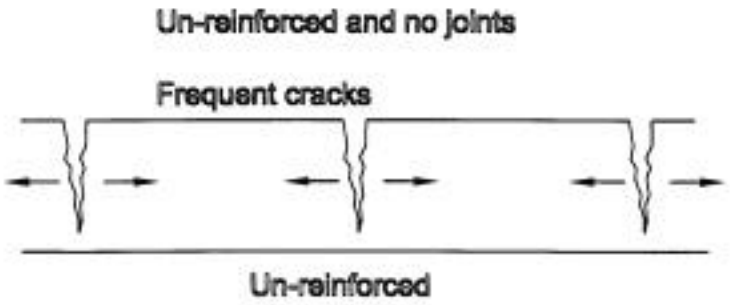
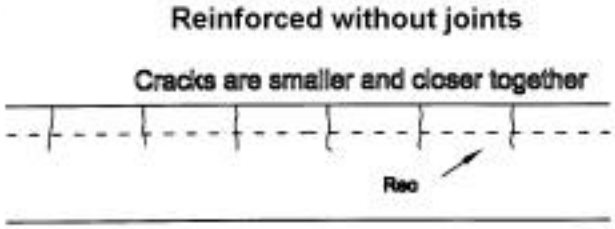
Concrete Basics and The Need For Joints

What Causes Concrete To Crack?
Many surface cracks in concrete slabs are not a result of structural failure of the slab but are formed by uncontrolled shrinkage of the concrete. These types of cracks can be avoided.

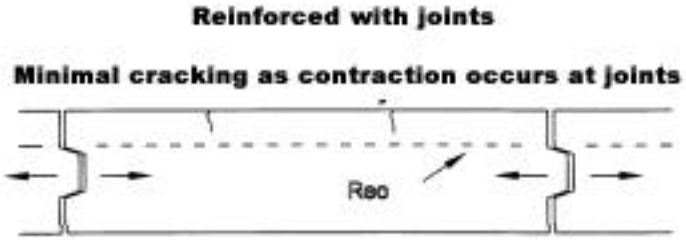
Shrinkage cracks are the result of the concrete volume decreasing as water is lost from within the concrete mixture. These cracks can still occur some months after the slab has been poured. However, the more rapid the drying process the more likely it is that shrinkage cracks will develop. The same type of cracking occurs in many other situations where moisture is lost from its structure. (eg. Clay soils will crack in times of low rainfall).



How To Control Cracking
In concrete slabs it is possible to reduce the width of these cracks by placing steel bars (reinforcement) in the concrete, which effectively holds the cracks together. Although shrinkage still occurs the cracks formed are closer together and are held together so tightly that they are usually too small to be visible. It is generally not economically feasible to place enough reinforcement in large concrete slabs to eliminate all cracking. The aim of reinforcement is to eliminate large visible cracks, and in conjunction with joint placement, minimise those that remain.



Combined with the use of reinforcement, one of the most effective means of reducing the amount of cracking in slabs is by using the correct type and placement of joints in the slab. This effectively breaks the pour into several smaller sections which reduces the resistance to contraction forces within each slab section. This was traditionally done by the old system of pouring adjacent slabs alternatively in a chequerboard pattern. However, in today's environment where larger pours are necessary in order to keep jobs on a tight schedule, this out dated system is often not practical. To enable a continuous pour, yet still break the slab into several smaller slabs, it is common practice to install contraction or control joints in the wet concrete. The aim of this type of joint is to allow the shrinking concrete to move freely away from the joint and thus prevent random cracking elsewhere in the slab.



The correct type of joint and the appropriate placement of the joint in a slab is considered by many contractors to be a good insurance policy against customer complaints. It is far easier to explain why a joint was placed in the slab than it is to explain why there is a random crack in a slab with no joints.

Location and Spacing of Joints

The location of contraction joints is an important part of overall slab performance and should be considered early in the design stage. The use of Connolly key joint gives designers greater control over the placement of contraction joints. As the joints are set up prior to concrete placement they can be inspected at the pre-pour stage and they do not have to rely on any post pour operations to be effective.

A common question asked by many designers and builders is "How far apart should contraction joints be?" This is a question to which there is no simple answer. The best solution is to consider all of the following factors before deciding on the joint locations prior to pouring.

