Architectural Precast Concrete Colour & Texture

Selection Guide

Index

Qualifications of Manufacturer

The precast concrete manufacturer shall be a member in good standing of the Canadian Precast/Prestressed Concrete Institute (CPCI) and have a proven record and satisfactory experience in the design, manufacture and erection of precast concrete facing units of the type specified.

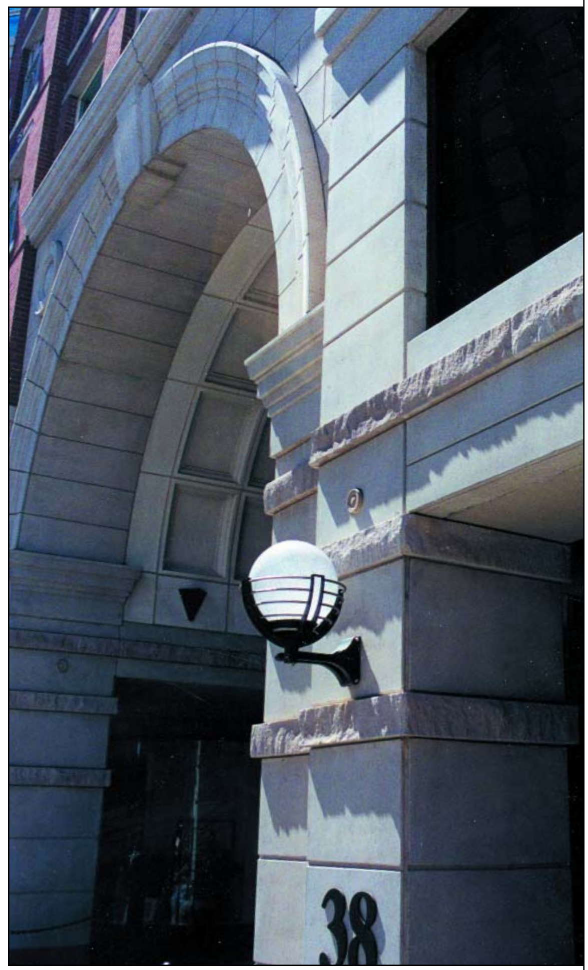
CPCI Members have access to the latest information and technology. CPCI Members are dedicated to providing the highest levels of quality and customer service.

For a current list of CPCI Members, see:
www.precastsearch.com

References

PCI Color and Texture Selection Guide
PCI Designer's Notebook
PCI Architectural Precast Concrete Manual
Dynamic Color Solutions Tech Notes
CPCI Design Manual

Introduction



The proper selection of colour, form, and texture for a building's precast concrete exterior is critical in creating a successful aesthetic appearance. By varying and combining aggregates, matrix colour, finishing processes, profiles and depth of exposure, different colours and textures can be achieved.

Precast concrete is cast in a fluid state that allows architects to create designs that cannot be accomplished with other materials. This Colour and Texture Guide published by the Canadian Precast/Prestressed Concrete Institute will explain the parameters of precast finishes and help with the selection of a suitable colour and finish for your next project.

The enclosed colour plates are intended to serve as a visual reference for the initial selection of colour, texture and finish. The development of samples at a precaster's plant will aid in the final selection of colour and texture for your project. The use of samples and/or mockups is often required to help the architect to visualize the desired aesthetics and to ensure the project's success.

Samples

The photographs of samples and the final precast panels produced may not be an exact match because of different material sources and manufacturing techniques used at each plant. Samples must be made to ensure the desired colours and textures are replicated satisfactorily. Samples for architectural precast concrete can be custom-produced to translate an architect's specific design concept into a standard for realistic and economic production requirements.

Precast samples are intended to represent the materials and finish used. Colour or appearance may vary during production, so samples showing the expected range should be requested. Product appearance is influenced by such factors as form profiles, complexity of casting and physical mass, curing, as well as the natural characteristics of the concrete mixes. These all should be considered. The designer should focus on selecting shapes, sizes, colours, textures, and finishes for the samples well in advance of final preparation of the project specifications.

