# Quartz-Based Stone

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NATURAL STONE INSTITUTE

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# QUARTZ-BASED STONE

## 1.0 GENERAL

For purposes of this manual, Quartz-based stone refers to sandstone, quartzitic sandstone, and quartzite.

### 1.1 Related Documents

**1.1.1** Drawings and general provisions, including General and Supplementary Conditions of the Contract and Division I Specification sections, apply to this section.

### 1.2 Applicable Publications

**1.2.1** The following publications listed here and referred to thereafter by alphanumeric code designation only, form a part of this specification to the extent indicated by the references thereto:

**1.2.2 ASTM International (ASTM):**

**1.2.2.1** C616, Standard Specification for Quartz-based Dimension Stone

**1.2.2.2** C97, Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone

**1.2.2.3** C99, Standard Test Method for Modulus of Rupture of Dimension Stone

**1.2.2.4** C170, Standard Test Method for Compressive Strength of Dimension Stone

**1.2.2.5** C241, Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic

**1.2.2.6** C880, Standard Test Method for Flexural Strength of Dimension Stone

**1.2.3 Marble Institute of America (MIA):**

**1.2.3.1** Membership, Products, and Services Directory

**1.2.3.2** Dimension Stone Design Manual

**1.2.3.3** Additional publications may be available from the MIA Bookstore. Go online at www.marble-institute.com.

### 1.3 Scope of Included Work

**1.3.1** The work to be completed under this contract includes all labor and materials required for the furnishing and installation of all Quartz-based stonework shown or called for on the contract drawings, specifications, and addenda.

### 1.4 Definition of Terms

**1.4.1** The definition of trade terms used in this specification shall be those published by the MIA or ASTM International.

### 1.5 Source of Supply

**1.5.1** All Quartz-based stone shall be obtained from quarries having adequate capacity and facilities to meet the specified requirements and by a firm equipped to process the material promptly on order and in strict accord with specifications. The Specifying Authority (architect, designer, engineer, contracting officer, end user, etc.) reserves the right to approve the Material Supplier prior to the award of this contract. Stone and workmanship quality shall be in accordance with Industry Standards and Practices as set forth by the MIA.

### 1.6 Samples

**1.6.1** The Quartz-based Stone Supplier shall submit through the General Contractor, for approval by the Specifying Authority, at least two sets of samples of the various kinds of Quartz-based stone specified. The sample size shall be 1'-0" x 1'-0" and shall represent approximately the finish, texture, and anticipated range of color to be supplied. One set of samples shall be retained by the Specifying Authority, and one set shall be returned to the Quartz-based Supplier for project record and guidance. It is noted herein that Quartz-based stone is a natural material and will have variations in color, markings, and other characteristics. Stone is a product of nature. It is not possible to guarantee that all the colors and markings of a large stone deposit will be present in every piece and that every characteristic will be uniformly present in other pieces. Depending on Quartz-based stone selected and quantity required, a range mockup may be required to further define the characteristics of the material. When required, the cost of the mockup shall be included in this section.

**1.6.2** Prior to fabrication, an inspection and approval by the Specifying Authority (and/or General Contractor and/or End User) of a representative number of the finished slabs may be desirable to understand the finish and full range of the material

## 1.7 Shop Drawings

**1.7.1** The Quartz-based Stone Supplier shall submit through the General Contractor, for approval by the Specifying Authority, sufficient sets of shop drawings showing general layout, jointing, anchoring, stock thickness, and such other pertinent information. These drawings shall show all bedding, bonding, jointing, and anchoring details along with the net piece dimensions for each Quartz-based unit. Setting numbers are to be shown, if applicable. One copy of the approved shop drawings shall be retained by the Specifying Authority, one copy shall be retained by the General Contractor, and one copy returned to the Quartz-based Stone supplier for fabrication. NO FABRICATION OF QUARTZ-BASED STONE SHALL BE STARTED UNTIL SUCH DRAWINGS HAVE BEEN FULLY APPROVED AND MARKED AS SUCH. The Quartz-based Stone Supplier shall not be responsible for determining, making, or verifying (1) design, structural, wind, seismic, or other design loads; (2) engineering estimates; (3) plans or specifications; or (4) the types, sizes, or locations of anchors, unless specifically added to the scope of work.

## 1.8 Defective Work

**1.8.1** Any piece of Quartz-based stone showing flaws or imperfections upon receipt at the storage yard or building site shall be referred to the Specifying Authority for determination as to responsibility and decision as to whether it shall be rejected, patched, or redressed for use.

## 1.9 Repairing Damaged Stone

1.9.1 Chips at the edges or corners may be patched provided the structural integrity of the stone is not affected and provided the patch matches the color and finish of the natural stone so that it does not detract from the stone's appearance.