Slab design / layout: The slab sections or panels should have a length to width ratio of a maximum of 1.5:1 and preferably 1:1. Panel shapes such as "L" and "T" should be avoided where possible.

Thickness: Generally the thicker the slab the further apart the joints may be.

Reinforcement: Joints in un-reinforced slabs should be spaced at closer intervals than in reinforced slabs. Slabs with light gauge reinforcement also require closer joint spacing then slabs containing higher percentages of reinforcement.

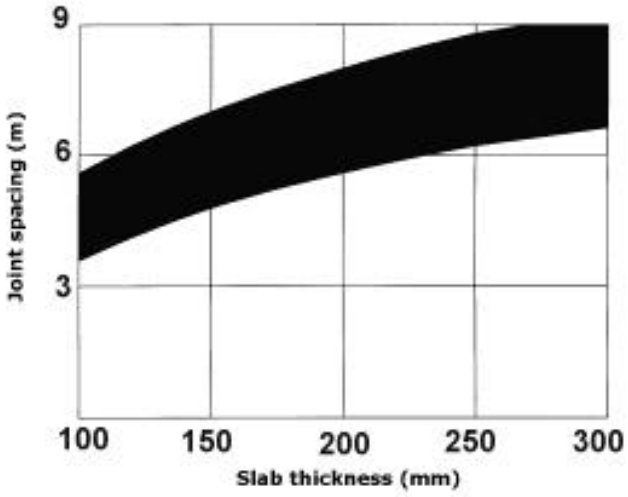
Concrete mixture: Cement type and quantity, aggregate size, quantity and quality, water/cement ratio and the use of any admixtures will all affect the amount of shrinkage that will occur. The more shrinkage, the closer the contraction joints should be.

Base friction & restraints: The sub-base should be as smooth and even as possible to allow the concrete to move freely as its volume decreases. A rough sub-base means closer joints.

Environmental Factors: High air temperature, drying wind and low humidity will all accelerate the drying process and increase shrinkage. Some of these factors such as temperature and humidity are seasonal and therefore joints spacings may not be the same for all jobs poured throughout the year.

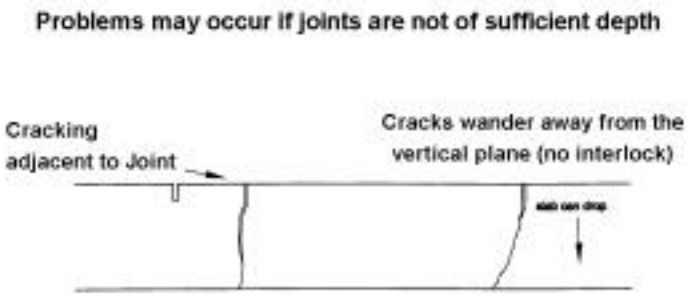
Curing methods: For various reasons, different curing methods may apply to different jobs. The slower the concrete is cured, the further apart the joints may be placed.

Despite all of the above variables the chart below is a guide to joint spacing for nominally reinforced slabs with square slab panel layouts. Please note that this chart is a guide only and the particulars of each individual job should be considered in determining contraction joint locations.

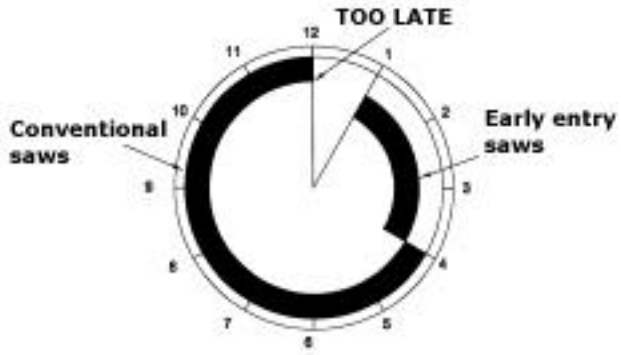


Contraction Joints
The installation of Connolly key joint prior to concrete placement is one of the best methods of providing a contraction joint. Unlike tooled joints or saw cutting, which can be ineffective if not done correctly or in the narrow timeframe required, Connolly key joint makes a definite break in the slab and virtually eliminates many of the problems associated with concrete shrinkage.

