STAMPED CONCRETE

Research

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Introduction

Stamped concrete or Patten Imprinted Concrete (PIC):

Is concrete that has been imprinted, or that is patterned, textured, or embossed to resemble brick, slate, flagstone, stone, tile, wood, or various other patterns and textures. The practice of stamping concrete for various purposes began with the ancient Romans. In the nineteenth and twentieth centuries, concrete was sometimes stamped with contractor names and years during public works projects, but by the late twentieth century the term "stamped concrete" came to refer primarily to decorative concrete produced with special modern techniques for use in patios, sidewalks, driveways, pool decks, and interior flooring.

History Of Stamped Concrete

The ancient Romans used basic concrete stamping techniques, as evidenced in well-known structures such as the Pantheon.

In the late nineteenth and early twentieth centuries, concrete companies who received government bids for public works projects sometimes used concrete stamps featuring the company name and sometimes the year in which the concrete was poured, creating a visible historical record of when certain sidewalks were made.

Concrete manufacturers started experimenting with modern decorative concrete techniques as early as the 1890s.

In the 1950s, Brad Bowman—considered the "father" of modern concrete stamping—began developing and patenting new techniques for producing concrete that resembled non-concrete materials, such as flagstone and wood. He used wooden platform stamps that could imprint multiple pieces of concrete at once. Later, platform stamps would be made of sheet metal or aluminium. In 1956, Bill Stegmeier of the Stegmeier Company, discovered that a colour powder used to impart an antiquing effect to concrete also had the property of preventing stamps from sticking to concrete, which opened up new possibilities. By the 1970s the demand for stamped concrete grew, and the material became a common component in building projects. In the late 1970s, manufacturer Jon Nasvik developed lightweight and durable urethane stamps for concrete. He later developed plastic stamps that could imprint both texture and pattern on wet concrete, making the process more efficient.

Modern stamped concrete increased in popularity in the 1970s in part because it was featured in the World of Concrete trade show. Builders saw it as a new way to satisfy the customer and make their budget work simultaneously. When stamped concrete for aesthetic purposes was first developed, there were very few choices of design and colors. However, as the industry grew more stamping patterns were created along with many different types of stains. Another advantage to using stamped concrete was that it could be applied to many different surfaces and textures, such as driveways, highways, patios, decks, and even floors inside the home.

In the twenty-first century, demand for stamped concrete in the non-residential construction industry has increased as part of a more general boom in demand for concrete products.

Application

The use of PIC can be divided into two main types:

-The residential customers wanting their driveways, patios, paths, poolside's, etc., surfaced, and

-The commercial sector, where clients look for a low-maintenance, attractive and decorative or customisable surface. It is rarely, if ever, used on medium-to-high speed vehicular traffic applications, such as roadways, as the finished surface is too uneven, and the same criterion seems to rule out its use in shopping malls and town centres, where

small-wheeled trolleys would struggle to cope with a highly textured surface.

PIC on a busy shopping street

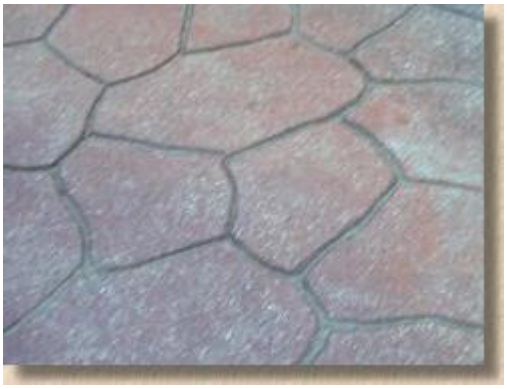
Shahidan Park in Sulaymaniyah

Hawari Shar Park in Sulaymaniyah

Patterns and Colours

There is a large selection of patterns and colours available. The latest catalogues offer dozens of patterns although these can be grouped into several distinct types: -

Ashlar Stone — riven or hewn stone effect in rectangles and squares



Random Stone — stone 'crazy' paving effect of irregular pieces

London Cobbles' — replicating coursed settwork, cobbles and fan effects

Brickwork — imitating herringbone, basketweave, etc.

Tiled — mimicking square, rectangular and/or octagonal tiles

Textures — seamless stone or slate textured effect

Decking simulating 'boardwalks' or planking

Safety — barred patterns for increased traction on ramps; blister paving etc.

The Ashlar stone and Herringbone brick would seem to be the most popular patterns in the British and Irish market.

