Snowy Technical Standards	
SHL-CIV-112	***Minor Concrete Works Standard***
Subject Matter Expert *John de Groote* *Principal Civil Engineer*	Version Date: 23/01/2018 Revision: Original

1. Executive Summary

This standard covers concrete for minor non-critical works which require less than 5 m3 of concrete. At least one person in the team must have prior knowledge and experience of mixing, placing and compacting concrete.

2. Scope

The purpose of this standard is to provide an easy to use guideline for concrete works, including guidelines on formwork, mixing, placing and finishing of concrete.

This standard must not be used where a specific design has been provided by an engineer or for complicated or critical load-bearing concrete.

3. Equipment and Resources

3.1. Human Resources

It is advisable that a team of 3 or more persons is available for concrete work. Depending upon the scope of work to be undertaken, the concrete team may require a person/persons experienced in concrete mixing, formwork construction, basic plant operation (e.g. concrete mixer, concrete vibrator, power float, excavator, etc.) and a person able to interpret construction drawings.

3.2. Equipment and Plant

If concrete is mixed off-site, some or all of the following may be required:

- Wheelbarrows
- Shovels
- Poker vibrator for compaction of concrete
- Formwork
- Ground/soil compaction equipment, if the in-ground foundation is to be compacted
- Small tools, such as screed bars, trowels, pliers, spirit level, stiff broom, etc.
- Reinforcement (if required)
- Covers to protect the concrete (for curing)
- In addition to covers, water, water sprayers, sand or other appropriate materials for curing (refer also to Section 5.2)

If on-site mixing of concrete is required, the following equipment will be required in addition to that listed above:

- Concrete mixer
- Water hoses/water supply/water bowser/buckets
- An adequate supply of materials (refer to Section 3.3 below)
- A good surface, such as a wooden base, upon which to mix concrete

3.3. Materials

The following materials may be required, depending upon the scope of work:

- Cement, either general purpose Portland GP cement or high early strength Portland HE cement.
- Stone aggregate. This may be crushed blue metal, crushed granite, crushed river gravel, or other suitable material.
- Fine aggregate (sand). Fine aggregate should consist of screened particles varying in size between 0.16 mm and 5 mm.
- Water. Water must be as clean as possible and must not contain salt. Tap water, clear river water, water from aqueducts and water from dams is generally suitable.
- Reinforcement. The minimum reinforcement to be used is SL92, but larger reinforcement must be used where required.

3.4. Storage of Materials

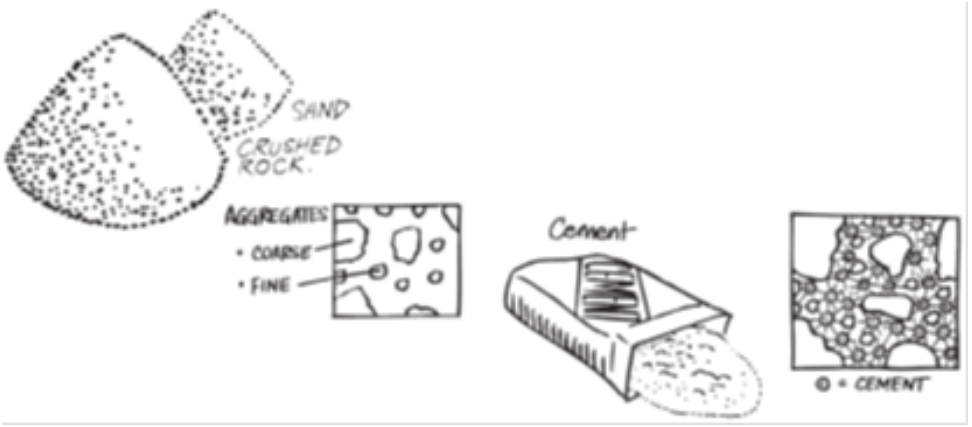
Cement in bags must be stored in dry conditions and protected against the weather, particularly rain. Bagged cement must be as fresh as possible, since it deteriorates with time. Bags must be placed on pallets off the ground, so that air can circulate beneath them and moisture from the ground cannot come into contact with the bags.