Reference Sample

Standard 300 x 300 x 25mm thick samples are often used as reference samples during the design and pre-award process.

Range Samples

Three initial production panels 1m x 1m square showing acceptable finish variations should be reviewed shortly after fabrication and accepted before full production begins. These panels should be marked and identified for future reference. At the start of production, the first panels should be reviewed to ensure compliance with previously approved samples.

Repair Techniques

The acceptability of repair techniques for chips, spalls, or other surface blemishes also should be established on these samples. The face of each sample

should contain at least two areas of approved size and shape, which have been chipped out and then patched and repaired. The colour, texture, and appearance of patched areas should match that of the adjacent surface.

Mockup Panels

Full size samples and mockups are not normally specified before a precast manufacturer is awarded the final contract unless the owner is prepared to pay in advance for this expense.

Full-scale mockups and ¼ - or ½ - scale samples can be used to evaluate the production methods and the finished product. For example, if return elements are to be cast with a major panel section, the samples should have returns cast with them to represent how the finish will be accomplished on such sections. The production of uniform, blemish-free samples, used to demonstrate the initial colour and texture selection, will be misleading and could cause endless difficulties when the production begins using actual manufacturing techniques and facilities, that have to match "the sample."

Mockups incorporating both precast and windows for the testing of the building envelope integrity should be considered where the project size warrants. These may be several modules wide by one or two stories high. Investing in such mockups removes uncertainties held by both the architect and owner and may lead to modifications that improve the appearance of the precast concrete and identify any weakness in the performance of the building envelope as a complete system. Corrective measures can be incorporated into the job site wall system.

Larger samples require considerable time to produce, and they should not be specified unless sufficient lead-time exists. Also, it may be desirable to separate the mockup costs from the base bid so the cost can be evaluated separately.

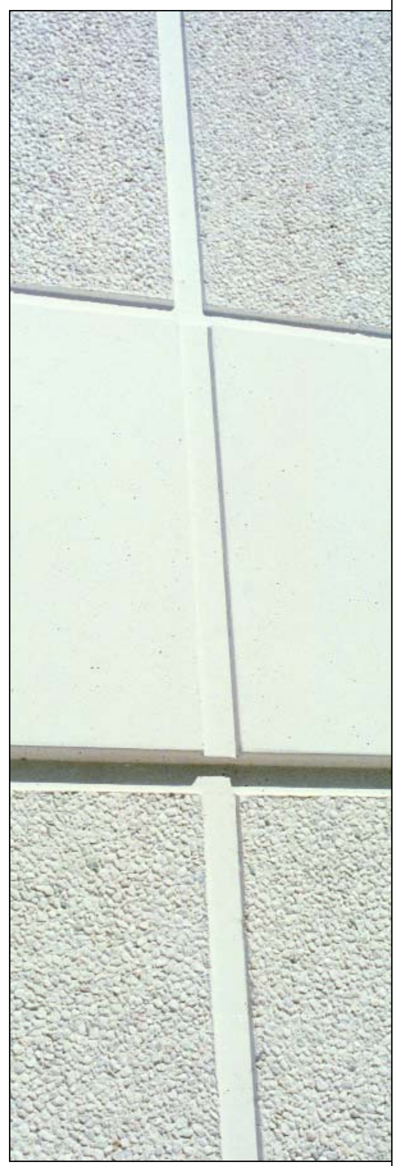
Where mockups are not used, the architect and/or owner should visit the precast concrete plant and approve (sign and date) the initial production units. This approval should precede a release for production to avoid potential controversies later. However, delays in visiting plants will upset normal operations and the job schedule. The contract documents should state clearly how long the production units or the mockup structure will be kept in the plant or at the jobsite for comparison purposes.

The contract documents also should permit the approved full-sized units to be used in the installation in the late stages of construction. The unit should remain identifiable even on the structure until final project acceptance.

