EXPERIMENT NO.: 3

IMPACT TEST OF METAL SPECIMEN



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Impact test of Metal Specimen

1. OBJECTIVE

-To study the Impact testing machine
-To evaluate the energy absorbing characteristics of metal materials at room temperature using the Charpy, Izod, and tension impact methods.
-To observe the failure patterns and failure surface

2. ASTM REFERENCE

ASTM E 23 Standard Test Methods for Notched Bar Impact Testing of Metallic Materials

3. SIGNIFICANCE

This experiment provides fundamental knowledge on impact behaviour of materials, test procedure, impact testing machine and its working principal, impact specimens, failure patterns etc.

4. APPARATUS AND MACHINE

Digital pendulum impact testing machine

5. SPECIMENS

Charpy (simple beam specimens), Izod (cantilever specimens), Tension Impact specimens made of different metals.

6. THEORY

An impact test normally determines the energy absorb in fracturing a test piece under high speed loading. Toughness is often measured by impact testing rather than by load – deformation (stress vs. strain) curves.

An impact test is a dynamic test in which a selected specimen which is usually notched, is struck and broken by a single blow in a specially designed machine. Using an impact. Machine, the energy absorbed while breaking the specimen is measured.

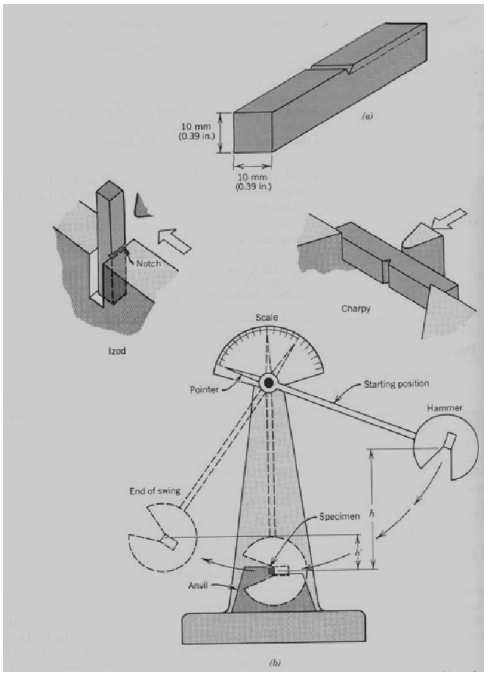
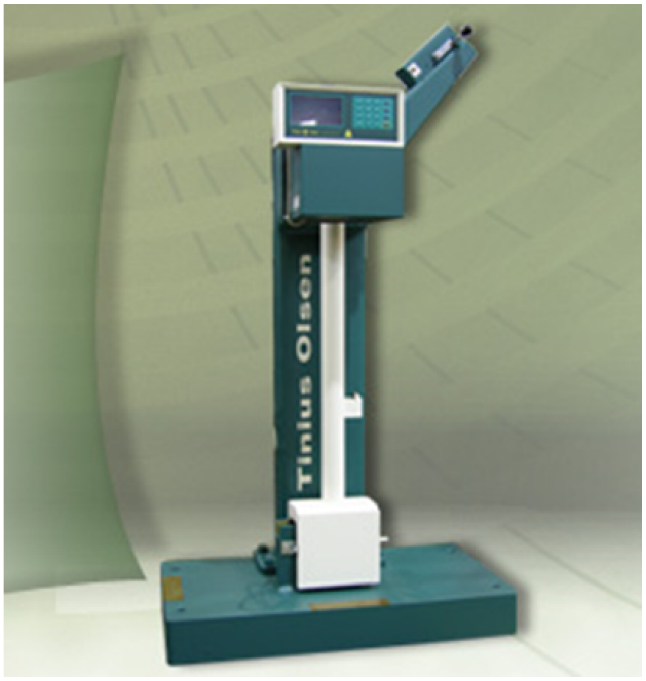


Figure 1: (a) Impact test mechanism
(Image source: Internet)



(b) Impact testing machine
(Image source: Internet)

Dynamic Load is that load which varies with respect to time.

Types of dynamic Load:
(1) Harmonic Load (machine)
(2) Periodic Load (dancing)
(3) Transient Load (walking)
(4) Impact Load (jumping)

Impact or shock loading differs from static and cyclic loads in two respects:
(i) Load is applied rapidly, that is with appreciable speed, and
(ii) Loading is seldom repeated, since failure often occurs on the first application, if it occurs at all.

