

CORROSION ENGINEERING INSTALLATION SPECIFICATION

TUFCHEM™ SILICATE CONCRETE - FOUNDATION GRADE

1. APPLICATIONS

- 1.1 TUFCHEM Silicate Concrete - Foundation Grade is an inorganic acid resistant polymer concrete. It can be used in lieu of Portland cement concrete mixes for structural applications such as floors and walls, or as an overlayment onto existing slabs. It can also be cast to refurbish pump bases plinths or trenches and sumps. When properly mixed and installed, will develop compressive strength exceeding 2,000 psi (14 MPa) in twenty-four hours and reach an ultimate strength in excess of 4000 psi (27 MPa). Consult product data sheet CE-252 for more detail. When fully cured, TUFCHEM Silicate Concrete - Foundation Grade is resistant to all concentrations of most acids including sulfuric, hydrochloric, nitric, chromic, acetic and phosphoric.
- 1.2 TUFCHEM Silicate Concrete - Foundation Grade is not resistant to acid fluorides or hydrofluoric acid and it should not be used in alkaline or caustic environments.
- 1.3 It is important that the first chemical exposure of cured TUFCHEM Silicate Concrete - Foundation Grade be of an acidic nature, whether from general industrial processes or acidic solution splash and spill events. If the initial exposure is alkaline rather than acidic, the surface of TUFCHEM Silicate Concrete - Foundation Grade may be affected and show erosion, exposing the aggregate matrix. Conditions to avoid before acidic exposure include general water exposure from plant cleanup or washdown procedures and exposure to rain or run-off onto the newly installed TUFCHEM Silicate Concrete - Foundation Grade.
- 1.4 This specification is inclusive of steps for a surface treatment procedure to minimize the effects noted in 1.3 above. They are outlined in section 4 of this document are intended to provide a conditioning effect that will significantly

TUFCHEM™ SILICATE CONCRETE - FG INSTALLATION SPECIFICATION
CES-343
05/17 SUPERSEDES 10/12 PAGE 2 OF 12

minimize surface erosion caused by exposing newly installed TUFCHEM Silicate Concrete - Foundation Grade to inappropriate initial chemistry.

2. REQUIREMENTS

- 2.1 Concrete surfaces against which TUFCHEM Silicate Concrete - Foundation Grade is to be cast shall be clean, sound, hard and of a roughened profile. To enhance the intimate mechanical bond, the concrete surface shall be roughened (1/8"- 1/4" (3-6 mm) profile minimum).
- 2.2 TUFCHEM Silicate Concrete - Foundation Grade can be used for structural applications in a similar manner to Portland cement concrete. When used in such fashion, the steel reinforcement must be designed, detailed and placed in accordance with the latest design and construction codes, just as one would do if the design would use a regular concrete mix of similar physical properties. One difference is epoxy coated rebar is usually suggested, as most applications for TUFCHEM Silicate Concrete - Foundation Grade are in corrosive environments. For certain demanding chemical service applications, uncoated steel rebar has been cleaned and coated with a high performance lining system such as PENNCOAT® 401 Lining System (CE-264) that offers even greater chemical service capabilities than epoxy coated rebar, or use of pultruded FRP rebar may be considered. Consult Corrosion Engineering for more detail.
- 2.3 It is suggested all reinforcement steel be covered with a minimum 2" (50 mm) thickness of TUFCHEM Silicate Concrete - Foundation Grade. Generally the minimum thickness for application of TUFCHEM Silicate Concrete - Foundation Grade is 1.5" (40 mm). For lesser thickness requirements consult Corrosion Engineering for optional suggestions.
- 2.4 Form work shall be adequately designed and reinforced to withstand a 140 pounds per cubic ft (2.2 gm/cm³) wet density castable concrete.
- 2.5 Forms must be sealed to prevent leakage of any liquid from the mix, and they shall be coated with a non-reactive form release agent. Release agents such as linseed oil, grease or plastic coated formwork are acceptable release agents.
- 2.6 Metal form ties shall be cut off flush with the casting surface after forms are removed.