Colour

Uniformity of Materials

The inherent natural beauty of sand and stone are most often expressed in architectural precast concrete. This is one of the main reasons precast concrete is chosen. As with many other natural materials, 100% colour uniformity is not a realistic expectation and must be considered when standards are set for precast concrete architectural products. Differences in uniformity related to the quarrying, crushing, screening and transporting of aggregates are fairly easy to recognize. Variations that are not quite so obvious include those caused by climactic conditions, which affect final curing. These material and production factors may cause differences in colour and texture. Like variations in other natural materials, such as masonry and natural stone, reasonable variation should be considered acceptable in precast concrete.



Uniformity of texture and colour within any individual panel will usually be consistent. The architect must determine the acceptable degree of variation for the complete facade. Where uniformity is essential, the precaster can help select the shapes, colours and textures to minimize variations. Sometimes one aspect must be sacrificed to achieve others.

The ease of obtaining colour uniformity relates directly to the ingredients supplying the colour. Whenever possible, the basic colour should be established using coloured fine or coarse aggregates (depending on depth of exposure) and/or a combination of aggregates and pigments. Extreme colour differences between aggregates and matrix should be avoided. In all cases, colour should be judged from a sample that has the proper matrix and has been finished according to planned production techniques.

A variety of colours can be achieved by varying aggregates, and size of aggregates, matrix colour, different types of sands and by introducing coloured pigments. Combining colour with texture accentuates the natural beauty of aggregates.

Colour and consequently colour tone, represent relative values. These are not absolute and constant, but are affected by light, shadow, density, nearby colours and the surroundings.

Colour selection should be made under lighting conditions similar to those where the precast concrete will be used, such as strong light and shadows or natural daylight. Surface texture influences colour. Ultimately, the building's appearance is a function of the architect's use of light, shadow, texture and colour.

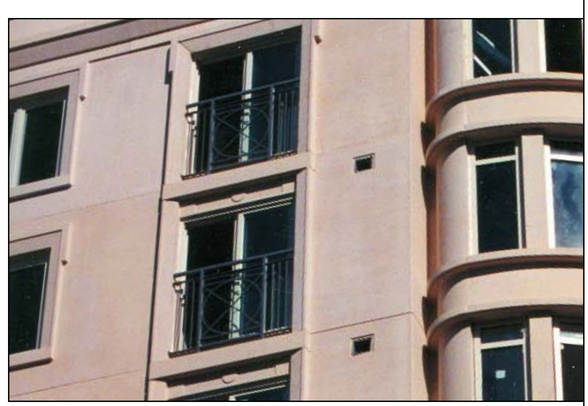
Cements

Cement exerts the primary colour influence on a smooth concrete finish because it coats the exposed surface. As the concrete surface is progressively removed and the aggregates are exposed, the panel colour increasingly reflects the fine and then the coarse aggregate colours. Nevertheless, the colour of the cement always has an effect on the general tone of the panel. Cement may be grey, white or a mixture. White cement usually costs 50% more than grey cement.

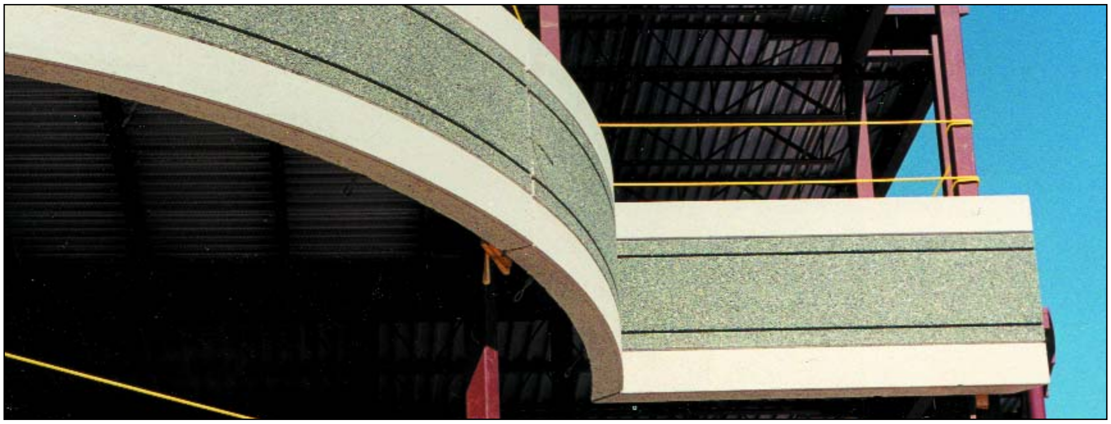
All cements have inherent colour and shading differences depending on their source. For example, some white cements have a buff or cream undertone. In addition, a finely ground grey or white cement is normally lighter in colour than a coarse ground cement of the same chemical composition. If colour uniformity is essential, white cement from only one source should be specified.

