

DEC 2017

## RESIDENTIAL Concrete Driveways and Paths

### INTRODUCTION

The basic function of residential pavements such as driveways, paths and patios is to provide safe, easy access onto or around a property. Concrete is typically used to not only provide a durable paving surface, but one which can also incorporate a wide range of decorative finishes to complement the design and landscaping of the residence.

While providing a concrete pavement on the ground is relatively straightforward, there are many aspects of residential pavement design and construction that need to be considered in order to produce a finished product that will satisfy both the functional and aesthetic requirements demanded by home owners.

This Data Sheet provides guidance on the planning, design, construction, maintenance and specification aspects that need to be considered to ensure a successful concrete paving project.

### PLANNING

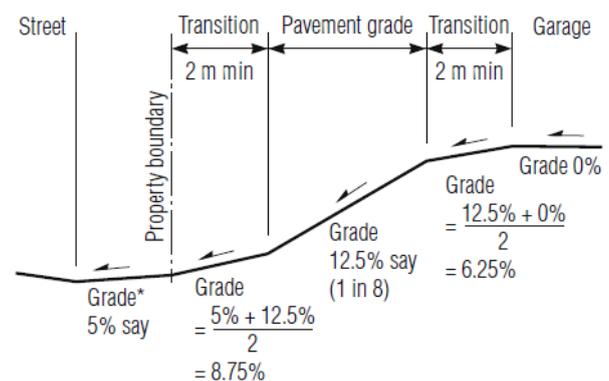
#### Footpath Area

Pavements between the “kerb-and-gutter” and property boundary will generally have to comply with the requirements of the Local Authority in respect of levels, grades and minimum details (thickness, reinforcement and minimum concrete strength). These requirements will vary with different Local Authorities and should be determined initially, as they may affect the grades (and possible need for transition zones) for the remainder of the driveway, especially on steep slopes with short distances from the boundary to the house.

#### Pavement Grades

To allow adequate drainage of the surface, the recommended minimum grade or cross-fall for a pavement is generally 1 in 100 (1%), or 10 mm per metre. The maximum grade should not exceed 1 in 20 (or 5%) in the footpath area or 1 in 4 (or 25%) within the property boundary. Note that as the actual requirements may vary from these limits, especially in hilly areas, it is always advisable to check this with the relevant Local Authority.

Where grades steeper than 12.5% are necessary for driveways or where vehicles have low ground clearance, a transition zone at either end of the steep section may be required to prevent vehicles from ‘bottoming’ on the driveway (see Figure 1).



\* The advice of the Local Authority should be sought to obtain grade requirements for the area between the street and property boundary.

Figure 1: Transition zones for driveways

## Drainage

The storm-water drainage system (including pavement levels and/or falls) should ensure that there is no ponding deeper than 10 mm on the surface 15 minutes after the cessation of rainfall.

Where a pavement can't be graded away from a building (e.g. driveways that slope toward the house), a suitable drain should be provided adjacent to the building to divert storm-water run-off.

## Trees

The presence of trees adjacent to the pavement may cause soil movements that change the ground levels and result in cracking of the pavement. Particularly with expansive clays, the moisture drawn by tree roots can dry the soil, causing it to shrink and affect the pavement levels. More directly, tree roots may find their way under the pavement and cause damage by lifting sections of the slab.

Further information can be found in BTF 18<sup>3</sup>.

## Adjacent Structures

Where driveways and pavements are constructed adjacent to houses and other structures, a number of items may need to be considered:

- **Termite barriers.** It is important not to construct the pavement at a level that will obstruct any required visual termite inspection zone.
- **Finished levels.** The National Construction Code <sup>2</sup> (NCC) requires paved areas that have a slope away from the building of at least 50 mm (25 mm in Low Rainfall Areas) over the first 1 m from the building to be at least 50 mm (100 mm in Low Rainfall Areas or with sandy, well drained soils) below the finished surface of the adjacent slab-on-ground. This minimum height may need to be increased if the required slope can't be provided, there is a possibility of flooding, or local plumbing regulations require specific heights between the overflow relief gully and drainage fittings and ground/paving level.
- **Flashings and damp-proofing courses.** The NCC requires that the height of a damp-proofing course or flashing serving as a damp-proofing course be at least 75 mm above the finished surface level of the paving adjacent to the wall.
- **Sub-floor ventilation openings.** If any existing sub-floor ventilation openings are covered by the paving, the NCC requires new openings to be provided to reinstate the required ventilation area.
- **Ground Movement.** In clay soils, the moisture content of the soil beneath areas of large paving may change over time, possibly causing movement of the soil and consequent changes to the paving and adjacent building levels. The possible effects of this movement on the drainage and adjacent walls should be considered.