TUFCHEM™ SILICATE CONCRETE - FG INSTALLATION SPECIFICATION
CES-343
05/17 SUPERSEDES 10/12 PAGE 3 OF 12

3. MEMBRANES

- 3.1 Tufchem Silicate Concrete overlayments, like all concrete materials, should not be considered liquid tight in and of themselves. Like all concretes, there is always the potential for the development of stress and structural cracks. As well these types of materials have a measurable degree of moisture absorption. From a design perspective what this means is while the material itself is unaffected by most chemical exposures, a chemical species can pass through it over time, potentially attacking the underlying substrate. The length of this time is a function of the frequency of a spill, the housekeeping in the area and the specific chemical service. For these reasons, these overlays should be treated like the time proven concept of chemical resistant masonry, and be used in conjunction with an impervious membrane first placed over the underlying substrate. The membrane is then further protected by the concrete overlayment.
- 3.2 The selection of the appropriate membrane to use under the concrete overlayment is a function of a number of selection criteria, including available down time to execute the overall project, required membrane cure time, specific chemical environment, the capability and familiarity with the material of the installation contractor, and cost.
- 3.3 Candidate membrane materials that are most commonly used with Tufchem Silicate Concrete include PENNCOAT™ 101 Membrane (data sheet CE-142), TUFCHEM™ II Membrane (CE-196), TUFCHEM II SL Membrane (CE-197), PENNCOAT 600 Membrane (CE-144), PENNCHEM™ 97 Membrane (CE-293), FURALAC Membrane (CE-295) and PACMASTIC™ 325 Membrane (CE-249). Each of these membranes offers specific advantages and limitations, and the specific data sheets referenced herein as well the associated installation specifications for these membranes should be consulted for specific information. For assistance in the selection of the appropriate membrane, consult your local ErgonArmor representative.
- 3.4 For castings on vertical surfaces, attention must be taken to insure the concrete overlayment is stable. In the case of casting over a membrane, and depending on the height of the vertical rise, this could mean the incorporation of a mechanical anchoring system. The sealing of certain of the above membrane systems in section 3.3 are more easily dealt with as anchors by their nature require a penetration through the membrane which must be sealed in always-wet environments. Consult your local ErgonArmor representative for specific detail in addressing with anchor penetrations through membranes on vertical rises.

TUFCHEM® SILICATE CONCRETE - FG INSTALLATION SPECIFICATION
CES-343
05/17 SUPERSEDES 10/12 PAGE 4 OF 12

4. INSTALLATION

- 4.1 The latest published Corrosion Engineering Data Sheet entitled TUFCHEM Silicate Concrete - Foundation Grade designated CE-252 shall be followed. If there are differences between CE-252 and this Specification, this Specification shall govern.
- 4.2 TUFCHEM Silicate Concrete - Foundation Grade is not a hydraulic cement (Portland Cement, calcium aluminate cement) based concrete and thus certain aspects of its installation must be duly followed as noted herein.
- 4.3 Paddle type mortar mixers capable of mixing a minimum of 5-7 cubic ft. (0.15 cu m) of a 140 pound per cubic ft (2.2 gm/cm³) wet density product shall be used for the mixing of the concrete.
- 4.4 Sufficient mixing capacity shall be available (minimum of two mixers is recommended) so as to allow a continuous placement of mixed TUFCHEM Silicate Concrete - Foundation Grade.
- 4.5 Mixers shall be clean and dry at their time of use. Any remnants of hydraulic cement based concretes or mortars which are attached to the mixing drum or mixing paddles shall be removed or neutralized before charging the mixer with the TUFCHEM Silicate Concrete - Foundation Grade components so as to prevent any contamination of the concrete's hardening system. Portland cement concrete mixes are alkaline in nature and the hardening system for TUFCHEM Silicate Concrete - Foundation Grade is acidic. Remnants of alkaline compounds in the mixing equipment can potentially neutralize and prevent the set of TUFCHEM Silicate Concrete - Foundation Grade.
- 4.6 Contractor will not begin to mix or place TUFCHEM Silicate Concrete - Foundation Grade if the weather is threatening, unless a shelter is constructed to protect the mixing and casting operations so as to prevent contamination of the mix.
- 4.7 Large Volume Pours and Concrete Pumping Technique
 - 4.7.1 TUFCHEM Silicate Concrete - Foundation Grade is not exothermic and can be mixed in large volume mixers, including ready mix concrete trucks, subject to its work life and set time properties. The ideal ready mix truck has separate compartments for each concrete component - sand, cement, aggregate etc and a separate

