



## Tiling in Swimming Pools

### BRIEF GUIDANCE NOTES ON THE INSTALLATION OF CERAMIC TILING

Ceramic tiling and mosaic are both excellent and popular finishes for swimming pools since they can provide attractive and durable surfaces both in the pools, on the pool surrounds and pool hall walls. Swimming pools range in size from large international pools, often with moveable floors, through leisure pools, with numerous water features, down to the smaller private pools. In all cases the fixing and grouting techniques of the tile and mosaic finishes are essentially the same.

With water retaining structures it is essential that the structure supporting the tiling is essentially watertight since the tile or mosaic bed is not installed to provide a tanking membrane. With large pools the construction normally consists of a reinforced concrete tank constructed in accordance with the relevant European standards (see below). The concrete tank can be formed using normal concrete construction techniques but sprayed reinforced concrete ('Guniting' or 'Shotcrete') is frequently used, being particularly useful where freeform pool tanks are required.

The best form of construction is to form the walls and floor of the concrete pool tank with sufficient accuracy to allow the tiles and mosaics to be fixed directly onto the prepared concrete surface. With concrete pool tanks this requires accurate formwork, which will not deflect or distort when the concrete is poured, or accurate finishing with free form pools. In many cases the alternative method of roughening the concrete surface and applying well-adhered screeds and renders to obtain the required accuracy in the pool walls and floors is adopted. In some competition pools with accurately constructed concrete walls one end wall may be rendered to control the lane length for competition purposes. The publication by the Cement and Concrete Association (now the British Cement Association) entitled 'Concrete Swimming Pools', which covers both of these techniques, is a useful guide.

Smaller pools are frequently constructed using reinforced concrete blockwork walls on a reinforced concrete base slab, as originally described in 'Building a Concrete Block Swimming Pool, published by the Cement and Concrete Association in 1972. It is important with these constructions to ensure that the junction between the concrete base and the blockwork walls is watertight by use of a water bar and the concrete fill between the blocks and thus around the steel reinforcement is solid and free of voids. An important factor in these pools is to ensure that the render on the walls provides an effective tanking since this type of swimming pool construction was originally designed for finishing with an impervious paint coating

With reinforced concrete pool tanks the normal procedure is to test the pool tank to confirm that it is watertight, this was normally carried out in accordance with clause 9.2 of BS 8007. With the latest standards the pool shell should be constructed to BS EN 1992-3:2006 Eurocode 2 Design of concrete structures. Liquid retaining and containing structures, taking into account the UK National Annex to Eurocode 2. Design of concrete structures. Liquid retaining and containment structures.

In some circumstances it will be necessary to install a tanking membrane beneath the tiling and this is usually applied directly on top of the screeds and renders prior to tiling. These tanking membranes are normally applied as a coating and particular attention

should be given to ensure that any penetrations through the tanking membrane are effectively sealed, this will include any inlets and outlets as well as any movement joints in the underlying structure.

It is important to ensure that the pool tank has completed most of its drying shrinkage before any rigid finish is applied. Clause 7.3.2.1 of BS 5385: Part 4: 2009 recommends that the following minimum time intervals should be allowed to elapse between the successive stages of construction with reinforced concrete pool tanks constructed as water retaining structures.

- Between the curing of the pool shell and rendering or screeding at least 6 weeks.
- Between completion of rendering or screeding and the commencement of tile fixing at least 3 weeks.
- After the completion of tile fixing and the commencement of grouting at least 3 days should elapse.
- Between completion of the grouting, movement joints and filling of the pool at least 3 weeks should elapse.

It is important to note that these minimum time periods are under good drying conditions (20°C and 65% RH) should be considerably extended under cold and damp site conditions. Note that in some countries a 6 month drying period is recommended for concrete.

With smaller pools, or pools of different construction, the periods between stages of construction tend to be shorter in practice due to time constraints imposed on site. If problems arise as a result of stresses from background shrinkage from shortened drying periods then these problems can ultimately become the responsibility of the contractor.

Note that it is important that where any renders, screeds or tiles and mosaics are to be adhered to concrete, the concrete surface should be suitably prepared to ensure maximum adhesion. Surfaces of thick concrete pool walls and bases can be mechanically roughened to provide a suitable key for screeds and renders, these being applied so that good adhesion is achieved with the prepared concrete surface.

Care should be taken to ensure that the mechanical keying of the concrete does not adversely affect the watertightness of the concrete pool tank. Where the preparation of the concrete surface cannot, or need not, be so aggressive then other less vigorous but effective techniques may be used to remove formwork release agents, cement paste and surface laitance such as water jetting and wet sand blasting.