Tooled joints, which are tooled in during the finishing operation, are time consuming and interrupt the finishing operations. In many cases they are not installed to a sufficient depth (recommended as ¼ of slab thickness) and as a result do not control all random cracking. If joints are not of sufficient depth they cannot be guaranteed to induce the fracture through the remaining thickness of the slab. Also, if the joint is not of sufficient depth the induced fracture may "wander" away from the vertical plane and increase the likelihood of stepping at the joint when it is subjected to vertical loads.



Saw cuts will control shrinkage cracking if they are installed early enough in the curing stage and they are to the minimum depth as mentioned above. To be effective, saw cutting must be carried out before the concrete starts to cool. If using a conventional wet saw, this usually means that cutting must be done between 4 and 12 hours after the surface finishing operations have ceased. The waiting period for early entry dry-cut saws is usually between 1 and 4 hours.

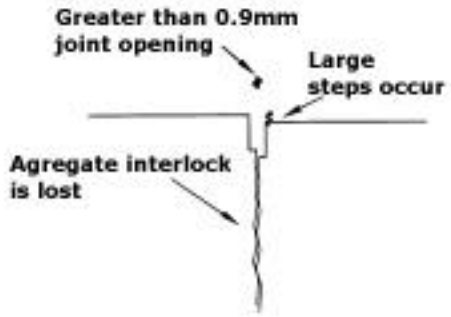


If the saw cutting is not carried out in this narrow window of opportunity, then it is likely that it will not be effective in controlling cracking. In many situations it is not practical to saw cut during this timeframe due to saw availability, darkness, noise considerations or other factors. If a slab is poured in the early morning, it is generally too late to saw cut effectively the following day.

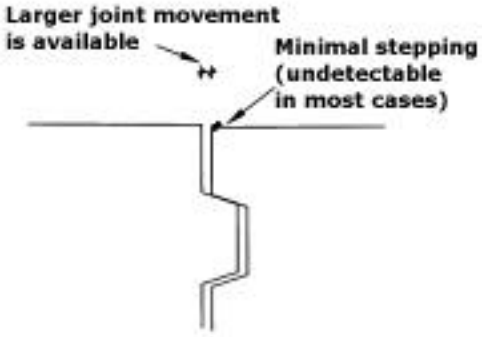
Preventing "Steps" and Load Transfer

To prevent vertical displacement of adjacent slabs at a joint, some form of load transfer is necessary. This enables the top surface of the slabs to remain at the same level even though they may be subjected to uneven loads. These loads may be in the form of vehicular traffic, or more commonly, as a result of the ground swelling and or shrinking below the slabs. The most effective way to minimise ground swell problems is to provide a firm sub-base and maintain a stable soil moisture content. It is recommended to avoid planting trees adjacent to pavements where possible and maintain plumbing work to ensure the sub-base is not affected by leakages.

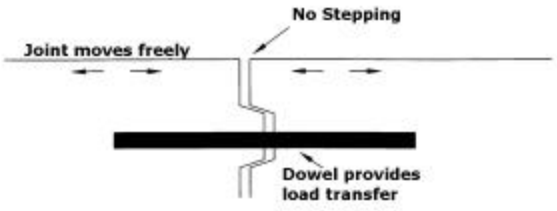
It is recognised that saw cut and tooled joints are not effective as a means of load transfer if the joint opens more than 0.9mm. To prevent joints opening by this amount it is necessary to place these types of joints quite closely together. If these types of joints are to be spaced at larger intervals a load transfer mechanism (eg. Dowels) would be required.



The interlocking tongue and groove of the Connolly key joint system provides an effective load transfer for light to moderately loaded slabs over much greater joint openings than either saw cut or tooled joints.

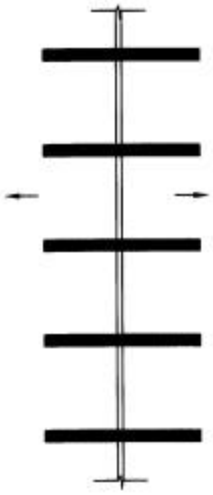


For heavily loaded slabs, it is recommended to provide dowels in all types of joints. If desired, dowels can be used with Connolly key joint by simply removing the pre-formed "knock-outs" and inserting the dowel through the key joint. When used in conjunction with Connolly key joint, the dowels provide the load transfer mechanism and the key joint provides the shrinkage control along with the benefits of having a preformed joint.