TUFCHEM® SILICATE CONCRETE - FG INSTALLATION SPECIFICATION
CES-343
05/17 SUPERSEDES 10/12 PAGE 5 OF 12

compartment for the water, although conventional trucks have also been used. See section 3.7.3 below for further precautions. Consult Corrosion Engineering for specific equipment details for large pours.

- 4.7.1 Standard concrete pumping equipment will suitably pump TUFCHEM Silicate Concrete - Foundation Grade with or without fiber additions. Fiber additions minimize shrinkage stresses during curing and therefore improve the concrete's resistance to cracking. Fiber additions do not appreciably increase physical properties such as tensile, compressive, and flexural strengths. See section 3.10 and 3.11 below for more detail on fibers.
- 4.7.2 The recommended hose diameter when pumping is 3-4" (75-100 mm).
- 4.7.3 All equipment used for handling, mixing, pumping, conveying and finishing the TUFCHEM Silicate Concrete - Foundation Grade must be clean, dry and free of any remnants of hydraulic cement based products or other contaminants. See section 3.5.
- 4.7.4 Hoses, mixing equipment, and pumping equipment are to be first wetted with either water or TUFCHEM Silicate Solution before being contacted with the specialty concrete components. After wetting the surfaces of the mixer, pump and hoses, any excess liquid shall be drained/discarded from the equipment.
- 4.8 The mix ratio of filler:solution shall be between 5.5 to 6.5 parts filler:1.0 part solution by weight depending on the degree of slump required. The slump of the wet mix as measured using a standard slump cone will range between 4" and 7" (100 to 175 mm).
- 4.9 The TUFCHEM Silicate Solution shall be added first to the mixer followed by the addition of the TUFCHEM Silicate Concrete - Foundation Grade Filler. The combination of solution and filler shall be mixed until a uniform fully wetted out mix is achieved. (Typically a mixing time of 2 minutes after the addition of the last bag of filler will result in a satisfactory mix.) A very practical field test to determine a good approximate mix ratio is the "wet ball in hand" test. If a baseball-sized (75 mm dia) handful of mixed concrete can be tossed by hand upwards 2-3" (50-75 mm) without falling apart, the mix is suitable, and not too dry.
- 4.10 Never add sand, pea gravel or other aggregates to TUFCHEM Silicate Concrete - Foundation Grade under any circumstances.

TUFCHEM® SILICATE CONCRETE - FG INSTALLATION SPECIFICATION
CES-343
05/17 SUPERSEDES 10/12 PAGE 6 OF 12

4.11 Polypropylene Fibers

4.11.1 Notwithstanding the incorporation and use of steel fibers for specialized applications (consult Corrosion Engineering) outlined in section 3.12 below, TUFCHEM Silicate Concrete - Foundation Grade is usually supplied with polypropylene fibers incorporated into the powder mix at the factory. The addition of these fibers helps to minimize propagation of small hairline cracks that may develop during curing. Fibers should not be considered as a replacement for structural reinforcement, and will not eliminate the potential for TUFCHEM Silicate Concrete - Foundation Grade to crack if stresses exceed its tensile capabilities. Consult Corrosion Engineering if a concrete without these factory added fibers is desired.

4.11.2 If the fibers are to be field added (very rare), they shall be sprinkled into the wet mix while the mixing paddles are turning. Mixing shall continue for at least (1) one minute after the fibers have been added and until they are uniformly distributed in the mix before the mix is dumped. If fibers tend to ball up, first add them to the Solution in the mixer before the filler is added.

