CERAMIC TILE INSTITUTE OF AMERICA, INC.

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CTIOA REPORT 2007-4-1

SUBJECT: STONE TILE

By: CTIOA Specialty Tile Products Committee:

Description

Modular stone tile is manufactured from a naturally occurring solid formation of one or more minerals (referred to in the industry as a natural stone) that is extracted (quarried) from the earth and shaped (fabricated) to form a tile generally not exceeding 24” in either dimension and having a thickness of less than 20 mm (3/4”).

The natural stone that is used to produce dimension tile falls into one of three commercial rock classifications

1. Igneous Rock (e.g.: granite, porphery, basalt, gabbro)
2. Metamorphic Rock (e.g.: marble, serpentine, slate, quartzite, soapstone)
3. Sedimentary Rock (e.g.: limestone, sandstone, travertine, onyx)

	Sedimentary	**Metamorphic**	**Igneous**
Calcareous	Limestone Travertine Onyx	Marble Serpentine	
Siliceous	Sandstone	Slate Quartzite	Granite

Acquiring a basic knowledge of these rock classifications may help the industry professional gain a better understanding of the performance characteristics of the natural stone used to produce dimension stone tile. There are currently over 6,000 different types of natural stone being quarried throughout the world. Some of these stones require special consideration. Consulting a geologist, mineralogist, or petrographer, to help determine the suitability of a particular dimension stone tile for a project may be

beneficial.

There are seven groups of natural stone recognized by ASTM, each of which have a corresponding ASTM standard Specification. The Marble Institute of America recognizes nine groups of natural stone, which includes the seven groups. These stone groups, with their respective ASTM standard specifications are listed below:

1. Granites (ASTM C615)
2. Limestone (ASTM C568)
3. Marbles (ASTM C 503)
4. Sandstones (ASTM C 616)
5. Serpentine (ASTM C 1526)
6. Slates (ASTM C 629)
7. Travertine (ASTM C 1527)
8. Onyx (no ASTM Specification exists at this time)
9. Soapstone (no ASTM Specification exists at this time)

Manufacturing

Quarrying is the extraction, or "harvesting" of the stone product from its in-situ position in the earth.
1. Historically, quarries used derricks to hoist blocks from the floor of the quarry, most of which were limited in lateral dimensions due to the radius of reach provided by the derrick. Today, most modern quarries are of an open "pit" type, or "drive-in" layout. This affords the quarry operator the ability to access the quarry floor with large capacity front-end loaders, allowing activities to occur simultaneously at multiple locations within the quarry site and eliminating the lateral dimensional limits of the previously employed derrick methods.
a. Some quarries of all stone types are above the level of the surrounding ground, where the stone is harvested from a mountainside or outcropping of the material
b. Some metamorphic and sedimentary quarries are underground "caves", or "mines", which eliminates the need to remove excessive overburden from above the region of harvestable stone.

Fabrication is the cutting of quarried blocks of natural stone into slabs or strips and the subsequent cutting of the slabs or strips into dimension stone tile.

1. Blocks are first squared-off, then cut by a multiple blade gang saw into slabs.
2. The slabs then travel through a progressive series of grinding and polishing wheels of progressively finer abrasives, which produce the finished surface.
   a. Some fabricators of marbles will use a chemically accelerated process, often times employing oxalic acid, in the polishing process.
3. The polished slabs are then cut to a specified size, producing a dimension stone tile that is beveled, packaged, and shipped. (When marble tiles are produced, they are cut to the narrowest thickness that can be handled, polished, packaged shipped and installed without breakage).

Specifying

Specifying the correct dimension stone tile for a particular application is the first step to achieving a successful installation. Some important considerations are:

- Specify a waterproofing/anti-fracture membrane for natural stone.
- Has the stone tile been previously used successfully for this type of application?
- Is there applicable test data for the stone tile?
- What is the hardness of the stone tile?
- Is this going to be used in a freeze-thaw environment?
- Is this going to be used in a wet environment?
- Is this going to be used in a heavy traffic area?
- Is the stone vulnerable to chemicals that will be encountered in the installation (e.g.: snow melting salts, acidic foods or beverages, chlorinated water, etc)
- Has an adequate sample, representing the range for the material been acquired?
- Is the proper finish (surface texture) being selected for this application?
- Does adequate inventory from one production lot exist to complete the project?
- If multiple production lots are required, what is the lot-to-lot consistency?
- Is replacement stock readily available, or should large quantities of attic stock be purchased?
- Does the stone tile need to be sealed?
- Has a maintenance package been include in the specification?
- Has the appropriate installation method for the substrate been specified?

This list is not intended to address all the possible considerations when specifying dimension stone tile, but represents a starting point for the specification process.

Possible Substrates

1. Concrete
2. Mortar beds
3. Masonry
4. Cement backer units
5. Exterior grade plywood (interior residential dry areas only)
6. Existing ceramic tile

Surface preparation must be in accordance with the proper ANSI specifications, depending on the method chosen. All exterior and wet areas are to have proper sloping to drains. All surfaces must be structurally sound clean, dry and free from contaminants that would prevent a good bond. Newly prepared concrete must be cured 28 days, finished with a steel trowel and have a fine broom finish. Existing surfaces should be scarified, level and all defects repaired. Substrates must be free of curing compounds and form release agents as well as being clean and free of paint, adhesive, grease, oil dust, primer sealers, or any loose particles. Test the slab using the water test, by sprinkling water on the slab and watching for the water to absorb into the slab. If water is absorbed quickly an adequate bond will be achieved. If the substrate is in question scarify or bead blast the slab.

