INSTALLATION OF CERAMIC TILE IN SWIMMING POOLS

T.D.S. 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 formwork on both

2. Applications - typically large commercial pools, elevated pools, or on-grade pools in areas with poor subsoil conditions.

B. Gunite or shotcrete 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 subsoil conditions; may also be used over formwork.

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 waterstops.

2. control joint - prevents random cracking by controlling drying and shrinkage in straight line; typically eliminated by use of additional reinforcing to control shrinkage and keeping concrete from drying out before filling.

3. expansion joint - accommodates thermal and moisture movement in large pools. *Example* - 50 m (164 ft) length pool expands 10 mm (.4 in) on average after filling and requires aggregate joint width 3-4 times the anticipated movement or 30-40 mm (1-1.5 in) 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 can not provide 100 % effectiveness as a barrier to water leakage. Sealants must be suitable for water submersion and be installed with proper backer rods and tooling by specialists.

b. secondary protection - waterstops are 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. Waterstops are critical secondary protection even when waterproof membranes are specified.

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 waterproof membranes or ceramic tiles. Improper preparation and cleaning are a primary cause of failure of waterproof 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 such as 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 psi (34-54 Mpa) to remove severe

contamination by removal of top 1/8"-1/4" (3-6 mm) and to expose aggregate for improved mechanical bond of standard Portland cement leveling mortars (screed and renders).

b. High Pressure Water Cleaning - 1,000 psi (6.8 Mpa) to clean surface dirt and contamination or weakened surface layer (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"-1/4" (1-6 mm) 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

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 dilutions and improper application methods (failure to saturate surfaces with water) and improper neutralizing/rinsing of residue can deteriorate concrete surface and or 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 bristle brush scrubbing is satisfactory if concrete has no surface defects or oily, organic contamination. Any cleaning agents must be completely rinsed/ neutralized.

B. Wall Patching, Plastering or Rendering - necessary if concrete can not be designed and finished accurately to meet levelness (flatness) tolerance for direct application of ceramic tile using thin set method 1/8" 10 ft (3 mm in 3 m) or if plumbness (vertical) deviation is within 1" (25 mm).

1. **Latex Portland cement leveling mortar (render)** – 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 to ½" (12 mm) thick per application; carry underlying movement joints to surface.

C. Floor Leveling or Screeding - necessary if concrete can not be designed and finished accurately to meet levelness tolerance for direct application of ceramic tile using thin set method 1/8" in 10 ft (3 mm in 3 m).

1. **Latex Portland cement mortar** - same type of mortar as B.1 above, applied from 1"-2 ½" (25-65 mm) mixed to a semi-dry consistency and placed over a latex/cement slurry bond coat consisting of LATICRETE 211 Crete Filler Powder mixed with LATICRETE 4237 Latex Thin Set Mortar Additive, leveled between screeding boards and thoroughly compacted.

II. Waterproofing

A. Methods of waterproofing swimming pools

1. **External or "sandwich" slab waterproof membranes** - sheet or fluid applied membrane installed between two layers of concrete or between grade and concrete shell; this method is costly and typically used when external or negative hydrostatic water pressure is present to protect ceramic tiles from delamination when pool is emptied, or with membranes that do not allow direct adhesion of ceramic tile.
2. **Direct bond waterproof membranes** – Use LATICRETE 9235 Waterproofing Membrane. 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.

B. Water / Flood testing - Test for water-tightness after application of LATICRETE 9235 Waterproofing Membrane is complete and cured for a minimum of 7 days at 70 degrees F (21 C). Fill at slow rate of 2 ft (600 mm) per 24 hours. Flood tests are generally conducted for 24-48 hours.

1. **Leak detection** - The use of fugitive dyes and scuba divers are an effective method to trace any

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leakage detected during flood testing.

III. Selection and Installation of Ceramic Tile

A. Considerations for selection of ceramic tile

1. Pre-mounted ceramic mosaics - use of paper faced ceramic mosaics is recommended; use precaution when considering back mounted mosaics using PVC rubber dots or adhesive mounted mesh; the types and quality of mounting methods vary and resulting bond strengths may be very low after saturation and chemical attack of pool water.

2. Moisture expansion - use only impervious (< .5 %) or vitreous (< 3%) tiles to reduce effects of moisture expansion, or in the case of exterior pools in cold climates to eliminate freeze/thaw problems. Tiles over 3-7% absorption may permanently expand from moisture exposure.

B. Installation recommendations (reference LATICRETE Detail Drawing # 7004)

1. Latex fortified mortars (thick or thin bed) - use mortars suitable for water submersion.
(e.g. Thin Bed: LATICRETE® 4237 Latex Thin Set Mortar Additive mixed with LATICRETE 211 Crete Filler Powder.)
(e.g. Thick Bed: LATICRETE 226 Thick Bed Mortar mixed with LATICRETE 3701 Mortar Admix.) Latex mortars improve adhesion, reduce chemical attack by coating Portland cement, and impart flexibility to withstand moisture expansion and shrinkage.

