VOLUMES OF BINS, SILOS, TANKS AND STOCKPILES

Volumes of material or capacity of containers can be calculated using general formulas for the volumes of various geometrical shapes: cone, frustum of a cone, cylinder, sphere, segment of a sphere, rectangular shapes, pyramid, frustum of a pyramid and others. Calculating the volumes of raw materials in bins and stockpiles is a key component of accurately inventorying materials and analysis of materials usage efficiency.

BINS, SILOS AND TANKS

The formulas for most of the basic shapes and the method used by the Concrete Plant Manufacturers Bureau to compute capacity of various bins and silos is covered in detail in *CPMB Publication Number 101 - Bin or Silo Capacity Rating and Method of Computation* (available from NRMCA). These formulas will be generally applicable for most tanks as well. The most common formulas from the CPMB publication are given in Figure I-1. Figure I-2 gives additional formulas for a sphere, segment of a sphere, sector of a sphere, cylinder, and cone.

STOCKPILES

Stockpiles are generally cone shaped or parallel tent shaped solid in form. The basic volume formulas are given in Figure I-3.

Example: the volume of 50-ft. high *cone shaped stockpile* with a base radius of 70 ft. would be:

$V = 1.0472\, r^2 H \quad = 1.0472 \times 70^2 \times 50 \quad = 256{,}564$ cu. ft.

$V = 256{,}564 \div 27 = 9{,}502$ cu. yd.

If the loose density of the aggregate in the stockpile is 90 lb. per cu. ft., then the total weight is:

(256,654 cu. ft.) × (90 lb./cu. ft.) = 23,098,860 lb.

In short tons = = 11,550 tons

If the stockpile is 50 ft. high, *tent shaped* with a base width of 140 feet (radius of ends = 70 ft.) and a length of 300 feet for the central section, then the volume would be as calculated below:

For Central Tent Section

$V = \frac{1}{2} d \times H \times L \quad = \quad = 1{,}050{,}000$ cu. ft.

$V = (1{,}050{,}000) \div 27 = 38{,}889$ cu. yd.

For the two half cones on the ends, the volume would be equal to one full cone with H = 50 ft. and r = 70 ft. This was already calculated above.

Total Volume = 38,889 cu. yd. + 9,502 cu. yd. = 48,391 cu. yd.

And sand unit weight at 90 lb./cu. ft. each cubic yard weight 90 × 27 = 2,430 lb./cu. yd.

Weight in the stockpile = 48,391 cu. yd. × 2,430 lb./cu. yd. = 117,590,130 lb.

In short tons = = 58,795 tons

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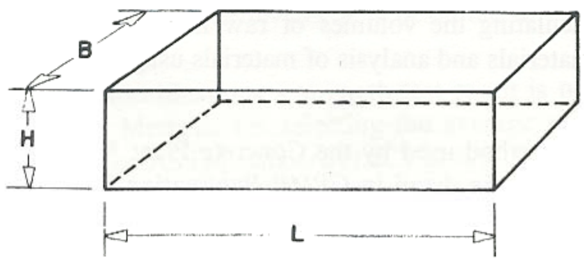
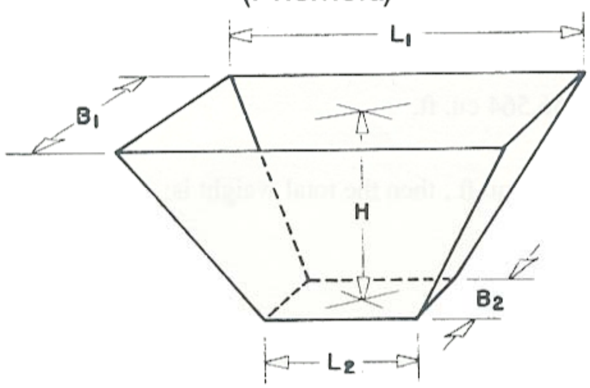
A. Rectangular Bin
(Parallelepiped)