Grey cements are generally subject to greater colour variation than white cement even when supplied from one source. Normal production variables such as changes in water content, curing cycles, temperatures, humidity, and exposure to climactic conditions at varying strength levels, all tend to cause greater colour variations in grey cement concrete than concrete cast using white cement.

While grey cement can be combined very effectively with many aggregates, the use of white cement, with or without colour pigments, greatly extends the range of possible colour combinations. Although white cement will give the least amount of colour variation, it is important to choose light-coloured aggregates to decrease the shadowing effect of aggregates close to the surface. Grey cement has a greater ability to provide an opaque covering of aggregates, but colour differences may offset this advantage.



If grey is the desired colour of the matrix and optimum uniformity is essential, a white cement with a grey or charcoal pigment is recommended.



Uniformity of Aggregates

Coarse aggregate colours become dominant as the surface of the concrete is removed to obtain the desired texture by means of sandblasting or exposing the aggregate by the use of chemical retarders and washing. Coarse aggregates should be reasonably uniform in colour. Light and dark coarse aggregates require care in blending so that colour uniformity is achieved within a single unit. Uniformity can be enhanced with a small colour difference between the light and the dark aggregates and a small variance in total amounts of each aggregate.

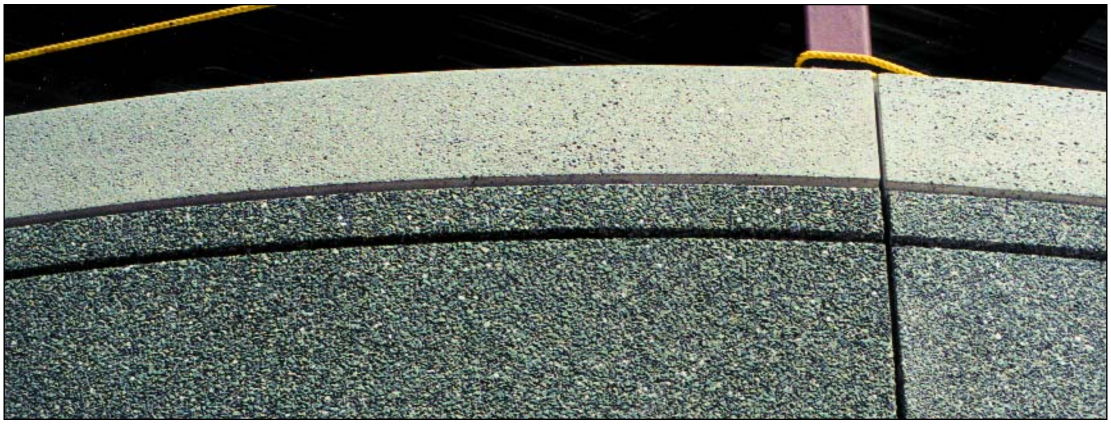
Architects should specify that the matrix's colour or tone match that of the coarse aggregate, so minor segregation of the aggregate will not be noticeable. Panels containing aggregates and matrices of contrasting colours will appear less uniform. As the size of the coarse aggregate increases, less matrix is seen and the panel's colour will appear more uniform.

Fine aggregates have a major effect on the colour of white and light buff coloured concrete, and can add colour tones when the surface is given a light sandblast or acid etch finish to increase their exposure.

