

# RESIDENTIAL Concrete Driveways and Paths

<b>1 INTRODUCTION</b>	<b>2</b>	<b>5 MAINTENANCE</b>	<b>10</b>
2.1 Footpath Area	2	5.1 Cleaning	10
2.2 Pavement Grades	2	5.2 Resealing	10
2.3 Drainage	2	5.3 Assessment of Cracks	10
2.4 Trees	2	<b>6 SPECIFICATION CHECKLIST</b>	<b>10</b>
2.5 Adjacent Structures	2	<b>7 REFERENCES</b>	<b>12</b>
2.6 Surface Finish	3		
<b>3 DESIGN</b>			
3.1 Concrete	3		
3.2 Reinforcement	4		
3.3 Joints	4		
3.4 Surface Tolerances	4		
3.5 Permeable Pavements	4		
3.6 Segmental Pavements	4		
<b>4 CONSTRUCTION</b>			
4.1 Subgrade Preparation	6		
4.2 Subbase	6		
4.3 Reducing Friction Under the Slab	6		
4.4 Reinforcement Fixing	6		
4.5 Formwork	6		
4.6 Addition of Water to Concrete	6		
4.7 Placing of Concrete	7		
4.8 Compaction of Concrete	7		
4.9 Surface Finishes	7		
4.10 Curing of Concrete	7		
4.11 Joints	8		
4.12 Joint Sealants	9		
4.13 Surface Sealers	9		



THE BASIC FUNCTION of residential pavements such as driveways, paths and patios is to provide safe, easy access onto or around a property.

## 1 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.

## 2 PLANNING

### 2.1 Footpath Area

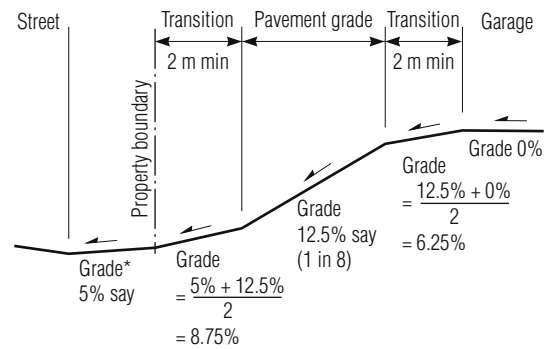
Pavements between the kerb-and-gutter and property boundary will generally have to comply with the requirements of the Local Authority in respect of levels, grades and minimum details (thickness, reinforcement and concrete strength). These should be determined initially, as they may affect the grades (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.

### 2.2 Pavement Grades

To allow adequate drainage of the surface, the recommended minimum grade or crossfall for a pavement is generally 1 in 100 (1%), or 10 mm per metre.

The maximum grade should not exceed 1 in 20 (5%) in the footpath area or 1 in 4 (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 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

### 2.3 Drainage

The stormwater 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 not be graded away from a building (eg driveways that slope toward the house), a suitable drain should be provided adjacent to the building to divert stormwater runoff.

### 2.4 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 BTF18<sup>1</sup>.

### 2.5 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 Building Code of Australia<sup>2</sup> (BCA) requires paved areas that have a slope away from the building of at least 50 mm (25 mm in South Australia) over the first 1 m from the building to be at least 50 mm (75 mm in South Australia) below the finished surface of the adjacent slab-on-ground. This minimum height may need to be increased if the required slope can not 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 BCA 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 BCA 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.

## 2.6 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 trowelled, polished, stamped and smooth aggregate type finishes may be unsuitable. Coarse broomed, tyned, dragged and stencilled finishes would be more suitable. Also, exposed aggregate finishes may require an angular (crushed) stone instead of a smooth rounded stone.
- **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 (ie around a pool) the texture should not be too coarse. Suitable finishes for these applications include wood float, light broom and pebblecrete.
- **Cleaning.** For pavements subject to spills (eg barbecue, outdoor kitchen and eating areas), smooth finishes are the most appropriate since they are easy to clean and maintain. Use of a surface sealer can prevent spillage from penetrating the concrete and facilitate cleaning.