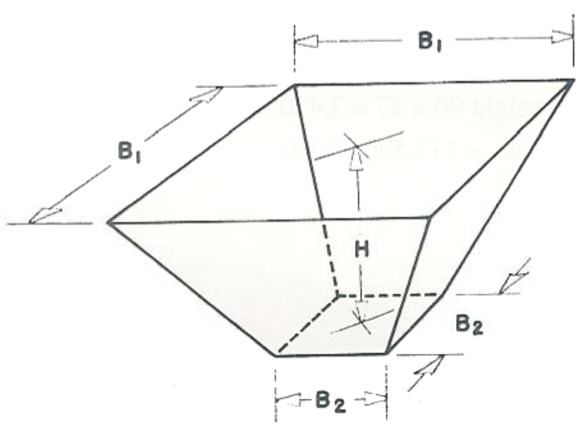
$V = BLH$

B. Rectangular Hopper
(Prismoid)



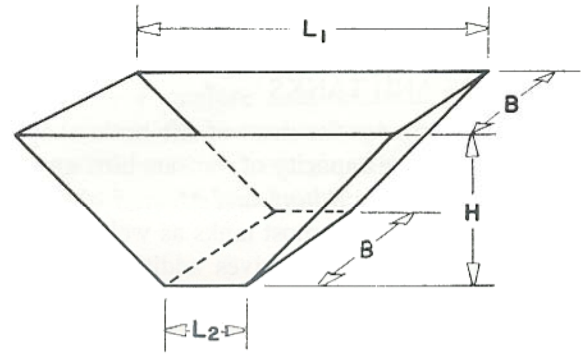
$V = 1/6\,H(2L_1B_1 + L_1B_2 + L_2B_1 + 2L_2B_2)$

C. Square Hopper
(Frustum of a Pyramid)



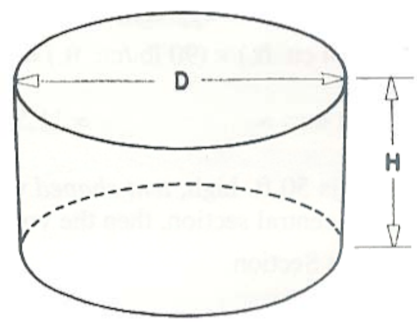
$V = 1/3\,H(B_1^2 + B_2^2 + B_1B_2)$

D. Hopper
(Frustum of a Right Prism)



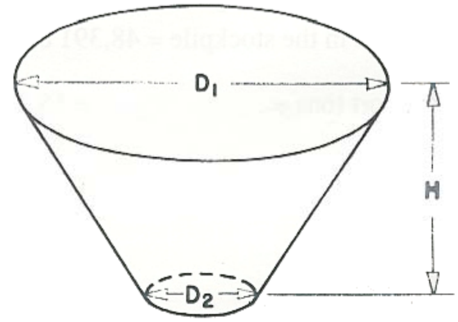
$V = 1/2\,HB(L_1 + L_2)$

E. Vertical Bin or Silo
(Cylinder)



$V = .785\,D^2H$

F. Circular Hopper
(Frustum of a Cone)



$V = .262\,H(D_1^2 + D_2^2 + D_1D_2)$

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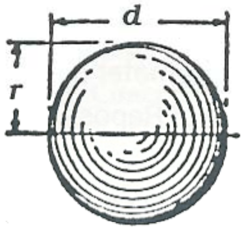
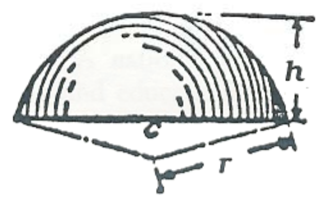
Volumes of Additional Geometric Solids



Sphere

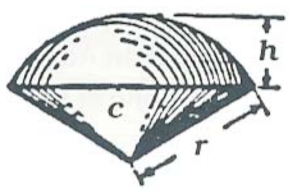
$$\text{Volume} = \frac{4\pi r^3}{3} = 4.1888\, r^3.$$

$$\text{Volume} = \frac{\pi d^3}{6} = 0.5236\, d^3.$$



Segment of Sphere

$$\text{Volume} = \pi h^2 \left(r - \frac{h}{3}\right) = \pi h^2 \left(\frac{c^2 + 4h^2}{8h} - \frac{h}{3}\right)$$



