## BUREAU OF INDIAN STANDARDS

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# भारतीय मानक <br> छंटनी के बाद लौह अयस्क छर्रों की संपीड़न शक्ति का निर्धारण पद्धति 

( आई एस 8604 का प्रथम पुनरीक्षण )

# Draft Indian Standard <br> DETERMINATION OF COMPRESSION STRENGTH OF IRON ORE PELLETS AFTER REDUCTION - METHOD (First Revision of IS 8604) 

ICS 77.100

| Ores and Feed Stock for Iron and Steel Industry | Last date for receipt of comments are <br> Sectional Committee, MTD 13 |
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## FOREWORD

This Indian Standard (First Revision) is to be adopted by Bureau of Indian Standards, after the draft finalized by Ores and Feed Stock for Iron and Steel Industry Sectional Committee had been approved by the Metallurgical Engineering Division Council.

The standard was first published in 1977. This revision has been brought out to bring the standard in the latest style and format of the Indian Standards.

In addition, the following changes have been made:
a) Scope clause has been modified;
b) References clause has been included;
c) In clause 3 , editorial change has been made,
d) In clause 4, apparatus clause has been modified;
e) In clause 4.2, speed of the compressive platen is modified from ' $5 \mathrm{~mm} / \mathrm{min}$ ' to 'between $10 \mathrm{~mm} / \mathrm{min}$ and $20 \mathrm{~mm} / \mathrm{min}$ ';
f) In clause 4.3, applied load is modified from ' 200 kg ' to 'atleast 10 kN ';
g) In clause 5, sampling clause has been modified;
h) Procedure clause has been modified;
i) 2 figures to measure crushing strength were indicated; and
j) Test report clause has been modified.

In recent years there has been a wide interest in assessing the quality of blast furnace burden during reduction and, as such, the conditions are being laid down to ensure requisite characteristics in the quality of the raw materials. This standard is one of such standards and relates to determination of crushing strength of iron ore pellets after reduction.

In the formulation of this standard, considerable assistance has been derived from the following publication ISO 4700:2015 - Iron ore pellets for blast furnace and direct reduction feedstocks - Determination of the crushing strength

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS $2: 2022$ 'Rules for rounding off numerical values (second revision)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

## Draft Indian Standard <br> DETERMINATION OF COMPRESSION STRENGTH OF IRON ORE PELLETS AFTER REDUCTION - METHOD

(First Revision of IS 8604)

## 1 SCOPE

1.1 This standard prescribes the method for measuring the crushing strength of iron ore pellets after reduction.
1.2 The amount of reduction shall be determined as per reducibility test conducted in accordance with IS 8167.

## 2 REFERENCES

The following Indian Standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

| IS No. | Title |
| :--- | :--- |
| IS 8167:1989 | Method for determination of reducibility index of iron ore oxides, lumps ore, <br> sinter and pillets (first revision) |
| IS 9101:1979 | Methods of sampling iron ore pellets |

## 3 SUMMARY OF METHOD

Individual reduced iron ore pellets are placed in a compressive testing machine and a load is applied at constant speed of compressive platen until the pellet breaks. The maximum pressure applied until the pellet breaks is recorded in kilograms. The crushing strength is calculated as the arithmetic mean of all the measurements obtained.

## 4 APPARATUS

### 4.1 General

The test apparatus shall comprise the following:
a) loading unit;
b) load transmission system;
c) load indicator or recorder; and
d) other lab equipment (oven, tools \& PPEs).

### 4.2 Loading Unit

Loading unit is formed by two compressive flat platens made of steel, installed in mutual parallel planes. The surface of the platens that will be in contact with the sample shall be made of surface hardened steel. A device capable of setting the speed of the compressive platen between $10 \mathrm{~mm} / \mathrm{min}$ and $20 \mathrm{~mm} / \mathrm{min}$ over the entire test period shall be used.

NOTE - If the platen speed is not constant during the test cycle, results may differ depending upon the test machine used. More uniform results may be obtained using a test machine that applies a constant load increase.

### 4.3 Load Transmission System

Load transmission system which shall be either a load cell or a lever. The capacity of the load cell for transmission of the applied load to the indicating unit shall be atleast 10 kN .