## 3 DESIGN

### 3.1 Concrete

**Strength** – The majority of concrete used in residential pavements is 'Normal' class concrete with a minimum strength of 20 MPa (ie N20 concrete). A higher strength may be required in certain situations, viz:

- **Heavier Loads.** If the pavement is being used by vehicles between 3 and 10 t 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.
- **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 t, an N25 concrete is recommended, and for vehicles over 3 t, an N32 concrete.
- **Freezing and Thawing.** An N32 concrete should be used if the pavement is subjected to occasional exposure to freezing, and an N40 concrete where more than 25 freezing cycles occur each year. Also, an air entraining agent should be used in the concrete mix. (Note: air entraining agent above 5% would make the concrete Special class.)
- **Salinity.** If salts are present in the soil or groundwater, increasing the concrete strength to provide improved durability is advisable<sup>3</sup>. N25 concrete is recommended for moderately saline soils, N32 for very saline soils and N40 for highly saline soils. 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.

**Other Properties** – If properties other than strength are required, a 'Special' class (eg S20) 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.
- **Aggregates.** Any information necessary to identify the stone required – size, type, texture, colour (eg 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 titanium white colour pigment.

**Thickness** – Pavements for foot traffic only (eg paths and patios) should have a minimum thickness of 75 mm. Pavements for vehicles less than 3 t gross mass should have a minimum thickness of 100 mm. Pavements for vehicles between 3 and 10 t 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.

### 3.2 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.

For footpaths which typically have closely-spaced joints (up to 2 m), and hence little risk of cracking, either no reinforcement, or an SL52 mesh is generally appropriate. For 100-mm-thick pavements having joints spaced further apart (up to 3 m), a minimum SL62 mesh would typically be used, and for 150-mm-thick pavements, SL82 mesh.

Note that in some cases increasing the minimum reinforcement would be recommended. For example, where decorative finishes are required, increasing the mesh size by one or even two sizes, will provide better control of cracking that may occur, so that it does not significantly affect the appearance.

### 3.3 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-m centres.

Control joints typically form a weakened plane at which the concrete cracks. Without them, drying shrinkage will result in random cracking. They should be provided at maximum 3-m centres, at any changes in shape (eg a narrow path attached to a driveway), at any changes in direction (eg around

corners, especially where a re-entrant corner may be formed), and at any rigid structures (eg 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 if possible be located to suit the proposed decorative pattern or finish.

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 more than 75° (and preferably at right angles) to the slab edge **Figure 3**.

### 3.4 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-m straightedge placed on the surface. For hand-placed pavements, a reasonable flatness tolerance is a maximum deviation or gap of 12 mm under a 3-m straightedge placed anywhere on the pavement, 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  $\pm 10$  mm from the designed level or elevation. For sloped surfaces, a maximum deviation of 10 mm from a line joining the 'control' points (ie the levels at the top and bottom of the slope) is recommended.

Note that the minimum slab thickness should be maintained.

