



Designation: **E382 – 12 E382 – 20**

Standard Test Method for Determination of Crushing Strength of Iron Ore Pellets and Direct-Reduced Iron¹

This standard is issued under the fixed designation E382; 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.

1. Scope

1.1 This test method describes a method for determining the crushing strength of fired iron ore pellets. ~~Cylindrical agglomerates, briquettes, and reduced pellets~~ pellets and direct-reduced iron. Cylindrical agglomerates and briquettes are not covered by this test method.

1.2 The values as stated in SI units are to be regarded as the standards. The values in parentheses are given for information only.

1.3 Results given by this test should be similar to those from ISO 4700 (see [Appendix X1](#) for details).

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate ~~safety~~ safety, health, and ~~health~~ environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*²

[E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)

[E50 Practices for Apparatus, Reagents, and Safety Considerations for Chemical Analysis of Metals, Ores, and Related Materials](#)

[E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process](#)

[E135 Terminology Relating to Analytical Chemistry for Metals, Ores, and Related Materials](#)

[E389 Test Method for Particle Size or Screen Analysis at No. 4 \(4.75-mm\) Sieve and Coarser for Metal-Bearing Ores and Related Materials](#) <https://standards.iteh.ai/catalog/standards/sist/b53cc8cb-7faf-4399-89df-7c005715fc69/astm-e382-20>

[E877 Practice for Sampling and Sample Preparation of Iron Ores and Related Materials for Determination of Chemical Composition and Physical Properties](#)

2.2 *ISO Standards:*³

[ISO 4700 Iron ore pellets for blast furnace and direct reduction feedstocks—Determination of the crushing strength](#)

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, refer to Terminology [E135](#).

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *crushing strength, n*—average compressive load needed to break the pellets in the test sample completely.

4. Summary of Test Method

4.1 A load is applied on a single pellet at a specified speed of the compressive platen until the pellet is broken. This procedure is repeated on all pellets of the test sample.

¹ This test method is under the jurisdiction of ASTM Committee [E01](#) on Analytical Chemistry for Metals, Ores, and Related Materials and is the direct responsibility of Subcommittee [E01.02](#) on Ores, Concentrates, and Related Metallurgical Materials.

Current edition approved ~~June 1, 2012~~ April 15, 2020. Published ~~July 2012~~ August 2020. Originally approved in 1968. Last previous edition approved in ~~2007~~ 2012 as [E382 – 07](#). E382 – 12. DOI: [10.1520/E0382-12-10.1520/E0382-20](https://doi.org/10.1520/E0382-12-10.1520/E0382-20).

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.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

4.2 This test method assumes that individual samples are essentially brittle; that is, at some level of applied force, the sample will break into two or more pieces. There are circumstances, however, when pellets are more ductile (for example, green pellets that have not yet been fired), and the sample may deform and not break. This test method does not apply to such pellets; refer to ISO 4700 for analytical methods to deal with ductile samples.

5. Significance and Use

5.1 The crushing strength aids the pellet producer in the determination of quality problems associated with the production of pellets.

5.2 The crushing strength is often used by the pellet consumer as a quality indicator for performance in the blast furnace and gas-based direct reduction plants.

6. Apparatus

6.1 Loading ~~Unit~~:Unit

6.1.1 The loading capacity shall be ~~1000 kgf~~ 981 daN or more (~~1000 kgf = 9.806 kN~~); (980.7 daN = 1000 kg_f).

6.1.2 The compressive platens shall be installed in parallel planes. The surface of the platens that are in contact with the sample shall be made of surface-hardened steel.

6.1.3 A device for setting the speed of the compressive platen at 0.25 mm/s \pm 0.08 mm/s over the entire test period shall be used.

NOTE 1—If the platen speed is not constant during the test cycle, results may differ depending upon the test machine used.

6.2 *Indicating Unit*, consists of a load transfer device and a load indicator.

6.2.1 Load Transfer ~~Device~~:Device

6.2.1.1 The transfer of the applied load to the load indicator shall be by a load cell or by a lever.

6.2.1.2 The capacity of the load cell shall be at least ~~1000 kg~~ 981 daN.

6.2.2 Load ~~Indicator~~:Indicator

6.2.2.1 The applied load shall be indicated either by an electric indicator (recording chart, meter with needle rider, or other suitable device) for the load cell type, or by a mechanical indicator (gauge equipped with needle rider or other suitable device) for the lever type, or electronically.

