PART VI.
SPECIAL CONCRETE APPLICATIONS

SLIP-FORMED CONCRETE

CEMENT CONCRETE & AGGREGATES AUSTRALIA

Slip-forming is fundamentally a concrete placing method that (in most cases) does not rely on fixed formwork to hold the plastic concrete in place until it has hardened sufficiently for formwork to be removed. It relies on the plastic concrete being sufficiently stiff to hold its shape once it is no longer being supported by the slip-form. The advantages of using slip-forming include increased speeds of placing and reduced cost due to there being (generally) no formwork involved, which reduces both materials costs and labour costs. As will be discussed, slip-forming can be used to place structures in both horizontal and vertical planes – each producing its own challenges. Slip-forming stands in contrast with the various formwork systems described in Section 27 *'Formwork'* in this Guide. While it is not unlike the climbing formwork described in Section 27, slip-forming may be more appropriately described as 'gliding formwork'.

CONTENTS

1. INTRODUCTION

Slip-forming concrete is by no means a modern construction method, with its first use occurring in the first decade of the 1900's. While slip-forming is not a commonly used method, it can be applied in a wide variety of applications where its use is appropriate, and where it provides advantages over conventional form-work systems. Slip-forming allows continuous concrete placing to occur. In the process, plastic concrete is introduced into the top of (effectively) continuously moving formwork to form a structure with no joints, and one which is not an assembly of discrete elements. The challenge is to optimise the formwork movement and the concrete performance characteristics so that the concrete exiting the formwork has hardened sufficiently to support its own weight and to resist any 'slumping' that might be caused by the placing (including compaction by vibration) of fresh concrete that is immediately adjacent to it. The main advantages of slip-forming include (a) the creation of joint-free concrete, and (b) improved cost efficiencies from not having to build and then strip formwork – with the resultant significantly lower labour costs. While in its initial applications slip-forming was used to build 'vertical' structures like grain silos, its use has now expanded into 'horizontal' applications like road paving and the manufacture of kerb and concrete road barriers. The two different approaches will be discussed separately below.

2. VERTICAL SLIP-FORMING

2.1 GENERAL

As previously mentioned, the first application of slip-forming occurred well over 100 years ago when it was used for the construction of silos and grain elevators. This activity occurred in the USA and developed over following decades to be applied not only to agricultural-related structures, but also to residential and commercial buildings. Vertical slip-forming was patented in 1917 by James MacDonald in Chicago, with the patent described as being 'for a device to move and elevate a concrete form in a vertical plane'. In the 1950's and 1960's, slip forming began to be applied more broadly in buildings in the USA and Canada, and also in mining and other industrial applications.

2.2 THE PROCESS OF VERTICAL SLIP-FORMING

In the first instance, foundations and 'wall starters' need to be constructed before the process of slip-forming can begin. These initial structures define the location of the final structure and provide a 'starting point' for the subsequent construction using the slip-forming process.

While there are a number of different approaches to slip-forming, a typical slip-forming system will comprise a structure on three levels. On the upper platform (or Top Deck) there will be equipment (e.g. reinforcing steel) storage and often a receival vessel for the plastic concrete. On the middle platform (or Working Deck) the actual concrete placement will be occurring, and it is critical that this deck is rigidly held to maintain the accuracy of the casting. On the lower platform (or Hanging Deck) workers are able to gain access to the concrete emerging from the formwork and are able to apply a finish to it if required (**Figure 19.1**).

The actual formwork – the slip-form panel – is typically 1-1.5 m high and made of steel plates. The form moves upwards at speeds that would typically be about 300 mm per hour.

Generally, the slip-form is kept full of plastic concrete, with the concrete being added in 100-250 mm layers as the slip-form is moved vertically at a rate that allows the concrete to reach initial setting when it is about 200-400 mm above the bottom of the slip-form. The slip-form panel is slightly inclined to allow the free movement of the form against the stiffening concrete. The slip-form is lifted gradually and incrementally (10-25 mm at a time) at a rate that is determined primarily by the setting characteristics of the concrete. The setting characteristics are in turn primarily determined by the nature of the cement and the ambient and concrete temperatures. Generally, no SCM's are used in the concrete for slip-forming as actual setting time and consistency of setting time are of paramount importance.

