

ITEM 11560.2004 M – REPLACE CEILING TILES

DESCRIPTION.

This work consists of the requirements necessary to remove existing ceramic tiles and furnish and install new ceramic tile in areas indicated on the Contract Drawings and where directed by the Engineer.

For matching purposes, the Contractor, with the concurrence of the Engineer, shall identify an area of ceiling tile to be replaced. The selected area shall include sufficient tiles, given the Contractor's removal techniques, to result in a minimum of twelve unbroken tiles after removal. Prior to the removal of the tiles, the area shall be cleaned, as described in the "Item 11560.2002 - Clean Ceiling and Wall Tiles". Within 48 hours after cleaning, the tiles to be replaced shall be removed, intact as much as possible, and the minimum twelve tiles shall be reserved for color matching purposes. Six of the tiles shall be delivered to the Engineer, and the remaining six shall be used by the Contractor to select his proposed tile color.

A Field Coordination Survey shall be performed by the Contractor in the presence of the Engineer to establish the approximate limits of tile replacement at each defective area. Repair areas shall include damaged, loose or missing tiles as indicated on the Contract Drawings; areas of substrate repairs, including shallow and deep concrete repair, and dry and leaking crack repair; areas disturbed by removals associated with trenches for roadway lighting or fireline rehabilitation; tiled surfaces affected by removals of signs; tiled surfaces affected by embedment of existing or new conduits in the existing surfaces, and other areas as identified by the Engineer during the Field Coordination Survey. The survey shall indicate which of the defects identified are shown on the Contract Drawings. The Contractor shall maintain detailed notes of the survey, describing each defect by location, orientation, dimensions, and area, and indicating whether the defect is to be repaired or not, as directed by the Engineer. The notes shall be submitted to the Engineer for review and approval prior to initiating repairs. Actual repair locations shall be indicated on the as-built drawings.

MATERIALS.

Tile:

Tile shall be ceramic vitreous glazed wall tile, if the same size and shape as the sample supplied. The quality of the tile shall be "Standard Grade", as defined in "Recommended Standard Specifications for Ceramic Tile of the Tile Council of America" and ANSI A137.1.

Tile shall have a nominal size matching the existing tile size. Tile size shall not vary from the nominal size by more than 1 mm. Tile shall be of a uniform thickness of not more than 14 mm nor less than 9.5 mm, including the projecting lugs or keys, and not less than 8 mm thick exclusive of said lugs or keys.

Tile shall have an approved cushion edge. Backs shall be free from glaze, glaze sheen or film. Edges shall be reasonably free from a glaze coating and shall not have drops or globules exceeding 0.4 mm in thickness. The body shall be free from concave warpage exceeding 0.6 mm. They shall be free from wedging or crooked edges exceeding 1 mm of edge length.

Tile shall have a semi-matte glazed finish surface on the face, free from all imperfections such as waviness, pinholes, specks, and blisters, which would affect the appearance of the tile.

Tile shall match, as closely as possible, the color of the existing cleaned tile as obtained from the field, for matching purposes.

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The Contractor shall provide equipment for checking tile for warpage, wedging and size. The equipment shall mechanically measure compliance or non-compliance of the tile with the specified limits of warpage, wedging and size.

Tiles shall be manufactured with projecting lugs or keys on the backs and with rough back surfaces so as to furnish a satisfactory mechanical bond with supporting mortar. The width of the lugs or keys on the back face of the lugs or keys shall be greater than the width at the base of said lugs or keys. The lugs or keys shall project not less than 2.4 mm beyond the back face of the body of the tile and shall be of such pattern as to avoid closed pockets by which air might be entrapped within the mortar backing. If tile is manufactured with projecting edge rims or borders on two or more adjacent sides, there shall be provided at least two slots on each side of the tile where said rims or borders occur, so as to avoid entrapment of air within the mortar backing. The slots shall be not less than 8 mm in width of said edge rims or borders and for the full depth of said edge rims or borders of the body of the tile, the pattern of the lugs or keys shall be subject to approval.