Cement with lumps in it must not be used for concrete.

4. Mixing and Placing Concrete

4.1. General

Concrete is normally made from a mixture of water, cement, crushed stone aggregate and sand.



4.2. Water

Water serves a twofold purpose, namely lubrication of the mix for ease of placing and hydration of the cement (which is its primary purpose).

Although water is essential in concrete, too much water will ruin the concrete. Excess water dilutes the cement paste and reduces the proportion of cement in the mix. This reduces the concrete strength.

4.2.1. Moisture in Sand

Since sand readily absorbs water, the amount of moisture (water) in the sand must be accounted for when mixing concrete. If the sand is not dry, it should be thoroughly wetted prior to mixing. Once this is done, the weight of sand to be added to the mix should be increased by 20% and the weight (or volume) of water should

be reduced by a corresponding amount (Note: 1 litre of water weighs 1 kg, so if the weight of wet sand in the mix has been increased by 20 kg, the amount of water added must be reduced by 20 kg, or 20 litres).

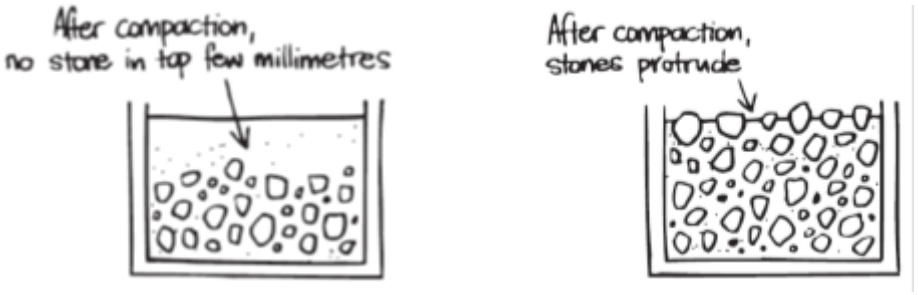
4.2.2. Water/Cement Ratio

The water/cement ratio (the weight of water divided by the weight of cement) is a vital measure and determines the eventual concrete strength.

The water cement ratio for 25 MPa concrete must be approximately 0.55 while that for 40 MPa concrete must be approximately 0.45.

4.3. Aggregates

Too much fine aggregate gives a “sticky” mix, while too much coarse aggregate gives a harsh or bony mix. Both result in poor durability and poor surface finish.



Too much sand **Too much stone**

4.4. Ordering Concrete from a supplier

When ordering pre-mixed concrete from a commercial supplier you need to provide the following information to him.

1. The quantity of concrete required, in cubic metres. Always order about 10% more than required and round up any calculations to the nearest cubic metre.
2. The class of concrete you require. N25 (25 MPa) concrete should be ordered for concrete work below RL 1,100 m while N40 (40 MPa) concrete must be ordered for concrete placed above RL 1,100 m.
3. The slump at the point of delivery, normally between 30 – 120 mm
4. The maximum aggregate size (10 or 20 mm)
5. How you will place the concrete (e.g. pump, chute, wheelbarrow)

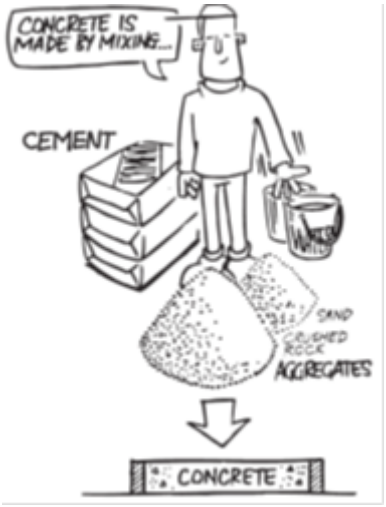
The slump must be measured on site and concrete must be placed and compacted within an hour of arrival. Unless prior arrangements have been made with the supplier for the addition of water on site, no water is to be added after arrival. If the slump falls outside the required slump by more than 20mm, the concrete must be rejected.

