Concrete for precasting small items

1. Introduction

Precasting is an economical means of producing high-quality concrete items.

This leaflet gives information for small-scale precasting of relatively small unreinforced or reinforced items such as paving slabs, planks and elements for post-and-panel walling.

It covers: choice of materials; mix proportions; and manufacture of concrete.

Concrete masonry units (bricks and blocks), prestressed concrete and heat-accelerated curing are outside the scope of the leaflet.

2. Important points

- Surface damage and breakages must be avoided if the precasting operation is to be economically successful. Precast items are especially prone to damage and breakage when they are de-moulded and when they are handled. Concrete should therefore have a relatively high strength which should develop as rapidly as possible after casting.

- Maximum stone size should be compatible with the minimum dimension of the precast element.

3. Choice of materials

3.1 Cement

All cement sold in South Africa must meet the requirements of SANS 50197 for Common cement or SANS 50413 for Masonry cement and the National Regulator for Compulsory Standards (NRCS) requirements as detailed in NRCS VC9085. Bags should be clearly marked with the strength grade, notation indicating composition and a Letter of Authority (LOA) number issued by the NRCS. An LOA is issued for each cement type from each source. To verify valid LOA numbers contact the NRCS on 012 428 5199 or www.nrcs.org.za.

Note that Masonry cements complying with SANS 50413 are not permitted to be used in concrete.

Cement strength class should preferably be 32,5 R or higher because the concrete must develop strength as rapidly as possible. Strength class 32,5 N cement may be used, but in this case mixes may need to have a higher proportion of cement than indicated in Table 2 to ensure adequate early strength.

3.2 Aggregates

Sand

Fairly coarse concrete sands are suitable. Either crusher sands or natural sands obtained from pits or river banks can be used. Replacing about a quarter of the coarse sand with a clean plaster sand tends to make the fresh concrete less harsh and more cohesive.

Stone

Any type of stone sold as concrete aggregate may be used. In South Africa stone is likely to be crushed rock. Natural pebbles, which are available in some areas, are also suitable.

Stone size is important. The largest particles should not exceed about one quarter of the thickness of the concrete item being precast. Table 1 gives minimum concrete thickness for various standard stone sizes.

Table 1: Minimum concrete thickness for various stone sizes

Nominal stone size, mm	6,7	9,5	13,2	19,0
Minimum concrete thickness, mm	30	40	50	80

3.3 Water

Use water that is fit for drinking. Water that is unfit for drinking should be tested and approved by a competent laboratory before being used.

3.4 Pigments

Use only best quality synthetic pigments based on metallic (usually iron) oxides.

Natural pigments may be cheaper, but the colour they produce is variable and less intense.

4. Mix proportions

4.1 Cement, sand and stone

In this section, trial mix proportions of cement, sand and stone are given for various stone sizes. Advice is also given on the assessment of proportions.

Trial mix proportions are given in Table 2.

Table 2: Trial mix proportions by volume for concrete for precasting

	6,7 mm stone		**9,5 mm stone**		**13,2 mm stone**		**19 mm stone**	
	Large batch	**Small batch**	**Large batch**	**Small batch**	**Large batch**	**Small batch**	**Large batch**	**Small batch**
Cement *	50 kg	1	50 kg	1	50 kg	1	50 kg	1
Sand	75 ℓ	2	75 ℓ	2	75 ℓ	2	75 ℓ	2
Stone	40 ℓ	1	50 ℓ	1,25	55 ℓ	1,5	75 ℓ	2

* The minimum proportions in this table have been calculated for a 32,5 R cement.

Notes:

- Use sufficient water in the mix to give a plastic mix that can be compacted with the means available. Slump (measured according to SANS 5862-1) suitable for various means of compaction is shown in Table 3.

- Cement is available in 50-kg bags.

