DATAsheet

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ASSESSING Concrete Volumes

SCOPE

This data sheet covers how to estimate the volume of concrete required for projects and discusses some of the factors that affect the volume required. It also covers the required quantities of ingredients for site mixing for small jobs, along with some tips on mixing of concrete.

ESTIMATING CONCRETE VOLUME

Estimating the concrete volume is a simple process and basically involves multiplying the length, width and depth (all in metres) of a concrete element to arrive at an estimated volume of concrete in cubic metres. For example the estimated volume of concrete for a garage floor slab 7.5 m long, 3.5 m wide and 0.1 m thick (100 mm), is calculated as follows:

Estimated Volume = 7.5 x 3.5 x 0.1 = 2.63 m^3

Larger projects are estimated in the same way, by breaking often complex shapes and buildings into basic elements, calculating the volume in each element and adding them together to arrive at a total volume estimate for the project.

CONCRETE VOLUME REQUIRED

The volume of concrete to be mixed or ordered for a project is more than the amount estimated, for a variety of reasons:

- Incorrect calculation of the form volume.
- The 'as constructed' formwork dimensions varying from the plan dimensions that the estimate was based on.
- Variations in the average slab thickness. For a 100-mm (nominal) thickness slab, a variation of 5 mm in average slab thickness results in a 5% variation in volume. Over a 20-m^3 slab this can equate to a 1-m^3 variation in concrete volume. Note that for the majority of concrete work, this 5% variation could be realised through the allowed tolerance on surface levels alone.
- Deflection or distortion of forms caused by the pressure of the plastic concrete.

THE VOLUME of concrete required is usually more than the amount estimated, for a variety of reasons.

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- Over excavation or uneven/irregular subgrade levels, particularly with elements such as footings.
- Placement over uncompacted sand or fill and subsequent settlement of the subgrade. (See *How to Minimise Volume Discrepancies*).
- Concrete used by other trades for various ancillary works not included in the estimate.
- Concrete wastage on site which can occur from a number of sources such as the small amounts of concrete, left in the concrete pump hopper and line.

Over the course of a project these last two items can often accumulate to a significant amount.

When ordering ready mixed concrete, it is far more economical to order a little extra than to have to order a small additional quantity to finish the job. As a general rule for small projects, 10% extra for wastage should be allowed for in the assessment of concrete volume required.

HOW TO MINIMISE VOLUME DISCREPANCIES

To minimise discrepancies between the volume of concrete estimated and required for a project, the following precautions should be taken:

- **Measure Formwork** Accurately measure formwork and estimate volume based on actual measurements and not on drawings or plans. In all cases, several measurements (particularly of depth) should be taken to arrive at a realistic average. Also, near the end of a large pour, carefully measure the remaining volumes so that the final deliveries can be adjusted to provide the required amount. This will prevent the costly process of waiting for the extra, say, 0.6 cubic metres to complete the pour.
- **Estimate Wastage** Estimate the extra concrete needed to cover on-site wastage. Where concrete is being placed by pump, allow for the concrete left in the lines and hopper. Allowances from 5–10%, and sometimes more, are appropriate depending on the nature and size of the job. The volume required for repetitive operations such as slip-forming can often be more accurately assessed than that for jobs involving a combination of concrete uses such as slabs, footings, walls and incidental fill around pipes.
- **Allowance for Variations** These include items such as slab thickness, compaction and/or the possible loss of air content of the concrete.
- **Secure Formwork** Construct and secure the formwork to ensure it will withstand the pressure of the wet concrete without excessive deflection or distortion.
- **Prepare Subgrade** For slabs-on-grade the subgrade should be accurately finished and compacted to the correct levels. Fill used as formwork should also be adequately compacted to avoid settlement under the weight of the concrete.

Checking Concrete Volume

For large projects, if concern about volume discrepancies is an issue, the procedures given in AS 1379[1] and AS 1012.5[2] for checking the mass per unit volume of freshly mixed concrete should be followed. If testing is required, ensure that the testing facility is NATA accredited and the test procedures and equipment comply with AS 1012.5.

QUANTITIES OF INGREDIENTS FOR SITE MIXING

The following guidelines for determining the volume of ingredients required apply only to site-mixed concrete for small or non-structural applications such as paths. Concrete strength cannot be guaranteed with either packaged concrete mixes ('Dry Mix') or concrete mixed from separate materials on-site.

There are two ways of obtaining the ingredients:

- In 'Dry Mix' bags
- As separate materials – cement, sand and coarse aggregate

Quantity of 'Dry Mix' required

'Dry Mix' concrete bags generally have information on the volume of concrete that the contents of the bag will produce. **Table 1** can be used to estimate the number of bags required for a small project.

Table 1 Quantities of 'Dry Mix'

Weight of 'Dry Mix' bag (kg)	**Approx. volume of concrete per bag** (m^3)	**Approx. number of bags to make 1 m^3 of concrete**
40	0.018	56
32	0.014	71
26	0.012	86

The number of bags required can be calculated by dividing the estimated concrete volume by the volume produced by one bag. For the garage floor slab volume estimated previously:

Estimated volume	2.63 m^3
Wastage at 10%	0.26 m^3
Required volume	2.89 m^3 – say 3.0 m^3

3.0 m^3 divided by 0.018 m^3/bag = 167 bags (40 kg)

Quantities of separate materials required

Table 2 can be used to estimate the quantities of materials required.