Before the fixing of the tiles or mosaics it is also important to check that the surfaces to be tiled are true and sufficiently flat, or to the required even curvature with free form pools. Generally the surface of renders and screeds should be wood float finished and the normal standard of surface regularity (flatness) of surfaces to be tiled such that when checked with a 2 metre straight edge any gap under the straight edge between points of contact with the surface should not exceed 3mm.

The tile adhesive should not be used to make good inaccuracies in the background whilst the tiles or mosaics are being fixed. Any making good of backgrounds should be carried out as a separate operation prior to the installation of the tiles or mosaics. Some cement-based adhesives can be used to pre-smooth or even correct small-scale irregularities in the backgrounds but this should only be carried out in accordance with the manufacturer's instructions. Rapid hardening render mortars that are easier to apply are now available that can be applied from 2mm up to 20mm in a single application on prepared concrete walls to make good any inaccuracies.

The adhesive selected to fix the tiles or mosaics should be suitable for use in permanently immersed conditions as well as being appropriate for the type of tile or mosaic being fixed. BS EN ISO 12004 classifies tile adhesives on performance (class) and type of adhesive. In practice the type C (cementitious) and type R (reaction resin) adhesives are the ones used in swimming pools. Tile adhesives will be designated on the basis of type, performance (normal or improved adhesion) and additional characteristics, e.g. C2TE, as in the following table.

Type	Classification		Additional designation (characteristics)		
	Class 1	Class 2	Fast setting	Reduced slip	Extended open time
C	Normal	Improved	F	T	E
R	Normal	Improved		T	E

A cementitious adhesive with an improved adhesion value (greater than 1N/mm<sup>2</sup>) that sets rapidly and has high slip resistance will be designated as a C2FT adhesive. A cementitious adhesive with a normal adhesion value (greater than 0.5N/mm<sup>2</sup>) and a normal setting time but with an extended open time will be designated as C1E. A reaction resin adhesive with improved slump resistance will be designated as R2T. If dense non-absorbent tiles, e.g. porcelain, fully vitrified tiles, etc., or glass and very dense non-absorbent mosaics are to be fixed, a Class 2 adhesive should be selected.

It should be noted that the tile and mosaic bed cannot be considered to be a watertight layer so in aggressive water conditions, e.g. negative Langelier Saturation Index, or the presence of soluble sulfates, erosion and degradation of the underlying cement based materials, concrete, renders and screeds, will still occur. If mosaic tiling is being installed in areas with soft or otherwise aggressive water supplies where cement-based grouts have been found to erode in contact with pool water, the use of a reaction resin adhesive and grout to install the mosaic tesserae will be best for long term durability.

The adhesive used to fix the tiles or mosaics should always be mixed in accordance with the manufacturer's instructions. Reaction resin adhesives (typically based on epoxide or polyurethane resins) are supplied as pre-gauged components that only need to be mixed together before use. Cement-based adhesives have to be mixed with either water or aqueous synthetic polymer dispersion and the manufacturer's recommended mix proportions should be carefully followed.

The consistency of the mixed cement-based adhesive should be slump resistant and this can be checked by bedding a normal pool tile on a wall and, if correctly mixed, the tile should not slide down under its own weight. Mixing with excess water or excess aqueous synthetic polymer dispersion should be avoided, as this will impair the slip resistance with wall tiling. Such bad practice will also extend the drying and setting times of the freshly applied adhesive as well as slowing up the rate of hardening and reducing the eventual density, strength and adhesion of the hardened adhesive.

As with all cement-based adhesives the temperature during application will affect the setting, hardening and strength development of the adhesive so that in cool conditions a longer period of time should be allowed before the freshly fixed tiles are grouted.

When tiling is installed the adhesive should be trowelled onto the prepared surface, pressing it into the surface and combing out a ribbed adhesive bed using a suitable notched trowel. The best procedure is to apply a straight ribbed bed so that the adhesive is evenly distributed. The size of the notched trowel should be selected so that,

when held at about 45° to the surface, the ribs provide sufficient adhesive to fill any gap under the tiles when the tiles are bedded in.

The ribbed adhesive bed should still be wet and workable when mosaics are bedded in so that the adhesive wets the back of the tiles, the period of time available for this operation is called the 'open time' of the spread adhesive. In all wet locations, on floors and in external locations it is necessary to ensure that tiles are bedded in so that no voids are left beneath the tiles. To achieve this requirement the BS Codes of Practice recommend that the backs of the tiles be buttered with adhesive and any back profile or indented key filled with adhesive immediately before bedding the tile into the ribbed adhesive bed. There is no need to apply a thick layer of adhesive to the back of the tile, just enough to cover it and also fill any profile on the back of the tile.