## Surface Finish

While the range of surface finishes possible with concrete is too extensive to cover here, a surface finish appropriate for the application must be selected. Items to be considered when selecting/specifying finishes include:

- **Grade of pavement.** Steep pavements generally require a coarse surface texture to provide skid and slip resistance, especially if a surface sealer is applied. Depending on the grade, steel troweled, polished, stamped and smooth aggregate type finishes may be unsuitable. Coarse broom, tined, dragged and stenciled finishes would be more suitable. Also, exposed aggregate finishes may require an angular (crushed) coarse aggregate instead of a smooth rounded coarse aggregate.
- **Slip resistance.** Some surface texture is required to provide slip resistance, particularly in wet conditions. Note that if the pavement is subject to barefoot traffic (e.g. around a pool) the texture should not be too coarse. Suitable finishes for these applications include wood float, light broom and smaller sized smooth exposed aggregate.
- **Cleaning.** For pavements subject to spills (e.g. barbecue, outdoor kitchen and eating areas), smooth finishes are the most appropriate since they are easier to clean and maintain. Use of a surface sealer can prevent spillage from penetrating the concrete and facilitate cleaning.

## DESIGN

### Concrete - Strength

The majority of concrete used in residential pavements is 'Normal' class concrete with a minimum strength of 20MPa (i.e. N20 concrete) in accordance with AS1379<sup>1</sup>. A higher strength may be required in certain situations, for example:

- **Heavier Loads.** If the pavement is being used by vehicles between 3 ton and 10 ton gross mass, and infrequently by heavier vehicles that do not exceed the statutory limits for tyre, wheel and axle loads, an N25 concrete is recommended. Pavements for heavier vehicles than this will require more detailed design by a qualified engineer.
- **Abrasion Resistance.** This is the ability of the concrete surface to resist wear. It is directly related to the strength of concrete and the quality of the surface finish. An N20 concrete is satisfactory for most residential paving applications, including typical driveways. For use by heavier pneumatic-tyred vehicles up to 3 ton, an N25 concrete is recommended, and for pneumatic-tyred vehicles over 3 ton, an N32 concrete will be required (AS3600<sup>2</sup>).
- **Freezing and Thawing.** An S32 concrete should be used if the pavement is subjected to occasional exposure to freezing, and an S40 concrete where more than 25 freezing cycles occur each year. Also, an air entraining agent should be used in the concrete mix to achieve air content between 4% and 8%. (See AS3600 <sup>2</sup>).

- **Salinity.** If salts are present in the soil or groundwater, increasing the concrete strength to provide improved durability is advisable<sup>5</sup>. An N25 grade concrete is recommended for moderately saline soils, N32 for very saline soils and N40 for highly saline soils (refer also AS3600<sup>2</sup>). Also, a plastic membrane should be provided under the pavement to reduce the risk of a white deposit of salts (efflorescence) developing on the surface.

### Concrete - Other Properties

If properties other than strength are required, a 'Special' class (e.g. S20 or higher grade) rather than normal-class concrete should be specified. For coloured and decorative pavement finishes, some of the properties (apart from the strength) that may be required include:

- **Colour pigments.** Supplier, colour and percentage by weight of cement to be used will need to be specified.
- **Aggregates.** Any information necessary to identify the coarse aggregate required – size, type, texture, colour (e.g. nominal 10-mm aggregate consisting of 90% brown rounded river gravel and 10% crushed white quartz).
- **Cement colour.** Normal grey, off-white or white. Note that the availability of these should be checked prior to specifying. An alternative to achieve a lighter colour is the use of a white colour pigment.

### Concrete Thickness

Pavements for foot traffic only (e.g. paths and patios) should have a minimum thickness of 75 mm. Pavements for vehicles less than 3 tonne gross mass should have a minimum thickness of 100 mm. Pavements for vehicles between 3 tonne and 10 tonne gross mass and infrequent use by heavier vehicles that do not exceed the statutory limits for tyre, wheel and axle loads, should have a minimum thickness of 150 mm. Pavements for heavier vehicles than this will require more detailed design by a qualified engineer.

### Reinforcement

The use of steel reinforcement or mesh does not increase the load capacity of the pavement, or affect its thickness. Its function is mainly to hold tightly closed any cracks that may form. In general, the amount of reinforcement required to provide the appropriate degree of crack control will depend on the thickness of the slab and the joint spacing. A guide to the minimum reinforcement used in slabs for different conditions is provided in AS3600<sup>2</sup> sections relating to "Crack control for shrinkage and temperature effects". These requirements on common slab formats are given in Table 1.

