



CALCULATING VOLUMES AND WEIGHTS IN EXCAVATION AND MATERIALS HANDLING

BULKING FACTOR

Bulking factor is a ratio comparing **the volume** of a quantity of moist granular material to the volume of the same quantity when dry.

E = Easy digging – Loose free running soils eg sands, fine gravels.

M = Medium – Denser cohesive soils eg clayey gravel, low PI clays

M-H = Medium to Hard – eg broken rock, wet heavy clay, gravel with boulders

H = Hard – material requiring blasting and hard high PI clays

(Typical diggability factors can be seen in Table 1 below.)

Excavation increases the volume of material. It is therefore necessary to use a bulking factor to determine the volume of material that will be created by excavation. Bulking factor is defined as:

Bulking Factor = Volume after Excavation/Volume before Excavation

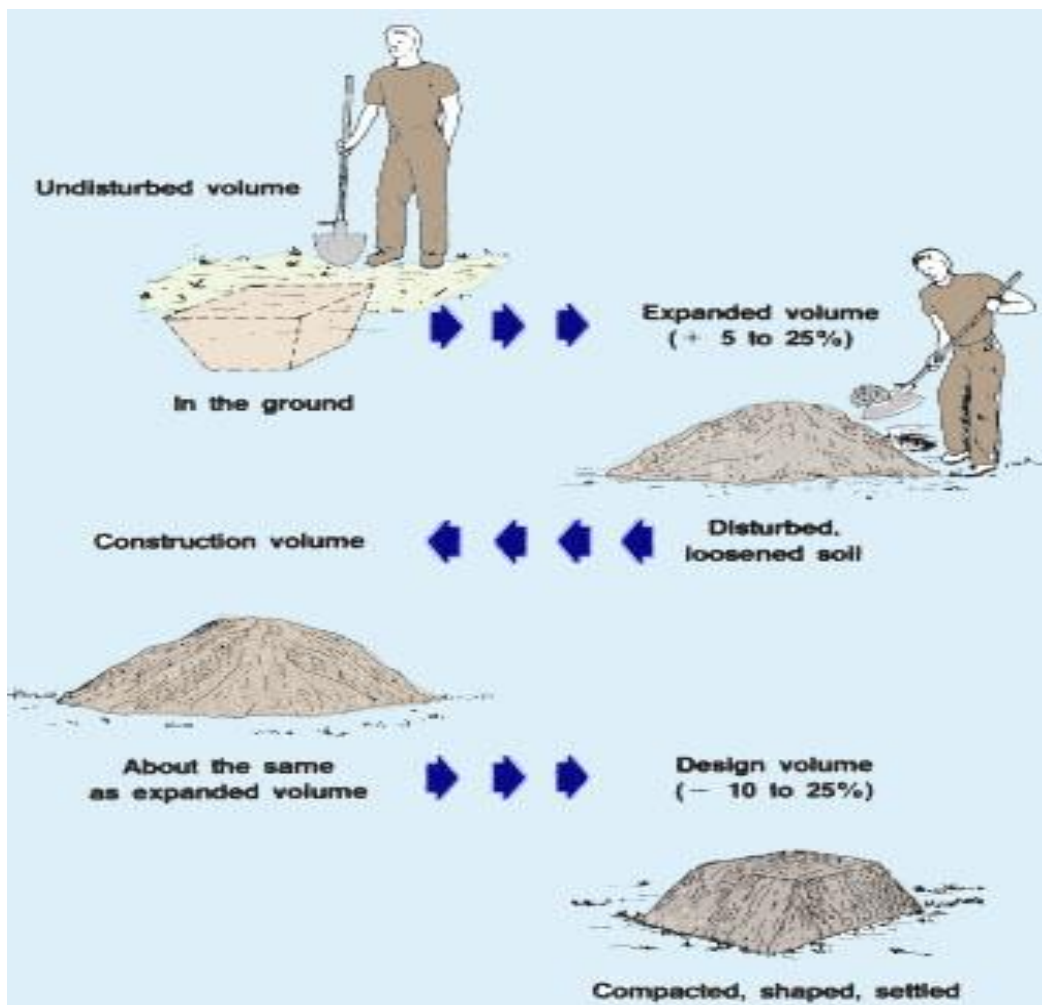
Similarly a shrinkage factor is defined for the compaction of a soil at it's final destination:

Shrinkage Factor = Volume after Compaction/Volume before Excavation

TABLE 1 MATERIAL BULKING AND SHRINKAGE FACTORS

Material	Compacted in situ Volume m3	Bulking Factor	Shrinkage Factor	Diggability
Clay (Low PI)	1.0	1.30	-	M
Clay and Gravel	1.0	1.35	-	M-H

Sand	1.0	1.05	0.89	E
Sand & Gravel	1.0	1.15	-	E
Gravel	1.0	1.05	0.97	E
Shales	1.0	1.50	1.33	M-H
Limestone	1.0	1.63	1.36	M-H
Sandstone (Porous)	2.50	1.60	-	M
Basalt	2.95	1.64	1.36	H
Granite	2.41	1.72	1.33	H



BULK DENSITY

This is a concept slightly different from the Bulking Factor CONCEPT.

This is a measure of the **WEIGHT** of a given volume of material and is often expressed as an In situ or compacted weight versus a loose weight of stockpiled or otherwise uncompacted material.

This is necessary information when dealing with excavations, filling, loading and transporting materials used in the landscape and construction industry.

It informs the estimator and site manager of the requirements for potential time, truck sizes, bin sizes, tip fees and purchasing of the required weight of materials.

The bulk density of a product or material will increase with its mineral content relative to organic content and you will see from the attached Bulk density chart that materials that are more organic in nature – e.g. soil mixes, mulch and wood products are generally much less weight than the corresponding volume of inorganic or mineral type products – rock, concrete, metals.




BULK DENSITIES OF QUARRY PRODUCTS AND LANDSCAPE MATERIALS (Rev 1 August 2004 ,Rev 2 2009, Rev 3 2010, Rev 4 2011, Rev 5 2016 Rev6 Sept 2017, REV 7 2018, Rev 9 2019, Rev 10 July 2020)
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Moisture level plays a part in the respective weights of materials.
Soils placed by hand are less compacted than those placed by machine.

MATERIAL	LOOSE DENSITY (Stockpile)	COMPACTED DENSITY
SAND	T / m3	T / m3
Washed River Sand (Paving, Concrete, Drainage)	*1.50	1.70
Brickies Sand (White, Yellow, Red)	*1.40 – 1.50	N/A
Propagating Sand (-3mm + 1mm)	1.45	1.70
Crusher Dust	1.50	2.20
Sydney (plastering) Sand	*1.50	*1.70
ROAD BASE & SUB BASES		
20, 40 & 75MM Crushed Hawkesbury Sandstone	1.50	2.10
Crushed Sandstone/Shale	1.40	1.95
20mm and 40mm Crushed Concrete (Recycled)	1.60	2.10
20 mm and 40mm Densely Graded Base (20 DGB)	1.70	2.40
20mm, 40mm Fine Crushed Rock (FCR)	1.70	2.40
20mm, 40mm, 75mm Road Gravel	1.70	2.25
20mm, 40mm Slag Road Base	1.50	2.10
DECORATIVE & CONSTRUCTION GRAVELS		
Crushed River Gravel (5, 7, 10, 14, 20mm) (CRG)	1.45	1.55
5, 7, 10, 14, 20, 40mm Round River Gravel (Pea Gravel)	1.50	1.60