The selected finish should be assessed during both wet and dry weather conditions. White concrete usually produces less of a difference in tone between wet and dry panels. Drying-out periods often produce a blotchy appearance in all grey cement facades, particularly on fine-textured surfaces. On the other hand, dirt (or weathering) normally will be less noticeable on grey surfaces.

Since acceptable colour uniformity and shading intensity are evaluated visually, they are generally subjective. The acceptable variations in colour, texture, and uniformity should be determined at the time the sample, mockup or initial production units are approved.

Although acceptability standards must be established in each case, suitable industry standards do exist. The finished concrete surface should have a pleasing appearance with minimal colour and texture variations from the approved samples. The surface should not



show any obvious imperfections other than minimal colour and texture variations, nor should it provide evidence of repairs when viewed in typical lighting with the unaided naked eye at a 6 meter viewing distance. Appearance of the surface should not be evaluated when sunlight is illuminating the surface from an extreme angle, as this tends to accentuate minor surface irregularities.

Pigments

Pigments are often added to the matrix to obtain desired colours. Standard colours for integrally coloured concrete include white, ivory, cream, buff, yellow, red, orange, brown, grey, and black. Green, olive, turquoise, blue and purple can be achieved but at a higher cost. These shades range from 3 to 20 times more expensive than for the standard colours.

Variable amounts of a pigment, expressed as a percentage of the cement content by weight, produce various shades of colour. High percentages of pigment (over 7% by weight with most iron oxides) reduce concrete strength because of the high percentage of fines introduced to the mix by the pigments. Therefore, the amount of pigment should

be controlled within the limits of strength and absorption requirements and not exceed 6% by weight of cement. Different shades of colour can be obtained by varying the amount of pigment or by combining two or more pigments. White Portland cement will produce cleaner, brighter colours and should be used in preference to grey cement, especially for the light pastels such as the buffs, creams, and ivories, as well as the bright pale pink and rose tones.

Shades of red, orange, yellow, brown, black, and grey are the least costly. Green is permanent, but relatively expensive, except in light shades. Blue is very expensive and cobalt blue is the only permanent pigment for use in concrete. All intense colours have a tendency to show efflorescence, which will appear as a lightening of the colour. If this becomes too objectionable, washing with a dilute hydrochloric acid and rinsing thoroughly can restore the original colour. Carbon black, due to its extremely fine particle size, has a tendency to wash out of a concrete mix. As the pigment dissipates the concrete substrate appears increasingly "faded." Synthetic black iron oxide will produce a more stable charcoal colour.

Titanium dioxide pigment in quantities of 1 to 3 percent is sometimes used to increase the opacity or to further intensify the whiteness of white concrete. It cannot, however, be used in place of white cement to achieve a white colour.

Architects can best specify the colour they desire by referring to the colour plates in this brochure, a swatch or colour card. A cement colour card is preferred but one published by a paint manufacturer is acceptable.

Colour Consistency

Significant points to consider when colour consistency is critical are:

- Quality and quantity of pigments.
- Fading characteristics of some pigments.
- Proper and consistent batching and mixing techniques of the concrete mix.
- Quality (freedom from impurities) of the fine and coarse aggregates.
- Uniform quantities and gradation of fine materials (passing No. 50 sieve and including the cement) in the concrete mix.
- Careful attention to curing and uniform duplication of curing cycles.
- Type and colour of cement.
- Constant water-cement ratio in the mix.
- Pre-order total quantity of aggregates for the entire project.
- Consideration of those factors that can contribute to efflorescence. (This is especially important for darker and more intense colours.) Efflorescence deposited on a panel surface may mask the true colour and give the appearance of fading even though the cement paste itself has shown no change. Washing with a dilute solution of hydrochloric acid and water and rinsing thoroughly may restore the original colour.

In addition, weathering of the pigmented cement paste exposes more of the aggregate to view. If the colour of the aggregate is in contrast to that of the pigment, a change in the overall colour of the surface may be noted.