*(**NOTE**: Where fly ash has been used in concrete for slip forming, colour bands resulting from variable carbon levels in the fly ash have also been observed.)*

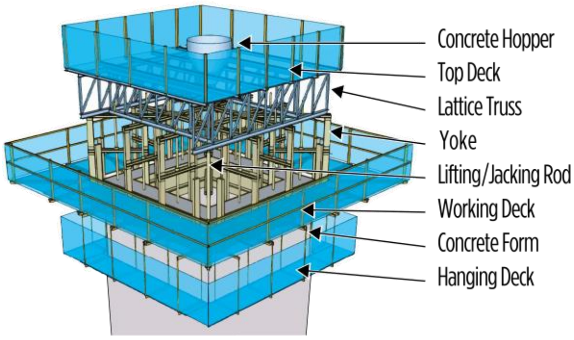

Figure 19.1 – General Structure used for Slip-forming

As important as the setting time characteristics are, so too are the workability characteristics. The concrete must have sufficient workability to be able to be fully compacted using the available compactive effort while not compromising the stiffness required in the formed concrete. Generally, the concrete mix design will have a higher than normal fines content and it has been noted that the use of rounded aggregates will improve workability. Concrete is delivered to the Top Deck either by pump or by crane and bucket and stored in a hopper prior to delivery to the slip-form.

As the slip-form moves upwards it is necessary to extend the reinforcing steel upwards. This steel is spliced or lapped against the steel already located in the lower level concrete. The extra lengths of steel reinforcing are often secured against the Top Deck to keep it in place while the slip-form moves upwards.

Accuracy of the dimensions of the structure in both the horizontal and vertical planes is critical, and it is a primary function of the other components (e.g. jacks and support elements) of the slip-forming system to maintain this accuracy. In modern systems lasers are used to measure and monitor slip-forming accuracy. The levels of deviation typically expected/required in the horizontal direction are <5 mm for structures <3 m in height, or 1/600 of the height for structures >3 m in height. This accuracy is maintained in the horizontal direction using a system of horizontal tubes or by laser measurement, while vertical plumb is maintained by laser.

Movement of the slip-forming system is achieved through a hydraulic jacking system that is required to lift the slip-form evenly to maintain the required accuracy levels and at a rate sufficient to ensure that initial setting is achieved prior to the concrete exiting the form (**Figure 19.2**).

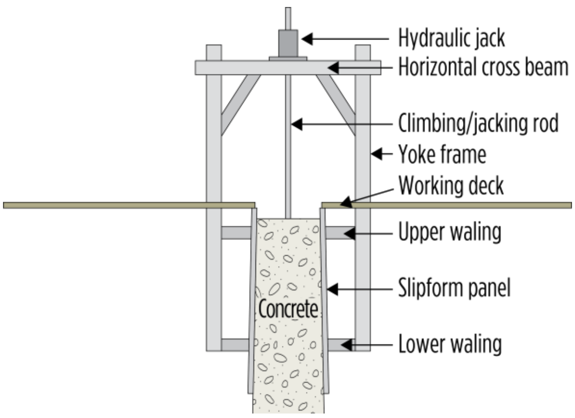

Figure 19.2 – Structural System used to Support and Raise Slip-form

While 'vertical' slip-forming is the norm, tapered slip-formed structures are also able to be produced where necessity or engineering/architectural design requires it (**Figure 19.3**).

Figure 19.3 – Tapered Slip-forming[19.1]

2.3 PRODUCTION CONSIDERATIONS

The plastic concrete is supplied, often at 75-100 mm slump, via concrete pumps or via a bucket and crane system. Vibrators are used to compact the concrete when it is being placed. There should be sufficient plastic concrete in the form to provide a buffer between the concrete being compacted and the formed concrete below, otherwise the formed concrete can be damaged by the vibrators used to achieve compaction.