4.12 Steel Fiber Addition

4.12.1 Steel fibers have been shown to enhance the abrasion resistance of TUFCHEM Silicate Concrete - Foundation Grade in very special applications such as coke wharf docks. Consult Corrosion Engineering for further details as to the use of steel fibers.

4.12.2 RIBTEC® - 316 stainless steel needles (fibers) or equal shall be uniformly distributed at an addition of 2% (by weight of the wet concrete mix) into the TUFCHEM Silicate Concrete - Foundation Grade wet mix while it is still in the mixer. Fiber size shall be determined based on the specifics of the application.

4.12.3 The fibers are to be sprinkled through a screen sieve having 3/8" openings into the wet mix of concrete while the mixing paddles are turning. Mixing shall continue for at least 1 minute after the fibers have been added until they are uniformly distributed in the mix before the mix is dumped.

TUFCHEM® SILICATE CONCRETE - FG INSTALLATION SPECIFICATION
CES-343
05/17 SUPERSEDES 10/12 PAGE 7 OF 12

- 4.12.4 After the stainless steel fibers have been added to the wet mix and uniformly dispersed, the mixed wet concrete shall be dumped and placed within twenty (20) minutes. Any surface finishing must be done immediately after placement. Once the surface is finished, it must not be disturbed. The silicate solution used in this specialty mix will react with carbon dioxide in the air to create a thin skin on the surface of the finished placed product and any attempt to finish the surface after this skinning has taken place will tear the surface
- 4.13 Pencil vibrators can be used and will aid in the proper placement of the wet concrete mix. They shall be held either against the formwork immediate to the area being cast and/or against the steel reinforcing, or used in the concrete itself. Do not vibrate to excess so as to cause separation of the liquid component. With the measured slump of the mix being between 3" and 6", (75-150 mm) this action will be sufficient for proper placement of the fiber reinforced TUFCHEM Silicate Concrete - Foundation Grade.
- 4.14 The finishing of the surface of TUFCHEM Silicate Concrete - Foundation Grade shall be undertaken with a wood float and/or a steel trowel. Do not over finish so as to create a skin on the placed material. TUFCHEM Silicate Concrete - Foundation Grade is an industrial material and cannot be finished glass smooth. If the placement of the TUFCHEM Silicate Concrete - Foundation Grade is disrupted, the surface against which new material is to be placed when the operation resumes shall be left as a roughened finish edge so that resumed placement of the product will well wet the interface and provide good mechanical bond. Consult Corrosion Engineering for further suggested construction joint details, but in general treat these details as if the pour was being made using Portland cement concrete based mixes.
- 4.15 TUFCHEM Silicate Concrete - Foundation Grade does not cure like concrete. There is no "fat" or cement paste in the material, and hence it does not respond to attempts to float cement paste to the top to work back and forth and tightly close the surface. Generally, place the TUFCHEM Silicate Concrete - Foundation Grade, and follow by a single wood float finish and/or a light steel trowel finish, and leave it. TUFCHEM Silicate Concrete - Foundation Grade develops a surface skin within 20 minutes to a few hours after placement depending upon temperature, and will appear to cure from the top down. Once this skin has formed, do not disturb it. Material has passed the point where further finishing can be done.
- 4.16 Any exposed surface of TUFCHEM Silicate Concrete - Foundation Grade

TUFCEM® SILICATE CONCRETE - FG INSTALLATION SPECIFICATION
CES-343
05/17 SUPERSEDES 10/12 PAGE 8 OF 12

shall be protected for a minimum of 24 hours while curing at 70°F (21°C). Do not apply curing compounds, burlap or water for curing. Lower temperatures (do not install below 10°C) of the wet concrete mix or its components, application temperature, ambient air temperatures, or curing temperatures will significantly retard the setting time and rate of strength development.

