for the tension test specimen, and specimens for shapes shall be taken from a location at an end of the shape at a point one third the distance from the outer edge of the flange or leg to the web or heel of the shape (see Fig. 1 and Fig. 2). For plates produced from coils, three impact tests shall be taken from the product of each coil or qualifying coil (see Section 5); one test coupon shall be obtained from a location adjacent to the location specified for each of the two required tension tests (see Specification A 6/A 6M) and the third test coupon shall be obtained from a location immediately after the last plate produced to the qualifying specification.

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.02 on Structural Steel for Bridges, Buildings, Rolling Stock and Ships.

Current edition approved March 1, 2007. Published March 2007. Originally approved in 1972. Last previous edition approved in 2005 as A 673/A 673M – 05a.

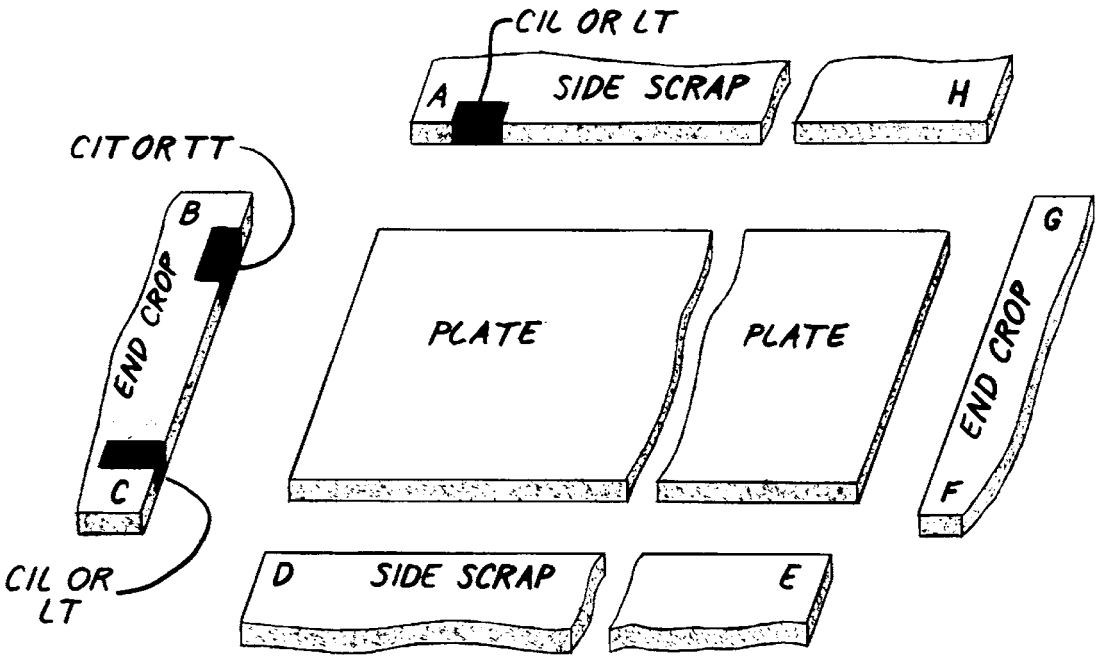
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard.**

Copyright © ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States.

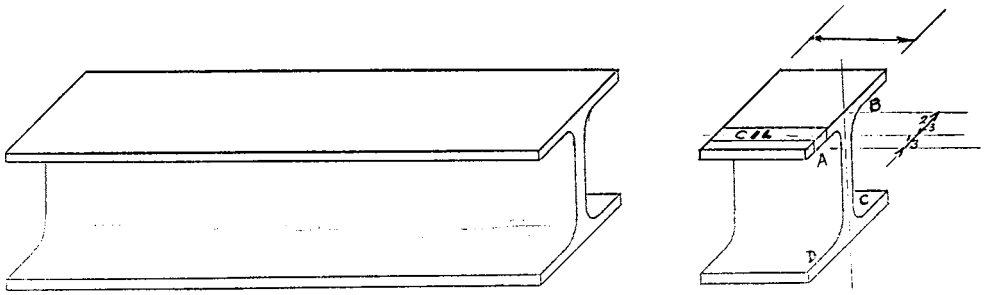


Provided by IHS
No reproduction or networking permitted without license from IHS
Not for Resale




NOTE 1—*LT* (Longitudinal tensile test) For widths through 24 in. [600 mm], may be taken at any location, *A* through *H*.
NOTE 2—*TT* (Transverse tensile test) For widths over 24 in. [600 mm], may be taken at location *B*, *C*, *F*, or *G*.
NOTE 3—*CIL* (Charpy impact longitudinal) May be taken at any location, *A* through *H*.
NOTE 4—*CIT* (Charpy impact transverse) For widths over 24 in. [600 mm], may be taken at location *B*, *C*, *F*, or *G*.