# 2.0 MATERIALS

## 2.1 Quartz-based Stone

**2.1.1 General**: All Quartz-based stone shall be of architectural standard grade, free of cracks, seams, starts, or other traits which may impair its structural integrity or function. Inherent color variations characteristic of the quarry from which it is obtained will be acceptable. Texture and finish shall be as shown in the sample(s) approved by the Specifying Authority.

**2.1.2 ASTM C616 [C97] [C99] [C170] [C241] [C880]** See the chart of applicable ASTM standards and tests in the Appendix.

**2.1.3 Schedule**: Quartz-based stone shall be provided as follows:

**2.1.3.1** For (_state location on building_) (_state name and color_) Quartz-based stone with a (_type_)

 

finish, supplied by (*name company or list several approved suppliers*).
**2.1.3.2** Provide information as in (1) for each different Quartz-based stone/finish combination in the project.

**2.1.4** **Finishes**: Available in cleft, chat sawn, and diamond sawn, sand sawn, honed, polished, rubbed, machine tooled, smooth planed, split face, and rock face.

**2.1.5** Finishes listed in the schedule shall conform with definitions by the MIA or ASTM International.

## 2.2 Setting Mortar

**2.2.1** Mortar for setting and pointing shall be one part portland cement and one part plastic lime hydrate to three to five parts of clean, nonstaining sand. It shall be mixed in small batches, using clean, nonalkaline water with a pH of 7 until it is thoroughly homogeneous, stiff, and plastic. After mixing, the mortar shall set for not less than one hour or more than two hours before being used.

## 2.3 Pointing Mortar

**2.3.1** Mortar for pointing shall be Type N, as defined in ASTM C270 (Standard Specification for Mortar for Unit Masonry). All mixing, handling, and pacing procedures shall be in accordance with ASTM C270.

## 2.4 Sealants and Backup Material (If Applicable)

**2.4.1** Where specified, (state type or name of sealant) shall be used for the pointing of joints. The backup material used with the sealant shall be (identify material). Joint sealants are to comply with ASTM C920. Submit samples for stain testing in accordance with ASTM D2203.

## 2.5 Anchors, Cramps, and Dowels

**2.5.1** All wire anchors, cramps, dowels, and other anchoring devices shall be nonferrous metal of the types and sizes shown on approved shop drawings.

# 3.0 FABRICATION

## 3.1 Beds and Joints

**3.1.1** Bed and head joint size shall be determined by analysis of anticipated building movements and designed to accommodate such movements without inducing undue stresses in the stone panels or joint filler materials. Expansion joints shall be designed and located to accommodate larger movements.

**3.1.2** Some slight lippage and variation is natural and unavoidable where a rough finish face comes together at the sawed joints.

**3.1.3** Joints ¼", 3/8", or ½" are recommended between standard-size panels. All joints are to be water- and moisture-tight and caulked with a proper sealant.

## 3.2 Backs of Pieces

**3.2.1** Backs of pieces shall be sawn or roughly dressed to approximately true planes. Back surfaces shall be free of any matter that may create staining.

## 3.3 Moldings, Washes, and Drips

**3.3.1** Moldings, washes, and drips shall be constant in profile throughout their entire length, in strict conformity with details shown on approved shop drawings. The finish quality on these surfaces shall match the finish quality of the flat surfaces on the building.

## 3.4 Back-checking and Fitting to Structure or Frame

**3.4.1** Stone coming in contact with structural work shall be back-checked as indicated on the approved shop drawings. Stones resting on structural work shall have beds shaped to fit the supports as required.

**3.4.2** Maintain a minimum of 1" between stone backs and adjacent structure. (Note: many bolted connections will require more space than this; 2" space may be more desirable. Large-scale details should illustrate and control these conditions.)

## 3.5 Cutting for Anchoring, Supporting, and Lifting Devices

**3.5.1** Holes and sinkages shall be cut in stones for all anchors, cramps, dowels, and other tieback and support devices per industry standard practice or approved shop drawings. However, additional anchor holes shall be drilled at job site by Quartz-based Stone Contractor to facilitate alignment.

**3.5.2** No holes or sinkages will be provided for Quartz-based Stone Contractor's handling devices unless arrangement for this service is made by the Quartz-based Stone Contractor with the Quartz-based Stone Fabricator.

(NOTE: It is not recommended that lewis pins be used for stones less than 3½" thick).

## 3.6 Cutting and Drilling For Other Trades

**3.6.1** Any miscellaneous cutting and drilling of stone necessary to accommodate other trades will be done by the Quartz-based Stone Fabricator only when necessary information is furnished in time to be shown on the shop drawings and details, and when work can be executed before fabrication. Cutting and fitting, due to job site conditions, will be the responsibility of the Quartz-based Stone Contractor.