- 4.17 It is recommended that the TUFCEM Silicate Solution and TUFCEM Silicate Concrete Foundation Grade Filler be brought to a minimum temperature of 50°F (10°C) at time of mixing. Ambient air temperature at time of mixing and placement and immediate to the location of material casting shall be a minimum of 50°F (10°C) . The minimum curing temperature of the placed castable shall be 70°F (21°C). Curing temperatures shall not exceed 100°F (38°C).
- 4.18 When the castings and test cubes are cured at 70°F (21°C) formwork may be removed when the test cubes exhibit compressive strength results of at least 1500 psi (10 MPa) when tested in accordance with ASTM C579.
- 4.19 If the surface of placed TUFCEM Silicate Concrete - Foundation Grade is exposed to hot direct sunlight, small bubbles of silicate may appear at the surface. Shading or covering from the sun will minimize this phenomenon.
- 4.18 No addition of water or any other additives shall be added to this specially formulated composition.
- 4.20 Use water for cleaning tools, mixing equipment and paddles, wheel barrels, shovels, conveyors, etc. For cleaning the mixer, the placement of pea gravel stone or other rounded aggregate into the mixer with water will help clean the surfaces of the mixer.
- 4.21 In immersion applications such as sumps and trenches, it is noted TUFCEM Silicate Concrete - Foundation Grade does have a measurable degree of absorption. When used for applications, use of an underlying membrane should be considered in keeping with good design guidelines for chemical resistant masonry. Consult Corrosion Engineering for more detail.

5. SURFACE TREATMENT

- 5.1 The surface of TUFCEM Silicate Concrete - Foundation Grade can be protected from developing an etched pebbly-appearing finish if exposed to rinse water too soon before full cure, by applying a surface treatment onto the freshly placed concrete. (Note: the surface etching does not affect the

TUFCHEM® SILICATE CONCRETE - FG INSTALLATION SPECIFICATION
CES-343
05/17 SUPERSEDES 10/12 PAGE 9 OF 12

structural integrity of the TUFCHEM Silicate Concrete - Foundation Grade, but rather is a surface appearance issue. Application of surface treatment outlined below is suggested to eliminate or minimize this effect.)

- 5.2 Surface treatment can proceed as early as when the installed TUFCHEM Silicate Concrete - Foundation Grade has cured enough to accept foot traffic. This time period will vary depending on environmental conditions. It is acceptable to wait up to 24 hours to apply the surface treatment, as long as there is no possibility of the TUFCHEM Silicate Concrete - Foundation Grade being exposed to water from any source.
- 5.3 This surface treatment procedure involves diluting muriatic acid and spray applying the solution onto a TUFCHEM Silicate Concrete - Foundation Grade substrate. Observe all precautions associated with handling muriatic acid and use all appropriate personal protection equipment.
- 5.4 Acid dilution presents many hazards and should only be done by a knowledgeable and competent person who fully understands all of the hazards involved and is trained in the proper techniques of this operation.
- 5.5 Materials and Equipment Required
 - 5.5.1 Safety Gear: All appropriate safety gear including, but not limited to, rubber gloves, rubber boots, goggles and face shields. Consult muriatic acid MSDS for recommendations.
 - 5.5.2 Treatment Materials:
 - Muriatic Acid, available from hardware supply stores, typically 31.45% concentration.
 - Plastic five gallon pail for preparing acid mixture.
 - Plastic hand held garden sprayer for applying diluted acid to TUFCHEM Silicate Concrete - Foundation Grade surface.
 - Clean/potable water for acid dilution.
 - Wooden or plastic stirring stick.
- 5.6 Acid Dilution Procedure
 - 5.6.1 Use all applicable personal protection equipment as specified on muriatic acid container label and MSDS. Prepare this acid mixture in a safe, well ventilated area, away from other workers or equipment that may be affected by acid or mixture exposure or contact.

TUFCEM® SILICATE CONCRETE - FG INSTALLATION SPECIFICATION
CES-343
05/17 SUPERSEDES 10/12 PAGE 10 OF 12

5.6.2 ALWAYS add ACID to WATER.

Never add water to acid. This order of addition can create dangerous heat generation and splashing of the mixture out of the mix container.