5, 7, 10, 14, 20, 40, 75mm Blue Metal	1.45	1.55
10, 20, 40-75mm Recycled Concrete Aggregate	1.40	1.50
Scoria 10mm, 20mm	0.85	1.00
Decomposed Granite	1.60	2.10
150mm Gabion Rock (Basalt)	1.80	N/A
150mm Gabion Rock (Sandstone)	1.60	N/A
Washed Sandstone Pebble	1.46	1.55
*White Quartz Pebble (10-20mm)	*1.50	*1.50
*Decorative Pebbles (<i>Variable according to size of pebble and depth of effective coverage</i>)	*1.60	*1.80
CONCRETE, BRICKWORK, ASPHALT, GRANITE		
In situ concrete (includes concrete pavers)		2.5t/m3
Cement - Portland		1600kg/m3
Cement – GP Builders in bags		1100- 1300kg/m3
Asphalt – revised 2020		2-4t - .2.6t/m3
Dry press brickwork		2t/m3
Extruded brickwork		1.85t/m3
Sandstone ex quarry in block/slab form		2.5t/m3
Granite ex quarry in block/slab form		2.8t/m3
SOIL, SOIL MIXES, SOIL CONDITIONERS		
Screened Sandy Loam	1.30	1.50
90% Washed Sand : 10% Topsoil and MENANGLE soil (2019)	1.40	1.60
80% Washed Sand : 20% Topsoil	1.35	1.55
50% Washed Sand : 50% Topsoil	1.30	1.50
Organic Garden Mix (ANL or equal)	1.10	1.30
3:1 Soil / Compost Blend	1.15	1.35
Lightweight Planter box mixes	0.6-1.0t/ m3	0.8-1.1t/m3
Organic top Dressing soil	1.4t/m3	
Horticultural Grade Ash	0.90	1.00
Mushroom Compost; Fowl Manure	0.42	N/A
Cow Manure	0.60	N/A
Composted Green Waste	0.70	N/A
Sawdust (soft or hardwood)	0.53	N/A
Peatmoss	0.33	N/A
*Organic Compost (average)	0.3 to 0.5	N/A
Greenlife mulch and compost		0.6t/m3
Botany Humus		0.7t/m3
Nitro Humus		0.9t/m3
*Mulch (softwood) e.g Pine bark, leaf chip and similar	0.33t/m3	N/A
Mulch- Hardwood	0.45t/m3	
TIMBER		
Treated pine and softwoods	0.55t – 0.7t/m3	0.55t – 0.7t/m3
Hardwood mixed species and lower durability	0.75-1.0t/m3	0.75-1.0t/m3
Hardwood – Class 1 durability species	1.0t- 1.2t/m3	1.0t- 1.2t/m3
Timber in Palm trunks and fresh cut softwood branches – assuming wet saturated	600 to 660kg/ m3	600 to 660kg/ m3
PLAYGROUND SURFACES -2019		

Rubber crumb/ rubber moulded items eg wheel stops		610- 660kg/m3
Rubber pavers and tiles – dense moulded with resin binder		740kg/m3
Synthetic grass - add for sand infill depth/ weight refer BD sand		2 to3 kg/ m2
Recycled plastic sections – beams/ play equipment structures		570kg/m3
STEEL / METALS		
Cast steel sections	7.9t/m3	7.9t/m3
ALUMINIUM -	2.7t/m3	2.7t/m3
Copper	9t/m3	9t/m3
Lead		11.4t/m3
OTHER		
WATER	1000kg/m3	=1T/M3
AIR	1.4kg/m3	
Unleaded fuel	735kg/m3	
Diesel	850kg/m3	
STONES and PAVERS		
Granite pavers, kerbstones and blocks	2800kg/ m3	
Clay bricks and pavers	1850-1900kg/ m3	
ANGLES OF REPOSE – COMMON LANDSCAPE MATERIALS Steepest angle to the horizontal for stockpile material without slumping. This is a measure of the internal friction between the particles of the material.		Ratio H / V Or % grade
Sand - dry	35 deg	1.5:1
Sand -Wet	45 deg	1:1
Sand -Coarse river sand	40 deg	1.3 :1
Clay – moist and firm	17-20 deg	1:3 or 33.5%
Gravels – crushed sandstone	45 deg	1:1
Gravel- coarse	25- 30 deg	1.7 : 1
Soil loam- dry	40-45 deg	1:1
Soil loam -Wet	20-25 deg	2:1
Mulch – Pine bark	45 deg	1:1