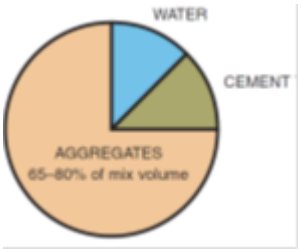
4.5. Mixing your Own Concrete

Cement is ordered by the bag (20 kg bags) and Type (e.g. Type GP = general purpose or Type HE = High Early Strength cement must be used), while aggregates are ordered in cubic metres by maximum size (e.g. 5 m^3 of size 20 mm, equivalent to about 2.5 tonnes).

Materials must be measured by weight or by volume. Volume can be converted to “shovel scoops” or “wheelbarrow loads” for site produced concrete. The minimum increment is 10 kg (half a bag) and must be based on the cement content.

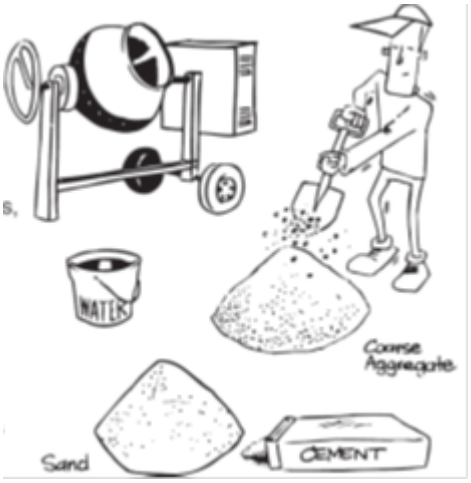
Full or half bags of cement must be used to ensure accurate on-site concrete mix proportions are achieved.



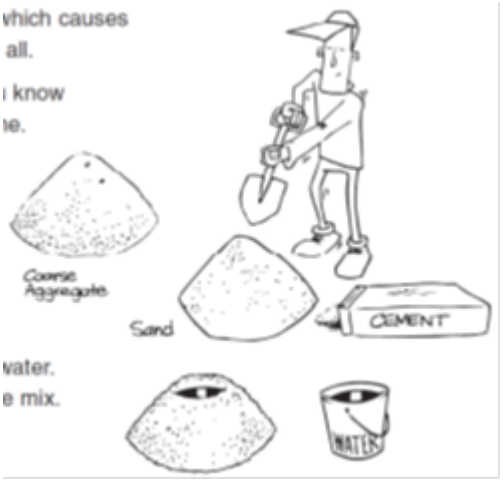


To make a more workable mix, add more cement together with additional water in accordance with the water/cement ratio. **Never add only water to make a concrete mix more workable** – this will reduce the strength and durability of the concrete.

Site mixing can be achieved by placing materials in a small drum mixer which churns them all together so that they are fully mixed throughout. Alternatively concrete can be produced by hand mixing the materials together – care must be taken to ensure that the materials are thoroughly mixed together and a uniform mix is obtained.



Small drum mixer



Hand mixing onsite

4.6. Mix Proportions

The following typical mix proportions can be used as a guide for small quantities of concrete.

Table 1 Mix proportions for site mixing

Material Constituent	Units	25 MPa Concrete	40 MPa Concrete
Cement	kg (20 kg bags)	350 (17.5 bags)	430 (21.5 bags)
Dry sand / saturated sand	kg	735 (dry)/882 (sat.)	665 (dry)/800 (sat.)