5.6.3 The mixture is prepared as follows:

- 1) Add three (3) quarts of water to a clean five gallon plastic pail.
- 2) Slowly add one (1) quart of muriatic acid to the water, gently stirring as the acid is being added.
- 3) Some heat will be generated while making this dilution. Allow the temperature to stabilize before transferring it to the plastic sprayer/application equipment.

5.7 Surface Treatment Application

5.7.1 Adjust the pattern to a wide fine spray.

5.7.2 Apply JUST ENOUGH of the acid mixture to the TUFCEM Silicate Concrete - Foundation Grade surface to thoroughly wet the surface.

5.7.3 DO NOT over apply the mixture to create puddles or standing pools of acid.

5.7.4 After applying the acid mixture, keep the area protected from water exposure until the surface has completely dried. Allowing 16 - 24 hours before water exposure will insure that the surface treatment has had time to achieve the full conditioning effects.

6. QUALITY ASSURANCE

6.1 The mix ratio of filler: solution should be between 5.5 and 6.5 parts filler: 1.0 part solution. Within this range of allowable mix ratios, the slump of the wet mix as measured using a standard slump cone will range between 4" and 7". The addition of fibers (reference 310 and 311) will result in the slump range being reduced to between 3" and 6". Where sections to be cast are heavily reinforced, placement will be enhanced with mixes exhibiting slump values of 5" - 6" (125-150 mm). Too dry a mix will result in voids in the concrete. Too wet a mix will result in lower strengths.

6.2 For determining compressive strength, cubes or cylinders can be used. 2 sets of specimens per set shall be prepared for every 4 cubic yards (3 cu m) to be installed. Test specimens shall be prepared in accordance with ASTM C579.

TUFCEM® SILICATE CONCRETE - FG INSTALLATION SPECIFICATION
CES-343
05/17 SUPERSEDES 10/12 PAGE 11 OF 12

- 6.3 If the mixed TUFCEM Silicate Concrete - Foundation Grade is placed by pumping techniques, the molds shall be filled at the hose discharge and externally vibrated as they are being filled. The filled mold shall be screeded flush with the top of the mold. The molds shall be suitably coded to identify placement location, time, date, and ambient temperature.
- 6.4 If the mixed TUFCEM Silicate Concrete - Foundation Grade is placed by casting techniques the molds shall be filled at the point of placement. The molds shall be filled in thirds and externally vibrated at each filling. The filled mold shall be screeded flush with the top of the mold. The molds shall be suitably coded to identify placement, time, date, ambient temperature.
- 6.5 The prepared test specimens shall be cured at the same temperatures as the field installed product.
- 6.6 When the castings are cured at 70°F (21°C) temperature, formwork may be removed when the test specimens exhibit compressive strength results of at least 1500 psi (10MPa) when tested in accordance with ASTM C579.
- 6.7 Test specimens shall be used if necessary for compressive strength gain determination. The curing temperature and ambient air temperatures during the curing period shall be reported.
- 6.8 After twenty eight (28) days curing time, final specimens from each set shall be crushed at ambient temperature to determine the ultimate compressive strength. The curing temperatures and ambient air temperatures shall be reported.

7. SAFETY PRECAUTIONS / DISCLAIMER

- 7.1 Read and follow the hazard information, precautions and first aid directions on the individual product labels and material safety data sheets before using. While all statements, technical information, and recommendations contained herein are based on information our company believes to be reliable, nothing contained herein shall constitute any warranty, express or implied, with respect to the products and/or services described herein and any such warranties are expressly disclaimed. We recommend that the prospective purchaser or user independently determine the suitability of our product(s) for their intended use. No statement, information or recommendation with respect to our products, whether contained herein or otherwise communicated, shall be legally binding upon us unless expressly set forth in a written agreement between us and the purchaser/user.

TUFCHEM® SILICATE CONCRETE - FG INSTALLATION SPECIFICATION
CES-343
05/17 SUPERSEDES 10/12 PAGE 12 OF 12

- 7.2 Please contact ErgonArmor for specific recommendations at +1-601-933-3000.

www.tufchem.com