Bonding Agent:

The bonding agent shall be polymer-type acrylic copolymer similar to Unibond as manufactured by Elastiment, or approved equal. The percentage of solids by weight shall be between 21% and 29 %, as mixed and ready for application.

Mortar:

Scratch coat mortar shall be composed of one part portland cement, ASTM C 150, and 2 1/2 parts sand ASTM C 144, by volume. Latex acrylic admixture, Elastiment102-GMA, as Manufactured by Elastiment, or approved equal, shall be added. Water shall be added to obtain the proper consistency to prevent sagging. Lime shall not be added.

Float coat mortar shall be composed of one part portland cement, ASTM C 150, 1/2 part hydrated lime, ASTM C 206 Type S, or ASTM C 207 Type S, and four parts sand. Latex acrylic admixture, as described above, shall be added. Water shall be added to obtain the proper consistency.

Bond coat mortar shall consist of a flexible latex-Portland cement mortar system complying with the requirements of ANSI A118.4. Tests shall be performed with tiles specified herein. Latex admixture shall be the acrylic emulsion type. Polyvinyl acetate, styrene butadiene rubber and ethylene vinyl acetate-type admixtures will not be accepted.

Grout: Grout shall be sand-cement grout conforming to the TCA Standard Specifications, with latex acrylic admixture, as described above. Portland cement and water shall conform to the requirements of NYSDOT Standard Specification Sections (Metric Edition) 701-01 and 712-01. Sand shall conform to the requirements of ASTM C144. The grout color shall closely match the existing grout.

CONSTRUCTION DETAILS.

SUBMITTALS

The Contractor shall submit twelve tile samples exhibiting the shape, color and surface finish of the tile. The sample tile color shall match as closely as possible that of the existing cleaned ceiling tile obtained by the Contractor for matching purposes.

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The Contractor shall submit certification of all test results as well as laboratory qualifications, for testing described herein, to the Engineer for acceptance.

The Contractor shall prepare and submit working drawings showing type of materials, dimensions, arrangements, and methods of setting tile.

The Contractor shall develop and submit tile setting procedures, set times and protection methods.

The Contractor shall submit samples of grout and caulk colors to closely match the existing materials.

The Contractor shall submit certificates for all materials to be used during the installation of the tiles.

References:

The work of this Section shall comply with the applicable provisions of the following specifically referenced sources:

American Society for Testing and Materials (ASTM): C 144; C 150; C 206; C 207; C 373; C 424; C 482; C 609.

American National Standards Institute (ANSI): A118.4; A137.1

Tile Council of America (TCA) Recommended Standard Specifications for Ceramic Tile

New York State Department of Transportation (NYSDOT) Standard Specifications (Metric Edition): Sections 701; 712; 705-06, as applicable.

Delivery, Site Inspection, Storage and Handling:

Delivery: Material shall be delivered in manufacturer's original packages, with grade seals unbroken. Labeling of tile packages shall comply with the requirements of ANSI 4A137.1

Inspection: a manufacturer's representative shall be on-site at delivery to open, inspect and certify each package for breakage, and reseal each package for storage. Breakage shall be replaced at no cost to the State.

Storage: Materials shall be stored under environmentally controlled conditions as directed by the Engineer. Tiles shall be kept dry and shall be stored in cool. Dry areas on dry floors, shelves or racks.

Handling: Materials shall be handled as recommended by manufacturer to prevent damage.

Extra Tiles: Upon completion of the work, all intact unused tiles shall be delivered to a location designated by the Engineer, packaged in boxes with appropriate protective wrapping for storage with labels clearly describing the contents.

Quality Assurance:

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Testing and Inspection:

The Contractor shall test sample lots of tile. Each sample lot shall contain five tiles. Five sample lots shall be selected at random from each group of 8,000 units or less as produced.

In case of failure of the tiles from a sample lot to meet the test requirements of these Specifications, additional sample lots from the same group shall be selected and shall be subjected to the prescribed tests, and the group will be accepted if the requirements are met by the additional sample lots. Should the additional sample lots also fail to meet the Specification requirements, the entire group of tile represented by the sample lots will be rejected. Rejected groups of tile shall be promptly removed and disposed of and shall not be used or submitted again.