**3.6.2** Incidental cutting such as for window frame clips, etc., which is normally not considered to be the responsibility of the Stone Supplier, will be provided only by arrangement by the General Contractor and Quartz-based Stone Contractor with the Quartz-based Stone Fabricator.

# 4.0 SHIPPING AND HANDLING

## 4.1 Packing and Loading

**4.1.1** Finished Quartz-based stone shall be carefully packed and loaded for shipment using all reasonable and customary precautions against damage in transit. No material which may cause staining or discoloration shall be used for blocking or packing.

## 4.2 Site Storage

**4.2.1** Upon receipt at the building site, stone shall remain in the factory-prepared bundles until beginning of the installation. Bundles shall be staged in an area which is least susceptible to damage from ongoing construction activity. Once unbundled, the granite shall be stacked on timber or platforms at least 2" above the ground, and the utmost care shall be taken to prevent staining or impact damage of the stone. If storage is to be prolonged, polyethylene or other suitable, nonstaining film shall be placed between any wood and finished surfaces of the stone. Polyethylene or other suitable, nonstaining film may also be required as protective covering.

## 5.0 INSTALLATION

### 5.1 General Installation

**5.1.1** Installation shall be accomplished with competent, experienced Stone Setters, in accordance with the approved shop drawings.

**5.1.2** All Quartz-based stone pieces shall be identified with a unique piece number corresponding with the number on the shop drawings. Interchanging of numbered pieces is not permitted.

**5.1.3** Quartz-based stone shall be free of any ice or frost at time of installation. Salt shall not be used for the purpose of melting ice, frost, or snow on the stone pieces.

**5.1.4** Adequate protection measures shall be taken to ensure that exposed surfaces of the stone shall be kept free of mortar at all times.

### 5.2 Mortar Setting

**5.2.1** Unless otherwise shown on approved shop drawings, each piece shall be carefully laid in a full bed of mortar and tapped to a full and solid bearing. Exposed surfaces shall be kept free of mortar at all times.

**5.2.2** If the thin-set method is used (for 5/8" thick stone) a dry-set portland cement mortar is applied with a 3/8" or ½" notched trowel with back buttering of the clean, moist tile surface.

**5.2.3** Apply mortar with flat side of trowel over an area that can be covered with tile while mortar remains plastic. Within ten minutes and using a notched trowel of type recommended by Mortar Manufacturer, comb mortar to obtain even-setting bed without scraping backing material. Cover surface uniformly, with no bare spots, with sufficient mortar to ensure a minimum mortar thickness of 3/32" between tile and backing after tile has been tamped into place. Tile shall not be applied to skinned-over mortar. Average contact area shall be not less than 80%, except on exterior or shower installations, where contact shall be at least 95% when no less than three tiles are removed for inspection.

**5.2.4** Veneer shall be set by spotting with gypsum molding plaster for interior use, or cement mortar and the use of concealed anchors secured in the wall backing.

**5.2.5** Where thin wall tile (nominal 5/8" thick) is used, nonstaining adhesives or dry-set mortars may be employed. Individually set thin tile (nominal 3/8" thick) on vertical surfaces exceeding 8' is not recommended.

**5.2.6** Panels set in metal frames shall have rabbeted edges and a sealant for all joints to prevent moisture seepage. Hairpin spring anchors in the back of the panels make Quartz-based stone easily adaptable as facings for precast units and systems.

### 5.3 Mortar Joints

**5.3.1** Mortar joints shall be raked out to a depth of ½" to ¾". Apply pointing mortar in layers not exceeding 3/8" and allow each layer to get hard to the touch before the next layer is applied. Tool finished joints with a concave tool having a diameter approximately 1/8" greater than the joint width.

**5.3.2** Care shall be taken to keep expansion joints free of mortar, which would compromise their function.

### 5.4 Anchorage

**5.4.1** The stone shall be anchored or doweled in accordance with the approved shop drawings.

**5.4.2** To the furthest extent possible, all anchor preparations in the Quartz-based stone units shall be shop-applied.

**5.4.3** All anchorage devices and anchor hole/slot fillers shall be in accordance with

ASTM C1242. Care must be taken to ensure that any holes capable of retaining water are filled after use to prevent water collection and freezing.

### 5.5 Sealant Joints

**5.5.1** Where so specified, joints requiring sealant shall be first filled with a closed-cell ethafoam rope backer rod. The backer rod shall be installed to a depth that provides optimum sealant profile after tooling.

**5.5.2** If recommended by the Sealant Manufacturer, primers shall be applied to the substrate surfaces according to the manufacturer's directions prior to application of the joint sealant.