Amounts of pigment in excess of 5% by weight of cement seldom accomplish further colour intensity, and in no case should pigment exceed 6% of the weight of cement.

Efflorescence

What is it?

Efflorescence is a white powdery crystalline deposit (crystal of salt) that can form under certain conditions on the surface of a precast panel after installation. One sure way to identify efflorescence that is present on a finished surface is to taste it. Because it is made up of soluble alkalies, it tastes salty.

Where does it come from?

Efflorescence comes from any free salts in the raw materials. Sand, cement and brick most commonly contain soluble salts, but fly ash and water can also be a source of contamination. There is no good test for efflorescence that can be easily performed to determine the source of contamination. As far as water is concerned, in general, as long as the water is potable there should be no problems.

When does efflorescence occur?

Efflorescence occurs when free salts are present in one or more of the raw materials and when these salts are dissolved and carried to the surface by water as drying occurs. This happens most frequently when there are low temperatures and high humidity. In Canada this happens most commonly in the early spring and late fall when there is constant wetting and drying, and the temperatures hover around the freezing point.

How can you reduce the possibility of efflorescence occurring?

There are some measures that can be taken in an effort to avoid efflorescence. If local cement contains free salts, a change to a low alkali cement (0.6% or less alkali) can be tried. Obviously, the lower the alkali content, the less likelihood of efflorescence. If the sand is contaminated, use washed sand that will eliminate the salts.

The addition of water repellent admixture chemicals can also help in preventing the occurrence of efflorescence. This group of chemicals comes under many names and formulations. The most commonly used products in this area have historically been stearates of one sort or another. The most dramatic effect produced by these products is often the densification of the product being treated; thereby inhibiting the migration of water into or out of the product after it is produced. Any reduction of the passage of water into and out of a panel will reduce the possibility of migration of soluble salts to the surface where they may show up as efflorescence. Due to the increased chances of incompatibility of colour and multiple admixtures, it is generally advised that a minimum of admixture chemicals be employed when colour is used. Some water-repellent admixtures can help prevent efflorescence and if a problem does develop on a particular project their use can be quite beneficial.

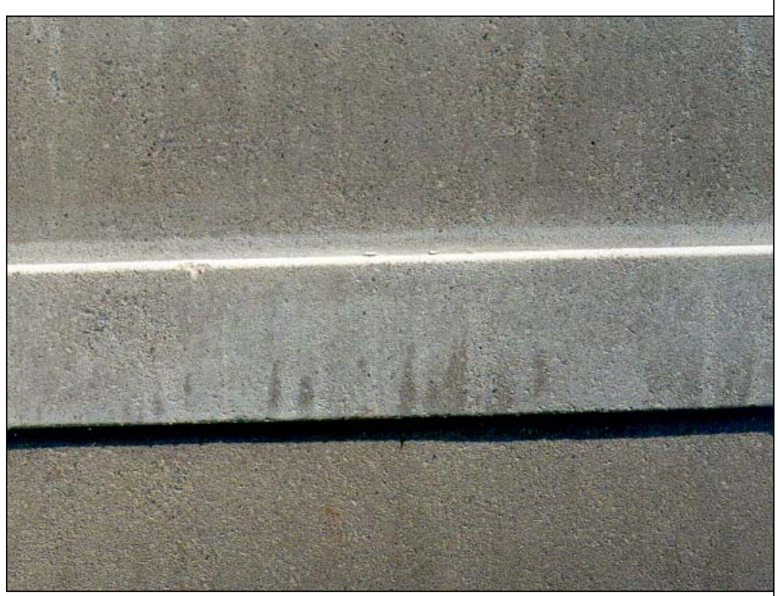
What part do colour pigments play?

Colour pigments themselves cannot cause efflorescence. When working with coloured products or coloured mortar, however, any efflorescence problems that do exist tend to be accentuated. All pigments used to colour concrete and mortar are virtually 100% inert and water insoluble. Therefore, there is nothing in any of the pigments that could possibly dissolve in the concrete or mortar and be deposited on the surface. This means that colour pigments may aggravate any efflorescence problem by making it more visible, but do not actually cause any problems on their own.

