
Drop-Weight Test for Determination of Nil-Ductility Transition Temperature

*User's Experience with
ASTM Method E 208*

Holt/Puzak *editors*



DROP-WEIGHT TEST FOR DETERMINATION OF NIL-DUCTILITY TRANSITION TEMPERATURE: USER'S EXPERIENCE WITH ASTM METHOD E 208

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Foreword

This publication, *Drop-Weight Test for Determination of Nil-Ductility Transition Temperature: User's Experience with ASTM Method E 208*, contains papers presented at the symposium on NDT Drop-Weight Test (E 208 Standard), which was held 28–29 Nov. 1984 in Williamsburg, Virginia. The symposium was sponsored by ASTM Committee E-28 on Mechanical Testing. John M. Holt, consultant, served as editor of this publication, along with P. P. Puzak, consultant, who was chairman of the symposium.

Related ASTM Publications

Fracture Mechanics: Seventeenth Volume, STP 905 (1986), 04-905000-30

Fracture Mechanics: Sixteenth Symposium, STP 868 (1985), 04-868000-30

Through-Thickness Tension Testing of Steel, STP 794 (1983), 04-794000-02

A Note of Appreciation to Reviewers

The quality of the papers that appear in this publication reflects not only the obvious efforts of the authors but also the unheralded, though essential, work of the reviewers. On behalf of ASTM we acknowledge with appreciation their dedication to high professional standards and their sacrifice of time and effort.

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Overview

In November 1984, ASTM Committee E-28 on Mechanical Testing held an international symposium to discuss users' experience with the ASTM Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels (E 208). The objectives of the symposium were to determine (1) unusual material behavior; (2) advantages of the test, including correlations of the results with service experience and other tests; (3) shortcomings of the method; and (4) unique testing equipment or experimental techniques. Of the twelve papers presented at the symposium, nine have been published in this Special Technical Publication. These nine papers cover the symposium objectives well; it is interesting to note that most of the authors found shortcomings in ASTM Method E 208-81 (the then current version of ASTM Method E 208) and made recommendations to overcome these shortcomings. The task group of ASTM Committee E-28 charged with oversight for the drop-weight (DW) test was aware of several of these deficiencies and had initiated appropriate action—for example, the crack-starter weld bead was changed to a single stringer bead without weave to minimize the heat input and thereby reduce the possibility of tempering the base metal at the notch. There were other deficiencies, however, of which the task group was not aware, and these are currently being studied.

The opening paper, by *Ando et al.*, presents the results of a study of welding parameters—welding current, preheating, shape of the bead, and other parameters—which shows that the welding current is the most influential parameter. In this study, the authors tested a sufficient number of specimens to make probability statements about the occurrence of nil-ductility transition (NDT) at specific temperatures.

The second paper, by *Sato et al.*, also shows the importance of the welding current and points out how heat sinks can influence the NDT temperature by changing the cooling rate of the heat-affected zone (HAZ), thereby producing a tough or not-so-tough microstructure. The authors indicate that good correlation between the NDT and Charpy impact transition temperatures can be obtained. (The editors caution that the correlations are probably based on the use of the Japanese Industrial Standard Charpy striker geometry and not on the ASTM test geometry; thus, the absolute values of the constants may be slightly affected.)

The next three papers, by *Onodera et al.*, *Lundin et al.*, and *Koshizuka et*

al, discuss the effect that the crack-starter weld bead has on the NDT temperature. They, too, demonstrate that the then standard two-pass technique of laying down the bead can temper the HAZ, which, in some materials, can significantly increase the toughness (lower the NDT temperature). (Because of these and other similar studies, ASTM Method E-208 was revised in 1984, prior to this symposium, to require that only the one-pass method be used when laying down the crack-starter bead.)

Koshizuka et al, in the fifth paper, also go on to estimate the NDT temperatures from K_{Id} values obtained from instrumented precracked Charpy specimens; they obtained good agreement.

The sixth paper, by *Hartbower*, points out the difficulties in interpreting the results when there is a through-thickness toughness gradient in the material and the DW test specimen is taken from the surface, as specified by ASTM Method E 208-69(1975). This gradient also manifests itself in the visual determination of whether the top-surface crack extends to the specimen edges and thus whether or not the specimen is "broken." The author suggests heat tinting the specimen after the test and then breaking it open to examine the extent of the original fracture.

Low and Early present the results of DW tests using specimens with curved surfaces, which had been removed from plates that were curved in two orthogonal directions. Their results indicate that the effect of the curvature is greater when the crack-starter weld is on the tension surface than when it is on the compression surface; however, they caution that the shift in NDT temperature may be masked by the inaccuracy associated with the E 208 test method.

Because many material specifications couple DW transition temperatures with Charpy V-notch transition temperatures to obtain a "reference temperature," data contained in a data bank were investigated by the authors of the eighth paper, *Oldfield and Server*, using computer techniques to determine reference temperatures for several steels. Predictions by the model of the NDT temperature and reference NDT temperature from dynamic fracture toughness data are in excellent agreement with measured values. They also show the dependency of the upper-shelf Charpy energy values in setting the reference temperature.

The final paper discusses the DW test from a fracture mechanics point of view. The author, *Sumpter*, postulates that shear lip development may be the common factor, which explains the empirically observed correlation between K_{Id} and the DW nil-ductility transition temperature.

The end of this volume contains an appendix, in which ASTM Method E 208 is reprinted in full. The version printed, E 208-85, was approved in 1985 and is the most recent version of this standard.

The editors of this publication would like to thank the authors and presenters at the symposium for their papers and the continuing discussion. A thank-

you is also extended to those who reviewed the manuscripts, and to the editors at ASTM, especially Helen Mahy, who saw to it that this Special Technical Publication was published.

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