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Earth-moving machinery — Volumetric ratings for hoe-type and grab-type buckets of hydraulic excavators and backhoe loaders

Engins de terrassement — Évaluations volumétriques des godets travaillant en rétro et des bennes preneuses de pelles hydrauliques et de chargeuses-pelleteuses

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 7451 was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 1, *Test methods relating to machine performance*.

This third edition cancels and replaces the second edition (ISO 7451:1997), which has been technically revised. It also incorporates the Technical Corrigendum ISO 7451:1997/Cor.1:1998.

Earth-moving machinery — Volumetric ratings for hoe-type and grab-type buckets of hydraulic excavators and backhoe loaders

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 $X/Y \geqslant 12$, 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

$$V_s = S_2 \cdot W_2 \left(1 - Y/X\right)$$

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 $X \geqslant W_4$:

$$V_t = W_4{}^3/6 + \left(W_4{}^2/4\right) \cdot \left(X - W_4\right)$$

— For wide buckets, where $X < W_4$:

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

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

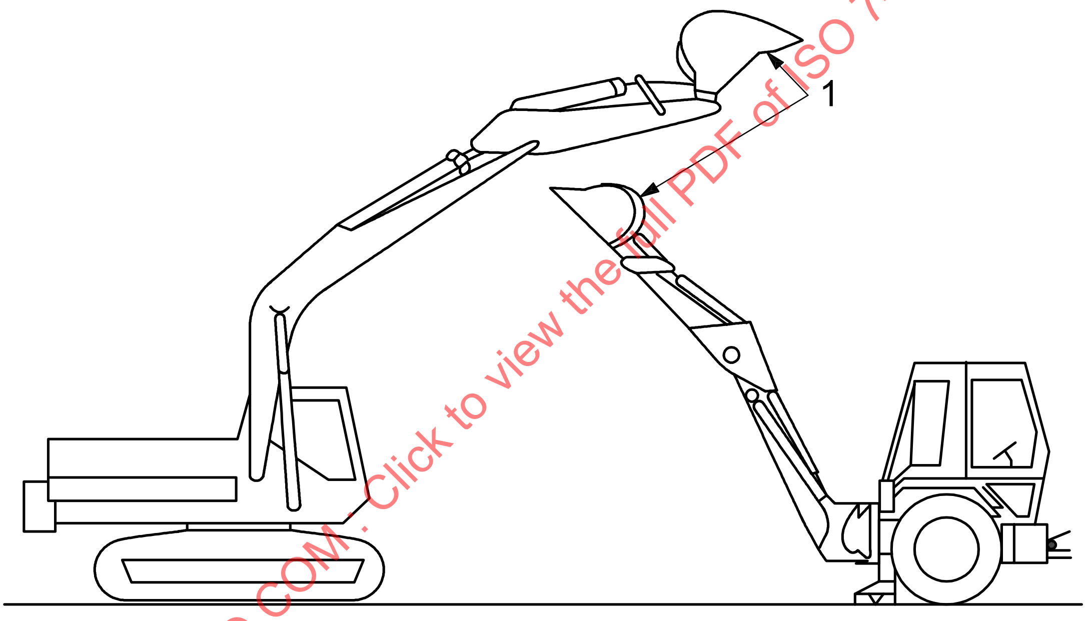
The sum resulting from the volume of the bucket and of the top is calculated as follows:

$$V_r = V_s + V_t$$

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

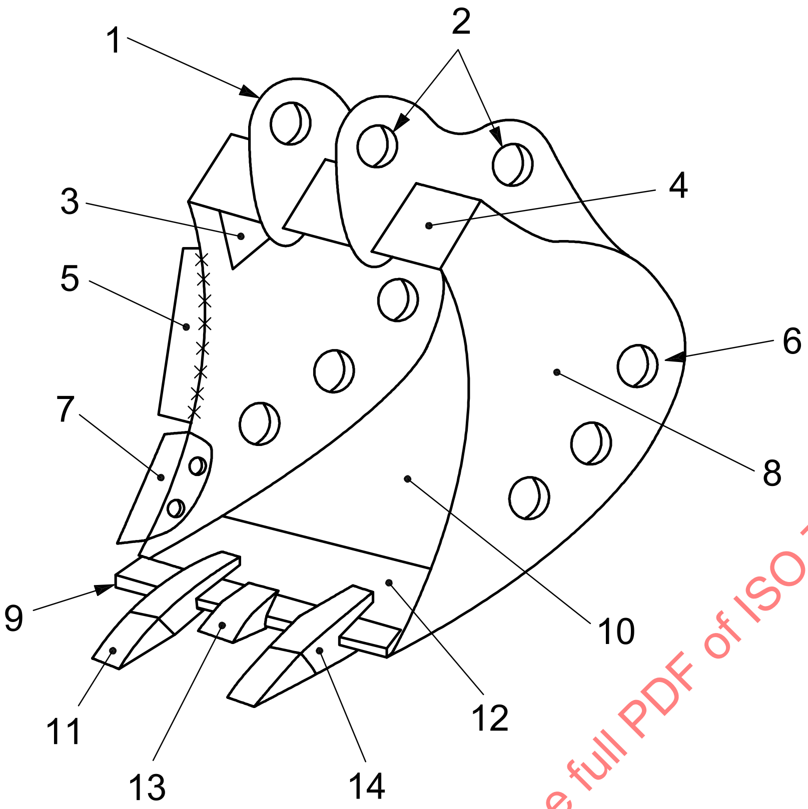
The designation of the commercial capacity shall be within ± 3 % of the calculated value.



Key

1 bucket

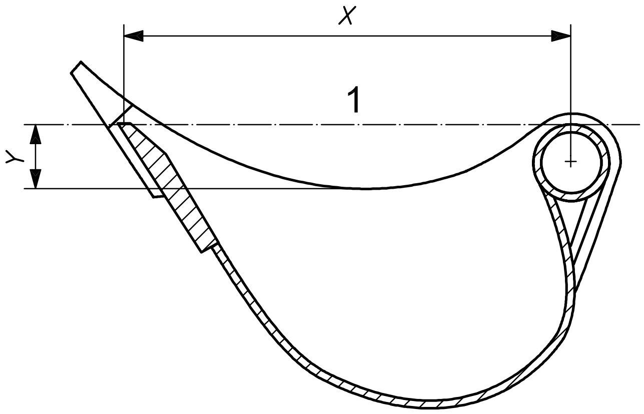
Figure 1 — Hoe-type bucket — Hydraulic excavator and backhoe loader



Key

1 attachment bracket
2 foot pins
3 gusset
4 backsheet or beam
5 side height extension
6 holes
7 side cutter
8 cutting sidewall
9 cutting edge or face
10 bottom plate or bottom sheet
11 removable tooth
12 leading edge
13 shield
14 tooth adaptor