Types of impact test are as follows:
(a)Bending impact test
(1) Charpy simple beam
(2) Izod cantilever beam
(b) Tensile impact test

In both methods the tested pieces are notched. The intention of the notch is to approximate end use conditions; the notch serves as a stress concentrator. These tests give a

value for toughness, yet their respective values are not directly comparable. This is due to the differences in how they are tested.

The major factors that affect the results of an impact test are:
(a)Velocity (b)Specimen (c)Temperature

Table 1: Features of different types of fracture

Ductile fracture	**Brittle fracture**
A mode of fracture characterized by the slow creak propagation which usually follows a zigzag path alone planes where a maximum resolved shear stress has occurred.	A mode of fracture characterized by the nucleation and rapid propagation of a crack, with little accompanying plastic deformation.
A surface experiencing ductile fracture generally has a dull, fibrous appearance.	Brittle fracture surfaces in crystalline materials can be identified by the shiny, granular appearance.
Example: Fracture of mild steel , aluminum,	Example: Fracture of cast iron, high carbon steel.

Table 2: Effect of angle of notch on energy of rupture of mild steel

Angle of notch (degree)	Sketch of specimen	Charpy impact value
0		22.1
30		24.4
45		23.1
90		25.9
120		41.8
150		66.2
180		63.1

In manufacturing locomotive wheels, coins, connecting rods etc. the components are subjected to impact (shock) loads. These loads are applied suddenly. The stresses induced in these components are many times more than the stress produced by gradual loading. Therefore, impact tests are performed to assess shock absorbing capacity of materials subjected to suddenly applied loads.

Impact tests provide information on the resistance of a material to sudden fracture where a sharp stress rise or flaw is present. In addition to providing information not available from any other simple mechanical test, these tests are quick and inexpensive. The data obtained from such impact test is frequently employed for engineering purposes.

Various standard impact tests are widely employed in which notched specimens are broken by a swinging pendulum. The most common tests of this type are the Charpy V-notch test and the Izod test which are described in ASTM E23, Standard test Methods for notched bar impact testing of metallic materials. Another test method, although not a standard test method, is the tension impact test.

These types of impact tests have given way to testing methods that make use of fracture mechanics. Fracture mechanics allow more sophisticated analysis of materials containing cracks and sharp notches. However, the advantages of fracture mechanics are achieved at the sacrifice of simplicity and economy. Impact tests such as the Charpy, Izod, and tension impact have thus remained popular despite their shortcomings, as they serve a useful purpose in quickly comparing materials and obtaining general information on their behavior.

Many materials, including metals, exhibit marked changes in impact energy with temperature. It is known that there tends to be a region of temperatures over which the impact energy increases rapidly from a lower level that may be relatively constant to an upper level that may also be relatively constant. Such temperature transition behavior is common for metal materials. This temperature dependence for various steel alloys with the same hardness but different carbon contents is graphically shown in Figure 2. This figure shows the impact energy obtained from Charpy V-notch impact specimens as a function of temperature. The temperature transition behavior is of engineering significance since it aids in comparing materials for use at various temperatures. In general, a material should not be severely loaded at temperatures where it has low impact energy.

In charpy test, the specimen is placed as ‘Simply supported beam’ and In Izod test, the specimen is placed as ‘cantilever beam’ (Figure 3). The specimens have V-shaped notch of 45°. U-shaped notch is also common. The notch is located on tension side of specimen during impact loading. Depth of notch is generally taken as t/5 to t/3 where ‘t’ is thickness of the specimen. Table 2 represents typical response of angle of notch on charpy impact strength