### 3.5 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 elsewhere<sup>4</sup>.

### 3.6 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>5</sup>.

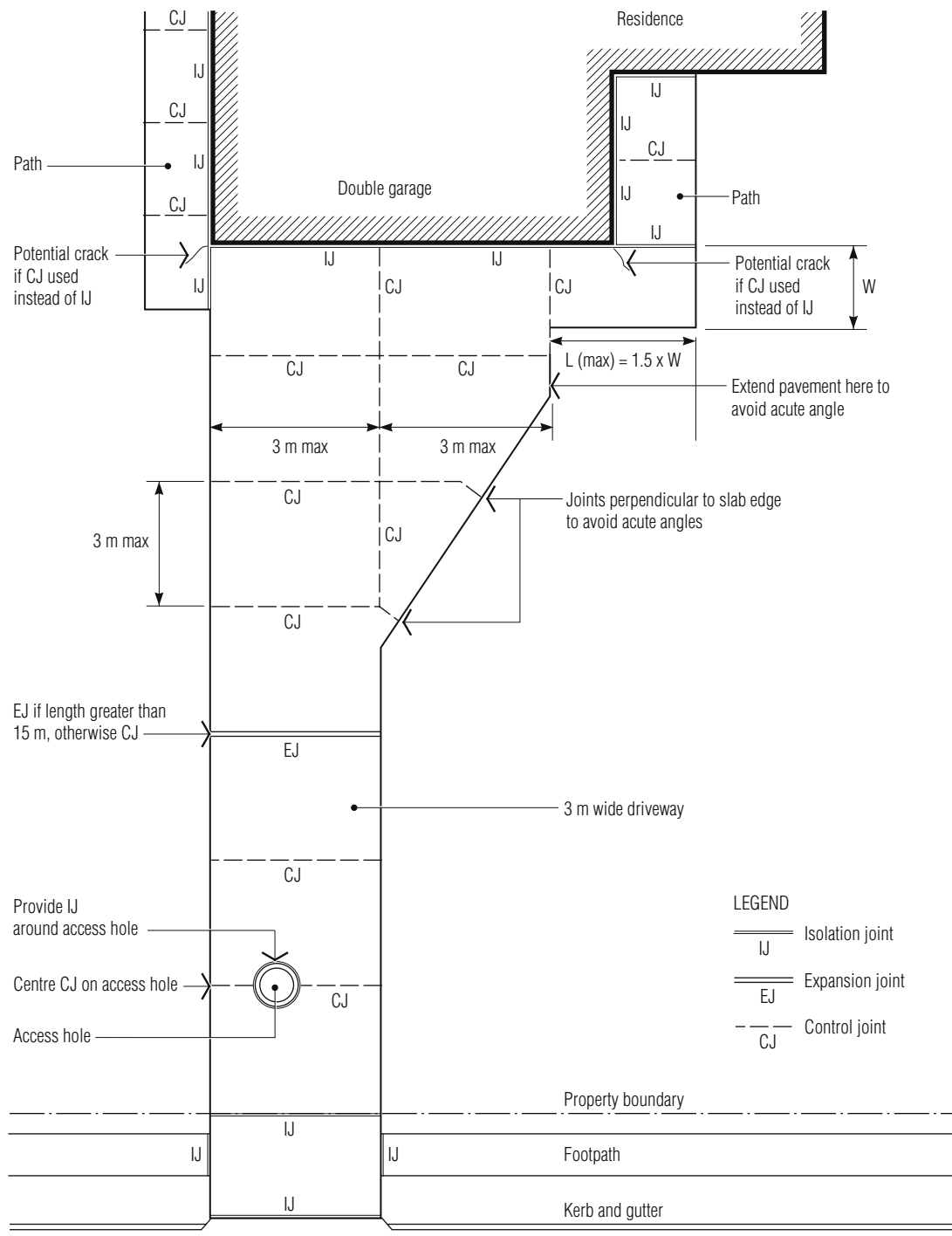


Figure 2: Typical joint layout



Figure 3: Joint perpendicular to slab edge

## 4 CONSTRUCTION

### 4.1 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, saturated, highly compressible or otherwise weak areas should be removed and replaced with suitable subgrade or roadbase 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.

#### 4.2 Subbase

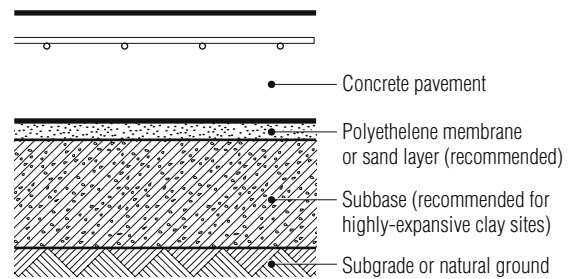
On highly expansive clay subgrades, significant volume changes can occur in the soil resulting in non-uniform support of the slab, and subsequently early slab failure. Potential problems can be minimised by appropriate pavement design, the provision of a subbase, or stabilisation of the subgrade material.

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

#### 4.3 Reducing Friction Under the Slab

Providing polyethylene sheeting or a 20-mm-thick layer of sand beneath the pavement is an effective way of reducing the friction between the slab and subgrade/subbase. Compared to placing the



**Figure 4:** Typical pavement cross-section

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 volume changes, thereby reducing the risk of cracking.

If using sand, it is important that the percentage of fine material such as silt and clay be limited to about 5%, so that the material does not bind together, thereby restricting movement of the slab.

#### 4.4 Reinforcement Fixing

The reinforcement (usually mesh) should be located within the top half of the pavement, and have a minimum 30 mm of concrete cover to the top of the slab. It should be fixed in position using suitable supports or bar chairs, spaced at maximum 800-mm centres to prevent sagging of the reinforcement during concrete placement. Note that for light meshes, 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 (ie the two outermost cross wires of each sheet are overlapped).

#### 4.5 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.

#### 4.6 Addition of Water to Concrete

No water (in excess of the mixing water) 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 may result in either unplanned cracking, or crack widths wider than would normally be expected.

