Bucket Rating
Wheel Loaders

The following method of calculating the capacity of Buckets for Wheel Loaders is representative of the method used by most O.E.M. Heavy Equipment Manufacturers. Similar methods are used for Rating Buckets for Hydraulic Excavators.

Use this link for help in understanding Wheel Loader Bucket Terminology.

Use this link for a copy of a Field Worksheet to help in collecting data for use with this standard.

The Society of Automotive Engineers publishes standards that define Bucket Capacities for Wheel Loaders and other machines. For detailed information contact *SAE* directly on their Web site and ask for:

- **SAE Standard J742b - "Front End Loader Bucket Rating"**

FRONT END LOADER BUCKET RATING

1. This discussion describes a method for determining the average volume of an average material carried by the bucket of a front end loader. The calculations used result in a realistically conservative heaped volume. They are based on physical dimensions of the bucket only without regard to bucket action provided by any specific machine. It has been determined that for rating purposes, a nominal heaped load will have a 2:1 angle of repose when the bucket is oriented as shown in Figs. 1 and 2. This in no way implies that the loader linkage must carry the bucket oriented in this attitude, or that all materials will naturally have a 2:1 angle of repose.

2. Rated capacity shall be expressed in cubic yards for all sizes ¾ cu yd or over, and in cubic feet for all sizes under ¾ cu yd. It shall be stated as the "Nominal Heaped Rating."

3. Rated capacities shall be stated in intervals of 1 cu ft for buckets under ¾ cu yd, 1/8 cu yd for buckets from ¾ to 3 cu yd, and ¼ cu yd for buckets over 3 cu yd.

4. Measurements and calculations are outlined in the Figs. 1 and 2. All linear measurements are in inches and the resulting volumes are in cubic inches. These are to be converted to cubic feet or cubic yards as specified above. If the calculated value falls below a given rating interval by more than 2%, the next lowest interval shall be deemed to be the rating.

EXAMPLE: A calculated value of 1.95 cu yd is under 2 cu yd by more than 2% and, therefore, the proper rating on the basis of the measurements and calculations is 1-7/8 cu yd.

5. To determine the rated capacity it is necessary to first determine the struck capacity. It is defined as the volume of material retained in the bucket after a heaped load is struck by drawing a straight edge across the width of the bucket with one end of the straight edge resting on the cutting edge and the other end resting on the uppermost portion of the bucket back sheet or spill guard. (See SAE J731.) For buckets with spill guards the struck capacity can be expressed by the following equation:

$$\mathbf{V_8 = AW - 2/3a^2b}$$

where:

A = cross section area at the center of the bucket; sq. in.

W = average inside width of the bucket; in.

a = height of the spill guard at the center of the bucket normal to the strike line; in.

b = length of opening at the center of the bucket; in.

For buckets without spill guards, the struck capacity is expressed as follows:

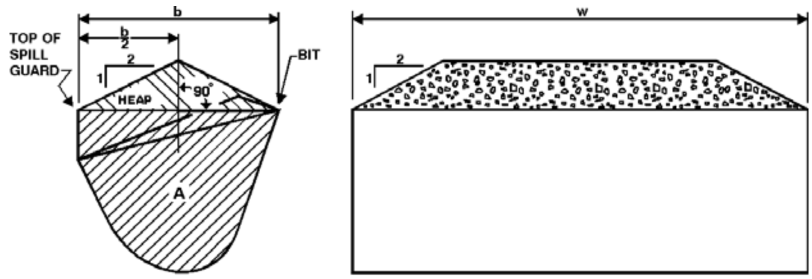
$$V' = A'W$$

Where:

A’ = cross section area at the center of the bucket; sq. in.

If struck capacity is shown in addition to the nominal heaped rating, it should be shown decimally to three significant figures.

NOTE: Where the terms A or A’ occur, they may be determined on an accurately drawn layout by use of a planimeter or by accurately cutting a template to fit the bucket profile. The template must be placed in a plane normal to the bucket back sheet and equidistant from corresponding points of the bucket side sheets.