**Table 1 – Common slab formats and reinforcement**

Type	Minimum Thickness	Maximum Joint Spacing	Minimum Steel Reinforcement (Minor Crack Control)	Minimum Steel Reinforcement (Moderate Crack Control)
Footpath	75mm	2.0m	1 Layer SL52	1 Layer SL92
Pavement	100mm	3.0m	1 Layer SL72	1 Layer SL102
Pavement	150mm	5.0m	1 Layer SL92	2 Layers SL92

Where decorative finishes are required or other concrete pavements where better control of cracking may be required (so that any cracking does not significantly affect the finished concrete appearance or performance), increasing the steel quantity to more than that for "Moderate Crack Control" in Table 1 may be required.

### Joints

Joints in concrete pavements fall into two basic categories: those that allow movement (isolation and expansion joints) and those that control cracking of the concrete (control or contraction joints). A further type, construction joints, used when there is a break in concrete placement, is rarely required in residential pavement work.

Isolation joints are used to separate the pavement from any abutting buildings, existing pavements, or rigid structures (such as drainage pits, access holes or columns) which may cause restraint of the pavement and thereby increase the risk of cracking.

Expansion joints are used in large areas of paving to accommodate expansion, primarily due to elevated temperatures during periods of hot weather. They should be provided at maximum 15 metre centres.

Control joints typically form a weakened plane at which the concrete cracks. Without them, drying shrinkage will result in random cracking that may be unsightly. Control joints should be provided at maximum 3 metre centres, at any changes in shape (e.g. a narrow path attached to a driveway), at any changes in direction (e.g. around corners, especially where a re-entrant corner may be formed), and at any rigid structures (e.g. access holes, pits, columns) that may prevent movement and increase the risk of cracking.

Wherever possible, the location of joints should be planned. A typical layout of joints in the paving to a residence is shown in Figure 2. Note that one aim should be to make the concrete panels defined by joints roughly square in shape. The ratio of width to length should not exceed 1:1.5.

For decorative work, joints should be located to suit the proposed decorative pattern or finish where possible. With all joint types, the angles formed at edges and intersections of joints should not be too acute, as this increases the risk of cracking and/or breaking off the tapered section of concrete. A good detail in these situations is to keep at least 500 mm of the joint at as close as right angles to the slab edge as possible (see Figure 3).



### Surface Tolerances

Pavements generally have to meet two independent tolerance criteria: the 'flatness' of the surface and 'levelness' or variation from the designed elevation. Both of these should be specified.

The flatness tolerance gives the permitted variation from a 3 metre length "straightedge" placed on the surface. For hand-placed pavements, a reasonable flatness tolerance is a maximum deviation or gap of 12mm under a 3 metre length "straightedge" placed anywhere on the pavement surface, including on slopes.

The levelness tolerance gives the permitted variation of the slab surface from a fixed external reference point or datum. A reasonable tolerance for the surface of a newly-constructed pavement would be  $\pm 10\text{mm}$  from the designed level or elevation. For sloped surfaces, a maximum deviation of 10mm from a line joining the 'control' points (i.e. the levels at the top and bottom of the slope) is recommended.

Note that the minimum slab thickness should be maintained across the entire slab surface.

### Permeable Pavements

For environmentally sensitive areas, permeable concrete which allows water to infiltrate through the pavement is available. Information on these types of pavements is outside the scope of this document but can be found in the CCAA data sheet addressing this subject <sup>6</sup>.

### Segmental Pavements

Concrete segmental pavers ranging from small brick-sized units to the larger flag pavers are available in a variety of colours, finishes and textures.

Information on segmental pavers is available from the Concrete Masonry Association of Australia <sup>7</sup>.

## CONSTRUCTION

### Subgrade Preparation

The preparation of the subgrade (supporting ground) for residential pavements is a relatively simple process as typically the loads are light. All topsoil (which may settle) should be removed and the area levelled to provide a uniform platform for the pavement. For heavy loads, the ability of the subgrade to adequately support the loads without excessive deflection and cracking of the pavement needs to be considered.

A reasonably uniform foundation is essential to the long-term performance of a concrete pavement. An assumption that a concrete pavement will bridge over a poor subgrade could lead to a false sense of security. Thus, any poor quality, saturated, highly compressible or otherwise weak areas should be removed. This is replaced with suitable subgrade or road-base material, adequately compacted with a plate compactor or small roller, to avoid subsequent settlement. The same applies to the backfilling of service trenches.

A level area also minimises the friction between the pavement and ground. This reduces the restraint of the pavement, and in turn, the risk of unplanned cracking.

### Sub-base

On highly expansive clay subgrades, significant volume changes can occur in the soil resulting in non-uniform support of the slab, and subsequently early slab failure. Potential problems can be minimised by appropriate pavement design, the provision of a sub-base, or stabilisation of the subgrade material.