### 5.6 Expansion Joints

**5.6.1** It is not the intent of this specification to make control or expansion-joint recommendations for a specific project. The Specifying Authority must specify control or expansion joints and show locations and details on drawings.

### 5.7 Caulking

**5.7.1** Where so specified, joints shall be pointed with the sealant(s) specified in Section 2.4 after first installing the specified backup material and applying a primer if required, all in strict accordance with the printed instructions of the sealant manufacturer.

**5.7.2** All sealants shall be tooled to ensure maximum adhesion to the contact surfaces.

### 5.8 Weep Tubes

**5.8.1** Plastic or other weep tubes shall be placed in joints where moisture may accumulate within the wall, such as at base of cavity, continuous angles, flashing, etc., or as shown on architectural drawings.

## 6.0 CLEANING AND PROTECTION

### 6.1 Cleaning

**6.1.1** Upon completion of various portions of work, all mortar stains, grease marks, and dirt should be removed by washing with a good grade of nonabrasive detergent with a pH of 7. Flush and clean with clear water. Floors can be swept, damp-mopped, or hosed off with clean water.

### 6.2 Protection of Finished Work

**6.2.1** Quartz-based stone installation in progress shall be protected with film, fabric tarps, and wood for exposed edge protection secured over the work.

**6.2.2** After the Quartz-based stone has been installed, it shall be the responsibility of the General Contractor to see that it is properly and adequately protected from damage and stains until all trades are finished. This responsibility includes the stone cleaning costs prior to the final inspection. The Quartz-based Stone Contractor will outline the needs for protection, in writing, to the General Contractor.

# PRODUCT DESCRIPTION – Quartz-based Stone

## 1.0 GEOLOGICAL CLASSIFICATION

**1.1** Most types of Quartz-based stones are clastic sedimentary stone, composed of particles or grains usually cemented with varying amounts of either hydrous silica or crystalline quartz. A notable exception is the chert group, including chert, agate, and flint, which are siliceous chemical sedimentary stones.

**1.2 The following are the main groups of Quartz-based stone:**

**1.2.1** Quartz, Crystalline Quartz

**1.2.2** Sandstone

**1.2.3** Quartzite

**1.2.4** Metaquartzite

**1.2.5** Quartz Pebble Conglomerates

**1.2.6** Metaconglomerates

**1.2.7** Chert, Agate, Flint

**1.3** The key to understanding all Quartz-based stone is the understanding of crystalline quartz as a mineral. The basic physical properties of quartz – with the possible exception of absorption and porosity – are the same as those of any Quartz-based stone.

**1.4 Quartz ($SiO_2$)** is composed of the two most abundant elements in the Earth's crust: silicon and oxygen, which respectively make up 28% and 47% by weight of our planet's lithosphere. Of all the common minerals, quartz lasts the longest in the environment. Most of the beaches in the world, with a few exceptions, are quartz sand.[1] Almost all other minerals are abraded away, broken up mechanically through weathering and transportation, or, if soluble, dissolved. Quartz is itself slightly soluble, giving rise to the chert deposits found in many sedimentary sequences.

**1.5** Weathering of igneous, sedimentary, and metamorphic rocks releases grains of quartz sand. Water, gravity, and wind transport this rock debris (detritus) down mountains, hills, and highlands, and across the plains to lakes, seas, and into the oceans, depositing the debris on beaches and beyond to form into new sedimentary stone. During this natural process, soluble salts are released from the debris, and some of these salts ultimately run off into below-sea level lakes and into oceans as dissolved salts, giving the oceanic water its briny content.

**1.6** Crystalline quartz has a fixed chemical composition: $SiO_2$. Some other quartz types occur as hydrous silica ($SiO_2$•$NaH_2O$), the mineral of chert, agate, flint, and fire opal. These stones are about H=6 to 6.5 on the Mohs Scale,[2] not quite as hard as crystalline quartz.

**1.7 Physical properties of crystalline quartz:**

**1.7.1 Hardness**. Quartz has a Mohs Scale hardness rating of 7. It can scratch minerals with a hardness of less than 7, such as calcite and feldspar, but cannot scratch other quartz or minerals with a hardness greater than 7, such as corundum and diamond.

**1.7.2 Shape**. Quartz crystals are always six-sided, elongate prisms with a pyramid-shaped termination usually on one end of the prism only. The prisms may be imperfect, but the angles between sides are always equal, even though the prismatic sides are very unequal in width.

**1.7.3 Lack of Cleavage.** Quartz does not have "cleavage," the weakness in molecular geometry along which a mineral consistently break.

