



Installation of Ceramic Tile in Swimming Pools

TDS 192

DESIGN CONSIDERATIONS

I. Primary types of swimming pool structures

A. Cast-in-place reinforced concrete

1. **Definition** – concrete placed or pumped on-site over steel reinforcing; vertical walls contained by form-work on both.
2. **Applications** – typically large commercial pools, elevated pools, or on-grade pools in areas with poor sub-soil conditions.

B. Guniting or Shot-Crete Reinforced Concrete

1. **Definition** – mortar or concrete projected through a hose and pneumatically projected at high velocity onto a reinforced surface, usually formed on one side by soil excavation.
2. **Applications** – below grade, small residential or light commercial pools with good sub-soil conditions; may also be used over form-work.

II. Movement / Expansion Joints

A. Definitions

1. **Construction / cold joint** – walls / floors typically are cast monolithically but large pools require multiple pours; concrete will crack at these weak intersections and require movement joint with integral water stops.
2. **Control joint** – prevents random cracking by controlling drying and shrinkage in straight lines; typically eliminated by use of additional reinforcing to control shrinkage and keep concrete from drying out before filling.
3. **Expansion joint** – accommodates thermal and moisture movement in large pools. Example – 50m (164 ft.) length pool can expand 10mm (0.4”) on average after filling, and requires aggregate joint width 3-4 times the anticipated movement or 30-40mm (1” – 1.6”) wide.
4. **Sealing movement joints** – whether a pool needs to be completely waterproof (prevents any leaks), or watertight (monolithic structure which contains water with minimal absorption and leakage), movement joints must be designed to prevent rapid loss of water.
 - a. **Primary protection – sealants** – provide primary closure of joints, but cannot provide 100% effectiveness as a barrier to water leakage. Sealants must be suitable for water submersion and be installed with proper backer rod, primer (as required), and tooling by specialists.
 - b. **Secondary protection – water stops** - flexible plastic or butyl rubber devices which are integrally cast in, or placed below movement joints in pools to provide a flexible yet monolithic, watertight connection across movement joints. Water stops are critical secondary protection even when a waterproofing membrane is specified.

III. Deflection

A. Systems, including the framing system and panels, over which tile or stone will be installed shall be in conformance with the International Residential Code (IRC) for residential applications, the International Building Code (IBC) for commercial applications, or applicable building codes. The project design should include the intended use and necessary allowances for the expected live load, concentrated load, impact load, and dead load including the weight of the finish and installation materials. In addition to deflection considerations, above-ground installations are inherently more susceptible to vibration. Consult grout, mortar, and membrane manufacturer to determine appropriate installation materials for above-ground installations. A crack isolation and higher quality setting materials can increase the performance capabilities of above-ground applications. However, the upgraded materials cannot mitigate structural deficiencies including floors not meeting code requirements and/or over loading or other abuse of the installation in excess of design parameters

INSTALLATION PROCEDURES

I. Surface Preparation

A. Preparation and cleaning – concrete pool shells are rarely smooth, free of contamination and defects, and level enough for bonding of waterproofing membrane and ceramic tile. Improper preparation and cleaning are a primary cause of failure of waterproofing membranes and leveling mortars (renders and screeds) in pools. Cast-in-place concrete walls present specific defects such as form release or curing agents, and surface defects (e.g. honeycombing and laitance). Concrete pool shells are also subject to surface defects such as dusting, crazing and laitance from improper finishing, as well as significant ground-in construction contamination.