AVERAGE BUCKET INSIDE WIDTH = W
PLANIMETER AREA A
BUCKET CAPACITY WITH 2:1 ANGLE OF REPOSE
STRUCK CAPACITY $V_S = AW - 2/3\, a^2 b$
RATED CAPACITY $V_R = V_S + \frac{b^2 w}{8} - \frac{b^2}{6}(a + c)$

FIG. 1 - RATED BUCKET CAPACITY FOR BUCKETS WITH SPILL GUARDS

Bucket Heap Diagram

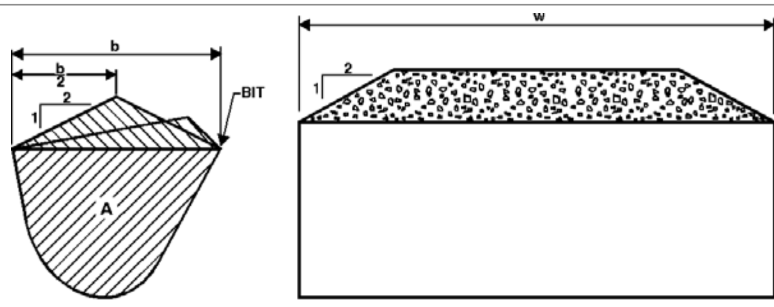
6. Using the 2:1 angle of repose of the heaped material, the rated capacity is expressed as follows:

$$V_r = V_s + b^2W/8 - b^2/6(a + c)$$

Where c is the length on a normal to the strike line. On one end it is determined by the assumed crest of the material. On the other end it is determined by the intersection with a line from the bit or cutting edge tip to the base of the spill guard.

For buckets without spill guards, the rated capacity is expressed as follows:

$$V_r = V_s + b^2W/8 - b^3/24$$

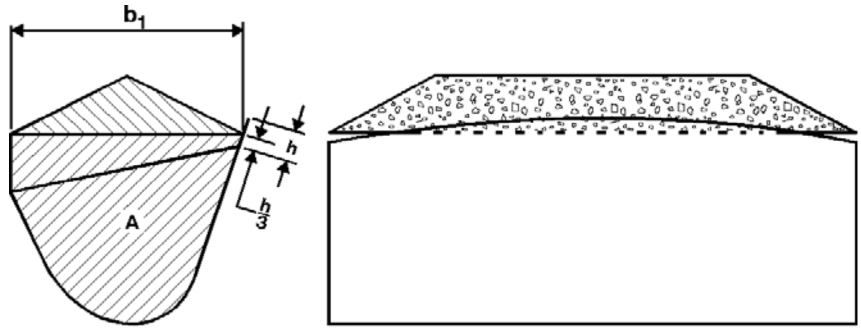


AVERAGE BUCKET INSIDE WIDTH = W
PLANIMETER AREA A
BUCKET CAPACITY WITH 2:1 ANGLE OF REPOSE
STRUCK CAPACITY $V_S = AW$
RATED CAPACITY $V_R = V_S + \frac{b^2 w}{8} - \frac{b^3}{24}$

FIG. 2 - RATED BUCKET CAPACITY FOR BUCKETS WITHOUT SPILL GUARDS

7. This method applies primarily to regular buckets having parallel sides and a cutting edge parallel to the edge of the spill guard or back sheet. Moderately clipped spill guard corners will introduce no appreciable errors.

8. The addition of any auxiliary guard to protect against spillage of material which might injure the operator will not be included in bucket capacity calculations. It is recommended that such a guard be of "see through" construction.



h = DISTANCE FROM SIDE CUTTING BARS TO FORWARD POINT OF CUTTING EDGE.
BUCKET CALCULATIONS MADE AS IN FIGURES 1 AND 2 WITH CENTER CROSS SECION AREA CORRECTED FOR IRREGULAR CUTTING EDGE AS SHOWN, THUS:

RATED CAPACITY $V_R = V_R + \frac{b1^2 w}{8} - \frac{b1}{6}^2$ OR $V_R = V_S + \frac{b1^2 w}{8} - \frac{b1^2}{24}$

FIG. 3 - RATED BUCKET CAPACITY FOR BUCKETS WITH IRREGULAR SHAPED CUTTING EDGES

BUCKET FILL FACTORS	
Loose Material Fill Factor	
Mixed Moist Aggregates	95-100%
Uniform Aggregates up to 3 mm (1/8")	95-100
3 mm-9 mm (1/8"-3/8")	90-95
12 mm-20 mm (1/2"-3/4")	85-90
24 mm (1") and over	85-90
Blasted Rock	
Well Blasted	80-95%
Average Blasted	75-90
Poorly Blasted	60-75
Other	
Rock Dirt Mixtures	100-120%
Moist Loam	100-110
Soil, Boulders, Roots	80-100
Cemented Materials	85-95
NOTE: Loader Bucket Fill Factors are affected by bucket penetration, breakout force, rackback angle, bucket profile and ground engaging tools such as bucket teeth or bolt-on replaceable cutting edges.	
NOTE: For bucket fill factors for hydraulic excavators, see Bucket Rating - Hydraulic Excavators section.	