**1.7.4 Fracturing**. When quartz fractures, it can break with dish-shaped, irregular surfaces.

[1] A few beaches are entirely carbonate sand created by waves breaking up seashells into coarse, sand-sized grains. Some of these beaches have no land-derived silicate minerals or rock fragments. The beaches of Bermuda are a well-known example. There, the sands are pink from coloration derived from the remains of small, red, single-cell marine organisms. In Hawaii, there are beaches of only black or green volcanic sand with no quartz sand content.

[2] See Appendix for the Mohs Scale of mineral hardness.

The dished surfaces often have small concentric ridges giving it a "conchoidal" surface effect, after sea-shells with similar shapes and concentric ridges. Fractured quartz faces are rough, uneven, and never flat.[3]

**1.7.5 Coloring**. Quartz occurs naturally in a range of colors. Some colored quartz crystals are prized as semiprecious gems, e.g., citrine (yellow), amethyst (lavender to purple), and jasper (yellow, brown, red), to name a few. This natural coloring is due to micro inclusions or traces of other elements in the stone's chemistry. However, not all quartz available on the market is naturally colored. Artificial coloring processes are sometimes used in the gem industry to dye fractured crystalline quartz in colors not seen in nature, such as bright pink and fluorescent shades of green, yellow, and blue.

**1.7.6 Electrical Properties.** Quartz is "piezoelectric," an unusual electrical property that has no effect on the performance of the mineral in normal dimension stone applications. If squeezed, quartz generates an electrical current proportional to the amount of pressure applied. When a small current is generated on two opposing faces of a cut, ground quartz crystal, it vibrates electrically, acting as an oscillator at a frequency determined by the exact thickness of the crystal. These were used in communications equipment from the 1920s to the 1950s to control broadcast frequencies, but are now obsolete.

**1.8 Sandstone** is a nonmetamorphic sedimentary stone. When firmly cemented with silica, sandstone could be correctly identified as quartzite. However, it is suggested the name quartzite should be restricted for sandstone tightly cemented with homogeneous crystalline silica (quartz crystals).

**1.9 Quartzite**, the silica-cemented, unmetamorphosed variety, tends to occur in sedimentary units or beds, and the thicker quartzite ledges are generally more useful than the thinner occurrences. With thicker units of quartzite, the distinction between metamorphosed and unmetamorphosed types makes little difference to those in the stone industry. Quartzite breaks across grains, not around grains. Thus it is very hard (H=7), durable, and for practical purposes, not a soluble stone, making it a desirable material for some difficult installations where exposure to water may be a problem.

**1.10 Metaquartzite**. The metamorphic equivalent of quartzite is metaquartzite. Often difficult to differentiate from its nonmetamorphosed parent stone, metaquartzite has certain distinct features; for example, thin "partings" of clear mica often separate layers or bands of pure metaquartzite. Some deposits of the stone occur in layers only 1/8" to ½" thick, separated by the micaceous parting that allows easy separation or cleaving characteristic of mica sheets, due to weak molecular bonds.

**1.11** These mica partings should not be confused with former bedding. The partings are a form of banding developed from the mineral segregation that occurs in the process of metamorphism. Thin metaquartzite is valued for use in flooring and decorative stone applications.

**1.12 Quartz pebble conglomerates**, unless silica-cemented, may tend to disaggregate rather easily, particularly if the quartz pebbles are highly rounded and smooth and the cement is not strong, especially if the cementing agent and matrix is the soluble mineral calcite or limestone. If the conglomeratic matrix is silica, then the stone will break through the quartz pebbles. A quartz pebble conglomerate may occasionally consist

[3] Crystalline Quartz can be deposited in a void *against* an existing crystal face of another mineral. The resulting flat face on quartz is an *artifact*, not originating as a consequence of the atomic geometry of quartz. The only true, flat quartz face is a crystal face.

 

of a variety of colored quartz pebbles including white, yellows, reds, black, and sometimes banded agate. A multicolored quartz pebble conglomerate with red siliceous cement is found on the Iberian Peninsula and in the Atlas Mountains of North Africa. This type is a valuable dimension stone.

**1.13 Metaconglomerates**. Metaquartz pebble conglomerates, like metaquartzite, will break through and not around grains and pebbles. Other strongly metamorphosed conglo-merates have been squeezed under such high pressure that the quartz pebbles are flattened. The plane of flattening is normal (perpendicular to the direction of pressure), and flattened pebbles of hard quartz are a notable example of how high the pressures of metamorphism can be.

**1.14 Chert, Agate, Flint**. These are varietal names for hydrous silica deposits that can occur in beds or nodules. Chert, the preferred geological name, is classified as chemical sedimentary stone. Cherts are true chemical precipitates emplaced within a sedimentary sequence at some time after burial and perhaps before cementation.