The setting characteristic of the concrete is a primary determinant of the rate of slip-forming able to be achieved. The setting characteristics are a function of the type of cement being used, the concrete temperature and the ambient temperature conditions. Retarding or accelerating admixtures can be used to match concrete setting times with required or expected slip-forming rates. If the slip-forming rate is too slow (relative to concrete setting) then cold joints may be formed and/or the form may adhere to the formed concrete surface and damage it. If the slip-forming rate is too fast (relative to concrete setting) then the formed concrete leaving the bottom of the form may not be self-supporting. In practice, slip-forming rates are varied during a project because of changes in concrete setting performance.

When the slip-form is lifted, a shear zone forms on the outer edge of the plastic concrete, adjacent to the slip-form panel. This shear zone contains cement paste and fine sand particles which act as a lubricant as the panel is lifted. The lifting force required is determined in part by the workability of the concrete and the aggregate shape. The initial 'static friction' needs to be overcome – and once it is overcome the resistance to lifting is due to 'sliding friction' which can be calculated. The mix design can then be amended (in part through optimising the fines content and the air content) to ensure appropriate levels of sliding friction are able to be obtained as well as required setting times. The three key concrete mix performance properties are generally considered to be (1) slump, (2) setting time and (3) stability (i.e. lack of segregation).

Typical production rates achievable with slip-forming are heights of 3-5 m per 24-hour period, though in certain circumstances rates as low as 2 m or as high as 10 m per 24-hour period can be obtained.

While many slip-form operations are continuous, there are circumstances where (a) slip-forming needs to stop overnight (due to noise or other limitations in the inner-city) or (b) slip-forming stops over weekends for logistical considerations. In any of these cases a proper construction joint needs to be formed at the finishing point as for any other concrete construction activity.

If wall openings are required in the structure, then wooden frames and block-outs are placed into the plastic concrete at the working level and the rebar is then adjusted to accommodate the insertion. The block-outs can be stripped later from the lower platform (or Hanging Deck).

2.4 FINISHING AND CURING

Finishing of slip-formed concrete can be by two methods – wet finishing and dry finishing.

Wet finishing is applied immediately after the concrete emerges from the slip-form and entails the use of a rubber float to impart the final finish.

The dry finish is applied after the concrete has hardened and the forms have been removed. Typically, a dry finish involves the application of a skim coat or plaster to achieve a smooth final finish. Curing can be applied after the wet finish.

The quality of the surface finish with slip-formed concrete is often not as good as off-form finishes – with banding being a typical indicator of slip-formed concrete. This banding reflects the progressive vertical movement of the slip-form and, as previously mentioned, may be amplified by the presence of variable colours in the cement (or SCM's) or fine aggregates.

2.5 SPECIFICATION OF VERTICALLY SLIP-FORMED CONCRETE

The key requirements of slip-formed concrete in vertical structures and their relative importance will depend on the design of the structure and the construction program. Some typical requirements that are common to these projects are:

- A specified maximum initial set time and final set time for the concrete mix design;
- A minimum early age compressive strength at between 12 hours and 24 hours;
- A target slump on delivery that is commonly 80 mm but may be lower than this. Slump control is critical to the success of slip-forming for the purposes of achieving a uniform finish and uniform setting characteristics;
- Concrete temperature as delivered to site may also be tightly controlled with both a maximum and minimum allowable temperature likely to be applied;
- A maximum aggregate size in the concrete mix that is generally 20 mm but may be 40 mm in thicker walls (i.e. greater than 500 mm thickness);
- The general properties of normal class concrete are also specified and as the concrete is often placed using a concrete pump in vertical structures, the mix design will normally be required to be suitable for pumping.

2.6 SAFETY ISSUES WITH SLIP-FORMS

There are a number of safety considerations peculiar to the use of slip-forming. These have been considered in a Safe Work Australia (www.swa.gov.au) document *'Guide to Slip, Jump and Travelling Formwork Systems'*. The particular concerns related to slip-forming include (a) the design of these systems is often more complex than is required for conventional formwork and requires specific engineering knowledge and expertise, and (b) problems with slip-forms may not be apparent until it is actually operating which requires a 'hands on' approach and ongoing contact with site personnel when assessing issues and making modifications if and as required. Detailed consideration needs to be given to minimum concrete strengths required to deal with live loads which are influenced by environmental conditions (e.g. wind) as well as possible eccentric loading of the structures. Entry and exit systems, edge-protection and dynamic loading when concrete is being delivered to the platforms are also key safety aspects.