Figure 2 — Hoe-type bucket components



$$\frac{X}{Y} \geqslant 12$$

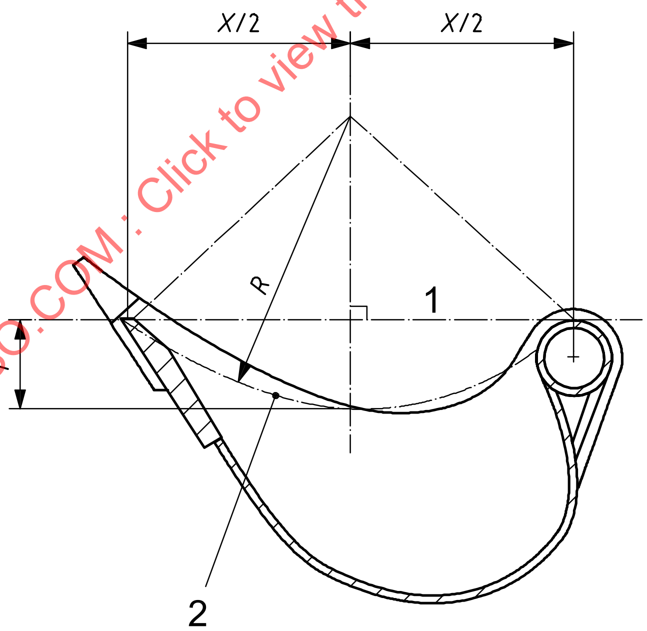
Key

X   *X* dimension

Y   *Y* dimension

1   strike plane

Figure 3 — Location of *X* dimension



$$R = \frac{1}{2}Y + \frac{X^2}{8Y}$$

Key

X   *X* dimension

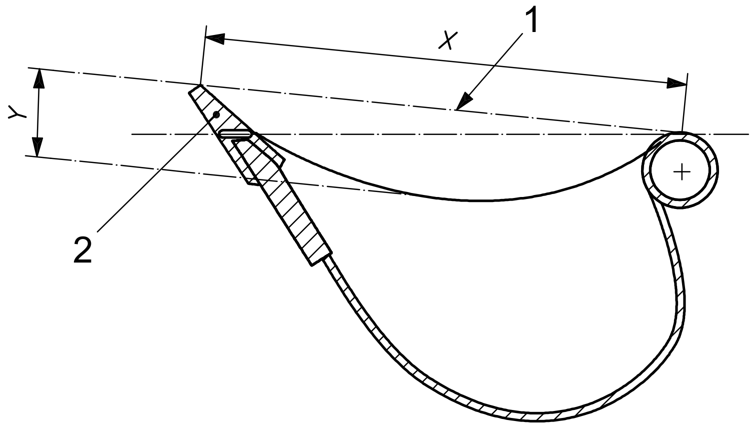
Y   *Y* dimension

R   radius of cylindrical surface

1   strike plane