2. Epoxy adhesives – (e.g. LATAPOXY® 300 Epoxy Adhesive) recommended to eliminate deterioration from chemical attack; many epoxies suitable for interior and exterior, and 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 Grouts

1. LATICRETE 1500 Series Tri-Poly Fortified Sanded Grout mixed with LATICRETE 1776 Grout Admix Plus with Microban®. Latex additive coats Portland cement particles and pigments and reduces attack from water treatment chemicals; latex imparts flexibility to withstand moisture expansion when pool filled and shrinkage when emptied.

2. LATAPOXY SP-100 Stainless Grout For Floors and Walls - 100 % solid epoxy contains no Portland cement and is not subject to effects of water treatment resulting in a hygienic and permanent grout surface; epoxies may discolor when exposed to ultraviolet rays in exterior application, but no effect on performance.

3. LATICRETE SpectraLock™ Grout – Unique cross linking technology grout contains no Portland cement and is not subject to effects of water treatment.

4. Movement joints - in addition to any movement joints carried through from the underlying concrete shell to the ceramic tile surface, additional joints must be provided every 8-12 ft (2.5-4 m) to provide for long term moisture expansion, and shrinkage upon emptying of pool. Refer to Tile Council of America (TCA) Detail EJ171-Current Year, for additional information on the construct, design, and placement of movement joints. Project Architect or Engineer must specify movement joints and show location and details on drawings and specifications.

a. sealants for movement joints - LATICRETE® LATASIL Tile and Stone Sealant

MAINTENANCE

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

A. Curing -Observe an average minimum cure time of 14 days at 70 degrees F (21 degrees C) for Latex Portland cement installations to prevent latex migration and 10 days at 70 degrees F(21 degrees C) for epoxies to reach maximum chemical resistance prior to filling pool. Curing times can be significantly increased or decreased due to temperature and humidity effects on curing.

B. Filling - fill pool with water at rate of 2 ft (600 mm) per 24 hours to allow gradual exposure to water

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pressure, thermal and moisture differentials. Initial alkalinity of pool water is very high from exposure to Portland cement based finishes, grouts, and mortars; careful and frequent balance is required (see *water balance* below section II. C.). Do not fill if potential thermal gradients exist (very cold source water, exterior pool exposed to several days of solar radiation.

C. Emptying - empty pool water at rate of 2 ft. (600 mm) per 24 hours to prevent hydrostatic pressure from de-laminating tiles of leveling mortar (in pools without waterproof membrane)

D. Closing (seasonal) - pool should be drained only below outlets and kept partially filled to minimize stress on the tile. Keeping pool filled prevents negative hydrostatic pressure (absorbed water within 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 Ceramic Tiled Swimming Pools

Swimming pool water chemistry is a very complex, but essential component to proper operation and maintenance of a ceramic tiled 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 and other non-chemical disinfection systems available.

1. common misconception is that chlorine treatment is the cause of attack and deterioration of Portland cement materials used to install ceramic tile in swimming pools. This is basically not true; any concentration of chlorine high enough to aggressively attack Portland cement based materials would cause bathers to become seriously ill. Chlorine is only strong enough to eliminate bacteria and algae growth. Improper chlorine levels (1.0-1.5 ppm normal level) will make balance of water (see below) difficult.

2. Chlorine uses and depletes calcium during the disinfection process; calcium balance is essential to prevent calcium depletion and deterioration of cement mortars and grouts.

C. Water balance- the balance of the water is primarily responsible for problems with maintenance of ceramic 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 based grouts, adhesive mortars, and leveling plasters.

1. pH value - The term 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 maintained between a pH of 7.2 & 8.0. If pH is too high (alkaline), mineral deposits will form on tile and grout, especially at the waterline. Mineral deposits may also form beneath the surface of ceramic tiles and exert pressure resulting in decreased bond strength or de-lamination. If pH is too low (acidic), etching and deterioration of Portland cement based materials will occur. If this condition persists, grout may become rough or completely deteriorated, leading to further deterioration of adhesive mortar and 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, pool water will use the free calcium present in Portland cement grout, leading to deterioration and etching. Balancing minerals (calcium) will also reduce mineral deposits on ceramic tiles, grout, as well as prevents deposits and corrosion of pool plumbing.

3. Total Alkalinity - measures the amount of carbonates in the pool water, which are buffering agents that control pH.

4. Metal content - Iron and copper are common metals occurring in source water. At low pH (acidic below 7.2) metals are in solution. At normal pH (7.2-7.8), metals are out of solution and can be deposited as a stain on ceramic tile, grout, and pool fittings/ fixtures.

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