What to do when efflorescence occurs?

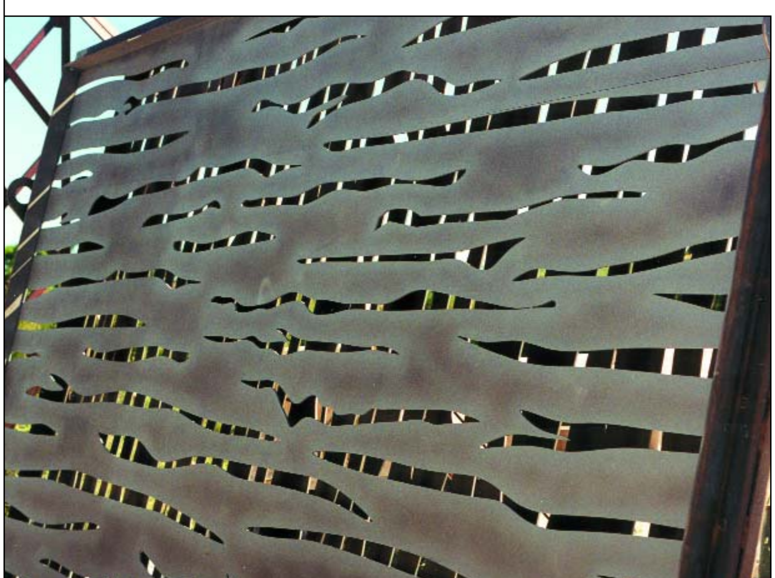
There are cases where parts of a building may effloresce even if one does everything correctly to reduce the possibility of efflorescence occurring. The best thing to do is absolutely nothing. In time almost all efflorescence will disappear. If you can wait for one year before doing anything to the building, 95% of the time all of the salts will work themselves to the surface and the problem will solve itself.

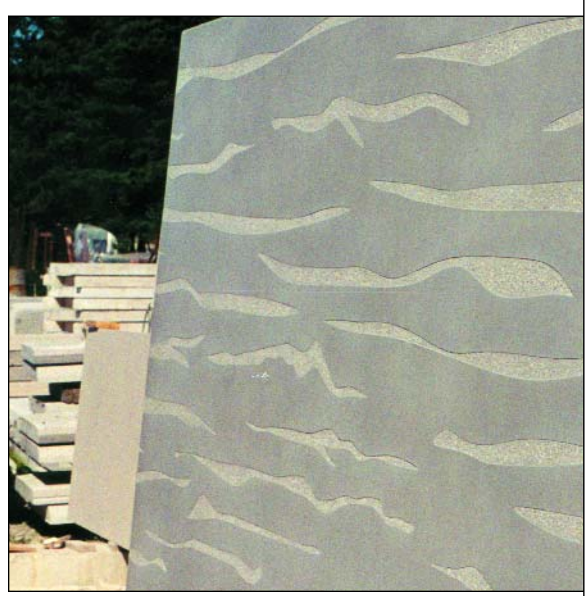
When waiting one year is not an acceptable option, wash the building. The best material is a detergent-based cleaner. Follow the manufacturer's directions exactly. Usually prewetting the building is necessary. Thoroughly rinse the building after applying the cleaner. Never use high-pressure water in the cleaning process because it can leave stains of its own. There is still a possibility that the cleaner could change the colour even if all the directions are followed and the cleaner is used properly. Therefore, prevention is always the best possible answer.



Textures & Finishing Techniques

A variety of finishing techniques are employed and when used in conjunction with various aggregates, sand and cement, provide a limitless palette of colours and textures that can be used to achieve a wide variety of design objectives.





Metal shield for sandblasting selected areas of a precast panel.