**FIG. 1 Plate Test Location**




NOTE 1—*CIL* = Charpy impact longitudinal.
NOTE 2—Test coupon for impact specimens may be taken from locations *A*, *B*, *C*, or *D* as shown laid out at location *A*.

**FIG. 2 Shape Test Location**

4.2.1 Except as allowed by 4.2.2, the longitudinal axis of each specimen shall be parallel to the final direction of rolling of the plate or parallel to the major axis of the shape.

4.2.2 If specified in the purchase order, for plate widths over 24 in. [600 mm], the longitudinal axis of each specimen shall be transverse to the final direction of rolling of the plate.

4.2.3 The longitudinal axis of each specimen shall be located midway between the surface and the center of the product thickness, and the length of the notch shall be perpendicular to the rolled surface of the product.

4.3 For shapes with a flange thickness equal to or greater than 1 ½ in. [38.1 mm], where alternate core location testing is specified in the purchase order, the longitudinal axis of each specimen shall be located midway between the inner flange surface and the center of the flange thickness at the intersection with the web mid-thickness (see Fig. 3).

4.4 The absorbed energy values obtained for subsize specimens shall not be less than the applicable values given in Table 1, which are proportional to the absorbed energy values required for full-size specimens.

4.5 Except as allowed by 4.6, the test temperature shall be as specified in the purchase order.

4.6 The manufacturer shall have the option of using a lower test temperature than is specified in the purchase order, provided that the absorbed energy values specified in the purchase order are met.

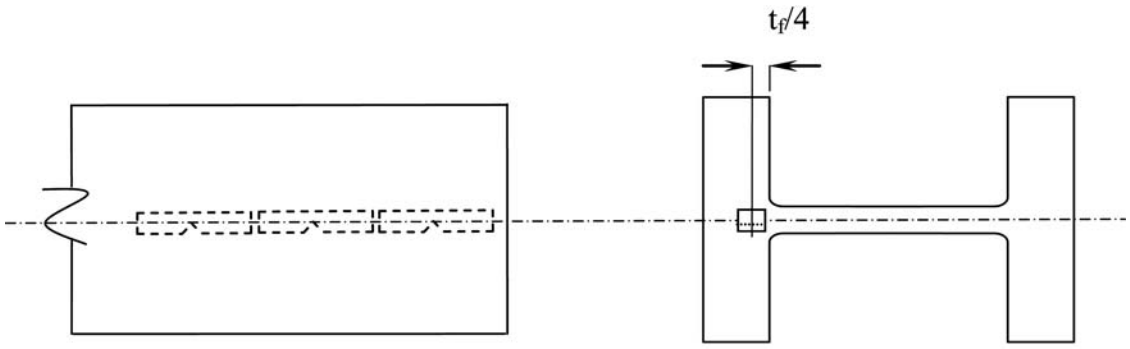
4.7 The actual test temperature used shall be reported with the test results.

## 5. Frequency of Testing

5.1 *Frequency (H) Heat Testing for Plates, Shapes, and Bars*—One impact test (a set of three specimens) shall be made



Provided by IHS
No reproduction or networking permitted without license from IHS
Not for Resale




NOTE—The notch for any of the specimens can be on either side of the beam centerline.