#### 4.7 Placing of Concrete

Concrete placement should commence from one corner of the pavement and proceed continuously out from that point, with new concrete always being deposited onto the face of the concrete already placed to ensure interblending and avoid segregation, ie 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 moved from the concrete truck to its final location by a concrete pump. If a wheelbarrow is used, a typical placing rate of about 1 to 1.5 m<sup>3</sup>/h can be achieved, the travel distance is limited to about 50 m 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 affect 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 m.
- **Slopes.** Concrete placement should commence at the lowest point.
- **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 temperatures exceed 35°C or fall 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, leading 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 and 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.

#### 4.8 Compaction of Concrete

Adequate compaction of the concrete significantly reduces its porosity, increases its strength, enhances the abrasion resistance and general durability, and minimises the risk of cracking.

While any deeper sections of the pavement such as edge thickenings and downturns should be compacted using an immersion vibrator, for slabs on ground that are 100 mm 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 100-mm-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.

#### 4.9 Surface Finishes

Slip- 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-typed comb can be used to groove the concrete surface. Compacting the surface of the concrete by trowelling will improve the strength and abrasion resistance, thereby assisting to maintain the skid resistant properties of the surface. It is important therefore that, where possible, the surface be trowelled either prior to the finish being applied (ie broom finish) or during the process of applying the finish (ie colour surface toppings).

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.

#### 4.10 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 (ie 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 (eg plastic sheeting, chemical curing compound); or keeping any exposed surfaces continuously wet (eg ponding or spraying with water). Wetting at intervals (eg in the morning and afternoon) does not keep the concrete continuously moist, particularly in hot weather conditions and is therefore not regarded as an adequate method. Black plastic should not be used for curing of external surfaces, as this may increase heat gain and cause problems with slab 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. Chemical curing compounds compatible with the sealer, or the sealer itself if complying with the requirements of a chemical curing compound, should be used for these types of decorative pavements.

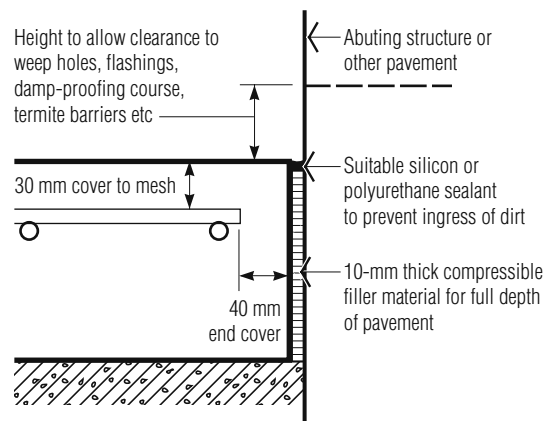
#### 4.11 Joints

Isolation joints **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.

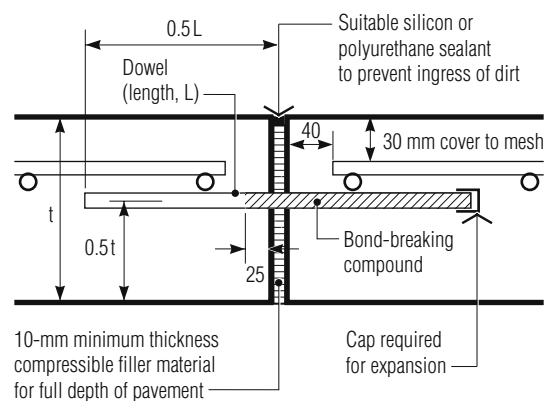
Expansion joints **Figure 6** typically have dowel bars connecting the slabs to provide load transfer and avoid changes in the levels from one slab to another. As a guide, for 100-mm-thick pavements intended for vehicles less than 3 t gross mass, 12-mm-diameter dowels at maximum 400-mm centres would be satisfactory.

Control joints **Figure 7** can be made by:

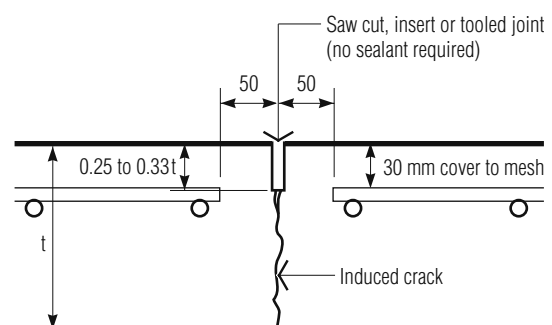
- inserting a pre-moulded strip into the concrete as it is being placed;
- use of a grooving tool immediately after the concrete has been placed; or
- sawing a groove when the concrete has hardened sufficiently to prevent raveling.
- Using a proprietary pressed metal key joint.