6.2.2.2 When using a load cell, the chart recorder response time shall be 1.0 s or less for a full-scale deflection.

6.2.2.3 The minimum graduation shall be 1/100 of the full scale.

6.2.2.4 The testing machine shall be calibrated periodically.

6.3 *Sieves*—Square mesh sieves 12.5 mm ($\frac{1}{2}$ in.) and ~~9.5 mm~~ (in.) and 9.5 mm ($\frac{3}{8}$ in.) are recommended; however, others may be used in agreement between parties.

7. Hazards

7.1 For precautions to be observed in this method, refer to Practice E50.

8. Sampling and Sample Preparation

8.1 The test sample for determining the crushing strength shall be obtained at random by riffle division of a sample ~~taken~~ and prepared in accordance with Practice E877.

8.2 Sixty or more pellets, or a number agreed upon between the parties concerned, shall be tested for each sample.

8.3 The size range of the test sample shall be between 9.5 mm and 12.5 mm (as determined in Test Method E389) or any size range as agreed upon between the parties concerned.

9. Procedure

9.1 Place a single pellet of the sample at the approximate center of the surface-hardened portion of the lower platen.

9.2 Apply the load at a constant rate of 0.25 mm/s \pm 0.08 mm/s throughout the test period.

9.3 Record the maximum load at which each test piece breaks completely.

10. Report

10.1 The test report shall include the following:

10.1.1 Crushing strength, expressed as the mean value, in ~~kilogram-force~~, decaNewtons (daN), of all measurements.

10.1.2 Standard deviation of the measurements.

10.1.3 Size range of the pellets tested.

10.1.4 Number of pellets tested.

10.2 Rounding of test results obtained using this test method shall be performed in accordance with Practice E29, Rounding Methods, unless an alternative rounding method is specified by the customer or by an applicable material specification.

11. Precision and Bias

11.1 *Precision*—The precision of this test method is dependent on the number of pellets selected for testing. The user is advised to use the proper equation from Practice E122 to calculate the number of pellets to select for testing in order to achieve the desired precision.

11.2 *Bias*—No information can be presented on the bias of this test method since no material having an accepted reference value is available.

12. Keywords

12.1 crushing strength; DRI; iron ore; pellets

APPENDIX

(Nonmandatory Information)

X1. COMPARISON BETWEEN THIS STANDARD AND ISO 4700

X1.1 The equipment used, experimental method, and results for this standard and the comparable standard are listed in the table below. One can see that all parameters are very close; essentially, the English-unit parameters used in the ASTM standard were rounded up to the even-numbered metric equivalent for the ISO standard.

TABLE X1.1 Table of Comparison

Applicable to	ASTM E382 Indurated Iron Ore Pellets and DRI	ISO 4700 Hot Bonded Pellets
Sample Feed		
size range (mm) pellets	9.5 to 12.5 mm or agreed upon	10 to 12.5 mm
overall sample mass	not specified	> 1 kg
# of random pellets	60 or number agreed upon see E122 for # to achieve desired precision	60 or more equation for precision supplied
pretreatment	not specified	dried at 105 ± 5°C (‘to constant mass’)
Equipment		
speed	0.25 ± 0.08 mm/sec [15 mm/min]	capable of 10–20 mm/min
load cell capacity (minimum)	981 daN (1000 kg _f)	1000 daN
load indicator	electric or mechanical, mentions electronic	same
chart recorder response	1.0 sec or less for full-scale deflection min gradation 1/100 of full scale periodic calibration	1.0 sec or less for full-scale min gradation 1/100 of full scale regular checking of equipment
Test Termination	until breaks completely	The test is complete when: <i>either</i> the load falls to a value of 50 % or more of the maximum load recorded, <i>or</i> the platen gap has reduced to 50 % of the initial mean test-piece diameter
Results	mean, in daN reference E29 for round-off	arithmetic mean, in daN report to one decimal place
Report	size distribution, size range, # of pellets tested mean value of all pellets tested	size distribution, size range of pellets, # of pellets per range relative frequency of results, at 50 daN intervals speed used
Bias	no info on bias can be presented	recommends reference material