**FIG. 3 Alternate Core Location for CVN Specimens**

**TABLE 1 Equivalent Absorbed Energy for Various Specimen Sizes**

| Full Size, 10 by 10 mm | | 3/4 Size, 10 by 7.5 mm | | 2/3 Size, 10 by 6.7 mm | | 1/2 Size, 10 by 5 mm | | 1/3 Size, 10 by 3.3 mm | | 1/4 Size, 10 by 2.5 mm | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ft·lbf | [J] | ft·lbf | [J] | ft·lbf | [J] | ft·lbf | [J] | ft·lbf | [J] | ft·lbf | [J] |
| 40 | [54] | 30 | [41] | 27 | [37] | 20 | [27] | 13 | [18] | 10 | [14] |
| 35 | [48] | 26 | [35] | 23 | [31] | 18 | [24] | 12 | [16] | 9 | [12] |
| 30 | [41] | 22 | [30] | 20 | [27] | 15 | [20] | 10 | [14] | 8 | [11] |
| 25 | [34] | 19 | [26] | 17 | [23] | 12 | [16] | 8 | [11] | 6 | [8] |
| 20 | [27] | 15 | [20] | 13 | [18] | 10 | [14] | 7 | [10] | 5 | [7] |
| 16 | [22] | 12 | [16] | 11 | [15] | 8 | [11] | 5 | [7] | 4 | [5] |
| 15 | [20] | 11 | [15] | 10 | [14] | 8 | [11] | 5 | [7] | 4 | [5] |
| 13 | [18] | 10 | [14] | 9 | [12] | 6 | [8] | 4 | [5] | 3 | [4] |
| 12 | [16] | 9 | [12] | 8 | [11] | 6 | [8] | 4 | [5] | 3 | [4] |
| 10 | [14] | 8 | [11] | 7 | [10] | 5 | [7] | 3 | [4] | 2 | [3] |
| 7 | [10] | 5 | [7] | 5 | [7] | 4 | [5] | 2 | [3] | 2 | [3] |

for each 50 tons [45 Mg] of the same type of product subject to the requirements of this specification produced on the same mill from the same heat of steel. The impact test(s) shall be taken from different as-rolled or heat-treated pieces. Impact specimens shall be selected from the thickest material rolled subject to the following modifications: When material rolled up to 2 in. [50 mm] inclusive in thickness differs ⅜ in. [10 mm] or more in thickness, one impact test shall be made from both the thickest and thinnest material rolled. When material rolled over 2 in. [50 mm] in thickness differs 1 in. [25 mm] or more in thickness, one impact test shall be made from both the thickest and thinnest material rolled that is more than 2 in. [50 mm] in thickness. If insufficient pieces of the thickest or thinnest material are produced to permit compliance with the above, then testing may proceed to the next nearest thickness available. When plates are produced from coils, three impact tests shall be taken from each qualifying coil (see 4.2). One such coil shall be tested for each 50 tons [45 Mg] of the same product produced on the same mill from the same heat of steel. When material from one heat differs 1/16 in. [2 mm] or more in thickness, tests shall be made from both the thickest and thinnest material rolled regardless of the number of coils represented.

5.2 *Frequency (P) Piece Testing*:

5.2.1 *Plates*—One Charpy V-notch impact test (a set of three specimens) shall be made from each plate-as-rolled except for material that has been heat treated by quenching and tempering, in which case specimens shall be selected from each heat-treated plate. When plates are produced from coils, three impact tests shall be taken from each coil.

5.2.2 *Shapes*—One Charpy V-notch impact test (a set of three specimens) shall be made from at least each 15 tons [15 Mg] or each single length of 15 tons [15 Mg] or more, of the same nominal shape size, excluding length, from each heat in the as-rolled condition. If the shapes are heat treated, one test shall be taken from each heat of each furnace lot. For shapes heat treated in a continuous furnace, a lot shall not exceed 15 tons [15 Mg].

5.2.3 *Bars*—One Charpy V-notch impact test (a set of three specimens) shall be made for each 5 tons [5 Mg] of the same heat and same diameter or thickness if the material is furnished as rolled or is heat treated in a continuous-type furnace. For material heat treated in a noncontinuous furnace, one test shall be taken from each heat of the same bar diameter or thickness for each furnace charge.

## 6. Heat Treatment

6.1 The material shall be heat treated when specified on the purchase order.

6.2 When the plates are to be supplied in the as-rolled condition the manufacturer or processor (see Specification A 6/A 6M) has the option to heat treat the plates by normalizing or stress relieving or normalizing and stress relieving to meet the desired toughness properties.

6.3 When the fabricator elects to perform the required heat treatment or fabricates by hot forming instead of heat treating,



Provided by IHS
No reproduction or networking permitted without license from IHS
Not for Resale

the plates shall be accepted on the basis of tests made on full-thickness specimens heat treated in accordance with the purchaser's order requirements. If the heat treatment temperatures are not indicated on the purchase order, the manufacturer or processor shall heat treat the specimens under conditions considered appropriate for grain refinement and to meet the toughness requirements. The plate manufacturer or processor shall inform the purchaser of the procedure followed in treating the specimens.