### 4.4 Load Indicator or Recorder

Load indicator or recorder which shall be either an electric indicator (digital read-out device, recording chart, meter with needle rider or other suitable device) for the load-cell type, or a mechanical indicator (gauge equipped with a needle rider or other suitable device) for the lever type. While using a load cell, the chart-recorder pen-response time shall be 1 second or less for a full-scale deflection. The minimum graduation shall be $1 / 100$ of the full scale. The compression device shall be calibrated regularly.

## 5 Sampling, Sample Preparation and Preparation of Test Portions

### 5.1 Sampling and Sample Preparation

Sampling of a lot and preparation of a test sample shall be in accordance with IS 9101. The size range for pellets shall be $-12.5 \mathrm{~mm}+10.0 \mathrm{~mm}$. A test sample of at least 1 kg , on a dry basis of sized pellets shall be obtained. Oven-dry the test sample to constant mass at $105^{\circ} \mathrm{C} \pm$ $5^{\circ} \mathrm{C}$ and cool it to room temperature before testing.

NOTE - Constant mass is achieved when the difference in mass between two subsequent measurements becomes less than $0.05 \%$ of the initial mass of the test sample.

### 5.2 Preparation of Test Portions

One test portion comprising at least 60 pellets, as agreed upon at the time of order, shall be taken from the test sample by random selection.

NOTE - A method of determining the exact number of pellets to obtain a specific precision in the test results is to use the following equation:

$$
n=\left(\frac{2 \sigma}{\beta}\right)^{2}
$$

where,
$n$ is the number of pellets;
$\sigma$ is the standard deviation, derived from several experiments; and
$\beta$ is the required precision, for $95 \%$ confidence levels
NOTE - The sample of pellets selected for the final compression strength tests after reduction shall be whole pellets (excluding broken and chipped pellets) available from reducibility tests conducted in accordance with IS 8167.

## 6 PROCEDURE

### 6.1 Number of Determinations for the Test

Carry out the test on 60 or more single pellets (see 5.2).

### 6.2 Load Application

Place a test piece (single pellet) at the approximate centre of the surface-hardened portion of the lower platen. Apply the load at a constant platen speed between $10 \mathrm{~mm} / \mathrm{min}$ and $20 \mathrm{~mm} / \mathrm{min}$ throughout the test period.

The test is complete when
a) Either the load falls to a value of $50 \%$ or more of the maximum load recorded (see Fig. 1); or
b) The platen gap has reduced to $50 \%$ of the initial mean test-piece diameter (see Fig. 2).

In either case, the crushing strength is the maximum load attained in the test
Key
X contraction, \%
Y load
1 1st peak
2 2nd peak
3 3rd peak
4 stop
5 strength


FIG. 1 - MEASUREMENT OF CRUSHING STRENGTH AS EXPLAINED IN CASE 1 IN THE PROCEDURE

Key
X contraction, \%
Y load
1 strength
2 stop


## FIG. 2 - MEASUREMENT OF CRUSHING STRENGTH AS EXPLAINED IN CASE 2 IN THE PROCEDURE

## 7 EXPRESSION OF RESULT

The average value of the above maximum load of compression of all the pellets tested shall be reported. Also, the number of pellets tested individual crushing strengths, their size range and the maximum and minimum values of the crushing strength shall be reported.

## 8 TEST REPORT

The test report shall include the following information:
a) A reference to this Indian Standard, i.e. IS 8604 : 2023;
b) All details necessary for the identification of the sample;
c) The name and address of the test laboratory;
d) The date of the test;
e) The date of the test report;
f) The signature of the person responsible for the test;
g) Details of any operation and any test conditions not specified in this international standard or regarded as optional, as well as any incident which may have had an influence on the results;
h) The crushing strength, CS;
j) The standard deviation of the measurements;
k) The size distribution of the sample for physical testing and the size range(s) of the pellets;

1) A table of the relative frequency, in percent, of the measurements, classified at 500 N intervals;
m) The number of pellets in each specified size range tested; and
n) The platen speed used, expressed in $\mathrm{mm} / \mathrm{min}$.