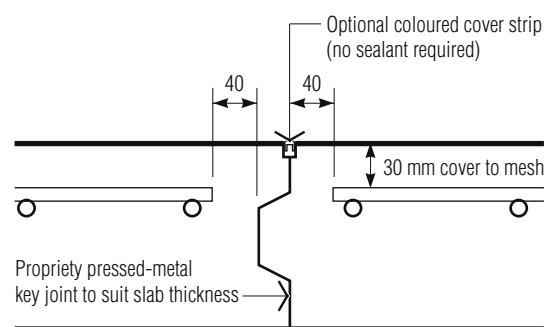
**Figure 5:** Typical isolation joint



**Figure 6:** Typical expansion joint



(a) CRACK-INDUCED JOINT (SAW CUT, INSERT OR TOOLED)



(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 (ie the same day) is possible using specialised equipment. The surface should be thoroughly cleaned after cutting.
- 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 50 mm away from control joints, it may extend across the joint to provide better control of movement on, say, 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 50 mm clear of the proposed joint location.

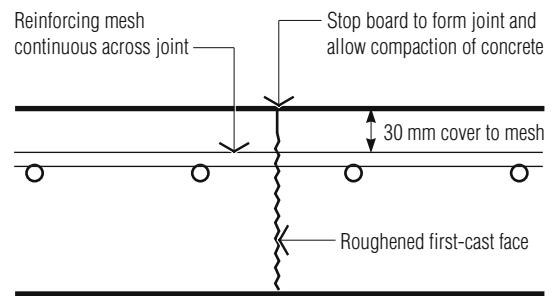
A construction joint **Figure 8** is used to accommodate an unplanned break in concrete placement. The joint should be formed to allow adequate compaction and finishing of the concrete along the edge. Once the concrete has hardened, the formwork is removed, the edge roughened to provide aggregate interlock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

#### 4.12 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.



**Figure 8:** Typical construction joint

- **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 2-3 mm 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.

#### 4.13 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; non-penetrating sealers that form a film on the surface can reduce slip and skid resistance, and are thus 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.

## 5 MAINTENANCE

### 5.1 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, with a range of chemical cleaning products such as bleaching agents and acid-based solutions 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.

### 5.2 Resealing

Numerous sealers in a range of categories are available, each offering different degrees of protection. Depending on the extent of abrasion and wear, and performance of the sealer itself, replacement after a number of years will be required. 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.

### 5.3 Assessment of Cracks

While adopting good design, detailing and construction practices as outlined in this document will minimise the risk of cracking, 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 0.3-mm-wide crack should be regarded as acceptable. Cracks wider than 1 mm 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.

## 6 SPECIFICATION CHECKLIST

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.

### SUBGRADE

- 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 roadbase, 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.

### SUBBASE

*(Recommended for highly reactive clay sites)*

- A minimum 100-mm -thick layer of low-volume-change material (roadbase or similar material, but not sand or gravel) should be provided under the slab.
- Subbase material should be compacted using a rammer plate compactor or small roller.
- The subbase 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- $\mu\text{m}$  (0.2-mm) thick polyethylene film should be provided under the entire slab area.
- Any joins in the plastic membrane should be lapped 200 mm minimum and taped.

### SAND LAYER

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

- A 20-mm layer of sand should be provided under the entire slab area.
- The sand should have no more than 5% of silt and clay particles.

### FORMWORK

- Edge formwork should extend the full depth of the slab.
- The vertical alignment should be within 5 mm for each 100 mm 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.

### 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 (30 mm) cover.
- The mesh should be supported on bar chairs at maximum (800-mm) centres.
- Mesh should have a minimum overlap of 2 cross wires (ie 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 40–50 mm away from the joint **Figure 7** depending on the joint type.

### CONCRETE

- The concrete strength should be nominated (N20 minimum).
- For special-class concrete all required properties such as strength (S20, etc), colour, aggregates and cement colour should be specified.
- The minimum slab thickness should be specified (100 mm usually).
- 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-m straightedge of 12 mm.