Colours tend to be somewhere in the black-brown-buff-red part of the spectrum, although there are greens and blues. Like the paint market, some of the colour names are not to be taken too literally.
Often a lighter and darker shade are combined to give the impression of extra 'depth' to the surfacing. For example, an ashlar stone effect surface might feature a darker brown base colour with 'highlights' done in a buff

Structure

The basic construction for this type of paving is relatively simple, consisting of a concrete layer laid over a suitable sub-base or sub-grade . There may be an edging or restraining kerb , if desired, or a temporary formwork or shuttering can be used and removed once the concrete has set, usually 3-7 days after pouring.
Many contractors will apply a different finish and/or colour to the perimeter of a PIC surface to give the impression of a soldier course edging or other edging detail.

The minimum thickness of 75mm is recommended for paths and pedestrian areas, and a minimum 100mm thickness for driveways or parking areas.
Steel mesh reinforcement is not usually specified for PIC residential driveways, although it may be used on higher specification jobs, where heavier loads or heavy traffic is expected.
Many Ready Mixed Concrete suppliers have specific mixes for this type of work, usually with a small-size aggregate (10mm) and fibre reinforcement. The small aggregate ensures that a reasonable amount of matrix (also known in the trade as 'fat') is present at the surface for imprinting and the polyester fibres serve a dual purpose, replacing cumbersome and costly traditional steel reinforcing mesh and reducing the occurrence of micro-fractures on the surface of the cured concrete, which could mar the finished effect.
The contractor and/or concrete supplier should be able to give more details on the exact mix that they recommend and supply., but it would

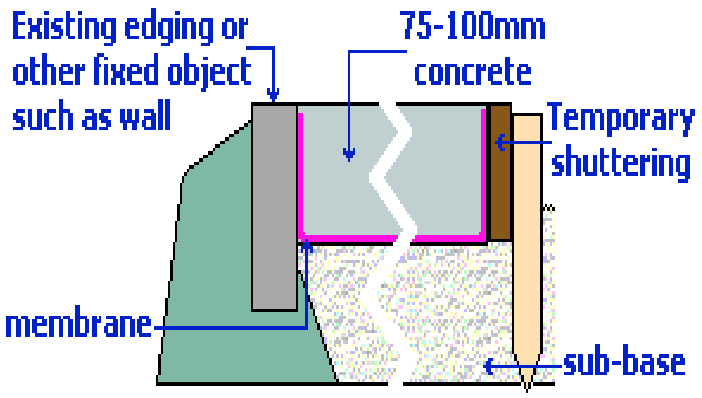
normally be a fairly high strength mix SP300 - SP375 (300-375 Kg of cement per m^3).

As with all areas of mass concrete, special consideration should be given to jointing, specifically movement joints, and also to drainage, as the finished surface is impermeable, to all intents and purposes. Even if no movement joints are present, crack control joints are an essential feature of most PIC pavements and these are discussed below . Careful pre-planning can ensure that any essential movement joints are positioned to coincide with decorative band courses, which help hide their presence to some degree.

Preparation

The sub-grade or sub-base is prepared in advance. It is essential that the **sub-base** or **sub-grade** is levelled out to an accuracy not exceeding ± 12mm to ensure a regular thickness to the eventual slab.

This is done to reduced cracking and to ensure even curing of the slab. As with certain other paving types, a sub-base is only required beneath those pavements expected to carry vehicular traffic. A sub-base is not essential beneath a patio or pathway, but may be used beneath driveways, forecourts, etc, if the ground is suspect in any way or exceptional loads are anticipated.
For many domestic driveways, no proper sub-base is constructed, although the sub-grade is usually 'blinded' with 25-50mm of a clean aggregate to level it up for the concrete pour.



A separation barrier (damp proof membrane or DPM) of at least 1200 microns is normally laid unless there are specific reasons not to do so. Pre-formed edging kerbs are constructed before placement of the concrete, otherwise temporary **formwork** must be installed prior to delivery of concrete to contain the concrete at any free edges.

Concrete

The concrete is delivered to the site by concrete mixer trucks. It is most unusual for PIC to be laid using concrete mixed on site, as a consistent quality is essential, with thorough mixing of the aggregates and cements, even distribution of the fibre reinforcement and a regular **slump** throughout the mix. Only by mixing in large quantities is this level of quality possible.

Levelling out the concrete

PIC Contractors like to work with a high slump concrete, typically 75mm or even 100mm, (sloppy or dead sloppy, in everyday parlance!), with an added air-entraining agent, as this makes the concrete easier to level out, but there is a tendency for such a wet mix to splash while being placed and during working. Consequently, the better contractors will use a disposable polythene sheeting or a protective gel to cover vulnerable areas such as walls or other hard surfaces. It's much easier to spend half an hour and 20 quid protecting the brickwork of a conservatory than having to spend half a day cleaning it off with brick acid and a wire brush!