The function of the sub-base (or cover layer) is to minimise moisture migration under the pavement, and hence changes in both the moisture content and volume of the underlying expansive soil (see Figure 4). It also provides more-uniform slab support by equalising minor subgrade defects. The appropriate thickness of the non-expansive sub-base layer depends on the site conditions and local experience. In the majority of cases, a 100mm thickness is recommended.

Alternatively, a layer of the existing clay soil may be stabilised (generally with lime or cement) to enhance its stability under conditions of alternate wetting and drying.

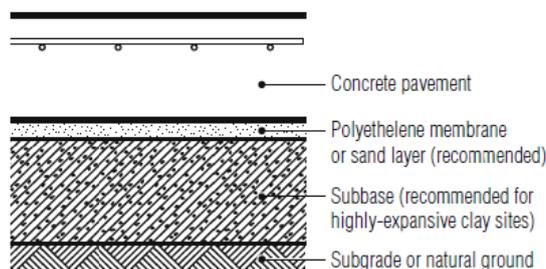


Figure 4: Typical pavement cross-section

### Reducing Friction under the Slab

Providing polyethylene sheeting or a 20mm thick layer of sand beneath the pavement is an effective way of reducing the friction between the slab and subgrade/sub-base. Compared to placing the concrete directly on a plastic soil such as clay, the frictional force (and hence restraint of the slab) can be more than halved. This allows the concrete slab to move more freely as a result of factors such as drying shrinkage and thermal expansion and contraction. Thereby this reduces the risk of the pavement cracking.

If using sand, it is important that the percentage of fine material such as silt and clay be limited by ensuring the materials used will comply with the requirements of AS2758.1<sup>8</sup> for fine aggregates. This ensures that the material does not bind together leading to restraint of the slab movement.

### Reinforcement Fixing

The reinforcement (usually welded steel mesh) should be located within the top half of the pavement, and have a minimum 30mm of concrete cover to the top surface of the slab.

It should be fixed in position using suitable supports or “bar chairs”, spaced at maximum 800mm centres to prevent sagging of the reinforcement during concrete placement. Note that for light meshes (SL52 and SL62), the spacing may need to be reduced to prevent sagging.

Mesh should not be walked into position or lifted to height using a hook during concrete placement. Nor should the concrete truck be driven over it to gain access for concrete discharge.

Where sheets of mesh are joined, they should have a minimum overlap of two cross wires (i.e. the two outermost cross wires of each sheet are overlapped).

### Formwork

Formwork should be secured accurately in position to maintain lines and/or shape during concrete placement, and set to the correct levels so as to provide a guide for the finished surface levels and tolerances.

### Addition of Water to Concrete

No water (in excess of the mixing water required to achieve the specified slump of the concrete) should be added to the concrete mix as this will increase the water-cement ratio, resulting in a lower strength concrete that is less able to resist the surface abrasion and wear caused by traffic.

Also, excess water will generally increase the drying shrinkage of the concrete, which in combination with reduced strength, may increase the risk of either unplanned cracking, or crack widths wider than would normally be expected.

### Placing of Concrete

Concrete placement should commence from one corner of the pavement and proceed continuously out from that point. New concrete should always be deposited onto the face of the concrete already placed to ensure interblending, avoid “cold joints” forming and avoid segregation (i.e. the separation of the aggregate from the cement paste within a concrete mix), which may lead to honeycombing in the hardened concrete. When placing concrete the following should be considered:

- **Transport.** The majority of concrete is delivered from the concrete truck to its final location by a concrete pump. If a wheelbarrow is used, a typical placing rate of about 1 m<sup>3</sup>/hour to 1.5 m<sup>3</sup>/hour can be achieved. The travel distance is limited to about 50 metres for continuous work, and a relatively level, smooth access is required to avoid jolting and possible segregation of the concrete.
- **Water.** Any water ponding on the ground should be removed prior to placing the concrete to avoid problems with increasing the water/cement ratio, segregation and washing out of cement paste from the aggregate. All of which can reduce the strength and durability of the concrete.

- **Segregation.** Segregation should be avoided by placing concrete as near as possible to its final location. Concrete should not be made to flow into its final position through the use of say immersion vibrators, or be dropped from heights of more than 2 metres.
- **Slopes.** Concrete placement should commence at the lowest point when forming a sloping pavement to avoid difficulty in maintaining pavement surface tolerances.
- **Hot and cold weather conditions.** Concrete should not be placed at ambient temperatures higher than 30°C or lower than 10°C without taking the appropriate precautions. If the concrete temperature exceeds 35°C or falls below 5°C concrete placement should not be undertaken.  
In hot weather, the main concerns are cracking of the surface due to rapid drying and loss of strength due to inadequate curing. Flaking of the surface may also occur as the rate of drying may exceed the rate of bleeding of the concrete before setting. This leads to premature finishing of the slab or the application of subsequent surface coatings/treatments. The use of wind breaks, shade covers and application of an evaporative retarder such as aliphatic alcohol should be considered. In cold weather, delayed setting with longer finishing times, slower strength gain and even freezing of the surface are of concern. Concrete should be protected from freezing for at least 24 hours after finishing.