This technique is described in the BS Codes of Practice as the solid bed fixing technique and the tiles should not only be firmly pressed into the ribbed adhesive bed to give solid contact with the background but no voids should remain behind the bedded tiles.

The notched trowel used to comb out the ribbed bed on the floors and walls of the swimming pools normally have from a 5mm square up to a 8mm square toothed and notched pattern as this is usually sufficient to solid bed fix the buttered ceramic tiles. The larger the tile the bigger the toothed and notched pattern should be and in all cases the ribbed adhesive bed should be squashed flat during the bedding of the tiles so as far as practicable no voids remain beneath the tiles. With mosaics a 3mm square toothed and notched trowel is normally appropriate to apply the ribbed adhesive bed.

It is recommended in the BS Codes of Practice that the solidity of bedding be checked as work proceeds by occasionally lifting up a freshly bedded tile to see if the bed beneath is solid and free of voids. Note that the amount of adhesive applied with a notched trowel not only depends on the pattern and size of the trowel notches but also on the angle at which the trowel is held against the background. This allows some adjustment to be made in by altering the angle at which the trowel is held to ensure the required amount of adhesive is applied.

On a suitably prepared and sufficiently flat background, with the application of the necessary amount of adhesive, the ceramic tiles can be bedded without excess adhesive filling the tile joints during the fixing of the tiles. The best technique is to place the tile being fixed against the sides of the tiles already fixed and press it into the ribbed bed and draw it away to form a joint of the required width. This technique avoids squeezing adhesive up the tile joints.

The normal size of notched trowel for mosaics is a 3mm square toothed and notched trowel and this usually applies sufficient adhesive for the tesserae forming the mosaic to be solidly bedded. An important point is to make sure that the individual tesserae are solidly bedded. This is one reason why the background should be sufficiently flat or of even curvature, without steps or irregularities, so that the mosaic tesserae will be uniformly bedded. The applied adhesive ribs will usually be no more than 2mm high so an ample depth of joint will be left empty for the subsequently applied grout. The thickness of the adhesive bed under the tesserae will be about 1mm after bedding in.

Mosaic tiling is usually supplied in pre-assembled arrays, with the tesserae being either glued with a water soluble adhesive to a paper sheet (paper-faced), or adhered to a mesh face upwards (mesh-backed). Some are supplied with the tesserae joined together with hot melt dabs or similar at the back edges, these should not rise unacceptably up the joints between the tesserae since this will provide insufficient depth of grout, however any ceramic mosaic supplied for swimming pools should be fit for use in immersed

conditions. With mesh backed mosaics the mesh and glue should be water resistant and not obscure more than 25% of the backs of the tesserae.

The suppliers of mosaics usually supply products that have a good track record and are specifically recommended for use swimming pools and similar wet locations. When mesh backed mosaics are installed the mosaic sheets should be placed in position as accurately as possible. The individual tesserae forming the mosaic should be thoroughly beaten in to ensure that the adhesive penetrates through the mesh and makes the maximum contact with the backs of the tesserae so that solid bedding is achieved and no voids remain beneath the tesserae

When paper-faced mosaics are bedded in adhesives the mosaic joints should not be pre-buttered with grout before being bedded in the ribbed adhesive bed. This technique was used where glass mosaic tiling was traditionally fixed using cement and sand mortar with a layer of neat white cement slurry on top of the cement and sand mortar bed. The backs of the sheets were grouted with the neat white cement paste to fill the joints immediately before being placed on the cement and sand bed and beaten in. This technique is now rarely used for installing glass mosaics in swimming pools.

If the above technique of pre-grouting the joints is used when bedding mosaic tiling in adhesives there is a risk that the backs of some tesserae will be partially coated with the grout mortar and will not be in full contact with the adhesive. The paper-faced mosaic sheets should be bedded in the ribbed adhesive bed and carefully tapped in with a wooden or rubber mallet so that the individual tesserae are solidly bedded with no voids beneath. The even spreading of the adhesive should prevent the joints being filled with adhesive and in most cases a 3mm square toothed and notched trowel is appropriate.

The alignment of the mosaics and joints should be checked as work proceeds. Normally the facing paper should be removed before the bedding sets. This is achieved by dampening the paper, either with a wet sponge, or by misting with a hand held sprayer, to wet and soften the glue between the tesserae and the facing paper until the glue softens sufficiently to allow the paper to be easily peeled off. Do not try to apply too much water at once, the object is to keep the facing paper continually damp until the glue holding the tesserae on the facing paper becomes damp and soft.