## 7. Retests

7.1 If more than one individual test value is below the specified minimum average value, or if individual test value is below the greater of 5 ft·lbf [7 J] and two thirds of the specified minimum average value, a retest of three additional specimens shall be made, and each individual test value for such retest shall be equal to or greater than the specified minimum average value.

7.2 If the required energy values are not obtained upon retest, the material may at the option of the manufacturer or processor be heat treated in the case of as-rolled material or reheat treated in the case of heat-treated material.

7.3 After heat treatment or reheat treatment a set of three specimens shall be tested and qualified in the same manner for the original material.

7.4 If the impact test fails for the thickest product tested when testing to frequency (H) that material shall be rejected and the next thickest material tested to qualify the heat in accordance with 4.1. At the option of the manufacturer or processor retests may be made on the rejected material in which case each piece shall be accepted or rejected on the basis of the results of its own test.

## 8. Test Reports

8.1 Test reports for each heat supplied are required when specified by the purchase order.

8.1.1 Test reports shall show the results of each test required by the specification. However, for (H) frequency, only one test need be reported when the amount of material from a shipment is less than 50 tons [45 Mg] or two tests when the amount of material from a shipment is 50 tons [45 Mg] or more.

8.1.2 The thickness of the product tested may not necessarily be the same as an individual ordered thickness when (H) heat testing is ordered. Tests from material thicknesses in accordance with 5.1 and encompassing the thicknesses in a shipment shall be sufficient for qualifying the material in the shipment. These test thicknesses may or may not be within previously tested and shipped thicknesses from the same heat.

8.1.3 For plates produced from coils, all three test results shall be reported for each qualifying coil. If only half or less of a coil is utilized, then only one test from the outer lap and one from the innermost portion shipped need be reported.

8.1.4 For plates produced from coils, both the manufacturer and processor shall be identified on the test report.

8.1.5 A signature is not required on the test report. However, the document shall clearly identify the organization submitting the report. Notwithstanding the absence of a signature, the organization submitting the report is responsible for the content of the report.

8.1.6 When finished material is supplied to a purchase order specifying ASTM A 673/A 673M, the organization supplying that material shall provide the purchaser with a copy of the original manufacturer's test report.

## 9. Keywords

9.1 charpy V-notch; impact; sampling procedure; steel; structural steel; testing

## APPENDIX

**(Nonmandatory Information)**

### X1. VARIATION IN CHARPY V-NOTCH TESTS

X1.1 A survey of the variation to be expected in Charpy V-notch test results obtained from three common fine grain plate steels was conducted by the American Iron and Steel Institute (AISI).[3] The results of the survey are contained in a Contributions to the Metallurgy of Steel entitled, "The Variations of Charpy V-Notch Impact Test Properties in Steel Plates,'' (SU/24), published January 1979. The survey data consists of test values obtained from six locations in addition to the locations shown in Fig. 1 of this specification. The plate conditions tested involved as-rolled, normalized, and quench and tempered. Sufficient full-size specimens were taken from each sample so that three longitudinal and three transverse specimens could be broken at three test temperatures defined for each grade. The data is presented in tables of probability that impact properties at other than the official location which may differ from those of the reported test location. Additional data of the same type, but utilizing samples from thicker plates, was published by AISI as SU/27[4]. Another survey sponsored by the AISI, entitled "Statistical Analysis of Structural Plate Mechanical Properties" was published in January 2003[5]. That study analyzed the impact properties of more modern higher strength as-rolled structural plate steels.

[3] Originally published by the American Iron and Steel Institute. Available from ASTM Headquarters as PCN:29-000390-02.

[4] "The Variations in Charpy V-Notch Impact Properties in Steel Plates" originally published by the American Iron and Steel Institute, July 1989.

[5] Available from AISI directly at http://www.steel.org/infrastructure/bridges/index.html.



Provided by IHS
No reproduction or networking permitted without license from IHS
Not for Resale

## SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last version (A 673/A 673M – 05a) that may impact the use of this standard. (Approved March. 1, 2007.)

*(1)* Revised Fig. 3.

*ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.*

*This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).*



Provided by IHS
No reproduction or networking permitted without license from IHS
Not for Resale