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Indian Standard

EARTH-MOVING MACHINERY — VOLUMETRIC RATINGS FOR HOE-TYPE AND GRAB-TYPE BUCKETS OF HYDRAULIC EXCAVATORS AND BACKHOE LOADERS

ICS 53.100
NATIONAL FOREWORD

This Indian Standard which is identical with ISO 7451 : 2007 'Earth-moving machinery — Volumetric ratings for hoe-type and grab-type buckets of hydraulic excavators and backhoe loaders' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Material Handling Systems and Equipment Sectional Committee and approval of the Mechanical Engineering Division Council.

This standard supersedes IS 12192 : 1993 'Earth-moving machinery — Volumetric ratings for hoe-type and grab-type buckets of hydraulic excavators and backhoe loaders'.

The text of ISO Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

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 : 1960 'Rules for rounding off numerical values (revised)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.
1  Scope

This International Standard specifies a method for estimating the volume of materials which a hoe-type or grab-type bucket of a hydraulic excavator or backhoe loader can normally contain. The volume assessments are based on the internal dimensions of the bucket and on the representative volumes at the top of the bucket.

The method employs the technique of dividing the complex shape of the material in the bucket into simple geometric shapes.

This method of assessment is intended to provide a conventional means of comparing bucket capacities. It is not intended to be used to define true capacities.

This International Standard is not applicable to buckets of cable excavators.

2  Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1  hydraulic excavator

self-propelled machine on crawlers, wheels or legs, having an upper structure capable of a 360° swing with mounted equipment and which is primarily designed for excavating with a bucket, without movement of the undercarriage during the work cycle

NOTE 1  An excavator work cycle normally comprises excavating, elevating, swinging and discharging of material.

NOTE 2  An excavator can also be used for object or material handling/transportation.

NOTE 3  For hoe-type bucket components, see Figure 2.

NOTE 4  Adapted from ISO 6165:2006.

2.2  backhoe loader

self-propelled crawler or wheeled machine having a main frame designed to carry both front-mounted equipment and rear-mounted backhoe equipment (normally with outriggers or stabilizers)

NOTE 1  When used in the backhoe mode, the machine is stationary and normally digs below ground level.

NOTE 2  When used in the loader mode (bucket use), the machine loads through forward motion.

NOTE 3  A backhoe work cycle normally comprises excavating, elevating, swinging and discharging of material. A loader work cycle normally comprises filling, elevating, transporting and discharging of material.

[ISO 6165:2006, definition 4.3]
2.3  
**X** dimension  
\[X\]  
distance between the cutting edge (or face) of the leading edge and the contact edge of the strike plane on the backsheet of a hoe-type bucket  

See Figure 3.

2.4  
**Y** dimension  
\[Y\]  
maximum depth of the indentation, perpendicular to the strike plane, on a hoe-type bucket  

See Figure 4.

2.5  
**strike plane**  
(hoe-type bucket) horizontal plane extending over the width of the bucket from the cutting edge or face of the leading edge to the contact edge between the horizontal plane and the backsheet

See Figure 3.

2.6  
**strike plane**  
(grab-type bucket) horizontal plane extending over the width of the bucket and passing through the top edges of the backbands

See Figure 12.

2.7  
**strike surface**  
cylindrical surface of radius \(R\) on the hoe-type bucket, which traverses the edges of the strike plane (face of the leading edge and contact edge of the backsheet) and which is tangential to a plane parallel to the strike plane and at a distance \(Y\)

See Figure 4.

2.8  
**surface area**  
\(S_1\)  
area of a hoe-type bucket’s side internal surface bordered by the strike plane

See Figure 8.

2.9  
**surface area**  
\(S_2\)  
area of a hoe-type bucket’s side internal surface bordered by the strike surface

See Figure 9.

2.10  
**surface area**  
\(S_3\)  
area of a grab-type bucket’s side internal surface bordered by the strike plane

See Figure 12.
2.11 surface area
\( S_4 \)
area of a grab-type bucket's side internal surface used for calculating top volume

See Figure 13.

2.12 struck volume
\( V_s \)
volume lying beneath the strike plane or the strike surface

2.13 top volume
\( V_t \)
volume of material situated above the strike plane

2.14 displaced volume
\( V_m \)
volume of material inside the grab-type bucket displaced by the operating mechanism or structure

2.15 volumetric rating
\( V_r \)
volume determined by the method detailed in this International Standard, providing a means of comparing the capacities of buckets

2.16 \( W \) dimension
\( W \)
internal width at the barycentre of the bucket section

See Figures 8 and 9.

2.17 \( W_4 \) dimension
\( W_4 \)
mean between the inside width of the backsheet level with the edge in contact with the strike plane and the inside width of the leading edge increased by twice the thickness of the sides

See Figures 10 and 11.

3 Restrictions and limitations for hoe-type buckets

The effect of the volumes of projecting parts such as tooth supports, removable tips, side height extensions, side cutters, and holes or gussets shall be ignored.

When calculating the volume of a hoe-type bucket, measurements shall include shielding of the leading edge and the true indentation (see Figure 5).