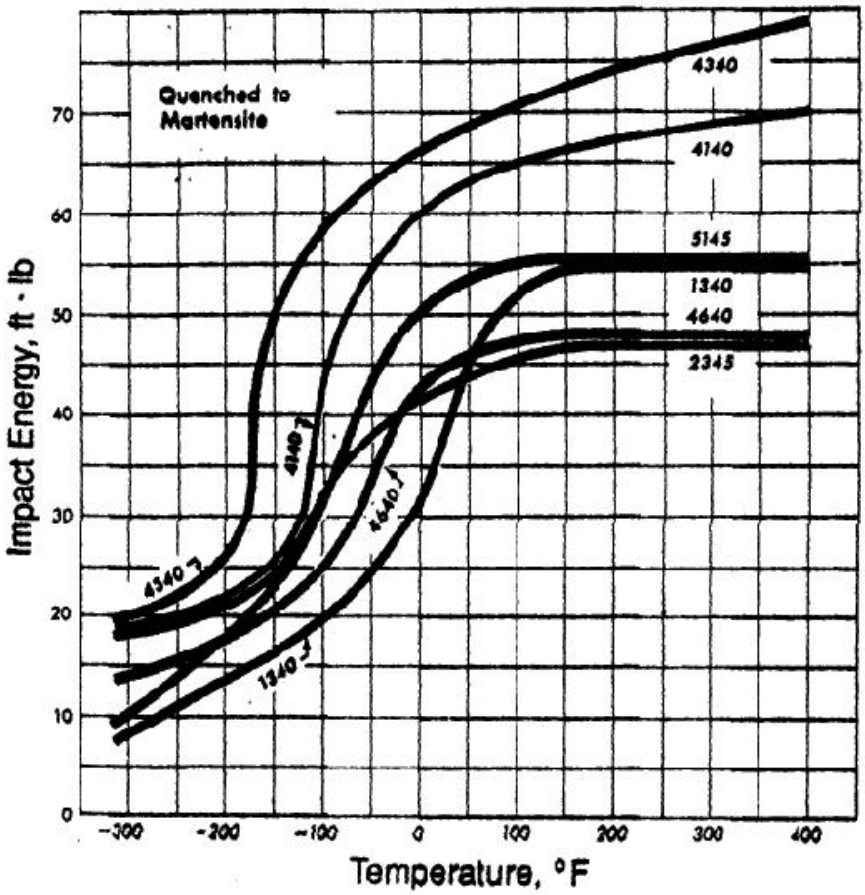


Figure 2: Temperature Dependence of Charpy V-Notch Impact Resistance for Different Alloys Hardened to HRC 34 (N.E. Dowling). (Image source: Internet)

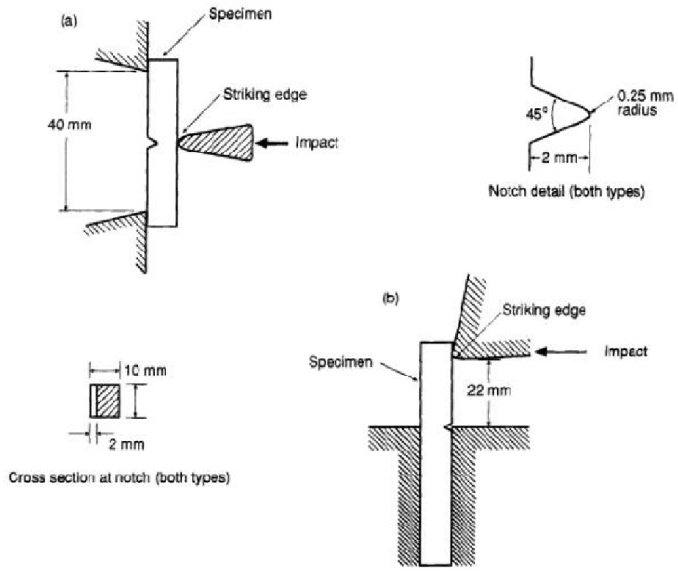


Figure 3: (a) Charpy setup (b) Izod setup (Image source: Internet)