### Compaction of Concrete

Adequate compaction of the concrete significantly reduces its porosity, increases its strength, enhances the pavement surface abrasion resistance and general durability, and minimises the risk of cracking. Any deeper sections of the pavement such as edge thickenings and downturns should be compacted using an immersion vibrator. Slabs on ground that are 100mm or less in thickness, adequate compaction can usually be achieved through the placing, screeding and finishing processes. Sometimes, surface vibration will be used in the form of a small hand-held vibrating screed. Immersion vibrators are not recommended for 100mm thick slab-on-ground construction as the slab depth does not allow proper immersion of the vibrator head, and the plastic membrane (if present) may be damaged.

### Surface Finishes

Slip-resistant and skid-resistant concrete surfaces can be achieved by the appropriate texturing during the finishing operations. The term ‘slip’ refers to pedestrian traffic while ‘skid’ is the term used for vehicular traffic. A wooden or sponge float finish is generally suitable for foot traffic on level or near-level paving. Broomed finishes can produce a greater degree of skid resistance, suitable for vehicular traffic. For greater skid resistance on ramps, a steel tynd comb can be used to groove the concrete surface.

Compaction of the surface of the concrete by troweling will improve the strength and abrasion resistance, thereby assisting to maintain the skid resistant properties of the surface. It is important that the surface be troweled either prior to the finish being applied (i.e. broom finish) or during the process of applying the finish (i.e. colour surface toppings) where possible.

Given the range of decorative products, finishes and finishing techniques available, the suitability of the finish for the intended purpose should be confirmed with either the manufacturer or applicator. Where a surface sealer that may affect the texture is applied, care should be taken to ensure the finished surface provides the necessary slip and skid resistance. Incorporating silica dust or carborundum dust in an applied sealer is another technique to either maintain or improve the slip/skid resistance.

### Curing of Concrete

Residential pavements for foot and light vehicular traffic should be cured for a minimum period of 3 days. This should be increased to 7 days if located near the coast (within 1 km) and/or subject to heavier traffic. Curing allows the concrete to achieve its potential strength and durability. When concrete is not cured (i.e. is allowed to dry out quickly), a significant reduction in its strength results. The reduction of concrete strength has a significant effect on abrasion resistance of the surface of the pavement when used by vehicular traffic. One of the main contributors to surface wear and dusting problems is the reduction in strength due to inadequate compaction and curing. Typical methods of curing concrete pavements include covering the concrete with an impermeable membrane (e.g. plastic sheeting, chemical curing compound), or keeping any exposed surfaces continuously wet (e.g. ponding or "mist" spraying with water). Wetting at intervals (e.g. in the morning and afternoon) does not keep the concrete continuously moist, particularly in hot weather conditions. This practice may be detrimental to the concrete surface durability – as such is not regarded as a suitable method. Black plastic should not be used for curing of external surfaces in hot weather, as this may increase heat gain and cause problems with slab cracking and curling. Coloured concrete pavements should not be cured with plastic sheeting, damp sand or wet hessian, as these materials may promote uneven colour or staining of the surface. Chemical curing compounds that are compatible with the sealer or the sealer itself (if the sealer complies with the requirements of a chemical curing compound) should be used for these types of decorative pavements.

### Joints

Isolation joints (see Figure 5) should not impede any relative movement. This may be horizontal, vertical or both and may include rotation. While movement from concrete drying shrinkage will normally cause the joint to open with time, temperature changes may give rise to joint closing movements.

Expansion joints (see Figure 6) typically have dowel bars connecting the slabs to provide load transfer and avoid changes in the levels from one slab to another. For example, a 100mm thick pavement intended for vehicles less than 3 tonne gross mass could use 12mm diameter dowels at maximum 400mm centres. Control joints (see Figure 7) can be made by:

- Inserting a pre-moulded strip into the concrete as it is being placed;
- Use of a grooving tool immediately after the concrete has been placed; or
- Sawing a groove when the concrete has hardened sufficiently to prevent raveling.
- Using a proprietary pressed metal key joint.