Coarse aggregate (10 to 20 mm)	kg	1,070	1,100
Water (dry sand / saturated sand)	kg (or litres)	180 (dry)/33 (sat)	180 (dry)/45 (sat)
Concrete Volume	m^3	1	1
Source		Geehi River Aqueduct mix design	Geehi River Aqueduct mix design

Note: Refer to Section 4.2.1 in regard to saturation of the sand if it is moist. (sat = saturated sand)

4.7. Slump Test

The slump test must be conducted for concrete ordered from off-site ready mix suppliers and for hand mixed concrete where more than one batch is required. When off-site concrete is ordered, an independent third party must conduct the slump test. For more information on the slump test, refer to Appendix A.

4.8. Placing Concrete

4.8.1. Formwork

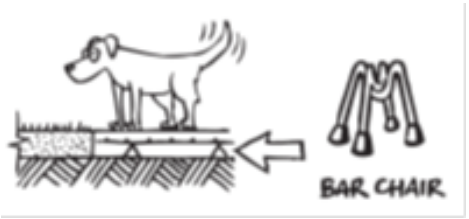
Formwork must be properly braced so that it is strong enough to resist the forces and it should not move or flex significantly under load.

Concrete with a deeper section will require more substantial bracing.

4.8.2. Reinforcement

Reinforcement is used to increase the resistance of hardened concrete to tensile forces. Such tensile forces can occur when concrete bends or when it shrinks after placing and dries out. Reinforcement is normally protected by a layer of concrete of specified thickness – this is termed the “cover” to the reinforcement. Cover to reinforcement for harsh conditions (regular wetting, freeze/thaw, ground) must be a minimum of 50 mm.

Horizontal reinforcement must be supported by “chairs”, which can be formed from, concrete blocks or special plastic forms. Steel chairs must not be supported directly on the ground. A person must be able to stand on the reinforcement without it touching the ground.



Reinforcement must be securely held in place and reinforcement must overlap by 50 times the bar diameter (10 mm reinforcement must overlap by 500 mm). Steel mesh must overlap by at least two squares.

4.8.3. Placing

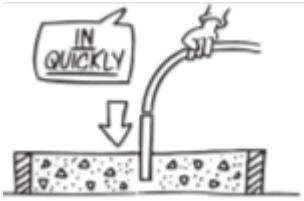
When placing concrete you must:

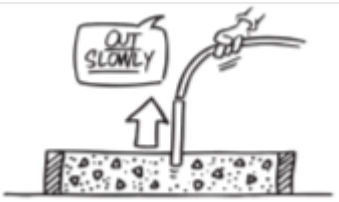
- Start placing the concrete at the lowest point
- Not drop concrete from higher than 1.0 m
- Ensure that the reinforcement and formwork does not deform or move.

4.8.4. Compaction

Compaction of fresh concrete occurs when it is vibrated. Compaction must be done as soon as the concrete is placed, not when it has dried out and stiffened. Compaction of fresh concrete results in a denser concrete. Poorly compacted concrete will result in honeycombing, which will not be easy to identify during compaction if it occurs beneath the surface of the concrete or against formwork. If honeycombing is identified once formwork is stripped, it will need to be chipped out and repaired with a suitable repair concrete.

Internal vibration is achieved with a poker vibrator. Poker vibrators must be placed into the concrete quickly and withdrawn from the concrete slowly to prevent a hole from forming where the poker vibrator is withdrawn.

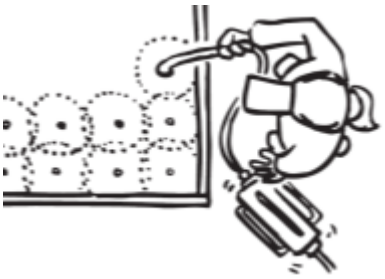




The area over which air bubbles rise to the surface will indicate the area over which a particular vibrator is achieving compaction. Compaction must be systematic so that the radii of action overlap one another and the entire concrete is compacted – refer to the diagram below..

Where concrete is placed in layers, the poker vibrator must be sufficiently long to penetrate the layer of concrete beneath the one being compacted.

Vibration must continue for approximately 15 seconds or until all the bubbles have disappeared.