- For small batches use the same size container for each material. For example if the container volume is 6 ℓ, the mix for 6,7 mm stone is
  cement: 1 x 6 = 6 ℓ
  sand: 2 x 6 = 12 ℓ
  stone: 1 x 6 = 6 ℓ

- Measure all materials by pouring loosely into the container and striking off flush with the brim.

Measure sand in the damp state.

The stone content of the mix influences the workability of the fresh concrete and the quality of the hardened concrete. Excessive stone makes the fresh concrete harsh and difficult to compact. Insufficient stone content can results in the hardened concrete shrinking more.

Table 3: Slump for means of compaction

Slump, mm	Compaction by
25 - 50	Intensive mechanical vibration
50 - 100	Moderate mechanical vibration
100 - 150	Hand

Stone content should be assessed as follows:

Make up a batch of concrete according to the proportions given in Table 2. Compact the concrete in the mould using the means available (i.e. mechanical vibration or hand tamping). Examine the top surface of the concrete. If stones protrude, the stone content of the mix is too high.

If not, scrape the concrete with the point of a nail.

If the stone content of the concrete is right, stone particles should be found about 2 mm below the surface. If the shallowest particles are deeper than this, the stone content is too low. If stone content is too high, reduce it by say 10% and increase the sand content by the same amount (same absolute volume). Then reassess. If stone content is too low, increase it by 10% and reduce the sand content by the same amount. Then reassess.

4.2 Pigment dosage

Pigment dosage depends on the colour and the intensity of the pigment. Dosage is normally between 3% and 5% of the mass of the cement. Note that the final colour of the dry concrete is determined by the combination of cement colour, sand colour and pigment colour and dosage. It is therefore advisable to make up trial mixes beforehand using the specific cement and sand with different pigment dosages. Wait for the concrete to harden and dry out before assessing the colour because the colour of wet concrete is darker and more intense than that of dry concrete.

5. Spacer blocks

If precast units are reinforced, the reinforcement should be kept in the correct position in the mould while the concrete is placed and compacted. Spacers of plastic or high-strength mortar may be used to support the steel and ensure that the minimum concrete cover is provided.

Plastic spacers are commercially available from specialist suppliers.

Mortar spacer blocks may be made with a 1:1 ratio of cement and concrete sand and sufficient water to make a workable consistence. Details of a spacer block are shown in Figure 1. Cover the blocks to prevent drying out after casting and place them in water the next day. Keep the blocks in water for at least a week before using them.

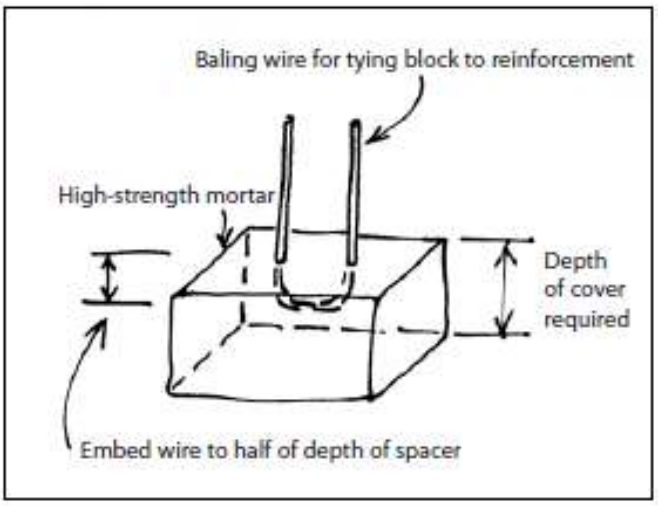

Figure 1: Details of mortar spacer block

6. Manufacture

6.1 Preparing the mould

Surfaces of the mould that will come into contact with the concrete should be cleaned and then given a very thin coating of mould-release oil. (Rubber moulds do not normally require a release agent.)

Specific mould-release oils are formulated for different mould types and finishes, and are obtainable from oil companies and reputable manufacturers of concrete admixtures. The use of lubricating oils is not recommended.