When the slip-form is climbing it is important to ensure (a) level is maintained across the platforms and (b) service connections (e.g. electrical cables and water supply) are not snagged as the form rises. In the unusual conditions experienced with slip-forming, rigorous systems of inspection and maintenance are required to ensure the ongoing safety of the structure and personnel.

2.7 VERSATILITY OF SLIP-FORMING

The versatility of slip-forming is illustrated by reference to a variety of projects discussed in a recent publication [1]. This reference describes a number of modern structures created using slip-forming, including:

- Platforms used for oil-drilling in the North Sea – with slip-formed heights of up to 242 m and with variable-shape components. One of the largest platforms occupied a footprint of about 16,000 m^2 and contained some 114,000 m^3 of 65 MPa concrete and about 14,000 tonnes of reinforcing steel. It was constructed over 42 days;
- LNG storage tanks of 75 m diameter, slip-formed at 2.5-3 m height increments per day with very strict tolerances;
- A 115 m high commercial building which incorporated 280 prefabricated beams which were incorporated during slip-forming – with the slip-forming operation being ceased from 10.00 pm to 6.00 am each day;
- A 143 m high concrete tower with a hexagonal base that inclined from the base to the top at an angle of 5.5°.

A range of other slip-forming projects have been completed under onerous conditions – including in both extreme heat and extreme cold – which attests to the versatility of the slip-forming process (**Figure 19.4**).

Figure 19.4 – Slip-forming of Fuel Tanks[19.2]

3. HORIZONTAL SLIP-FORMING

3.1 GENERAL

There are three main categories of concrete structures created using horizontal slip-forming, namely paving, kerb and barrier walls. The most important of these is paving and the largest volume product type produced by slip-form paving is concrete roads. While concrete roads are very common is some overseas countries, particularly the USA, they are not being used extensively in Australia, except for NSW. Major highways in NSW, like the Hume Highway and the Pacific Highway, have long stretches of concrete paving and they seem to be performing well. Their success in NSW is probably best endorsed by their continuing specification and use. While Queensland trialled concrete pavement in a couple of locations and then committed to an approximately 60 km stretch between Brisbane and the Gold Coast (which opened in about 2000), there has been no further significant commitment to concrete roads. In other states the use of concrete paving is minimal. Kerb and barrier wall, on the other hand, are routinely produced by slip-forming and extrusion processes and this is the situation nationally. Each of the slip-formed structure types will be discussed separately.

3.2 SLIP-FORMED CONCRETE PAVING

There are several types of concrete paving that can be produced by slip-forming. The three main types are (a) Plain Jointed Concrete Pavement (PCP), (b) Jointed Reinforced Concrete Pavement (JCRP) and (c) Continuously Reinforced Concrete Pavement (CRCP).

The use of paving machines for concrete roads/pavement began in about 1958 in the USA, while the first CRCP pavement was constructed in 1962 – again in the USA. Like any new technique, there was scepticism about whether concrete pavements could be reliably constructed, and particularly with those that were designed to contain reinforcing steel. There have been major engineering advances in the design, construction and operation of paving machines over the last several decades to the point where they are now considered to provide reliable and cost-efficient pavement construction. Essentially, low slump concrete is deposited in front of the machines, and in one pass of the machine the concrete is levelled, compacted and finished. The resulting pavement does not require formwork to hold it in place until setting has occurred. Post-paving there are several processes required including (a) applying a final finish by (typically) using either a tyne or a hessian drag, (b) applying curing compound by spraying, and (c) sealing joints with PCP and JCRP pavement types. Single-lane and double-lane pavers are now available, and they can place large areas of high-quality (smooth riding) pavement in a matter of hours. While most commonly used in road construction, paving machines are also used for the construction of aircraft taxi-ways.

The three main concrete pavement types (**Figure 19.5**) differ in terms of their construction and application, and these will be discussed in the following.