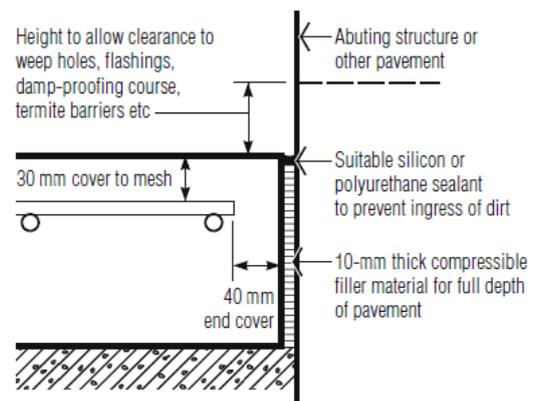


Figure 5: Typical isolation joint

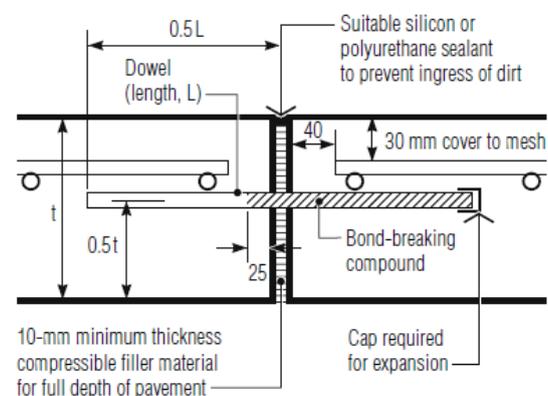
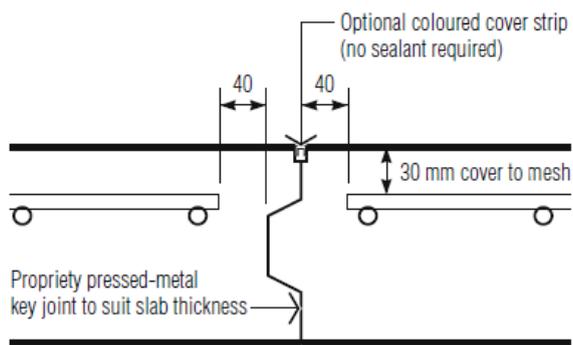


Figure 6: Typical expansion joint



(b) KEY JOINT (PRESSED-METAL OR FORMED)

**Figure 7: Typical control joint**

Note that:

- If joints are saw cut, these should be installed prior to shrinkage cracking occurring. As a guide, saw cuts should be made not more than 12 hours after finishing of the slab if temperatures exceed 25°C, and not more than 16 to 18 hours after finishing of the slab for lower temperatures. To avoid delays, early-age saw cutting (i.e. the same day) is possible using specialised equipment. The surface should be thoroughly cleaned after cutting to avoid staining.
- If joints are wet-formed by scoring the plastic concrete with an edging tool (tooled joint), ensure that the groove does not fill with cement slurry and render the joint less effective.
- If joints are formed by using proprietary pressed metal key joints, they should be securely fixed in position to maintain straight lines during placement of the concrete.
- While reinforcing mesh will normally be terminated 50mm away from control joints, it may extend across the joint to provide better control of differential, vertical movement across the joint. This may result from curling of the slab or movement from the impact of highly expansive clays. In this case, 50% of the mesh should be cut to assist in the formation of a plane of weakness at the joint location. To allow some tolerance in the location of the saw cut, crack inducer or tooled joint, the ends of cut wires should be at least 50mm clear of the proposed joint location.

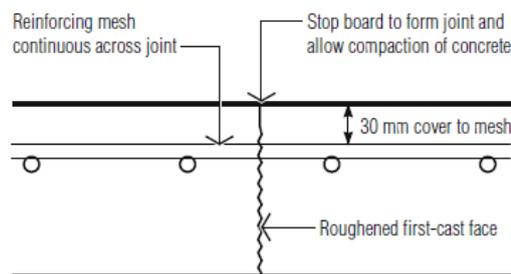
A construction joint (see Figure 8) is used to accommodate an unplanned break in concrete placement. The joint should be formed to allow adequate compaction and finishing of the concrete along the edge. Once the concrete has hardened, the formwork is removed, the edge roughened to provide aggregate interlock across the joint and the new concrete placed against the existing edge.

### Joint Sealants

Many types of joint sealants are available. For pavements, high-performance sealants such as polyurethane or silicone should be used.