Sector of Sphere

$$\text{Volume} = \frac{2\pi r^2 h}{3} = 2.0944\, r^2 h$$

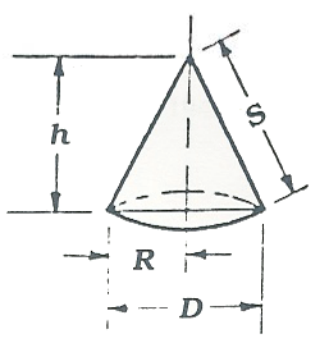
$$= \frac{2\pi r^2}{3}\left(r - \sqrt{r^2 - \frac{c^2}{4}}\right)$$

Cylinder

c = circumferance.

$$\text{Volume} = \pi r^2 h = 0.7854 d^2 h$$

$$= \frac{c^2 h}{4\pi} = 0.0796\, c^2 h$$



Volume of a Cone

V = Volume

$$V = \frac{3.1416 r^2 h}{3} = 1.0472 r^2 h = 0.2618 d^2 h$$

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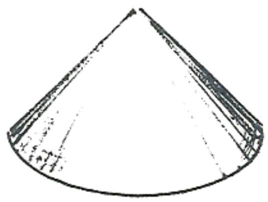


Cone Stockpile

Volume = (1/3 Area of Base) × Height

$V = (\pi r^2/3)\,H = 1.0472\ r^2H$

or

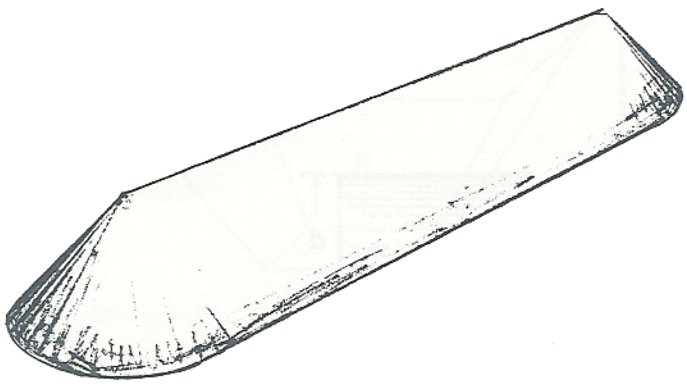
$V = 0.2618\ d^2H$

where: r = radius of circular base,

or d = diameter of base

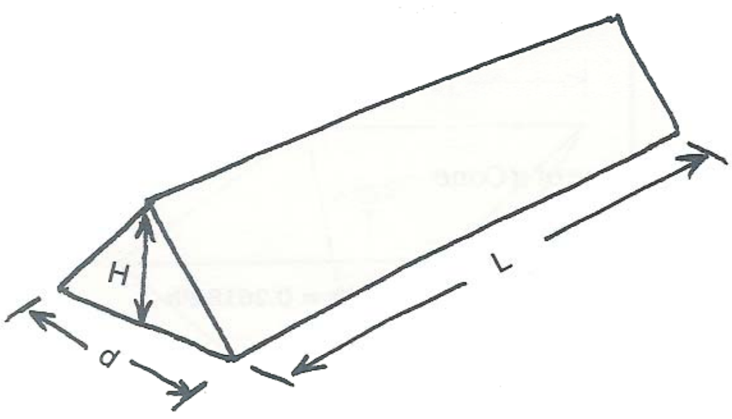
For 37° Angle of Repose

$V = 1.836\ (H)^3$



Parallel Tent-Shaped Stockpile

Calculate Volume Intermediate Section and then Add Volume of the Half Cone at Each End



Volume = $(1/2)\ dHL$

For 37° Angle of Repose

$V = 1.33\ (H)^2L$

(If calculations are done in feet and cu. ft. divide the volume by 27 to get cu. yd.)