6.2 Batching

Containers used for batching should be robust. Builder's wheelbarrows (which have a capacity of 65 ℓ) and steel buckets and drums are suitable. Batching should be done by pouring material loosely into the container to overfill it, and striking off level with the brim. Partial filling of containers leads to non-uniform batching. Containers should therefore be sized accordingly.

To avoid errors, there should be sufficient containers to measure out a complete batch without having to use any container more than once.

6.3 Mixing
The concrete must be thoroughly mixed.

Although small quantities may be mixed by hand on a concrete floor or steel sheet, machine mixing is preferable. The best type of mixer is a pan mixer which has forced counter action mixing.

The amount of water added to the mix depends on the workability required.

NOTE It is important not to use more water than is needed, as this reduces the strength of the concrete.

The workability of the concrete should be compatible with the means of compaction. Relatively stiff, unworkable mixes can be compacted using high-energy mechanical vibration. On the other hand more workable mixes are best compacted using moderate vibration. See Table 3.

6.4 Transporting
Transport the concrete from the mixer to the mould in such a way that it does not segregate. If segregation (separation of stone and mortar) is unavoidable, remix the concrete before placing it in the mould.

6.5 Placing
Distribute the concrete evenly in the mould. Do not place the concrete in one position and rely on the vibration to distribute it because this causes segregation.

6.6 Compacting
Precast concrete is usually compacted by means of mechanical vibrators attached to the mould or by placing the mould on a vibrating table. Continue to vibrate the concrete until a water sheen appears on the surface and air bubbles no longer breakthrough the surface.

Hand compacting, which should be used only for limited numbers of small items, may be done by: tamping the concrete with the end of a conveniently sized piece of timber or steel; jigging or jolting the mould; or a combination of tamping and jigging.

6.7 Striking off and floating
Use the edge of a screed board (a planed wooden plank used on edge) which rests on the top edges of the mould to strike off the concrete flush with the top of the mould. The concrete can be wood-floated if necessary.

6.8 Protecting
Newly cast concrete must be protected from rain which could damage and soften the surface.

It is also very important to protect the concrete against loss of moisture from the exposed surface. If moisture is lost the fresh concrete shrinks and this shrinkage can cause serious cracking. Possible ways of preventing moisture loss are:

- Work indoors or at least in shade.
- Place screens around the working area to keep out drying winds.
- Once the concrete has been compacted, struck off and floated, maintain a water sheen on the surface by fog spraying with water or cover with plastic sheeting.

Concrete must be protected until it sets and curing can start.

6.9 Demoulding
Precast items must be demoulded carefully so as to avoid damage to the concrete. Once they are de moulded they should be stacked or supported in such a way that they do not warp or twist.

6.10 Curing
Concrete is cured by ensuring that there is sufficient moisture available and that the temperature is suitable for the cement to hydrate. Note that concrete gains strength as the cement hydrates (combines chemically with water). It does not gain strength by drying out and if allowed to dry prematurely it will fail to achieve its full strength. The optimum temperature for cement hydration is between 20°C and 25°C. At lower temperatures hydration takes place more slowly and minimum mould turn-around time increases. At higher temperatures hydration is more rapid but the quality of the mature product may be inferior.

The following methods may be used to wet-cure concrete:

- Immerse in water.
- Spray continuously with water.
- Wet the concrete and then wrap or cover with plastic sheeting.
- Apply a membrane-forming curing compound of good quality to all surfaces of the concrete.

Curing should be continued for at least seven days in normal weather (20°C to 25°C) and longer at lower temperatures.

Cement & Concrete SA
P O Box 168, Halfway House, 1685
Block D, Lone Creek, Waterfall Park, Bekker Road, Midrand
T 011 315 0300
E-mail: info@cemcon-sa.org.za
Website: www.cemcon-sa.org.za

Published by: Cement & Concrete SA, Midrand, 2021