1. Typical Methods

- a. High-pressure water blasting** – 5,000 – 8,000 (34–54MPa) to remove severe contamination by removing top 1/8” (3mm) to 1/4” (6mm) of concrete and to expose aggregate for improved mechanical bond of standard portland cement leveling mortars (screeds and renders).
- b. High-pressure water cleaning** – 1,000psi (6.8MPa) to clean surface dirt and contamination or weakened surface layers (laitance) without aggregate exposure; use in conjunction with detergents and degreasers to remove dirt or light coatings of oil or other contamination.
- c. Shot blasting** – effective for floors and walls (with hand held equipment); removes and collects debris in one step from top layer 1/16” (1.5mm) to 1/4” (6mm) with fine to coarse steel pellets. Use to remove existing paint coatings or concrete surface defects such as laitance
- d. Grinding** - variety of mechanical scarifying methods available, must ensure final cleaning of residue with high pressure water or air cleaning.
- e. Grit blasting** – includes traditional sand blasting, which is effective but intrusive and hazardous; or, new methods incorporating water soluble, mechanically refined sodium carbonate grit media.
- f. Acid cleaning** – this method is not recommended if other methods are available because improper dilution and/or improper application methods (failure to saturate surfaces with water), and improper neutralizing/rinsing of residue can deteriorate concrete surfaces. Improper methods and dilutions can also cause post installation efflorescence from residual soluble chlorides. Residual chloride can also inhibit bond, accelerate set of cement based mortars and adhesives, or cause chloride ion deterioration of steel reinforcing.
- g. Low-pressure water/scrubbing** – ordinary garden hose washing with stiff bristle brush is satisfactory if concrete has no surface defects or oily, organic contamination. Any cleaning agents must be completely neutralized and rinsed.

2. Wall Patching, Plastering or Rendering – necessary if concrete cannot be designed and finished accurately to meet levelness or flatness tolerances for direct application of ceramic tile or stone using thin-set method. For thick bed (mortar bed) ceramic and stone tile installations and self-leveling methods: maximum allowable variation in the installation substrate to be 1/4” in 10’ (6mm in 3m).

For thin-bed ceramic tile installations when a cementitious bonding material will be used, including medium bed mortar: maximum allowable variation in the tile substrate – for tiles with edges shorter than 15” (375mm), maximum allowable variation is 1/4” in 10’ (6mm in 3m) from the required plane, with no more than 1/16” variation in 12” (1.5mm variation in 300mm) when measured from the high points in the surface. For tiles with at least one edge 15” (375mm) in length, maximum allowable variation is 1/8” in 10’ (3mm in 3m) from the required plane, with no more than 1/16” variation in 24” (1.5mm variation in 600mm) when measured from the high points in the surface. For modular substrate units, such as exterior glue plywood panels or adjacent concrete masonry units, adjacent edges cannot exceed 1/32” (0.8mm) difference in height. Should the architect/designer require a more stringent finish tolerance (e.g. 1/8” in 10’ [3mm in 3m]), the subsurface specification must reflect that tolerance, or the tile specification must include a specific and separate requirement to bring the subsurface tolerance into compliance with the desired tolerance.

B. Latex portland cement leveling mortar (render) – LATICRETE® 3701 Fortified Mortar Bed; or, LATICRETE 226 Thick Bed Mortar mixed with LATICRETE 3701 Mortar Admix is recommended for best adhesion and performance under thermal and moisture movement differential and exposure to effects

of water treatment; should be mixed to a plastic consistency and applied no greater than ½” (12mm) thick per application (lift). Carry any underlying movement joints to the surface.

- C. **Floor leveling or screeding** – necessary if concrete cannot be designed and finished accurately to meet levelness tolerance for direct application of ceramic tile using the thin-set method of ¼” (6mm) in 10 ft. (3m).
1. **Latex portland cement mortar** – same type of mortar as B.1 (above), applied from 1’ – 2 ½” (25 – 63mm) mixed to a semi-dry consistency and placed over a latex/cement slurry bond coat consisting of LATICRETE 254 Platinum, or LATICRETE 211 Powder gauged with LATICRETE 4237 Latex Additive, leveled between screed boards and thoroughly compacted.

II. Waterproofing

A. Methods of waterproofing swimming pools

1. **External or “sandwich” slab waterproofing membranes** – sheet or fluid applied waterproofing membrane installed between two layers of concrete or between grade and concrete shell; this method is costly and is typically used when external or negative hydrostatic pressure is present to protect ceramic tile from delamination when pool is emptied, or with waterproofing membranes that do not allow direct adhesion of ceramic tile.
 2. **Direct bond waterproofing membranes** – protects underlying leveling mortars and concrete shell from saturation and prevents problems caused by moisture penetration such as moisture expansion, chemical attack (chloride ion deterioration of reinforcing steel), and efflorescence. LATICRETE products in this category include LATICRETE Hydro Ban™ and LATICRETE 9235 Waterproofing Membrane.
- B. **Water / flood testing** – test for water-tightness after application and required cure time of LATICRETE Hydro Ban™ or LATICRETE 9235 Waterproofing Membrane is complete. Please refer to LATICRETE WPAF.5 for cure time of LATICRETE 9235 Waterproofing Membrane or DS 663.5 for cure time of LATICRETE® Hydro Ban™ prior to flood testing. Fill at the rate of 2 ft. (600mm) per 24 hours. Flood tests are generally conducted for 24 – 48 hours.