The \( V \) values of the leading edge shall be included for an \( h \) value corresponding to the barycentre of the projecting surface (see Figure 6), taking into account the true indentation.

The bucket shall be positioned such that the plane defined by the cutting edge (or face) of the leading edge and the contact edge of the backsheet is horizontal (see Figure 7).
4 Calculation

4.1 Hoe-type bucket

4.1.1 Struck volume, \( V_s \)

The struck volume is calculated as follows.

When the ratio \( X/Y \geq 12 \), the strike plane is used, and then

\[
V_s = S_1 \cdot W_1
\]

See Figure 8.

When the ratio \( X/Y < 12 \), the strike surface is used. This provides a reduction of the struck volume so as to take the indentation into account. Then

\[
V_s = S_2 \cdot W_2 \left( 1 - \frac{Y}{X} \right)
\]

See Figure 9.

4.1.2 Top volume, \( V_t \)

The \( Y \) indentation shall not be taken into consideration for the calculation. The \( W_4 \) dimension (see Figure 10) shall be included for the calculation.

The top volume is calculated as follows (see Figure 11).

- For narrow buckets, where \( X \geq W_4 \):

\[
V_t = W_4^3/6 + \left( W_4^2/4 \right) \cdot (X - W_4)
\]

- For wide buckets, where \( X < W_4 \):

\[
V_t = X^3/6 + \left( X^2/4 \right) \cdot (W_4 - X)
\]

4.2 Grab-type bucket

4.2.1 Struck volume, \( V_s \)

The struck volume is calculated as follows.

\[
V_s = S_3 \cdot W_5
\]

See Figure 12.

4.2.2 Top volume, \( V_t \)

If the operating mechanism of the grab-type bucket is included in the top volume \( (V_t) \), the top volume shall be decreased by the volume of the mechanism \( (V_m) \):

\[
V_t = S_4 \cdot W_6 - V_m
\]

See Figure 13.
5 Expression of volumetric rating

5.1 Volumetric rating of hoe- or grab-type bucket

The sum resulting from the volume of the bucket and of the top is calculated as follows:

\[ V_r = V_s + V_t \]

The volumetric rating shall be expressed in cubic metres or in litres and published as a rated capacity in accordance with this International Standard.

5.2 Designation of commercial capacity

The designation of the commercial capacity shall be within ±3 % of the calculated value.

Figure 1 — Hoe-type bucket — Hydraulic excavator and backhoe loader

Key

1 bucket
Figure 2 — Hoe-type bucket components
\[ \frac{X}{Y} \geq 12 \]

**Key**
- \(X\) \(X\) dimension
- \(Y\) \(Y\) dimension
- 1 strike plane

**Figure 3 — Location of \(X\) dimension**

\[ R = \frac{X}{2Y} + \frac{X^2}{8Y} \]

**Key**
- \(X\) \(X\) dimension
- \(Y\) \(Y\) dimension
- \(R\) radius of cylindrical surface
- 1 strike plane
- 2 strike surface

**Figure 4 — Location of \(Y\) dimension**
Key

$X$  $X$-dimension
$Y$  $Y$-dimension
1 strike plane
2 shielding of leading edge

Figure 5 — Relationship between shielding of leading edge and strike plane

Key
1 strike plane
2 barycentre of hatched surface

a With shields.
b Without shields.

Figure 6 — Effect of leading edge shape on $h$ value
Key
1 strike plane
2 backsheat
3 cutting edge or face of leading edge or shielding of leading edge

Figure 7 — Establishment of bucket position relative to horizontal plane

Key
$W_1$ $W'$ dimension
1 surface area $S_1$
2 strike plane
3 barycentre of $S_1$

Figure 8 — Establishment of $W'$ dimension when $X/Y \geq 12$
Key

$W_2$  $W$ dimension
1  surface area $S_2$
2  strike surface
3  barycentre of $S_2$

Figure 9 — Establishment of $W$ dimension when $X/Y < 12$

$$W_4 = \left( \frac{L_1 + L_2}{2} \right) + 2E$$

Key

$L_1$  backsheet width
$L_2$  inside width of blade
$E$  thickness of side plate
$X$  $X$ dimension

Figure 10 — Establishment of $W_4$ dimension
**Figure 11** — Geometric representation of top volume, $V_t$, for narrow and wide buckets

**Key**

- $X$ : $X$ dimension
- $W_4$ : $W_4$ dimension

**Figure 12** — Establishment of struck volume, $V_s$, for grab-type buckets

**Key**

- $W_5$ : $W$ dimension
- 1 : strike plane
- 2 : surface area $S_3$
Figure 13 — Establishment of top volume, $V_t$, for grab-type buckets

**Key**

- $V_m$: displaced volume
- $V_t$: top volume
- $W_s$: H’ dimension
- 1: side plate
- 2: surface area $S_4$
Bibliography

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Telephones: 2323 0131, 2323 3375, 2323 9402  Website: www.bis.org.in

Regional Offices:
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg
          NEW DELHI 110002
          | 2323 7617, 2323 3841
Eastern : 1/14 C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi
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          | 2337 8499, 2337 8561, 2337 8626, 2337 9120
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