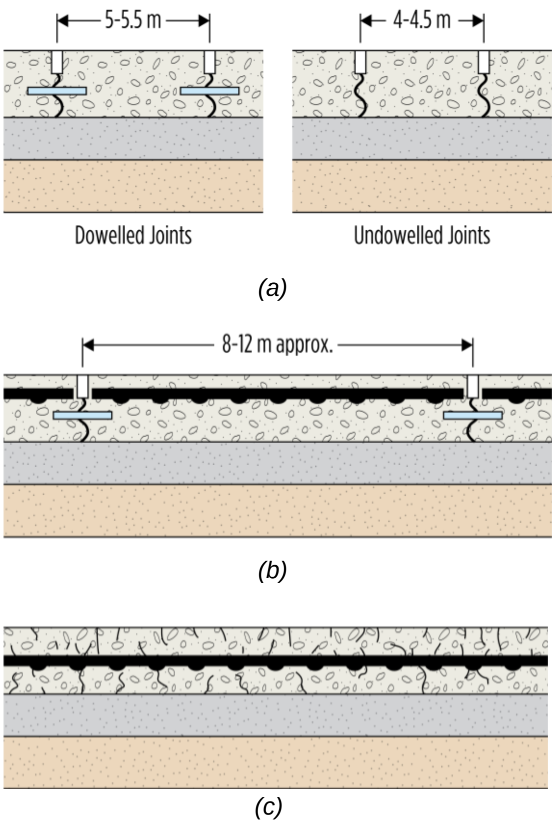

Figure 19.5 – (a) PCP;(b) JRCP;(c) CRCP

Plain Jointed Concrete Pavement (PCP) – This type of pavement can be applied to roads but is also able to be applied to airport and industrial pavements. Pavement thickness can vary between 150 mm and 300 mm depending on the load conditions expected. Joints are provided for in the pavement design, with typically 'square' slabs being created – the dimensions of each slab being dependent on factors that include the slab thickness, the type of aggregate and the joint type. Joint spacings vary from about 4 m up to 7 m, depending on the slab design and dimensions. Joints may be dowelled or not – with un-dowelled joints relying on aggregate interlock for load transfer, while dowelled joints (typically using 300 mm dowels) provide vertical load transfer from one 'slab' to the other (refer to Part I and Part V, Section 17 of this Guide for more information). The joint system protects the slab from unwanted cracking due to drying shrinkage. The joints are provided to a depth of about one-quarter to one-third the depth of the slab, while the dowels are generally located at one-half the depth of the slab. The pavement usually sits on a sub-base which may be a lean concrete or other stabilised material. As with all pavements, preparation of the sub-grade is also a strong determinant of the ultimate performance of the pavement.

Jointed Reinforced Concrete Pavement (JRCP) – This type of pavement is not now widely used but may be applied where high levels of load concentration are expected. Where used it provides control over mid-slab transverse cracking and allows much longer distances (8-12 m) between joints to be used. With the higher levels of expected drying shrinkage, dowels are necessary at each transverse joint to transfer vertical shear forces from slab to slab and to reduce load on the sub-base.

Continuously Reinforced Concrete Pavement (CRCP) – This type of pavement is used in heavily-trafficked environments where access for maintenance is limited. No joints are used in the construction of these pavements, and reinforcement is provided through the full length of the pavement – this reinforcement being held in place by transverse bars (**Figure 19.6**). The pavement does crack – with the distance between cracks (typically 1-2 m) being determined by the longitudinal reinforcement – though the cracks are sufficiently fine to not cause issues for the quality of 'ride' nor to allow aggressive materials to penetrate the concrete and attack the steel reinforcing. These pavements may be covered by a thin concrete or asphalt wearing course. The high proportion of steel in this form of pavement construction means higher construction costs, but these costs are offset by low ongoing maintenance costs.