The Contractor shall provide facilities for inspection equipped with the apparatus required to make the tests specified herein, and shall perform such tests in the presence of the Engineer at the location of the manufacturing facility. The Contractor shall give the Engineer 15 days advance notice prior to commencement of testing.

Sample lots of tiles shall meet the requirements set forth herein for the tests specified below:

Absorption Test: A sample lot from each group of tiles shall be tested in accordance with the procedure described in ASTM C 373. Each tile shall have an absorption not exceeding 2 3/4 %. The sample lot of tile shall have an average absorption not exceeding 2 %.

Crazing Tests: A sample lot from each group of tile shall be tested in accordance with the procedure described in ASTM C 424, using 1379 kPa steam - After being subjected to the five consecutive cycles of the foregoing crazing test, the sample lot shall show no crazing, chipping, spalling or cracking of either the body or glaze. The glazed surface of the tile shall show no permanent clouding, dulling or pitting. Slight dull streaks will be permitted provided they do not comprise more than 20% of the glazed surface areas.

Thermal Shock Test: a sample lot from each group of tile shall be placed in an oven at room temperature. The temperature within the oven shall then be uniformly raised to 110°C in a period of one hour, and then maintained at that temperature for an additional hour, after which the tile shall be removed from the oven and immediately plunged into a mixture of ice and water having a temperature of not more than 2°C. At the end of ten minutes, the tile shall be removed from the water mixture and liquid dye applied upon the glazed surfaces and bodies. After being subjected to five consecutive cycles of the foregoing thermal shock test, the sample lot shall show no crazing, chipping, spalling, or cracking of either the body or the glaze.

Weather Test: A sample lot from each group of tile shall then be boiled for a period of two hours and permitted to cool gradually to room temperature. The tiles shall then be removed from the water and their surfaces wiped dry with a clean, damp cloth. Immediately thereafter, they shall be placed in a freezing chamber (not immersed in water) for a period of four hours. The freezing chamber shall be maintained at a temperature below minus 12°C. The tiles shall then be removed from the freezing chamber and immediately immersed in water at room temperature. After the tiles have completely thawed in the water, they shall be removed, their surfaces wiped dry with a clean damp cloth, and a liquid dye applied on their surfaces. After being examined, the tiles shall again be immersed in water until such time as is convenient to again place them in the freezing chamber for the additional cycles of the weather test. After being subjected to five

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consecutive cycles of the foregoing weather test, the five samples tested shall show no crazing, chipping, spalling, or cracking of either the body or glaze.

Glaze Hardness Test: A sample lot of tile from each group shall be used in the glaze hardness test utilizing the Mohs scale of hardness for minerals. A piece of mineral having a deformed hardness, measured by the Mohs scale, shall be slowly drawn across the glazed surface of the tile with a steady uniform force, approximately 11.3 kg. The scratch hardness of the glaze tested shall be recorded as the lowest number of standard mineral in the Mohs scale at which the surface is scratched. Tile shall have a minimum hardness of four.

Color Measurement Test: Color shall be measured as described in ASTM C609. The average variation of two sample lots from each group shall fall within 1.5 units of the nominal for each of the Tristimulus values. Total within lot variation shall not exceed 3.0 judds. After each two sample lots of tile have been checked, the standardization of equipment shall be recalibrated to ensure that no machine drift error has occurred. Two sample lots shall be checked for each test group of tiles.

Testing shall be performed on mock-up test assemblies to verify the bond strength and setting time provided by the proposed mortar and additive mix. Two test panels shall be constructed to closely approximate actual field conditions. The panels shall be 0.92 m on each side, with anchored concrete laid as a base and allowed to achieve its full strength. The test panels shall then be mounted horizontally, and the mortar and tiles shall be applied on the lower side as described herein. Bond tests shall be performed as follows:

Initial Bond Tests: Tests shall be performed in accordance with ASTM C 482. Five test specimens shall be prepared for the initial bond measurements. Testing shall be performed to determine the bond strength at the end of the initial hour of set time. The strength of bond in shear for each specimen in these initial tests shall not be less than 69 kPa. Based on these tests, the Engineer will establish a new initial set time, if more than one hour of set time is required.