2   strike surface

Figure 4 — Location of *Y* dimension



Key

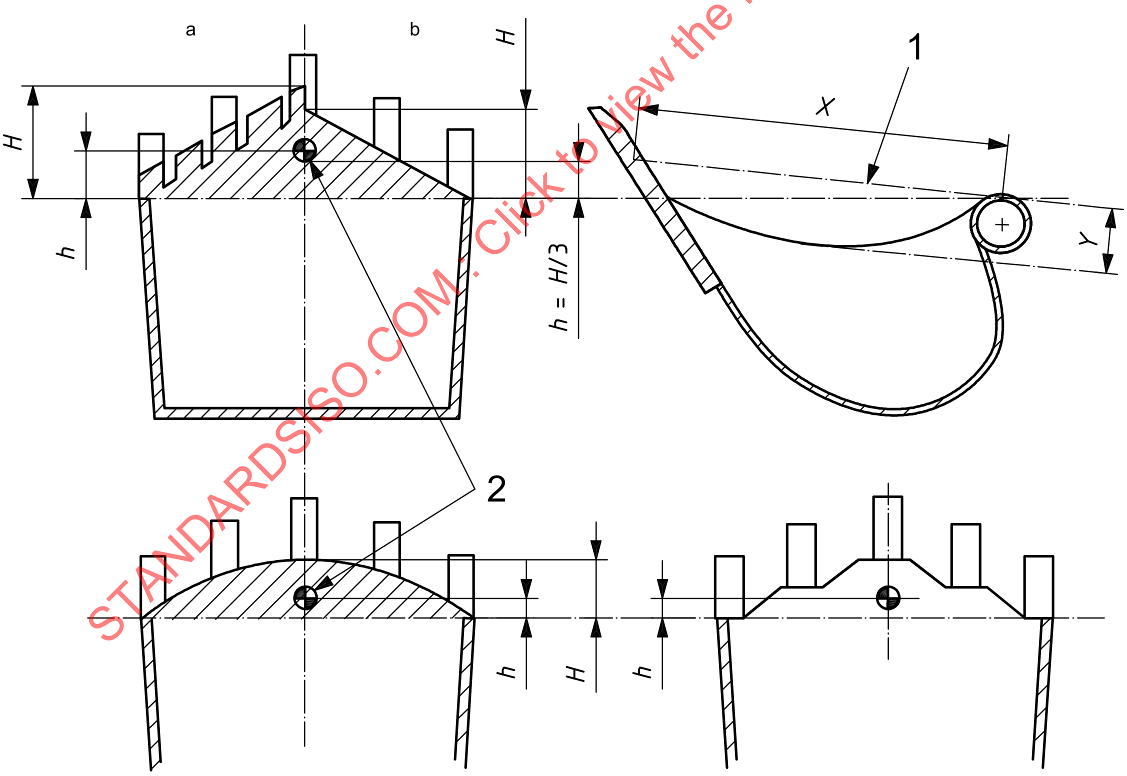
X *X* dimension

Y *Y* dimension

1 strike plane

2 shielding of leading edge

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



Key

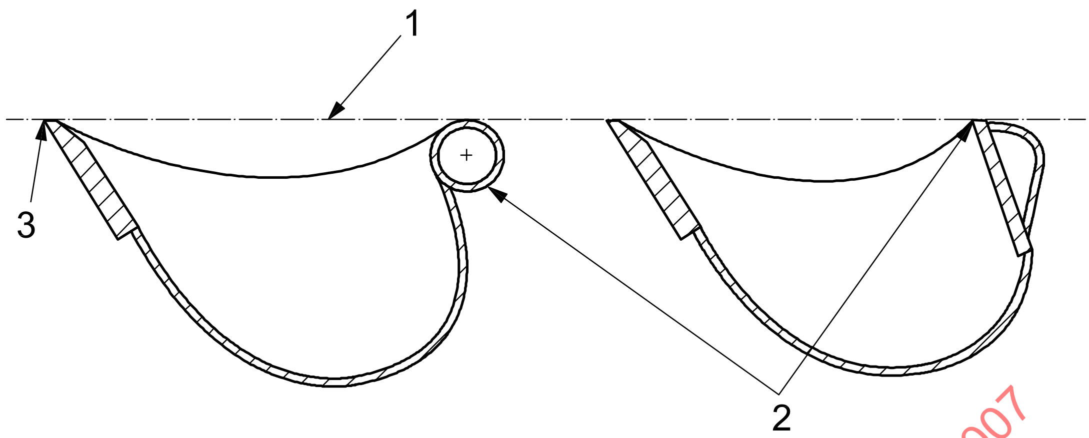
1 strike plane

2 barycentre of hatched surface

a With shields.

b Without shields.