In each type of paving, the requirements for the actual concrete used are similar. The concrete is supplied usually as a low (20-40 mm) slump material – often produced in dedicated wet-mix plants using a split drum mixer. These mixers are able to provide the high volumes required to keep the paving machine mobile and they tend to produce concrete with more consistent quality – particularly in relation to concrete slump. Inconsistencies in supply and quality are both contributors to variable ride performance of the concrete pavement – a criterion that is an important determinant of pavement quality. Managing concrete heat of hydration and concrete temperature also provides more consistency in the final cracking pattern and spacing that is achieved. Delivery of the low-slump concrete to the paver is often carried out using tippers – particularly where there is a site plant within a relatively short distance of the paving operation. Segregation of the low-slump mixes is not typically an issue over these short conveying distances (**Figure 19.7**).

Figure 19.6 – Paving Machine and a CRCP Pavement

A non-erodible base layer is important to the success of CRCP and sometimes asphaltic concrete is used. The asphaltic material provides friction which enables a good cracking pattern to develop. It also provides enduring protection beneath the CRCP.

The application of laser and GPS technologies has improved the accuracy of pavement heights and alignments compared to the wire and 'string-line' systems that were used decades ago. The precision and continuity of paving that these provide also assists in improving the 'ride' quality.

While there is no debate about the cost-effectiveness of concrete road pavements from an economic perspective (see CCAA Marketing Sheet, March 2018) when compared with other common alternatives, it is also clear that without some surface treatment(s) concrete roads are noisier than asphalt pavements. Treatments like 'diamond grinding' to lower noise levels and the use of surface coatings (like open-graded asphalt) have been used in some situations to reduce road noise to acceptable levels.

Figure 19.7 – Concrete Supply by Tipper to a Paving Machine

3.3 KERB PRODUCTION

The importance of kerb is often understated or misunderstood. Kerb serves a number of functions related to safety and engineering function of roads including (a) directing stormwater to drains, (b) providing a clear border between the paved surface and adjacent areas (e.g. paths), (c) acting as transition areas, and (d) helping to minimise deflection of the pavement surface. Many years ago, kerb was hand-placed, but is now generally machine-placed using dedicated kerb machines that effectively slip-form (or extrude) the kerb (**Figure 19.8**).

3.4 KERB MIX SPECIFICATION

An Australian Standard (AS 2876 *'Concrete kerbs and channels'*) provides guidance in relation to concrete quality and performance.

The Australian Standard defines the mix to be a special class concrete as it is not specified by a standard compressive strength. The Standard sets minimum cement contents – these dependent on the nature of the adjacent road (**Table 19.1**). The kerb concrete as tested by the supplier (to AS 1012) will be fully compacted in accordance with AS 1012 and therefore produce a compressive strength on testing that is higher than levels that will be achieved in the kerb as placed.

The requirements for kerb concrete relate to its ability to (a) be able to be slip-formed and (b) achieve adequate strength performance in place. Kerb must be able to be formed through the kerb machine and retain its formed shape without formwork. This requires a stiff, low water content mix – one that usually has a specified maximum aggregate size of 10 mm (and sometimes 7 mm or 5 mm) – and is produced with a slump of 10 mm ±5 mm. The

Standard allows workability to be modified, noting 'water addition on site should be adjusted by the person in charge of placement'. Compaction with these stiff mixes can be problematic and AS 2876 requires that if cored, the placed kerb should have a density of not less than 95% of that achievable with the batched concrete. As kerb is generally coated immediately after 'extrusion' with a cement-based slurry, it is possible that any compaction problems will not be easily detected.

Figure 19.8 – Kerb Construction[19.3]

Table 19.1 – Minimum Cement Contents for Kerb Mix

Class of Road	Minimum Cement (kg/m^3)
Local Roads	240
Collector Roads	280
Main Roads	320

***NOTE**: Maximum aggregate size is 20 mm.*

The quality of concrete kerb is dependent on a couple of key items namely (a) the machine and the experience/competence of the operator, and (b) the quality of the sub-base or sub-grade. If the surface on which the kerb is placed has not been wetted down prior to placement then it is possible that it may absorb water from the dry kerb-mix which may lead to problems (e.g. achieving compaction). Some contractors prefer to place the kerb concrete in a dry state as they are able to achieve more lineal metres of kerb with less concrete – which is easier to do on downhill runs.