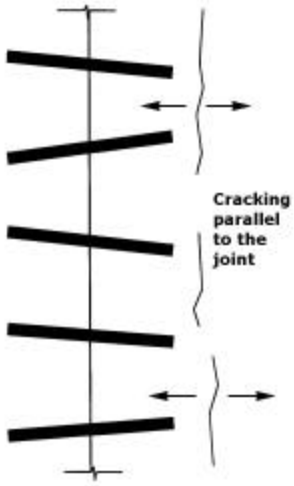


For doweled joints to be effective it is imperative that they be aligned within very close tolerances at 90 degrees to the joint direction and parallel to the joint movement. If this is not achieved, the dowels form a dovetail effect and the joint can "lock up" and will not function properly.

Dowels correctly aligned
Joint moves freely

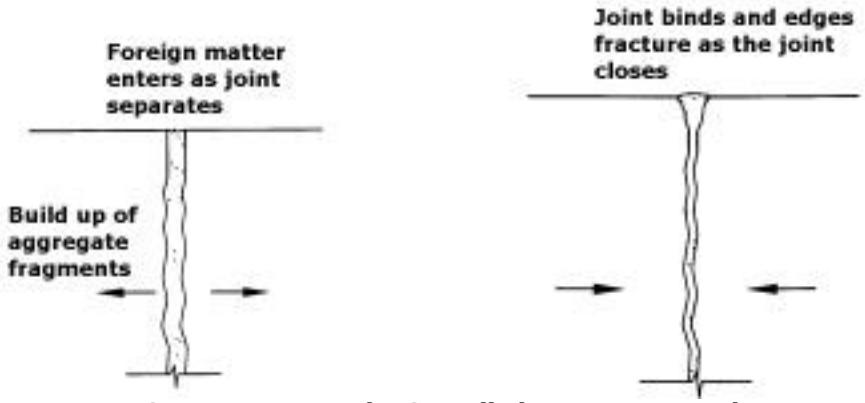


Missaligned dowels
Joint "locks up"

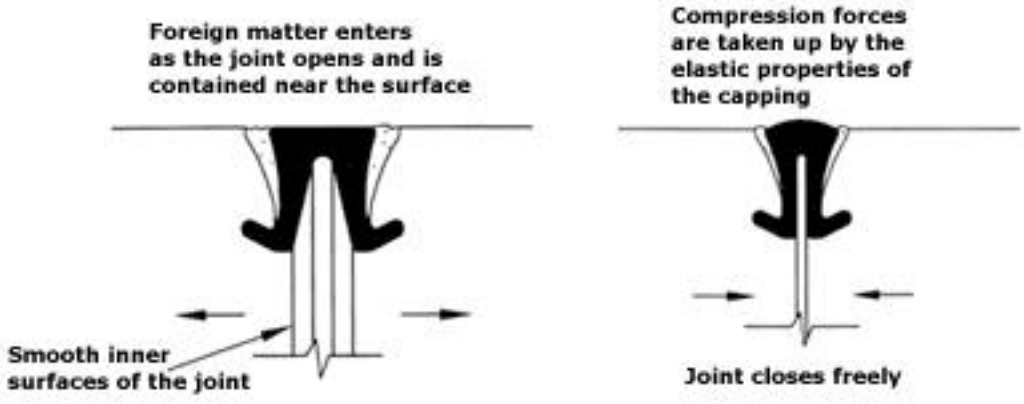


Sealing of Joints

Where the finished joint is exposed to outdoor environments it is recommended that all such joints be fillled. This ensures that foreign materials such as dirt and sand do not get washed into the joint. If foreign material enters the joint, the joint will not function properly when subjected to expansion elements and buckling or spalling can occur at the joint. Additionally, as a preformed metal key joint produces a smooth “off the form” inner surface, it does not produce a build up of aggregate fragments in the joint over time, as saw cut and tooled joints do.