Cement should be either Type GP (General Purpose Portland cement) or GB (General Purpose Blended cement) complying with AS 3972[3] It should be stored off the ground in a dry environment and used as soon as possible.

Sand should be sharp, clean and free of organic matter (concreting sand). Washed river sand or crushed sand can be used. Sands such as 'Brickies

Table 2 Volume of cement, sand and coarse aggregate

			Volume of concrete (m^3)				
Concrete use	**Ingredients**		0.2	0.4	0.6	0.8	1.0
General purpose projects such as driveways, paths, patios	Cement	(40-kg bags*)	2	3	5	7	8
	Sand	(m^3)	0.1	0.2	0.3	0.4	0.5
	Coarse agg.	(m^3)	0.2	0.4	0.6	0.8	1.0
	Water	(litres)	50 to 60	70 to 80	145 to 150	180 to 200	200 to 220
	Cement	(40-kg bags*)	2	3	5	7	8
	All-in agg.	(m^3)	0.3	0.5	0.8	1.0	1.3
	Water	(litres)	50 to 60	70 to 80	145 to 150	180 to 200	200 to 220
Concrete subject to wear (ie truck driveway)	Cement	(40-kg bags*)	2	4	6	8	9
	Sand	(m^3)	0.1	0.2	0.3	0.4	0.5
	Coarse agg.	(m^3)	0.2	0.4	0.5	0.7	0.8
	Water	(litres)	50 to 60	70 to 80	145 to 150	180 to 200	200 to 220
	Cement	(40-kg bags*)	2	4	6	8	9
	All-in agg.	(m^3)	0.3	0.5	0.8	1.0	1.3
	Water	(litres)	50 to 60	70 to 80	145 to 150	180 to 200	200 to 220

**If 20-kg bags are used, the number of bags should be doubled.*

loam' and plasterer's sand are not suitable for concrete as they contain a high proportion of silt.

Coarse aggregates can be either river gravel or crushed stone, having a nominal size of 20 mm. Coarse aggregate should also be clean and free from organic matter. If smaller aggregates are used (ie 10 mm), the volumes given in **Table 2** may need to be adjusted.

Water should be from a source suitable for drinking (ie mains water), and added carefully, as it is the key to a successful mix. Note that less water may be required due to the inherent dampness of the materials, particularly sand. If extra water to that given in **Table 2** is required to achieve a workable mix, extra cement must also be added – never add water on its own.

All-in aggregate, sometimes called 'Concrete Blend' is a mixture of sand and coarse aggregate and may be available from some landscape or sand/soil suppliers. Note that as the materials used for concrete must be accurately batched (proportioned) the procedure for blending the sand and coarse aggregate needs to be confirmed.

To calculate the volume of ingredients required for say 1.8 m^3, add the amounts for 0.8 and 1.0 m^3 shown in the last two columns of **Table 2**. For 2.8 m^3 add amounts for 0.8 m^3 to twice those for 1.0 m^3 etc.

MIXING

Concrete is normally mechanically mixed, either by a ready mixed concrete supplier, or on site.

Ready Mixed Concrete

Ingredients are normally batched into a truck-mounted drum mixer or 'concrete truck' for mixing. The rotating drum of the truck is used to mix the concrete on the way to the job site. To ensure uniformity of the concrete, AS 1379 requires a minimum number of drum revolutions, or minimum mixing time before the concrete is discharged.

If water or admixtures are added to the concrete in the drum on-site, AS 1379 requires that *'the mixing mechanism shall be operated at mixing speed for a time equivalent to at least 30 revolutions of the mechanism, and for such additional time as may be necessary to re-establish uniformity of the mix'*.

On-site Mixing

Whether mixing by hand or with a small mechanical mixer, all materials should be carefully batched/measured by volume in a suitably sized bucket/container – not larger than 10 litres or it may be too difficult to lift into the mixer. Never measure by the shovelful, as a shovelful of sand is not the same volume as a shovelful of cement or aggregate.

For hand mixing (on a board, concrete slab or in a wheelbarrow), mix the cement, sand and coarse aggregate until a uniform colour is achieved. The water is then added slowly, while continually turning and mixing the materials. Mixing continues

until all the coarse aggregate is uniformly coated with the cement/sand paste.

Mechanical mixing is less strenuous and much more reliable than hand mixing. The later should therefore be used only for very small quantities.

With mechanical mixing, two thirds of the water is added first, followed by the coarse aggregate, sand and then cement. After a uniform colour is achieved, add the remainder of the water slowly until a workable mix is achieved, and continue mixing for at least two minutes.

REFERENCES

1 AS 1379 *Specification and supply of concrete* Standards Australia, 1997
2 AS 1012.5 *Methods of testing concrete, Method 5: Determination of mass per unit volume of freshly mixed concrete* Standards Australia, 1999
3 AS 3972 *Portland and blended cements* Standards Australia, 1997

This data sheet replaces the following:

Estimating quantities of ingredients for concrete, *Estimating the quantities of concrete required for a project* and *Concrete mixes and mixing* previously published by the Cement and Concrete Association of Australia as well as *Assessing concrete volume requirements* previously published by the Australian Pre-Mixed Concrete Association.

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