**1.15** Some cherts, like red jasper, are valuable as semiprecious stones sold and used by gemstone hobbyists. Banded or lace agate can be valuable for jewelry or as an exceedingly rare and expensive dimension stone. Entire fireplace mantles and part of the surround have been made from large, exquisite sheets of agate. Because it is softer than crystalline quartz, Agate was often the material used to carve mortars and pestles for use in 19th century pharmacies. It was also used to make marbles for the game popular with 19th and early 20th century children.

## 2.0 COLOR AND VEINING

**2.1** The color, veinings, clouds, mottlings, and shadings in Quartz-based stone are caused by substances included during formation.

**2.2** The purest Quartz-based stones are nearly white. Colors are primarily due to iron oxides. The presence of limonite usually yields yellow, brown, and buff shades; the presence of hematite yields darker brown or red. Oxidation of iron-bearing minerals upon exposure may cause some stones to change color after installation.

**2.3** Since most Quartz-based stones are formed in layers through centuries, each layer may have considerable color variations. It is not uncommon that some may have a color range of possibly up to 12 shade variations. If a minimal amount of shade variation is desired, then additional quarrying time will be required, as well as special, hand-selection costs.

## 3.0 TEXTURE

**3.1** The term "texture," as applied to Quartz-based stone, means size, degree of uniformity, and arrangement of constituent minerals. Quartz-based stones are essentially quartz; some are nearly pure quartz.

**3.2** Grains of quartz may be well-rounded or angular, depending upon the degree to which they were water-worn before consolidation. Some deposits show remarkable uniformity in size of grains. This grain composition can affect the texture.

**3.3** Texture of Quartz-based stone is also affected by the way that the grains of silica fracture. Sandstone fractures around the constituent grains. Quartzitic sandstone fractures around or through the constituent grains. Quartzite fractures conchoidally through the grains.

**3.4** Quartz-based stones are the most variable type of dimension stone due to wide variety in degree of cementation and type of cementing material between the grains. There are four common cementing materials: iron oxides, clay, calcite, and quartz. All stages of cementation are found in nature, from incoherent sandstones that may be crumbled between the fingers, to the most hardened quartzites. All types between these extremes are used commercially.

**3.5** Sandstones may be relatively high porosity stones. Quartzites, on the other hand, can have as little pore space as granites.

## 4.0 FINISHES

**4.1** A common finish for Quartz-based stone is natural cleft finish. It should be noted that the face of natural-cleft stone is not necessarily a true flat surface. This surface may vary from flat to variations up to ¼" from true flat. This could result in a surface that is concave or convex, or could also be warped or "propellered" (corners tipping either down or up).

**4.2** Many of the standard finishes can be applied to Quartz-based stones.

**4.3** Some stone finishes can affect strength and durability. Examples are bush-hammered and thermal finishes, which reduce a stone's thickness, making it more vulnerable to weakening from exposure to freeze and thaw cycles.

## 5.0 THICKNESS

**5.1** As these are split stones, standard thicknesses are highly variable, e.g., ¾", 1½", 2", 4", or 8".

Note: As Quartz-based stone is cut thinner, its tensile strength is diminished.

## 6.0 SIZES

**6.1** Quartz-based stone is a product of nature with many varieties available, each possessing varying characteristics. Little can be done to alter the condition in which nature presents these varieties to us. Therefore, size may become a limiting factor to consider in the selection of a particular Quartz-based stone.

**6.2** A jointing scheme which permits the use of appropriate sizes of Quartz-based stone yielded by the particular quarry will greatly facilitate selection and delivery.

## 7.0 PRODUCT SAMPLING

**7.1** Quartz-based stones are formed by nature; thus, there are variations in the tonal qualities of the stones. However, it is these natural variations that make Quartz-based stone unique, valuable, and highly desirable. Because of these variations, selection of a stone should never be made on the basis of one sample only. It is recommended that selection be based on viewing sufficient samples to show the complete range of color of the desired stone. (See "2.0 Color and Veining" in this chapter section for additional information.)

## 8.0 PROPER USAGE TIPS

**8.1** Recommendation for commercial floors:

**8.1.1** Minimum ¾" thickness.

**8.1.2** A honed finish.

**8.1.3** A minimum hardness value of 2 (Sandstone), 8 (Quartzitic Sandstone), and 8 (Quartzite) as measured by ASTM C241.

**8.2** Avoid the use of gypsum or molding plaster setting spots for the installation of exterior stone.

## 9.0 TOLERANCES

**9.1** Because of the many variances in cementation and porosity, it is recommended that the Quartz-based Stone Quarrier or Fabricator be contacted regarding size and thickness tolerances.

## 10.0 FABRICATION

**10.1** One process after quarrying Quartz-based stone is to guillotine the slabs to the desired length and thickness, thus the thick slabs can be split to the desired thicknesses of 2", 3", or 4".