*(**NOTE**: Some specifications require that any coring of kerb be carried out on locations in the kerb where there is the steepest incline.)*

As is the case with road paving, the advent of laser and GPS technologies and their use on kerb machines has led to more accurate placement of kerb.

3.5 BARRIER WALLS

Barrier walls and similar cast-in-place structures (e.g. V-drains, mine walls, feedlot troughs) can be effectively produced using slip-forming in an effectively continuous process producing elements with no joints – these replacing numbers of discrete elements which would otherwise need to be transported to site. A wide variety of moulds is available to produce a range of structures.

The most common of these structures is the road barrier (or jersey barrier) which are now a common feature on multi-lane roads (**Figure 19.9**). Similar structures can also be made to separate roads from tunnel walls in an effective way. The concrete requirements for the production of barrier walls etc are similar to those for other slip-forming processes. Reinforcing steel can also be incorporated in these structures.

Figure 19.9 – Barrier Wall Under Construction[19.4]

Once again, the use of laser and GPS technologies has led to more precise and accurate positioning of barrier walls in road construction in particular.

3.6 BARRIER WALL CONCRETE MIX SPECIFICATION

Like kerb mix concrete, the barrier wall concrete mix design specification is dependent on both the machine being used for placement and the specifying authority. The finish of the formed concrete surface and ability to retain its formed shape after leaving the machine forms are crucial even though some manual finishing is generally applied to the surface.

Some common specification requirements for the concrete are:

- A specified characteristic compressive strength at 28 days (typically 32 MPa or 40 MPa);
- The concrete mix is normally specified as having a 20 mm maximum size aggregate;
- The slump of the concrete is critical to retaining its form after slip-forming. Typically, the mix will be specified as having a target slump between 40 mm and 80 mm depending on the machine used;
- The concrete may be specified as containing fibres (normally synthetic) with the aim of improving the barriers' impact resistance;
- The concrete is generally specified with a target air content with tight limits on its variability. The target varies between 4.0% air and 4.5% air (with a minimum tested value of 3.5% and maximum of 5.0% in most cases).

The entrained air aids the ability of the concrete to hold form at the specified slump. The tight limits on air content and the requirements to hold form may limit the use of larger quantities of fly ash in these mix designs.

4 RELEVANT AUSTRALIAN STANDARDS

1) AS 1012 – *Methods of testing concrete*
2) AS 1379 – *Specification and supply of concrete*
3) AS 2876 – *Concrete kerbs and channels*
4) AS 3610.1 – *Formwork for concrete, Part 1: Specifications*

5 OTHER REFERENCES

1) Fossa, KT; Kriener, A; and Moksnes, J., *'Slipforming of advanced concrete structures'*, in *'Tailor Made Concrete Structures'*, Walraven and Stoelhorst (Eds.), Taylor and Francis Group, London (2008), ISBN 978 0 415 47535 8
2) CCAA, *'Guide to Off-Form Concrete Finishes'*, CCAA T57 (2006)
3) CCAA, Briefing 15, *'Sustainable Concrete Roads'* (October 2010)
4) CCAA Marketing Sheet, *'Concrete Roads – better value across the life of a project'* (March 2018)
5) Safe Work Australia*, 'Guide to Slip, Jump and Travelling Formwork Systems'* (July 2014), www.swa.gov.au

End Notes:

19.1 Photo adopted from '*Off shore oil platform (of Condeep type) under construction in Norway*', by Bluemoose, licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license, https://commons.wikimedia.org/wiki/File:Oil_platform_Norway.jpg

19.2 Photo adopted from '*Slipform Bitschnau Silo*', by Bitschnau, licensed under the Creative Commons Attribution-Share Alike 4.0 International license, https://commons.wikimedia.org/wiki/File:Gleitschalung_Bitschnau_Kohlesilo_L%C3%BCnen.jpg

19.3 Photo adopted from '*A curb being poured for the Poinciana Parkway, along Kinney Harmon Road, near Loughman, Florida*', by Osceola County Expressway Authority, licensed under Public Domain license, https://commons.wikimedia.org/wiki/File:Curb_pour_for_Poinciana_Parkway.jpg

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