They are supplied in cartridges for easy use with a caulking gun, come in a range of colours to suit various decorative finishes and are UV light resistant. While the life of the sealant depends on a number of factors, the following basic rules concerning their use should be observed to achieve adequate performance:

- **Joint preparation.** The surfaces should be clean, dry and primed if necessary. Applying sealants to 'green' concrete can result in bubbling and loss of adhesion. The surface temperature should be above 5°C.
- **Joint geometry.** For typical joints, the cross-sectional depth of the seal should be at least half the width, and never greater than the width.
- **Backing systems.** To perform adequately when the pavement moves, sealants should adhere only to the sides of the joint. While the joint filler will normally ensure this, a backing rod may sometimes be necessary to achieve the required joint geometry.
- **Setting time.** The setting time of the sealant determines when it can be brought into service, or when the pavement can be used. Polyurethane sealants will cure at a rate of about 2-3mm of depth per day in temperatures over 5°C. Fast-curing and two-part products will be marginally faster. Silicones skin quickly but have a slower cure-through-depth – time hours after finishing.



**Figure 8: Typical construction joint**

### Surface Sealers

Sealers are used to prevent staining and to facilitate cleaning of the concrete surface. They should be applied after the curing period and when the concrete has dried out sufficiently to allow the sealer to penetrate into the concrete surface. Note that some sealers may also function as a chemical curing compound and should be applied after finishing. Some sealers may also be tinted and thus provide both a seal and a coloured finish.

As the penetration of sealers into the concrete surface varies, their suitability for a particular application should be discussed with the manufacturer. Steep driveways warrant special consideration as non-penetrating sealers that form a film on the surface can reduce slip and skid resistance. This type of sealer is generally not suitable for this application unless the surface texture applied to the concrete is coarse enough to still provide adequate slip and skid resistance. Penetrating sealers or those with slip-resistant properties are recommended for steeper grades.

## MAINTENANCE

### Cleaning

Cleaning should be undertaken as soon as possible following contamination or staining. Extending the area to be cleaned may also be necessary to achieve a uniform surface appearance.

High-pressure water is typically used for general cleaning. A range of chemical cleaning products such as bleaching agents and acid-based solutions are also available to remove specific types of stains.

Consideration needs to be given to the environmental effects along with the corrosiveness of the chemical and its effect on surface sealers and/or the colour and texture of the surface.

For colour-sensitive situations, the use of mild detergent and steam cleaning should be considered initially. Milder chemicals such as oxalic acid should then be tested before resorting to harsher chemicals.

### Resealing

Numerous sealers in a range of categories are available. Each sealer will offer different degrees of protection. Depending on the extent of abrasion, wear and performance of the sealer itself, replacement will be required after a number of years. Note that penetrating sealers permeate and close off the small pores in the concrete, and are thus protected by the abrasion resistance of the concrete itself.

Due to the different types of sealers available, the sealer used should be noted so that a compatible sealer can be reapplied at a later stage if required.

### Assessment of Cracks

Adopting good design, detailing and construction practices as outlined in this document will minimise the risk of cracking. Even when following these procedures there will be situations where cracks may occur as a result of movements in concrete due to changes in its moisture content and temperature. Pavements may also be subjected to excessive loads that may result in cracking.

If cracking does occur over time, it is important to identify the cause, and then assess whether the cracking is acceptable, or needs repair.

While the visual acceptability of cracks is very subjective, a 0.3mm wide crack should be regarded as acceptable. Cracks wider than 1mm should be assessed on an individual basis in terms of possible effects on durability and performance requirements and, depending on the surface texture and finish, also on aesthetic requirements.

## SPECIFICATION CHECKLIST

### General

The following provides guidance on the main items that may need to be considered in the specification for the construction of residential driveways and paths.

### Planning

- The Local Authority's requirements for grades and pavement details between the property boundary and kerb should be ascertained.
- A sketch or drawing should be prepared indicating the location, dimensions, levels and or grades of the pavement and any associated drainage and Local Authority requirements.

### Sub-grade

- All topsoil, vegetation, debris and other foreign matter should be removed from the location of the proposed pavement.
- Any soft, weak, saturated or otherwise unsuitable material should be removed and replaced by good quality material from the site or by imported road-base, and compacted in layers using a rammer plate/upright compactor.
- All service trenches and other excavations should be backfilled with good quality material from the site or other suitable trench filling material and compacted in layers using a rammer plate/upright compactor, to avoid future settlement.
- The subgrade should be dampened prior to placement of the concrete. Note that this is not required if a membrane and/or subbase is used.

### Sub-base

*(Recommended for highly reactive clay sites)*

- A minimum 100mm thick layer of low volume change material (road-base or similar material, but not sand or gravel) should be provided under the slab.
- Sub-base material should be compacted using a rammer plate compactor or small roller.
- The sub-base should be dampened prior to placement of the concrete.

### Plastic Underlay

*(Optional – to reduce friction under the slab or ingress of salts in saline environments)*

- A 200 micron (0.2mm) thick polyethylene film should be provided under the entire slab area.
- Any joints in the plastic membrane should be lapped 200mm minimum and taped.