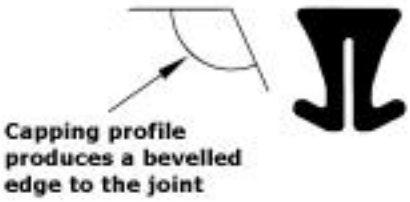


By attaching our permanent PVC capping strip to the Connolly key joint prior to the concrete pour, no further operations are required after the final finishing and sealants are not required unless the joint is to be watertight. In addition to the, time, material and cost savings Connolly key joint has the added benefit of being able to be used to screed off. This makes getting the right level quick and easy during the pour as it is all set up before pouring commences. The Permanent PVC capping reduces the amount of particles that enter the joint and allows the volume of any particles that do enter the joint to be taken up by the compression properties of the capping.



It is also important to keep the width of the joint as small as possible, as a wide joint puts more stress on the corner of the concrete at the joint. These stresses can be from wheel traffic over the joint or from foreign particles that enter the joint. The 180 degree fold to the top of the Connolly key joint allows substantially narrower joints to be achieved than those of other manufactures.

The shape of the Connolly capping also reduces the likelihood of damage occurring to the joint edge as it forms a slightly bevelled edge to the joint.



For water-tight joints or for load bearing joints to be filled with semi rigid epoxy fillers, it is recommended to use either Connolly Removable Capping or Connolly Rebate Mould in conjunction with an appropriate sealant/filler.

Preventing Liability for "Slips & Trips"

Local Government Councils are concerned about escalating insurance costs following a High Court ruling regarding their liability for injuries suffered on pathways. This ruling now means that councils can be sued whether or not they created the danger that causes an accident. This decision by the High Court means that now, more than ever, it is imperative to take all possible measures to reduce the likelihood of "steps" occurring in pavements. Connolly key joint is used by many Councils right across Australia as a means of limiting their liability to these types of actions. Richmond Valley Council, which is located in northern NSW, has this to say about Connolly key joint.

"The product permits quick and easy joint control and ensures a reliable "keying" of adjacent slabs. It allows continuous pours to be effectively jointed without the need for alternate slab pouring. Council has quoted this method of construction in court proceedings as evidence of how we now minimise the occurrence of trips caused by differential slab movement in footpaths"

P.J. Radnidge
Manager of Works

Providers of Public Services and those who contract to them cannot afford to ignore the implications of this High Court decision on their liability risks. By using "best practice" methods of construction, including the use of Connolly key joint, your liability will be greatly reduced.

Joints in House Slabs & AS2870

Many builders have been using Connolly Key Joint for a number of years with great success in driveways and paths. Some have recently expressed an interest in having key joints included in their house slab designs to prevent cracking of floor tiles.

Thickening beams in slabs can restrain the slab from shrinking and result in cracks occurring parallel and adjacent to the beams. Some builders have decided to use Connolly key joints in their slabs to avoid these problems. With careful design, key joints can be placed strategically in slabs, usually adjacent to walls, where they will not interfere with brittle floor coverings and many of the problems associated with concrete shrinkage are avoided.

Although AS2870 does not include any joints in the standard designs that it contains, Clause 3.1.1 (c) states that the standard designs **"shall not apply to slabs containing permanent joints, e.g. contraction or control joints"**. So in fact AS2870 does not preclude the use of joints in slabs it simply does not apply to slabs that contain these joints.

Furthermore, a slab designed with joints to control shrinkage cracking is considered to be good engineering practice in other slab applications so why should it not be considered good practice for house slabs. Clause 1.1 of AS2870 states that the **"Standard shall not be used to prevent the use of locally proven designs, or alternative designs in accordance with engineering principles"**. This clause recognises the fact that other designs, including those with contraction joints, are acceptable if designed correctly.

While some engineers are reluctant to incorporate joints into slabs for fear of penetration by termites, past research shows that only 4.7% of termite entry points are through joints as opposed to 20.2% through cracks in the slab. With the majority of houses now using the slab as a physical termite barrier, all proprietary barrier systems have installation methods to protect key joints. Surely it is far better to have a protected joint than an unprotected crack in a slab.