# TECHNICAL DATA – Quartz-based Stone

## 1.0 PROPERTIES OF QUARTZ-BASED DIMENSION STONE

**1.1** In centuries past, relatively little importance was attached to the ultimate physical capabilities of most building materials. Rule of thumb was a common structural design criterion. As a result, the widely used materials of the day, for the most part natural rather than man-made materials, were seldom stressed to their ultimate limits.

**1.2** In present-day construction, this is far from being true. Performance requirements are daily become more demanding. In striving for taller structures, greater spans, firmer foundations, thinner walls and floors, stronger frames, and generally more efficient buildings with more usable space, today's Architects and Engineers must get the most out of the materials with which they work.

**1.3** Quartz-based stone is a product of nature and not always subject to the rules of consistent behavior that may apply to manufactured building materials. Physical property values of Quartz-based stone may, however, be measured using the standard test methods approved by the Dimension Stone Committee C-18 of ASTM International. The MIA and Member companies are represented on the ASTM committee and are active in its technical work of establishing proper test methods and specifications consistent with the latest technology.

**1.4** Final design should always be based on specific values for the stone variety ultimately to be installed. These values may be obtained from the Stone Supplier. All materials are not suitable for all uses. In order to avoid mistaken selections, tests for material values should be made prior to final material selection.

**1.5 Physical Properties of Quartz-based Stone**
(These historical data and information are provided only as a guideline. Recommended minimums or maximums are established and provided by ASTM International.)*

**<u>Property</u>** **<u>Range of Values</u>**

Compressive Strength (C170)
lbs/in² .............................. 2,000-37,000
Recommended (min):
4,000 (sandstone),
10,000 (quartzitic sandstone),
20,000 (quartzite)

Flexural Strength (C880)
lbs/in² .................................. 700-2,300

Modulus of Elasticity** (in millions)
lbs/in² .................................... 1.0-1.75

Density, lb/ft³ (C97) ................. 135-170
Recommended (min):
125 (sandstone),
150 (quartzitic sandstone),
160 (quartzite)

Modulus of Rupture (C99) lbs/in².300-2,500
Recommended (min):
350 (sandstone),
1,000 (quartzitic sandstone),
2,000 (quartzite)

Absorption (by weight) % (C97) .....1.0-20.0
Recommended (max):
8.0 (sandstone),
3.0 (quartzitic sandstone),
1.0 (quartzite)

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* Test methods described in current ASTM standards.
** Also known as Young's Modulus.

## 2.0 STRENGTH (ASTM C99, C170, C880)

**2.1** Values for modulus of rupture, compressive strength, and flexural strength are ascertained by testing specimens of Quartz-based stone under laboratory conditions until they fail.

**2.2** Size and finish of test samples required by the standard ASTM test methods may not reflect the actual performance of stone when used in lesser thicknesses or with other finishes that affect strength. For this reason, the Modulus of Rupture (C99) test is recommended when the stone to be used will be two or more inches thick. The Flexural Strength (C880) test is recommended when the stone thickness will be less than two inches.

**2.3** The strength of a Quartz-based stone is a measure of its ability to resist stresses. This strength depends on several factors: the amount of free silica, degree of cementation, porosity, and whether the stone is metamorphosed.

## 3.0 FIRE RESISTANCE

**3.1** Stone is not combustible according to underwriters' ratings, and therefore is considered a fire-resistant material. Because of its thermal conductivity, heat transfer is fairly rapid. Most stone is not considered a highly rated thermal insulator.

**3.2** Underwriters' fire-resistance ratings evaluate whether or not a material will burn, as well as how long it will keep surrounding combustible materials from reaching temperatures which will cause them to ignite. Methods of estimating fire-resistance periods of masonry walls and partitions utilizing component laminae are given in "Fire Resistance Classifications of Building Construction," BMS92, National Bureau of Standards.

## 4.0 ABRASION RESISTANCE (ASTM C241)

**4.1** Abrasion resistance is a property of stone that should be tested per ASTM C241 to provide an indication of the stone's wearing qualities when exposed to foot traffic.

**4.2** The hardness and uniform wearing qualities of most Quartz-based stones make them extremely desirable and economically practical for floors and stairs. Varieties with an abrasive hardness ($H_a$) of 8 or more, as measured by ASTM C241 tests, are recommended for use as flooring exposed to normal foot traffic. A minimum abrasive hardness of 12 is recommended for commercial floors, stair treads, and platforms subject to heavy foot traffic. If floors are constructed with two or more stone varieties, the $H_a$ values of the stones must not differ by more than 5, or the floor surface will not wear evenly and uniformly.