Once the paper glue has softened sufficiently the facing paper should then be carefully removed within the open time of the adhesive exposing the joints to see if any adjustments of the joints are necessary, especially between individual sheets, and if any damaged tesserae need to be replaced. This generally requires the facing paper to be removed within about 20 minutes of bedding the mosaic tiling. If the facing paper is not kept moist for sufficient time the facing paper glue will not have softened enough to allow the paper to be removed without dislodging the tesserae.

Any surplus adhesive in the joints or on the face of the mosaic should be removed before it sets, taking care not to dislodge the tesserae. If difficulty is experienced during the removal of the paper with the tesserae remaining adhered to the facing paper, this is usually due either to the tile adhesive not being mixed to a sufficiently stiff consistency, or the paper being removed before the paper glue has softened sufficiently. Some mosaics are supplied very accurately positioned on sheets with the tesserae at the edges of the sheets projecting beyond the facing paper. These can be accurately positioned and the facing paper can be dampened and removed.

Allow the adhesive bed to set and harden sufficiently before attempting to grout the joints between ceramic tiles or mosaic tesserae. In swimming pools and similar locations, where the tiling will be immersed, the adhesive should be allowed to harden and dry for at least 3 days before grouting commences. The grout used should be mixed

and applied in accordance with the manufacturer's instructions and should be suitable for the width of the joints and the type of exposure the completed tiling will have to withstand.

Avoid mixing cement-based grouts to a wetter consistency than recommended. The over wet grout mortar will be more easily excavated from the surface of the joints during cleaning off so that the joints will be more recessed, whilst grout mortars mixed to the correct consistency will be denser and harder so that the joints will be less recessed.

Always check to see if the pool water supply is likely to be aggressive to cement-based mortars, e.g. having a negative Langelier Index, very soft or having high levels of soluble sulphate. If it is not possible to take steps to modify and conscientiously monitor the pool water so that it remains non-aggressive then consideration should be given to the use of an epoxide resin based grout. It should be noted that the tile bed, even with an impervious grout, is not a waterproof membrane and will not protect the concrete, render and screed underneath from sulfate attack. There are always places where the pool water will be in direct, or indirect contact with the underlying pool construction via microscopic cracks and pores.

For general guidance it is always advisable to use cement-based mortars where the pool water has adequate calcium hardness and bicarbonate alkalinity levels and run at an appropriate pH so that the pool water has a slightly positive Langelier index. In most cases the calcium hardness should be greater than 250 mg/litre (as CaCO<sub>3</sub>) and the bicarbonate alkalinity should be greater than 80 mg/litre (as CaCO<sub>3</sub>) with a suitable pH range so that the Langelier index will ideally be in the range of 0.0 to +0.5, but kept within the extremes of - 0.5 to +1.0. The range of tests and the frequency of testing of the pool water should be established and records made of the results obtained and the amounts of chemicals added to the pool water as well as the amount of main supply water added to replace the water used for filter backwashing.

Additions of sulphate based chemicals in the treatment of swimming pool water should be avoided. Even at the recommended maximum sulfate level of 360 mg/litre as SO<sub>4</sub> (300mg/litre as SO<sub>3</sub>), sulphate attack on concrete and cement mortars will still occur. This means that, at any level of sulfate ion concentration, damage and gradual degradation of cement based materials in the underlying will still continue to occur, the rate of attack increasing as the sulfate concentration increases. Basically the sulfate ions in the swimming pool water can migrate through the smallest microscopic pores and cracks likely to be present in the tile bed so they can reach and 'attack' the underlying concrete and cement mortars.

Movement joints should be placed in the tile bed in accordance with clause 7.3.2.8 of BS 5385: Part 4: 2011 and any structural movement joints in the pool tank should be brought through the screed, render and tile bed. Movement joints in the tile bed are usually incorporated at changes in construction, i.e. at the junction between the pool wall and pool floor tiling, at internal corners between walls and at changes in slope in the pool floor. These are normally sufficient for tiles with joints 5mm or more in width and mosaics. Tiles with joints narrower than 5mm might require additional movement joints in the pool wall and floor tiling, spaced no more than 6 metres apart, but always obtain the tile suppliers advice whenever possible on this point. Outside the pool movement joints should be included at junctions with the pool structure, e.g. where the concrete pool tank abuts the pool surround slab/screed, as well as in the wall tiling on pool hall

walls, on the floors and walls of changing rooms and ancillary areas in accordance with the clauses in the relevant Parts of BS 5685.

If ceramic tiles and mosaics are correctly installed in well-constructed pools and the pool water correctly balanced with suitable water treatment they will provide an attractive, durable and easy to maintain finish. The client will then be able to appreciate the use of an attractive, good quality swimming pool for many years to come.

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