Final Bond Tests: Tests shall be performed in accordance with ASTM C482. Five test specimens shall be prepared for the final bond measurements. Testing shall be performed to determine the bond strength at the end of a three day period. The average strength of bond in shear of the specimens for these final tests shall not be less than 550 kPa, with no specimen less than 413 kPa.

Field Testing:

The Contractor shall perform testing of the tile after the first tile installation under field conditions. The tile shall be tested for initial and final shear/bond prior to proceeding with the repair operation. Three sample tiles shall be tested for initial shear, in accordance with ASTM C 482. The initial strength of bond in shear for each sample tile, measured one hour after setting the tiles, shall not be less than 69 kPa. After the tile has been in place for three days, three additional sample tiles shall be selected and tested for final shear, accordance with ASTM C482. The average 3-day strength of bond in shear shall not be less than 550 kPa, with no strength less than 413 kPa.

The Contractor shall assist the Engineer, as requested, with required equipment or manpower to perform additional shear/bond testing during the progress of the Project. One initial and one three-day test will be made for each tile installation workshift.

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The Contractor shall delineate proposed tile areas to be replaced as described herein, and provide detailed descriptions of the proposed replacement procedures.

The Contractor shall after approval of the repair proposal, saw cut the perimeter of each repair area.

The Contractor shall chip out existing grout and tiles to sound substrate in the designated areas, taking care not to damage or loosen any adjacent tile or other tunnel items.

After removal of ceramic tiles, repairs to substrate materials shall be performed in accordance with appropriate repair sections, as applicable. Placement of new mortar grout and tile shall begin no sooner than seven days after completion of substrate repairs.

Concrete surfaces which are to be faced with tile shall be scarified for bonding. All loose material shall be cleaned from concrete or shotcrete substrates by air or water blasting as approved by the Engineer. Adjacent areas shall be protected during scarifying and/or cleaning processes.

Surfaces to receive the scratch coat shall be dampened, but not saturated, with water.

Surfaces shall be coated with bonding agent in accordance with the manufacturer's recommended procedures immediately prior to placing the scratch coat mortar.

Scratch coat mortar shall be built-up in two or more layers. The proper distance back from the finished face tile shall be established to accommodate the tile and bonding mortar. (It is recommended that there be a minimum bonding mortar thickness of 2.4 mm between the tile and backing after tile has been beaten into place). Mortar shall be built-up layers not less than 6.4 mm nor more than 9.5 mm. The surface shall be scratched and the bonding agent applied to act as a curing compound. The final scratch coat, while still plastic, shall be scored or scratched approximately 3 mm deep, both horizontally and diagonally with marks about 12.7 mm apart. Each layer shall be permitted to cure for a minimum of 24 hours. The bonding agent shall be reapplied prior to the placement of subsequent mortar layers.

After the float or last coat of mortar has cured for a minimum of 24 hours, bonding mortar shall be applied to a cleaned surface after re-coating with bonding agent.

Bonding mortar shall be applied with flat side of trowel over an area no greater than can be covered with tile while mortar remains plastic. Within ten minutes before applying tile and using a notched trowel of the type recommended by the mortar manufacturer, mortar shall be combed to obtain even setting bed without scraping backing material. The surface shall be covered uniformly with no bare spots, with sufficient mortar to insure a minimum mortar thickness of 2.4 mm between the tile and float coat after tile has been beaten into place. Tile shall not be applied to skinned-over mortar. Skinned-over mortar shall be removed in its entirety and replaced with fresh material prior to installing tile.