Figure 6 — Effect of leading edge shape on *h* value



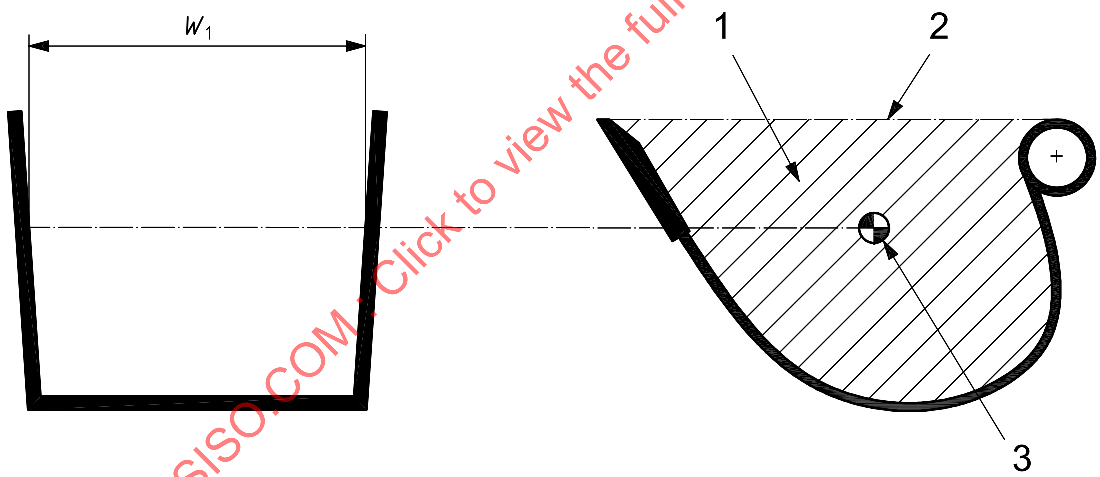
Key

1 strike plane

2 backsheet

3 cutting edge or face of leading edge or shielding of leading edge

Figure 7 — Establishment of bucket position relative to horizontal plane



Key

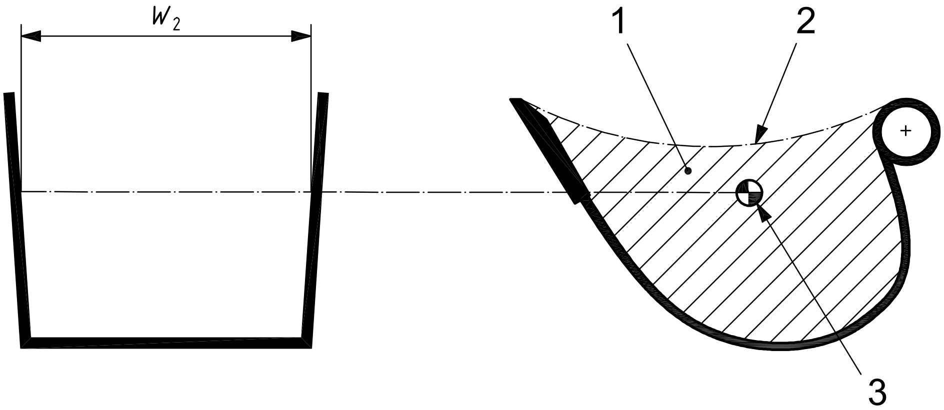
W_1 W dimension

1 surface area S_1

2 strike plane

3 barycentre of S_1

Figure 8 — Establishment of *W* dimension when $X/Y \geqslant 12$



Key

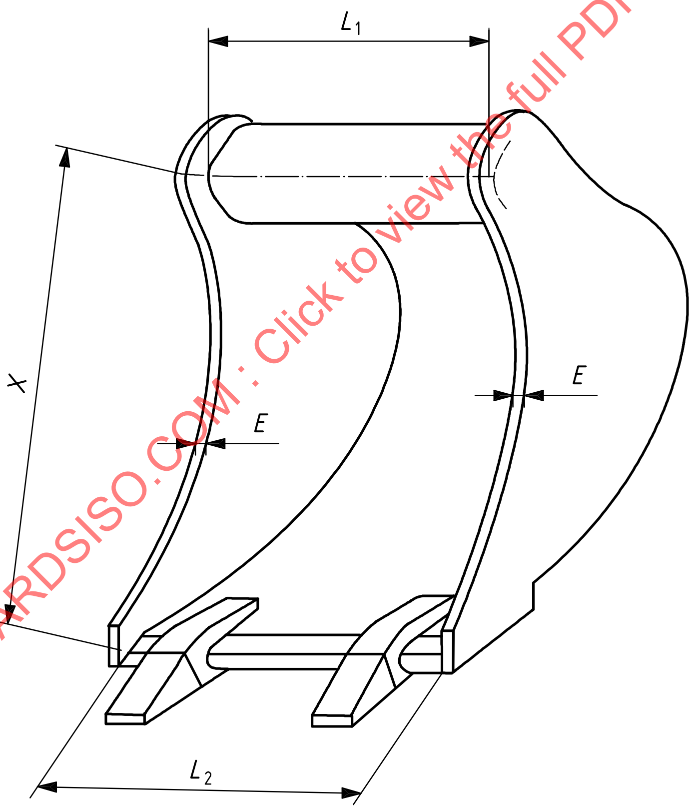
W_2 W dimension

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