Once the concrete is placed, it is roughly distributed by shovel and/or concrete rake to an approximate level. It will then be **screeded** to ensure a smooth, flat surface level is achieved, with no high spots or hollows, and then worked with pierced tampers and/or bug rollers to depress any hard aggregate and ensure a layer of 'fat' is present at the surface. Finally, it will be worked with Bull Floats to achieve a fairly smooth finish, free of any major trowel marks. This floating helps bring excess water (bleed water) to the surface.

Apply Colour

Scatter colour hardener

As soon as the concrete has been tamped and floated sufficiently and excess bleed water removed, the special colour dyes combined with a surface hardener are applied, usually by hand.
Some gangs have various gadgets such as flour drifts purloined from the kitchen at home to aid even distribution, but most rely on hand-scattering. Most contractors tend to make 2 or 3 passes with the dye/hardener powder, first up-down, then side-to-side and finally diagonally or up-down again. The rate of application for the colour hardener is approximately 1.5Kg per m^2, but this can vary from brand to brand.
Care is required with the colour hardener, and the release agent, as rough scattering can result in it being cast beyond the boundaries of the work, and so polythene sheeting or back-boards should be used to minimise accidental contamination of other areas. Spillage or overthrow should be cleaned up immediately.

For work with more than one colour, a true artist is needed to achieve the right balance and distribution of powder dye to achieve the desired effect. This is a skill that can only be learned by practice and experience. It is well-nigh impossible to rectify bad distribution of the colour dyes/hardener, so a steady hand and keen eye are essential.

There is some variability in the effectiveness and fading-resistance of different products. With this type of paving, it really does pay to make sure you are getting the best quality colours, and, as in other walks of life, quality comes at a price.

The dye/hardener absorbs water from the concrete and once wetted is trowelled onto the surface of the concrete, creating a tough, durable surface to the slab.
The hardener agent has a more or less immediate effect and work must continue uninterrupted to achieve best results. Edges of the pavement are normally arrissed (rounded) with a special finishing trowel while the body of the surface is flat floated to a smooth finish with no trowel marks.

Apply Release Agent

The coloured and chemically hardened surface will need some 'help' to avoid it sticking to the imprint mats or lifting as the mats are removed, and so a special Release Agent is applied, again by hand broadcasting over the surface.
Many of these release agents also contain a dye that enhances the colouring of the concrete by adding a subtle extra tone. For highly decorative finishes, two or more colours of release agent may be used. Rate of application again varies from brand to brand but is approximately 200g per m^2 (1 kg treats 4-5m^2)

Imprinting

As soon as the release agent has been applied, the imprinting must be started. This is done via texture mats, a sort of stiff plastic or alloy 'negative' of the chosen pattern.
There are also highly flexible 'floppy mats' for those areas where a full mat cannot fit, so a 'floppy' mat is folded or twisted to cover the required area and then imprinted.

Many of the texture mats are modular, in that a series of mats are aligned to build up a pattern over a larger area, but there are also 'freeform' mats with no definite edges which are used to apply a simple texture (such as 'stone' or 'slate') over the surface, with no need for exact alignment or careful working at edges and boundaries.
These freeform texture mats tend to be considerably larger than the pattern mats, up to 1.8m x 1.8m, and are allowed to overlap their neighbours rather than be positioned exactly. This enables quicker working with a lower skill level, although the more decorative patterns are not possible using this technique.

The standard pattern mats tend to be of a more manageable size, usually between 300x300mm and 900x900mm, as they need to be carefully positioned on the surface, abutting their immediate neighbour and aligning with previously imprinted concrete. Once in position, they are tapped gently into the still workable concrete with the aid of a panel to imprint the chosen pattern.
The whole area of each mat must be panelled to ensure edges and centre imprint evenly. The operative doing the panelling (often known as the 'Stamper') is usually an experienced hand with a wealth of experience in judging just how hard to panel the mats to impart the correct depth of pattern, something that can only be determined by trial, error and experience.

Different mats are used to create variety and it is common for one particular pattern be used to imprint the edging course, say a soldier brick edging, and a different pattern, say ashlar stone, be used for the body of the pavement. The exact design of the pavement will determine the most effective working sequence, but, normally, any edge pattern, such as a soldier course, will be completed in advance of the body pattern.

Care has to be taken to deal with 'snots', the concrete matrix that can squeeze-up between adjacent mats when imprinting is being carried out. These 'snots' are normally removed immediately so that they are not accidentally kicked onto the already-stamped area or carried elsewhere on the site on the soles of boots.