Tile shall be back-buttered to fill spaces between the lugs and keys firmly embedded in the mortar, tapped into place to remove air pockets, and brought flush with adjacent tiles. Full (100 rlo) contact shall be verified by removing no less than one tile per workshift for inspection at a randomly selected location. Broken, cracked, marred, or otherwise defective tiles shall be replaced before mortar sets. Width of joints shall be approximately 2.4 mm and shall be adjusted slightly to avoid cutting tiles. Joints shall be raked to a minimum depth of two-thirds of thickness of tile. Joints shall be kept straight and true by use of wet rope or other

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approved spacing devices for horizontal joints. Spacing and alignment of tiles shall match spacing of existing tiles. Joints shall be straight lines parallel and perpendicular to finish roadway surface.

Tile shall be field cut and drilled as necessary to complete the installation. All cutting shall be done by power saws and the cut edges shall be free from chipping and shall be smooth and straight. Tile shall fit neatly at all fixtures, niches and elsewhere. Tiles shall be laid out both horizontally and vertically so that a minimum amount of cuts occur.

New tiles that become broken, cracked, marred or otherwise defective during installation shall be replaced before the mortar sets.

Tiles shall not be set when ambient temperature in the tunnel is below 7°C or likely to fall below 7°C within 72 hours after setting the tiles.

Grouting and curing shall be performed at temperature between 10 and 32°C. Before grouting, all tiles must be firmly set, and all spacers, string, ropes, or pegs removed.

At least 24 hours, but not more than 48 hours after the tile has been set loose mortar shall be raked out and the faces of the glazed surfaces shall be thoroughly washed clean with water. Prior to grouting, the tiles shall be fog sprayed. The joints between the tiles shall be grouted with a neat portland cement which shall be the color as selected by the Engineer, using sufficient water to obtain consistency of thick cream. The grout shall be forced into the joints by troweling or other approved method, and finished straight and true. Special care shall be taken to prevent the scratching of the glaze on the face of the tile. Prior to hardening, any excess grout shall be washed off with a sponge and water, leaving all joints full, smooth and flush with the cushion edge of the tile and leaving the face of the tile clean. Remixing or use of grout that has partially hardened will not be permitted.

All grout joints shall be filled with grout material a minimum of two-thirds of the thickness of the tile. All grout shall be uniformly finished. A maximum amount of grout shall be forced into the joints. Cushion edge tile shall be finished evenly to the depth of the cushion. The finished joint shall be uniform in color, smooth, and without pinholes, voids or low spots.

The grout shall be damp cured by fogging during the next three work shifts and shall be protected from construction dirt for a minimum of 72 hours.

Tile setting operations shall be suspended prior to the end of each shift, allowing the tile to set for one hour or the amount of time approved by the Engineer.

Final clean-up shall be done by finishing or polishing with a terry cloth or similar pad.

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Cleaning and Repair:

As the work progresses, the Contractor shall remove all rubbish, cartons, dust, dirt, mortar, grout, and cement as it accumulates. At the completion of a section of the tile work, the tile, roadway, curbs and drains shall be thoroughly cleaned of all mortar. Precautions shall be taken to protect cleaned areas of tile, roadway and roadway drains from becoming dirty or encrusted with mortar and grout. A final, thorough cleaning shall be given to all tile work prior to acceptance of the work of the Contract. The roadway surface shall be left in proper condition at the end of each shift.

As a condition precedent to acceptance and final payment for the work, the Contractor shall remove and replace with approved units, all imperfect, loosened and misplaced tiles. Such replacement work shall be performed to the satisfaction of the Engineer at no additional cost to the State.

METHOD OF MEASUREMENT. Replacing Ceiling Tiles will be measured by the number of square meters to the nearest tenth of a square meter of finished surface, including grout joints.

BASIS OF PAYMENT.

The unit price bid per square meter, shall include all labor, supervision, material, equipment, and all incidentals and appurtenances necessary to satisfactorily complete the work, including delivery, inspection and storage of spare tile.

Payment will not be made for repairs to damaged areas caused by the Contractor's operations. No payment will be made for replacing ceiling tiles that have not been accepted by the Engineer or that have been damaged by the Contractor's operations.