Never touch the formwork or reinforcement with a vibrator.

Never spread or move concrete sideways with a poker vibrator – always use a shovel.

4.9. Hot and Cold Weather Concreting

Extreme temperatures can result in cracking of concrete, caused by temperature differentials during cold weather or drying out during hot weather. Concrete must not be placed when the ambient temperature is above 30 ºC or below 10 ºC.

4.10. Safety

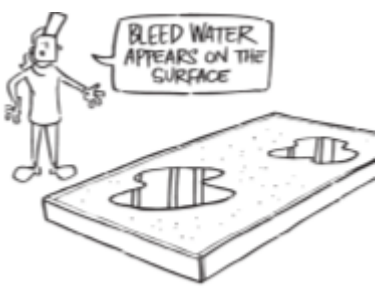
Personnel must undertake concrete work in a safe manner and use the correct personal protective equipment. Please refer to SCP006.

5. Finishing and Curing

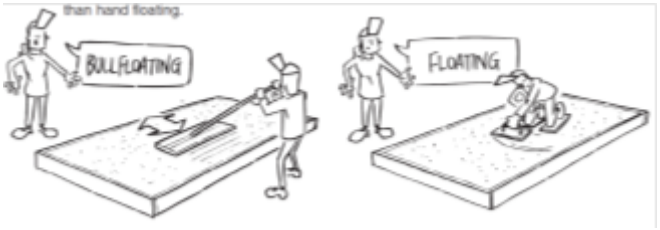
5.1. Finishing

Finishing consists of screeding, floating and/or trowelling the surface of the concrete to produce a dense surface with the required surface texture. Finishing is normally completed in two steps, **initial finishing** and **final finishing**.

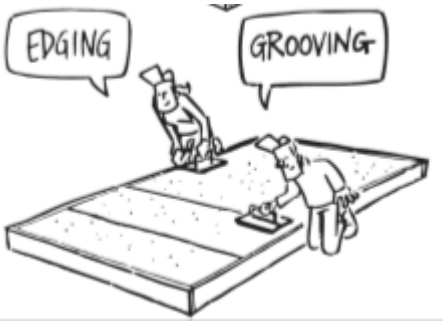
During **initial finishing** the concrete is screeded to the level of the formwork, then floated and left to “set” (normally about one hour). Depending upon the surface texture required, screeding can provide a good enough finish. Water (known as bleed water) will often appear on the surface. Never try to dry the surface by the addition of cement, sand or stone dust. Once the bleed water dries, the **final finishing** can be completed.



Floating may be required to achieve a smooth surface finish. Floating can be achieved in two stages, namely **bull floating** and **hand/power floating**.

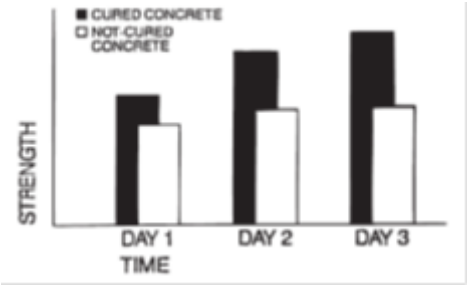


Final finishing can involve floating, trowelling, edging, jointing or patterning of the concrete.



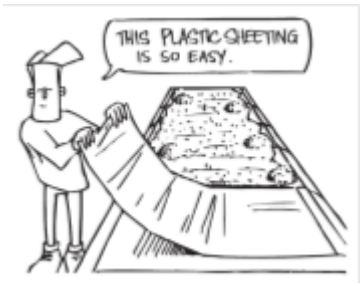
5.2. Curing

In order for concrete surfaces to be durable and hard, they need to be **cured**. Essentially curing consists of keeping the concrete surface moist or preventing the loss of moisture from the surface of the concrete. Curing must commence immediately after finishing the concrete surface and continue for at least 7 days. Care must be taken not to damage the concrete surface during curing operations, particularly early in the process while the concrete surface is still soft. Formwork must remain in place for entire curing period.