A set of mats will be used to imprint the pattern. In normal circumstances, the contractor will use a full 'row' of mats to span the pavement and to commence the next 'pass'. The mats from the first pass are then lifted in sequence and re-positioned for the next pass. One operative is normally appointed as 'Toucher-Upper' and it is their responsibility to follow behind the 'Mat Placer' and the 'Stamper', to tidy the freshly imprinted area, re-tooling any parts that have not imprinted cleanly, removing snots, stamping the floppies and generally ensuring the work is up to standard. This touch-up work is often the giveaway, identifying the artisan from the lackadaisical sloven. It is the attention to detail that can make or break a job.

Wash Down

24-96 hours later, the now hard and patterned concrete will be power-washed to remove excess release agents and any other detritus.
The timing of this operation is critical, as if done too soon, it can damage the surface, marring the pattern or the colour, or, if left too late, can fail to clean the surface properly.

Power washing after 2-5 days

Again, the timing of this operation is something that cannot be accurately predicted but is judged by experience.

During the power-washing, the surface is again checked for any snots (lumps and bumps of excess concrete) should be removed before the final stage, application of the sealants

Sealant

The patterned concrete should be allowed to thoroughly dry, and then 1 or preferably 2 applications of a transparent sealant are made, to safeguard the concrete from spills and stains, and to protect the colours from UV light fading.

A solvent-based acrylic sealant will protect the surface while still allowing the concrete to 'breathe', ie, lose moisture content.
Many sealants impart a gloss finish, although there are satin and matt finishes available, these being typically silicon-based and more expensive than acrylics.

It should be noted that acrylic sealants are not particularly durable and pavements experiencing heavy wear may wish to consider a top-coat of

a urethane or epoxy-resin sealant 6-8 weeks after completion of the work. Under normal conditions, a good acrylic sealant will have a life-span of 2-5 years after which, it should be re-coated.

Jointing

Crack control joints are essential on most PIC projects.

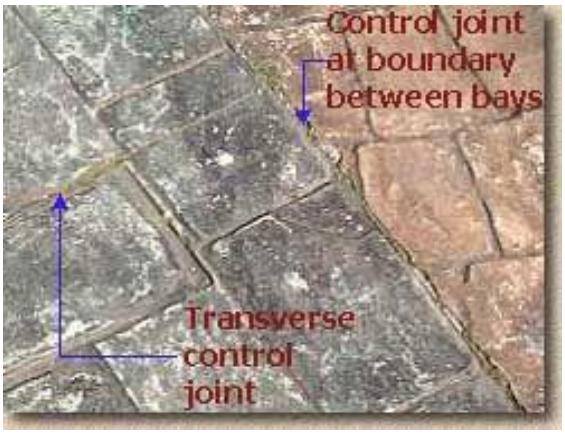
Their purpose is to ensure that when the concrete slab cracks, it cracks at this point and nowhere else, and that this control joint has been prepared in advance to cope with the eventual crack.

The usual recommendation is for some form of movement joint to be created in a non-reinforced slab at a separation of approximately 30 times the slab thickness. So, for a 100mm thick slab, there should be some form of joint every 100mm × 30 = 3000mm = every 3.0-3.6m and, in a 150mm slab, 150mm × 30 = 4500mm = 4.5-5.4m.

Naturally, there is some leeway with these calculations, and joints can be positioned to coincide with band courses or to be 'centred' within a slab for aesthetic reasons.

If crack control joints are required, there are two common methods of creating them;

1-They can be created during the actual laying of the surface or
2-They can be sawn at a later date, after the sealant has been applied.

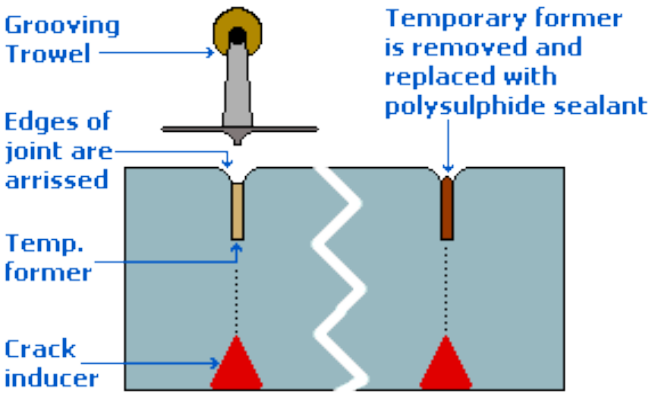


On residential driveways, most contractors seem to prefer sawing control joints at the end of the works, although it is debatable whether this practice would be acceptable on larger, supervised commercial works.