## 5.0 FACTORS AFFECTING PROPERTIES

**5.1** The ultimate test of a building material is its ability to have and maintain the necessary structural strength, as well as beauty of appearance and low cost of maintenance, over the useful life of the structure. Experience has proven that stone meets this test as few other building materials can. Studies have shown that the durability of most stones is little affected by cycles of weather. This is because most have a low rate of moisture absorption.

## 6.0 SAFETY FACTORS

**6.1** Good engineering practice requires that allowable design stress must provide a margin of safety in any structural element. As a necessary precaution against such conditions as wind, ice, snow, impact, temperature changes, and imperfect workmanship, these allowable stresses must be smaller than those which produce failure.

**6.2** Within the accepted limits of safe design practice, the closer the allowable load is to the ultimate failure load, the more efficient is the use of the material and the less the cost of the construction.

**6.3** Contemporary building design does not usually employ stone as part of the structural frame, but rather as an independent unit, a curtain wall, or veneer. Therefore, the primary concern in such cases is with wind or seismic loads, and a safety factor of 8.0 is recommended. Where the stone is to be subjected to concentrated loading, such as stair treads or lintels supported only at the ends, a factor of 10.0 should be used.

**6.4** These safety factors may be adjusted using sound engineering principles and judgment.

**6.5** As buildings become taller and individual stone-slab veneer becomes larger in area, the lateral forces due to wind loads must be considered. Wind tunnel tests are often used on major structures to determine wind dynamics and force magnitude. Reinforcement is sometimes necessary for large dimension-slab veneer in critical areas.

## 7.0 SEISMIC CONSIDERATIONS

**7.1** Seismic considerations generally require that low buildings be stiff, and that tall buildings be relatively flexible. Design of connections must account for seismically induced horizontal loading. Local building codes vary and must always be checked to determine specific requirements for each area. The National Bureau of Standards has published two documents on the topic: "Earthquake Resistant Masonry Construction," NBS Science Series 106; and "Abnormal Loading on Buildings and Progressive Collapse: An Annotated Bibliography," NBS Science Series 67. The U.S. Army Corps of Engineers has also published TM 5-809-10, "Seismic Design for Buildings."

## 8.0 EFFLORESCENCE AND STAINING

**8.1** Efflorescence is a salt deposit, usually white in color that appears on exterior surfaces of masonry walls. The efflorescence-producing salts found in masonry are usually sulfates of sodium, potassium, magnesium, calcium, and iron. Salts which are chlorides of sodium, calcium, and potassium will sometimes appear, but they are so highly soluble in water that they will be washed off by rain.

**8.2** The water-soluble salts causing efflorescence come from other materials in the wall. The salts exist in small amounts and are leached to the surface by water percolating through the walls. The most feasible means of prevention is to stop the entrance of large amounts of water. Absorption from the face will not cause efflorescence unless there are open joints.

**8.3** Quartz-based stones are seldom injured by efflorescence. However, some of the salt crystals may form in the stones' pores near the surface. Crystal growth (recrystallization) in the pores can cause stress on the walls of the pores and cause the stone to flake off. If the conditions bringing about this action persist, scaling may continue and flake off one layer after another. For this to happen, large amounts of water must enter the wall and must contain large amounts of salts.

**8.4** Research indicates that staining and discoloration occurring on new buildings are caused by the action of water percolating through cement from which soluble alkali salts are leached. The salts are then carried through the stone, where partially oxidized organic matter is picked up. This is then transported to the surface of the stone, where it is deposited as a stain as evaporation of the water takes place.

**8.5** This staining phenomenon is similar to efflorescence except that it involves organic material. It does not harm the stone other than leaving an objectionable appearance during or soon after erection. However, if left alone, the stain is removed naturally by the action of the elements, usually in the course of a few months.

**8.6** A considerable amount of water passing through the stone is necessary to bring out conspicuous discolorations. Proper precautions taken during construction of the walls will usually prevent such troubles. A simple and helpful expedient is to provide frequent weep holes in the base course and above shelf angles. These should be placed in the vertical joints so they can be sloped upward from the front to back.

**8.7** Stains sometimes appear on the base course when Quartz-based stone is in contact with soil, due to the carrying of soluble salts and some colored soil constituents up through and to the surface of the stone by capillary action. Almost all soils contain soluble salts. Therefore, this staining phenomenon should disappear when the source of moisture is eliminated.

**8.8** Avoid contact between soil and stone. Damp-proofing treatments of either a bituminous or cementitious nature may be used as a barrier to the groundwater or construction moisture causing these stains.

## 9.0 THERMAL EXPANSION

**9.1** The thermal expansion of Quartz-based stone is an important consideration when it is used with dissimilar materials to form large units which are rigidly fixed. The coefficient of thermal expansion varies from one variety to another; actual thermal characteristics of a specific Quartz-based stone should be obtained from the Quarriers or Fabricator before making a final selection.

 