III. Selection and Installation of Ceramic Tile

C. Considerations for selection of ceramic tile

1. **Pre-mounted mosaics** – use of paper face mounted ceramic, stone and glass mosaics is recommended; use caution when considering back mounted sheets using PVC dot mounting or adhesive mounted mesh mosaic tile; the types and quality of mounting methods vary and resulting bond strengths may be very low after saturation and chemical attack of pool water. Check with the manufacturer of the selected tile to verify compatibility in submerged installations. For further information on the installation of glass mosaics, please refer to TDS 145.
 2. **Moisture expansion** – use only impervious (<.5% absorption rate) or vitreous (<3% absorption rate) tiles to reduce the effects of moisture expansion, or, in the case of exterior pools in cold climates, to eliminate freeze/thaw problems. Tiles with an absorption rate over 3% may permanently expand from moisture exposure.
- D. **Installation recommendations (reference LATICRETE Execution Statement ES-P601 at www.laticrete.com/ag)**

1. **Latex fortified mortars (thick or thin bed)** – use mortars suitable for continuous water submersion. Latex mortars improve adhesion, reduce chemical attack by coating portland cement, and impart flexibility to withstand moisture expansion and shrinkage. For thick bed mortars use LATICRETE 3701 Fortified Mortar Bed; or, LATICRETE 226 Thick Bed Mortar gauged with LATICRETE 3701 Mortar Admix. For thin bed applications use LATICRETE 254 Platinum or LATICRETE 211 Powder gauged with LATICRETE 4237 Latex Additive
2. **Epoxy adhesives** – (e.g. LATAPOXY® 300 Adhesive) are recommended to eliminate deterioration from chemical attack. Many epoxies suitable for interior and exterior use have flexibility and exceptional adhesive qualities to withstand differential movement from thermal and moisture expansion and drying shrinkage.

IV. Grouting of ceramic tile

A. Types of grout

1. **LATICRETE SpectraLOCK® PRO Premium Grout* and LATICRETE SpectraLOCK PRO Grout** - unique cross linking technology grouts which contain no portland cement and are not subject to effects of water treatment; epoxies may discolor when exposed to ultraviolet rays in exterior applications which does not affect the grouts' performance
2. **LATICRETE PermaColor™ Grout** – high performance, polymer fortified grout that provides a durable, dense and hard grout that is ideal for submerged installations; mixes with water only
3. **LATICRETE 1500 Sanded Grout mixed with LATICRETE 1776 Grout Enhancer** – latex additive coats the portland cement particles and pigments, reducing attack from water treatment chemicals; latex imparts flexibility to help withstand moisture expansion when pool is filled and shrinkage when emptied
4. **Movement joints** – in addition to any movement joints carried through from the underlying concrete shell to the tile surface, additional joints must be provided every 8–12 (2.5–4m) to provide for long term moisture expansion, and shrinkage as the pool is emptied. Refer to Tile Council of North America (TCNA) EJ-171 for further information on the construct, design and placement of movement joints. The project architect or engineer must specify movement joints and show location and other details on drawings and specifications.
 - **Sealant for movement joints** – LATICRETE Latasil™ with LATICRETE 9118 Primer