For creation during construction.

The control joints may be pre-formed using a timber strip and/or a Grooving Trowel.

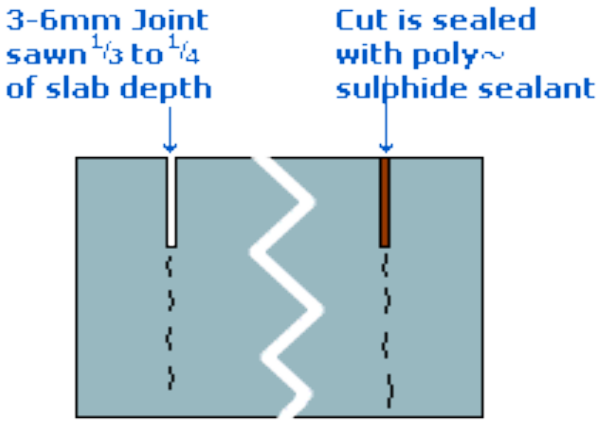
The inclusion of a crack inducer will help ensure cracking takes place in exactly the right place. Depending on the type of joint required, additional work may be necessary once the concrete has cured. If a timber or other temporary former has been used to create the wet-formed joint, it should be removed and the joint sealed with a suitable sealant, usually a polysulphide such as Thioflex.



Wet-formed crack control joint

Sawn joints are normally cut a week or more after sealing, so that the concrete will have had a reasonable amount of time to cure and avoid 'spalling' at the cut edges, and for the sealant to protect the surface from the concrete dust. On no account should concrete dust be allowed to rest on the surface for any length of time as it will set and could damage the surface when forcibly removed.

They are cut into the cured pavement using a **power saw** with diamond-blade, and should be between 25% and 33% of the depth of the slab. A trolley-mounted floor saw will ensure a neat and true cut is made; hand-held cut-off saws have a tendency to 'wobble' during the cutting operation, giving a cut with all the straightness of a dog's back leg. If a hand-held cut-off saw is the only option, a suitable guide rail should be used to keep the cut straight and true.



Sawn crack control joint

The work is now finished. The contractor will advise as to when it will be safe to traffic, usually 4-7 days after laying.
Any temporary formwork should have been removed after 3-7 days and the edges made good with backfilling or similar. Any protective sheeting used to prevent concrete splashing onto walls or other surfaces during the work should be removed and the site left in a clean and tidy condition

Pros and Cons

When done properly, and not aggravated by adverse weather conditions, PIC paving can look very attractive, and will require almost no maintenance other than sweeping and re-application of the sealant every 2-4 years. Unfortunately, good contractors in this particular discipline are few and far between, so it is essential that references are taken, previous jobs visited, and clients quizzed, to ensure you have chosen a reliable and competent firm.

When done badly, there is no way of correcting any problems, as the concrete is rigid and impossible to patch repair invisibly. If the contractor does not get the job right first time, there is no remedial action other than to rip it up and redo.

Also, there is concern regarding underground services and drainage that may be covered by the PIC. Should any remedial work ever be required on buried services, the PIC will need to be broken out and any patching will be impossible to hide. The only solution is to create band courses or similar to delineate the original surface from the patched area.

Yes! That really is a beer crate imprint!

Cons

Common problems reported with PIC include:

-Cracking of the surface at places other than control joints and 'flaking' of the surface. Both of these faults are directly attributable to bad workmanship.

Correct preparation of the **sub-base** and **sub-grade** along with the inclusion of well-formed **crack control joints** should eliminate all unwanted cracking, while flaking is often a result of poor floating of the colour hardener and/or the release agent. This spalling of the surface can also be brought about by the addition of extra water to the mix, which adversely affects the design strength of the concrete.

Cracking and Flaking of PIC

Algae and traffic wear

- And despite the claims often made by the sales agents, algae and lichens *do* colonise PIC, so it is not completely maintenance free.
- The surface needs to be swept regularly to keep it free of detritus which can accumulate on the uneven surface and in the 'joints' of certain patterns. Also,
- The sealant will need to be re-applied every 2-4 years, especially on heavily trafficked areas, which can wear quite quickly, exposing the plain uncoloured concrete beneath, if the original sealant is allowed to deteriorate.

Pros

Overall, PIC can be a beautiful, cost-effective and low maintenance paving provided it is installed by competent professional contractors using the very best practices and top-quality materials. It would not be fair to consider PIC to be a faithful reproduction of other paving surfaces, such as **cobbles** , **setts** or **flagstone** , but rather that it gives an general impression of that type of surface, often achieved at a lower price and in a shorter time.