Recommended Substrates

1. Concrete
2. Cement-based Mortar beds
3. Masonry
4. Cement Backer units
5. Exterior grade plywood (with appropriate membranes)

The MIA recommends for poured in place concrete floors, to design the substrate for a total load deflection not exceeding L/360, as measured between control or expansion joints. For frame construction, the subfloor areas over which stone tile is to be applied must be designed to have a deflection not exceeding L/720 of the span. In calculating load, the weight of the stone and setting bed must be considered Allowance should be made for live load and impact, as well as all dead load, including weight of stone and setting bed. Other factors may influence the suitability of the substrate, including, but not limited to radius of curvature of the deflected substrate, differential deflection between adjacent framing members, size of stone tile units, and flexural modulus of elasticity (resistance to bending) of the stone unit.
Variation from plumb: not to exceed 1/8" in 10' Variation from level: not to exceed 1/8" in 10'

Movement

(MIA) Expansion joints are essential for the success of stone and tile installations. Various designs require proper design and location of expansion joints as shown in "method EJ171," from the Tile Council of North America "Handbook for Ceramic Tile Installation". Because of the limitless conditions and structural systems in which stone can be installed, the specifying Authority shall show locations and details of "Expansion Joints" on project drawings. The Architect must specify "Control and Expansion Joints" and show location and details on drawings.

Product Quality Control

Material procurement, particularly on large jobs, is a crucial part of the overall quality of the project. Several recommendations to maintain quality control when working with dimension stone tile are:

- Use 100 sq ft. of the product (or larger) for submittals (not 4 or 5 pieces).
- Set up large control boards on the jobsite with the selected color range.
- Many dimension stone tiles are imports. On large projects make quarry visits or hire local consultants to work with the quarry employees on quality control and delivery schedules. Have large sample boards available at the plant; one for" Select Grade" and one for "Reject Grade".
- Allow ample time for the procurement process. (Quarries in some countries may stop production for as much as 6 weeks for holiday or vacation seasons. Quarries in cold climates may stop production for several months during the winter season. Check continuity of production schedules to ensure uninterrupted deliveries)
- Storage: Inspect material before storing.
  Setting Adhesives

1. Thinsets (ANSI 118.4)
2. Medium bed mortars (ANSI 118.4)
3. Thick bed mortars (ANSI 108.1A or B)
4. 100% solid Epoxy (ANSI 118.3)

Bonding mortars rarely fail. Typically the cause is either improper substrates or contaminants on one or more of the surfaces to be bonded to (a bond breaker). The mortar must be keyed into the substrate and the back of the stone (back buttering). The mortar must be keyed into the substrate and the back of the stone with straight lines.

Installation Techniques

1. Thinset method (ANSI 108.5
a. Cement backer unit (ANSI 108.11)
b. E.G.P. exterior Glue Plywood latex thin set (ANSI 108.12)
2. Medium Bed Mortars (similar to thin-set methods using thicker mortars per manufacturers recommendations
3. Thick bed (mortar bed or mud bed)
a. Wet set (ANSI 108.1A)
b. Cured Mortar Bed (ANSI 108.1B)
c. Contractor's Option (ANSI 108.1C)
4. 100% Solid Epoxy (ANSI 108.6)
5. Waterproofing (ANSI 108.13)
The finished surface should not exceed more than 1/8" over a 10' distance with no more than a 1/32' variation between individual tiles. A thinset floor will only be as flat as the substrate to which it is applied.

Special Considerations

When setting serpentine or green marble, (this may also include a few red and black marbles, as well as some green and blue colored limestone's) use 100% solid epoxy method (ANSI 108.6) due to potential curling and/or warping of the stone as a result of exposure to water-based thinset adhesives. These stones contain unique mineralogy that causes them to curl, warp, swell, or blister when they come in contact with water from the setting material. This method should also be used for setting any stone that has been reinforced with any resin, (commonly epoxy or polyester based) adhered backer material, whether the reinforcement is fiberglass mesh or sand.
Care must be taken when selecting the color of the setting mortar, as some stones will ghost or show the setting material through the stone itself.

Check with sealant manufactures to be sure their sealant is non-staining to the particular stone. Some sealants, particularly silicon sealants, may contain plasticizers of oil or other staining agents, which can wick into the stone and discolor it. The best safeguard against this is to view exemplar projects where the same stone type and sealant have been used together successfully. In the absence of available exemplar projects, accelerated laboratory tests can be performed to detect the staining potential of a particular sealant to a particular stone.

Care should be taken when grouting soft stones (e.g.: marble, limestone, onyx) with sanded grouts, as the sand in the grout is harder than the primary minerals in the stone. Scratching of the stone surface, particularly polished surfaces, can result if the grout is rubbed over the stone surface.

Some Stone can be moisture sensitive and in order to avoid problems a properly installed vapor retarder should be installed per ANSI A 108.01 – 3.2.1.4