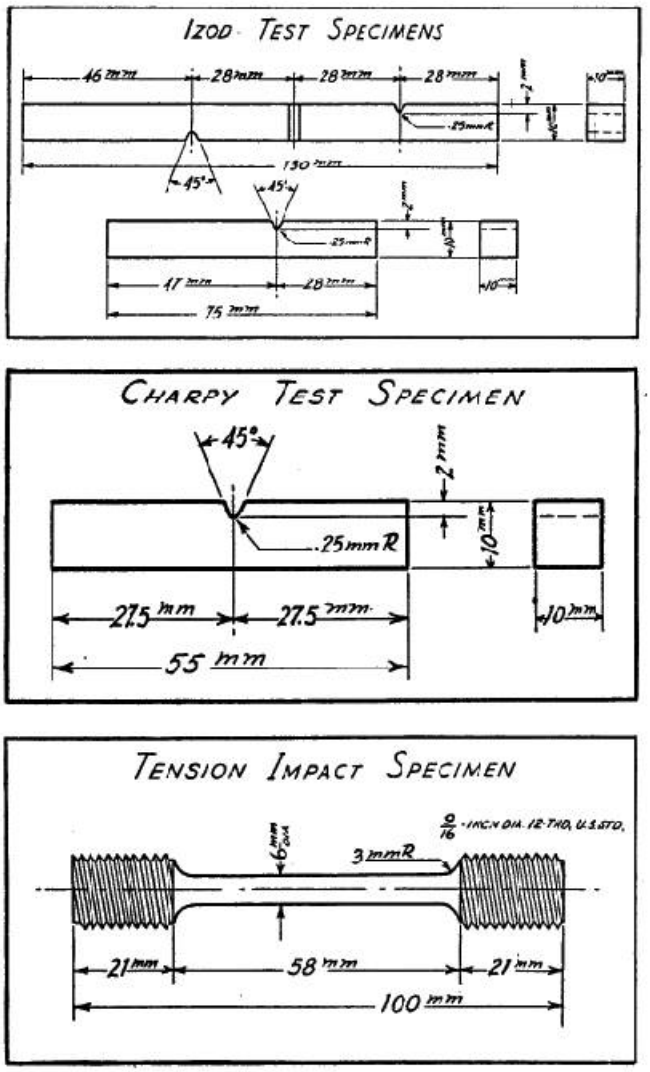


Figure 4: Impact test specimen with specification (Image source: Internet)

7. SPECIFICATION OF MACHINE AND SPECIMEN

Impact testing machine:

Impact capacity = 407.74 joule
Weight of striking hammer = 27.22 kg (60 lb)
Swing radius of hammer = 900.1 mm (35.437 inch)
Angle of hammer before striking = 160°
Striking velocity of hammer = 5.47 m/sec. (17.9 ft/sec.)

Specimen:

Specimen size = (Figure 4)
Type of notch = (Figure 4)

Angle of notch = (Figure 4)
Depth of notch = (Figure 4)

8. PROCEDURE

i) Measure the lateral dimensions of the specimen at full section and at the notch.
ii) Place the specimen in proper position. Set the hammer block at a certain height and then release it.
iii) When the hammer block stops swinging, record the value of absorbed energy displayed on the screen.

9. DATA

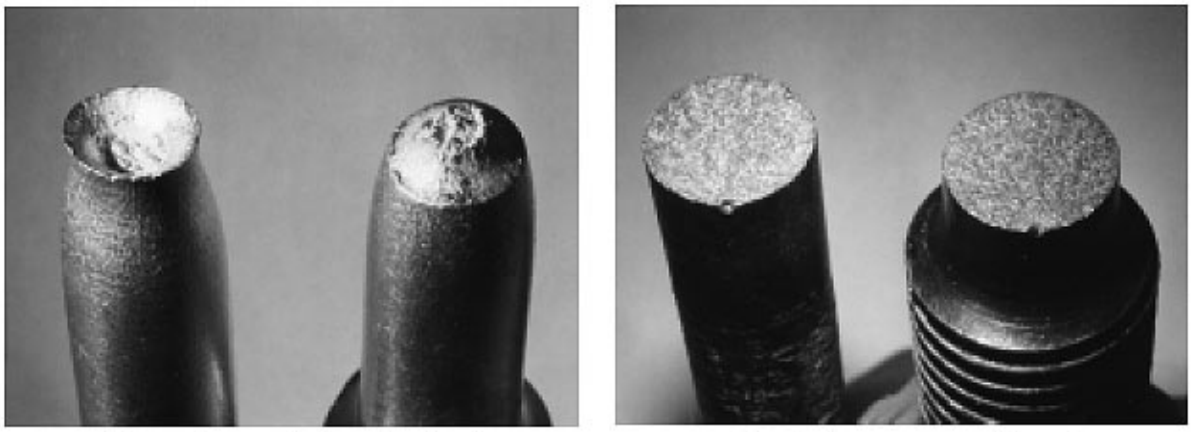
Obs. No.	Type of test	Name of metal	Specimen type	Specimen depth	Specimen width	Depth of notch	Depth at notch	Absorbed Energy, E (J)
1	Charpy							
2	Izod							
3	Tension							

Depth at notch = Specimen depth - Depth of notch
Cross sectional area at notch, A_{Notch} = Depth at notch × Specimen width
Energy required to break the specimen = Absorbed Energy, E
Notch impact strength / Impact toughness, U = Absorb energy / Effective cross section area at notch = E/A_{Notch}

10. FAILURE PATTERNS



Figure 5: Fractured pieces of Charpy Impact specimens



Cup-and-cone fracture in aluminum. Brittle fracture in a mild steel.

Figure 6: Fractured piece of Charpy tension Impact specimens



Figure 7: Fractured piece of Izod(top) and Charpy(bottom) specimens

11. PRECAUTIONS

1. The specimen should be prepared in proper dimensions.
2. Do not stand in front of swinging hammer or releasing hammer.
3. Place the specimen in proper position.

12. GRAPHS

1. Charpy Impact Strength vs. HRB
2. Izod Impact Strength vs. HRB
3. Tension Impact Strength vs. HRB