### JOINTS

- Isolation joints as shown **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 **Figure 6** should be provided at maximum 15-m centres in any direction. Colour of joint sealant if required and dowel size and spacing should be specified. For 100-mm-thick driveways, 12-mm-diameter dowels at maximum 400-mm centres along the joint would be satisfactory.
- Control joints as shown **Figure 7** should be provided at maximum 3-m centres, and at locations where there is a likelihood of a crack occurring (eg 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  $75^\circ$  to avoid tapered and narrow sections of pavement.

### SEALING OF THE SURFACE

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

## 7 REFERENCES

- 1 Building Technology File (BTF) 18 *Foundation Maintenance and Footing Performance: A Homeowner's Guide*, CSIRO (formerly Information Sheet 10-91).
- 2 *Building Code of Australia, Volume 2, Housing Provisions*, Australian Building Codes Board, 2005.
- 3 *Guide to Residential Slabs and Footings in Saline Environments* (T56) Cement Concrete & Aggregates Australia, 2005.
- 4 *Permeable Concrete Pavements Data Sheet*, Cement Concrete & Aggregates Australia, 2004.
- 5 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.

## FURTHER INFORMATION

CCAA Data Sheets:  
*Hot Weather Concreting*  
*Cold Weather Concreting*  
Download from [www.concrete.net.au](http://www.concrete.net.au).

*The Housing Concrete Handbook* (T53) Cement and Concrete Association of Australia, 2000.

*Guide to Concrete Construction* (T41/HB64) Cement and Concrete Association of Australia and Standards Australia, 2002.

## CCAA OFFICES

### SYDNEY OFFICE:

Level 6, 504 Pacific Highway  
St Leonards NSW Australia 2065

### POSTAL ADDRESS:

Locked Bag 2010  
St Leonards NSW 1590

**TELEPHONE:** (61 2) 9437 9711

**FACSIMILE:** (61 2) 9437 9470

### BRISBANE OFFICE:

Level 14, IBM Building  
348 Edward Street  
Brisbane QLD 4000

**TELEPHONE:** (61 7) 3831 3288

**FACSIMILE:** (61 7) 3839 6005

### MELBOURNE OFFICE:

2nd Floor, 1 Hobson Street  
South Yarra VIC 3141

**TELEPHONE:** (61 3) 9825 0200

**FACSIMILE:** (61 3) 9825 0222

### PERTH OFFICE:

45 Ventnor Avenue  
West Perth WA 6005

**TELEPHONE:** (61 8) 9389 4452

**FACSIMILE:** (61 8) 9389 4451

### ADELAIDE OFFICE:

Greenhill Executive Suites  
213 Greenhill Road  
Eastwood SA 5063

### POSTAL ADDRESS:

PO Box 229  
Fullarton SA 5063

**TELEPHONE:** (61 8) 8274 3758

**FACSIMILE:** (61 8) 8373 7210

EXTRACTIVE INDUSTRIES OFFICE

PO Box 243

Henley Beach SA 5022

**TELEPHONE:** (61 8) 8353 8151

**FACSIMILE:** (61 8) 8353 8151

### TASMANIAN OFFICE:

EXTRACTIVE INDUSTRIES OFFICE

PO Box 246

Sheffield TAS 7306

**TELEPHONE:** (61 3) 6491 2529

**FACSIMILE:** (61 3) 6491 2529

**WEBSITE:** [www.concrete.net.au](http://www.concrete.net.au)

**EMAIL:** [info@ccaa.com.au](mailto:info@ccaa.com.au)

**LAYOUT:** Helen Rix Design

**Disclaimer:** Cement Concrete & Aggregates Australia is a not for profit organisation sponsored by the cement concrete and aggregate industries in Australia to provide information on the many uses of cement and concrete. This publication is produced by CCAA for that purpose. Since the information provided is intended for general guidance only and in no way replaces the services of professional consultants on particular projects, no legal liability can be accepted by CCAA for its use.

CCAA respects your privacy. Your details have been collected to provide you with information on our activities, publications and services. From time to time your details may be made available to third party organisations who comply with the Privacy Act such as affiliated associations, sponsors of events and other reputable organisations whose services we think you may find of interest. If you do not wish to receive information from CCAA or wish to be taken off the database please write to the Privacy Officer, CCAA, Locked Bag 2010, St Leonards, NSW, 1590