

IMPACT TEST FOR PLASTICS

Application

This method is used to determine the impact resistance of plastics.

Apparatus Required

Impact Test Stand

The test fixture used for this test consists of a heavy metal base to which is mounted a sample support ring of 2 inches (50.8 mm) inside diameter. The inside perimeter of the sample support is cut to 1/4 inch (6.35 mm) radius. Mounted and centered over the support ring is a carrier which holds the impact dart. The dart is free to move in its carrier and rests on the sample under static conditions. The dart has 1/2 inch (12.7 mm) diameter with one end rounded to 1/4 inch (6.35 mm) radius; the other end has a 1 inch (25.4 mm) diameter flat impact head. The dart is long enough to protrude 3/4 inch (19.1 mm) below the sample plane into the support ring. Impact weights are 1 inch (25.4 mm) diameter metal rods and are dropped through a guide tube which is mounted and centered over the impact dart. The tube has 1 1/32 inch (26.2 mm) diameter and is 50 inches (1270 mm) long. Its entire length is slotted and calibrated into 1 inch (25.4 mm) increments along the slot. The weights are lifted by a pin which protrudes through the slot in the guide tube. A wide selection of weights from 1/4 pound (113 g) to 10 pounds (4.54 kg) should be available so that any force range can be maintained with a weight velocity at impact of 7 to 15 ft/s (2.1 to 4.6 m/s). Guide tube calibrations are clearly marked so that when the weight is raised to a specific height and dropped, it strikes the impact dart driving it against the sample with a specific impact force in inch pounds.

Freezer

In determining cold impact strength, a chest freezer or other cooling apparatus capable of maintaining the desired temperature within +/- 2 °C should be used, such as Revco Cold Box - Model ULD 1234.

Source: Revco Corporation
Industrial Products Division
Deerfield, Michigan 48238

or equivalent.

Samples

Impact test samples should be injection molded 4 x 4 inch (102 x 102 mm) plaques with smooth surfaces and be all of the same thickness, either 0.100 inch (2.54 mm) or 0.125 inch (3.18 mm).

Date	Action	Revisions
2001 03 28	Revised	Editorial – no technical change A. Cockman
1996 10 16		

Printed copies are uncontrolled

Page 1 of 11

Copyright © 2001, Ford Global Technologies, Inc.

Conditioning and Test Conditions

All test values indicated herein are based on material conditioned in a controlled atmosphere of 23 +/- 2 °C and 50 +/- 5 % relative humidity for not less than 24 h prior to testing and tested under the same conditions unless otherwise specified.

Test Procedure

1. Place a test sample on the support ring letting the dart rest freely on the surface of the sample.
2. Choose a weight which will deliver an impact force when dropped from 25 inches that is in the range of the expected impact resistance of the material to be tested.
3. After the appropriate weight is selected, the test force increment should be set at 5 % or less of the approximate impact resistance of the material. (For very low ranges, the force increment may be as high as 10 %.)
4. Impact a few plaques to verify that the weight chosen yields both passes and failures in the desired height range. (If more than six or seven consecutive passes are encountered, increase the force impact and start test over. Conversely, if more than six or seven consecutive failures are encountered, decrease the force and start test over).
5. After this is verified, perform the test by the following method:
 - (a) If the sample presently being impacted fails, the next sample will be impacted at a level one increment lower.
 - (b) If the sample presently being impacted passes, the next sample will be impacted at a level one increment higher.

Failure is defined as any evidence of cracking. A minimum of 20 samples should be tested. The weight should not be allowed to bounce and strike the sample a second time. The sample should be held firmly and flat on the support ring during the entire procedure. If impact resistance is being determined at a sub-ambient temperature, the sample should be held at the sub zero temperature for a minimum of 8 h and impacted within 5 s after removal from the freezer.

6. Record the data on a data sheet (example data sheet included) with force increments marked under column "F" and failures and/or passes in the appropriate sample number box in the center of the page.

Calculations:

A computer program titled "STAIR" is available for analysis of impact data. It is stored in corporate time sharing library, and can be accessed by any user from any time sharing console using the procedure described in Exhibit III of General Parts Division Reliability Memo No. IV-12. The following procedure is given for manual analysis:

1. Count the number of passes and failures. Determine which occurred the least number of times. If the force range of the least frequent event is more than 20 % of the highest force value, the confidence of the test is decreased. (For very low ranges, a 30 % variation is allowable.)
2. Starting with "O" for the lowest force increment at which the least frequent event (pass or fail) occurs, number the force increments with ascending integers so that the highest integer corresponds to the highest force increment at which the least frequent event occurred. These numbers should be entered in Column "I" of the work sheet.
3. Count the number of the least frequent events which occurred at each force level (horizontally). Enter these numbers in Column "N". For each horizontal line, multiply $I \times N$ and $I^2 \times N$ and enter results in the appropriate columns.
4. Add Columns N, ($I \times N$) and ($I^2 \times N$) so that:

$$A = \Sigma N \qquad B = \Sigma (I \times N) \qquad C = \Sigma (I^2 \times N)$$

5. Compute the force impact sample mean by the following equation:

(Space is provided on the work sheet for calculations in Steps 5, 6, 7, and 8)

$$\bar{x} = F_o + d (B/A \pm 0.5)$$

Where: $\bar{x}$ = Force Impact Sample Mean
 F_o = Lowest Force Value of Least Frequent Event
 d = Force Increment
 B/A = Mean of Force Impact Integer Value

In the expression ($B/A \pm 0.5$) use + (plus) if the least frequent event is pass; use - (minus) if the least frequent event is fail.

6. Compute Upper Limit by the following equation:

$$U = \frac{(AC - B^2)}{A^2}$$

Where: U = Upper Limit
 $A = N$
 $B = (I \times N)$
 $C = (I^2 \times N)$

If "U" is less than or equal to 0.3, the standard deviation cannot be estimated and the test should be repeated using a smaller force increment. If "U" is larger than 0.3, then continue to Step 7.

7. Compute the standard deviation by the following equation:

$$S = 1.62 d \times \frac{((AC - B_2) \div 0.03)}{A^2}$$

Where: S = Standard Deviation

1.62 = Constant

$(AC - B^2)/A^2$ = Upper Limit

0.03 = Constant

8. The impact value, R, of the material is computed as follows:

$$R = \bar{x} - .84S$$

Where: $\bar{R}$ = Impact Resistance of Material

$\bar{x}$ = Sample Mean

S = Standard Deviation

The impact resistance of the material is defined to be the level at which 20 % of the samples would be expected to fail and 80 % pass. The 20 % failure level is chosen so that the material which has a high scatter of data will be penalized more than a very consistent material.

9. Report should contain:

- (a) Material description and identification
- (b) Sample number tested
- (c) Sample size and thickness
- (d) Mean impact level ($\bar{x}$)
- (e) Standard deviation (S)
- (f) Expected 20 % failure level (R) to the nearest inch pound.
- (g) Test conditions: temperature, painted or unpainted, side of plaque impacted, etc.

Statistical methods are available for more detailed analysis. If more analysis is required, refer to General Parts Division Reliability Memo No. IV-12.

Chemicals, materials, parts, and equipment referenced in this document must be used and handled properly. Each party is responsible for determining proper use and handling in its facilities.