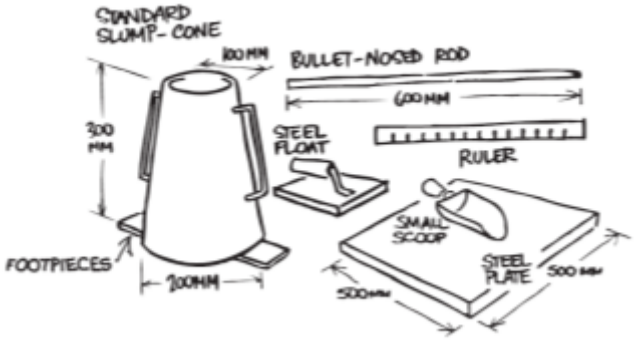
Options for curing include:

- Ponding (submerging in water)
- Sprinkling or mist spray
- Covering with wet hessian bags (hessian bags must be maintained in a wet condition for the entire period)
- Covering with plastic sheeting (sheeting must be sealed and weighed down to prevent exposure to the wind).



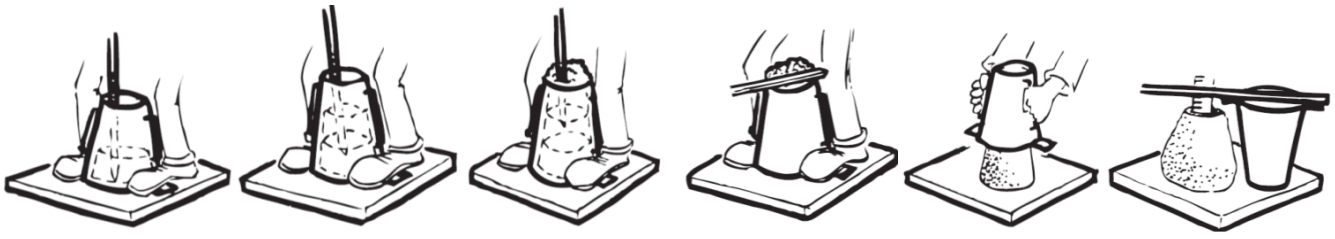
Appendix A - Slump Test

The slump is a measure of the workability of the concrete mix. A slump range of between 60 and 100 mm is normal, but is also dependent upon the mix design proportions. The tools required for the test are shown below.

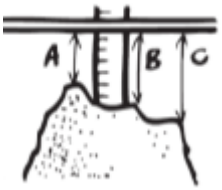


The following method for measuring the slump should be followed:

1. Clean the slump cone and dampen the inside surfaces. Place the cone on an impervious flat plate. The plate must be clean and level.
2. Place a sample of the concrete to $^{1}/_{3}$ height in the cone, while placing one foot on each foot-piece. Compact the concrete by rodding into the concrete 25 times (Step 1).
3. Fill the cone to $^{2}/_{3}$ of the height with a second sample of concrete (from the same batch) and rod the fresh layer 25 times. The depth of rodding must be just into the first layer (Step 2).
4. Fill the cone to overflowing and rod 25 times so that the rod just penetrates into the second layer (Step 3).
5. Top up the cone until it overflows. Level off the surface with the steel rod using a rolling action. Clean concrete from around the base and top of the cone. Push down on the handles of the cone and step off the cone. (Step 4)
6. Carefully and slowly lift the cone up vertically, making sure that the sample is not moved (Step 5).
7. Turn the cone upside down and place the rod across the top of the upturned cone (Step 6).
8. Take several measurements and report the average distance to the top of the sample.
9. If the sample fails by being outside the tolerance (i.e. the slump is too high or too low), another sample must be taken. If this also fails the test, the batch of concrete must be rejected



Step 1 Step 2 Step 3 Step 4 Step 5 Step 6



Average the slump measurements