### Sand Layer

*(Recommended – to reduce friction under the slab)*

- A 20mm layer of sand should be provided under the entire slab area.
- The sand should comply with fine aggregate grading requirements of AS2758.1<sup>8</sup>.

## Formwork

- Edge formwork should extend the full depth of the slab.
- The vertical alignment should be within 5mm for each 100mm of height.
- Formwork should be fixed rigidly with pegs to prevent movement during placement of concrete.
- The position of formwork should be within  $\pm 5$ mm of the location shown on the drawing(s).
- The formwork levels should be set to a tolerance of  $\pm 5$ mm from the designed level.
- A sketch or drawing should be prepared indicating the location, dimensions, levels and or grades of the pavement and any associated drainage and Local Authority requirements.

## Reinforcement

- The appropriate mesh size for the particular slab thickness and joint spacing should be provided.
- The mesh should be located in the top half of the slab with minimum (30mm) cover to the exposed surface.
- The mesh should be supported on bar chairs at maximum (800mm) centres.
- Mesh should have a minimum overlap of 2 cross wires (i.e. the two outermost cross wires of each sheet are overlapped).
- One N12 trimmer bar should be provided around all penetrations such as access holes.
- 40 mm of cover should be provided to all isolation and expansion joints, and to all slab edges.
- If the mesh is discontinuous at control joints, it should be terminated 40–50mm away from the joint (see Figure 7) depending on the joint type.

## Concrete

- The concrete strength grade should be nominated (N20 minimum but must comply with Local Authority requirements where appropriate).
- For special-class concrete all required properties such as strength (S20, etc.), slump, colour, aggregates and cement colour should be specified.
- The minimum slab thickness should be specified (typically 100mm).
- Slabs and areas thicker than 100 mm should be compacted using an immersion vibrator.
- Concrete should be continuously cured for at least 3 days from the completion of finishing operations, and then allowed to gradually dry out.

- Excess water should not be added to the concrete on site.

## Finishing

- The type of surface finish should be specified. If proprietary products are involved such as dry shake colour hardeners, the coverage and application should be in accordance with the manufacturer's/supplier's recommendations.
- The surface levels and flatness should be specified. As a guide, the deviation in levelness can be specified as  $\pm 10$ mm from the designed level, and flatness by a maximum deviation or gap under a 3 metre "straightedge" of 12mm.

## Joints

- Isolation joints as shown in Figure 5 should be provided wherever the slab abuts existing buildings, pavements, or rigid structures such as drainage pits, access holes or columns. Specify colour of sealant if required.
- Expansion joints as shown in Figure 6 should be provided at maximum 15 metre centres in any direction. Colour of joint sealant if required and dowel size and spacing should be specified. For 100mm thickness driveways, 12mm diameter dowels at maximum 400mm centres along the joint would be satisfactory.
- Control joints as shown in Figure 7 should be provided at maximum 3 metre centres, and at locations where there is a likelihood of a crack occurring (e.g. at re-entrant corners). The type of control joint should be nominated, along with any requirements for saw cutting, or cutting of the mesh if continuous across the joint.
- Joints should be located so that the longer dimension of any slab panel is no more than 1.5 times the shorter dimension.
- Any angle formed between joints, or a joint and the slab edge, should not be less than 75° to avoid tapered and narrow sections of pavement.

## Sealing the Surface

- The sealer should be specified, along with its use in accordance with the manufacturer's recommendations.

## REFERENCES

1. AS 1379 Manufacture and supply of concrete, Standards Australia, 2007.
2. AS 3600 Concrete structures, Standards Australia, 2009.
3. Building Technology File (BTF) 18 Foundation Maintenance and Footing Performance: A Homeowner's Guide, CSIRO (2003).
4. National Construction Code, Volume 2, Building Code of Australia, Australian Building Codes Board, 2016.
5. Guide to Residential Slabs and Footings in Saline Environments (T56) Cement Concrete & Aggregates Australia, 2005.
6. Permeable Concrete Pavements Data Sheet, Cement Concrete & Aggregates Australia, 2004.
7. The Concrete Masonry Association of Australia website ([www.cmaa.com.au](http://www.cmaa.com.au)). Information on Concrete Segmental Pavements and Concrete Flag Pavements can be found under technical publications.
8. AS2758.1 Aggregates and rock for engineering purposes: Part 1 – Concrete Aggregates.

## FURTHER INFORMATION

- CCAA Data Sheets (Download from [www.ccaa.com.au](http://www.ccaa.com.au)) :
  - Hot Weather Concreting
  - Cold Weather Concreting
- The Housing Concrete Handbook (T53) Cement and Concrete Association of Australia, 2000.
- Guide to Concrete Construction (T41/HB 64) Cement and Concrete Association of Australia and Standards Australia, 2002.

This data sheet replaces:

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