MAINTENANCE

I. Opening, seasonal closing and pool idling for maintenance and repairs

- A. **Curing** – observe an average minimum cure time of 14 days at 70°F (21°C) for latex fortified portland cement grout installations to prevent latex migration, and 10 days at 70°F (21°C) for epoxy grouts to reach maximum
- B. chemical resistance prior to filling pool. Cure time can be significantly increased or decreased due to temperature and humidity effects on curing.
- C. **Filling** – fill pool with water at a rate of 2 ft (600mm) per 24 hours to allow gradual exposure to water pressure, thermal and moisture differentials. Initial alkalinity of pool water is usually very high from exposure to portland cement based finishes, mortars and grouts, so careful and frequent balancing is required (see Water balance below in section II.C). Do not fill if potential thermal gradients exist (e.g. very cold source water into an exterior pool which has been exposed to several days of solar radiation).
- D. **Emptying** – empty pool water at the rate of 2 ft (600mm) per 24 hours to prevent hydrostatic pressure from delaminating tiles of leveling mortar.
- E. **Closing (seasonal)** – pool should be drained to a point below outlets and kept partially filled to minimize stress on tile. Keeping pool filled prevents negative hydrostatic pressure (absorbed water within the pool shell, and from subsurface ground water) from affecting ceramic tile and waterproofing bond, and, prevents significant movement that can occur from drying shrinkage and thermal differential.

II. Effects of water treatment in tiled swimming pools – swimming pool water chemistry is a very complex but essential component to proper, and healthy, operation of any swimming pool.

- A. **Source water** – sulphate content
- B. **Disinfection** – chlorine is the most popular and effective disinfection agent for swimming pool water. Bromine, chlorine gas, ozone, salt, and other non-chemical disinfection systems are also available.
 1. a common misconception is that chlorine treatments are the cause of attack and deterioration of portland cement based materials used to install tile in swimming pools. This is basically not true; any concentration of chlorine high enough to aggressively attack portland cement based materials would cause pool occupants to become seriously ill. Concentrations of chlorine used in a pool should only be strong enough to eliminate bacteria and algae growth. Improper chlorine levels (1.0 – 1.5 ppm normal level) will make balance of water difficult.
 2. chlorine uses and depletes calcium during the disinfection process; calcium balance is critical to prevent calcium depletion and deterioration of cement based materials (including grout).
- C. **Water balance** – the balance of the pool water is primarily responsible for problems with maintenance of tiled swimming pools. Acidity, alkalinity and the amounts of mineral salts (water hardness) in swimming pool water must be kept in balance to prevent, among other things, contamination and deterioration of portland cement plasters, mortars and grouts.

1. **pH value** – pH is used to measure balance between acidity and alkalinity of water on a scale of 0–14, with 7 indicating a balanced or neutral state. Swimming pool water needs to be maintained between a pH of 7.2 & 8.0. If the pH is too high (alkaline) then mineral deposits will form on tile and grout, especially at the waterline. Mineral deposits may also form beneath the surface of tiles and exert excess pressure which can result in decreased bond strength or delamination. If pH is too low (acidic) then etching and deterioration of portland cement based materials will occur. If this condition persists, grout may become rough or completely deteriorated. This can lead to further deterioration of adhesive mortar or leveling mortars beneath the tile.
2. **Mineral content (calcium hardness)** – water hardness or the amount of calcium is defined as the quantity of dissolved minerals (calcium) in water. If the level of calcium is too low (below 200 – 250 ppm) then the chlorine in the pool water will use the free calcium present in portland cement based products. This will lead to deterioration and etching. Balancing minerals, including calcium, will also reduce mineral deposits on tile and grout, as well as prevent deposits and corrosion of pool plumbing.
3. **Total alkalinity** – measures the amount of carbonates in the pool water, which act as buffering agents and help control pH.
4. **Metal content** – iron and copper are common metals occurring in source water. At low pH (acidic) metals are typically in solution. At normal pH (7.2–7.8), metals are out of solution and can be deposited as a stain on tile, grout, and pool fittings/fixtures.

Please refer to Tiled Swimming Pool, Fountain and Spa Technical Design Manual available at www.laticrete.com for more in-depth information.

United States Patent No.: 6881768 (and Other Patents)

Technical Data Sheets are subject to change without notice. For latest revision, check our website at www.laticrete.com
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LATICRETE INTERNATIONAL, INC. ▪ 1 LATICRETE Park North ▪ Bethany, CT 06524-3423 USA
800.243.4788 ▪ support@laticrete.com ▪ www.laticrete.com

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