Finishes

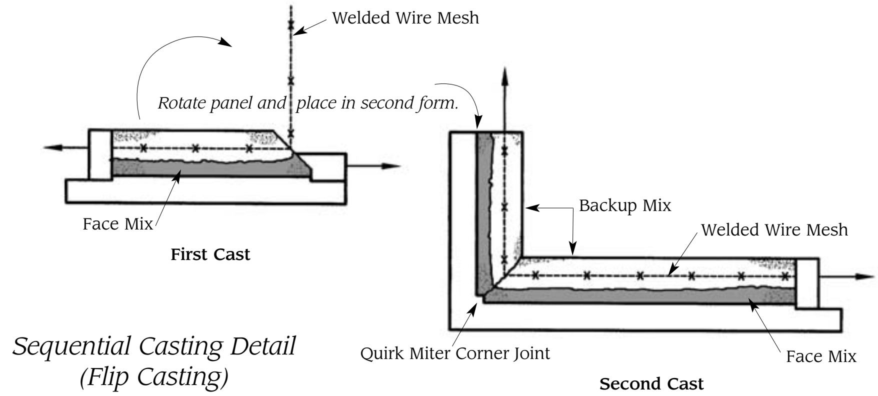
Smooth as Cast
(Post paint)

Smooth, as cast finish is the most economical. Unfortunately, this finish is seldom aesthetically acceptable due to pinholes on return surfaces and because of colour variation. Smooth as cast precast concrete panels have a smooth film of hardened cement paste, and the finished colour is therefore determined primarily by the colour of the cement. As discussed earlier, one can expect variation in grey cement colour and therefore uniform colour is difficult to achieve. If an application of paint or stucco finish is to be provided, then this finish will provide an excellent surface. (A designer should review the cost implications of painting, because in many cases, a colour can be achieved with a precast product, with cement, sand and aggregates at a fraction of the cost of field painting. For colours not available as a precast product, bright reds, blues, pastels, then a post paint application is the most expedient.)

Another variation of a smooth finish, smooth steel trowel finish is achieved on the back surface of a precast (or top when panel is in the mold). This finishing technique is used to provide a smooth finish suitable for field painting on the interior surface of insulated precast panels. Fabricators often make use of a power steel trowel machine to impart a smooth back surface on the precast panel. Once again, expect significant colour variation on the back of panels.

Exposed Aggregate
(Washed finish)

This type of finish is a non-abrasive process, which makes use of a chemical retarder. The application of a chemical retarder to the concrete surface, normally by painting the mold surface prior to the casting of concrete, delays the surface cement paste from hardening for a particular period of time, and to a depth dependent on the type of retarder. The retard depth is typically $1/3$ the depth of the coarse aggregate to ensure the stone is anchored into the panel surface. After the precast panel has hardened sufficiently to permit removal from the mold (usually overnight), the outer layer of cement paste is removed by brushing, by high-pressure washing or by a combination of both. This process should take place immediately after panel has been stripped from the mold.



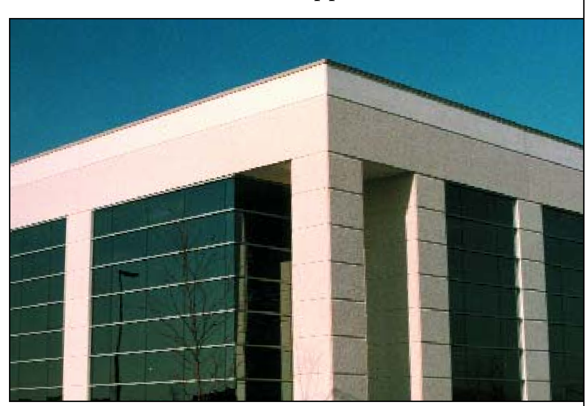
Sequential Casting Detail (Flip Casting)

With the removal of the cement and sand from the concrete surface, the coarse aggregate provides the texture and colour of the precast panel. The appearance of exposed aggregate finishes will vary to some degree with the surface orientation. This is especially critical in panels with returns, where vertical sides are expected to match the bottom cast face. (Hence the preference to miter corners with sequential casting.) On complicated shapes with large returns or radius details, concrete placement may scour the retarder on the sloped surfaces of the mold and compound the problem of matching bottom and returns.

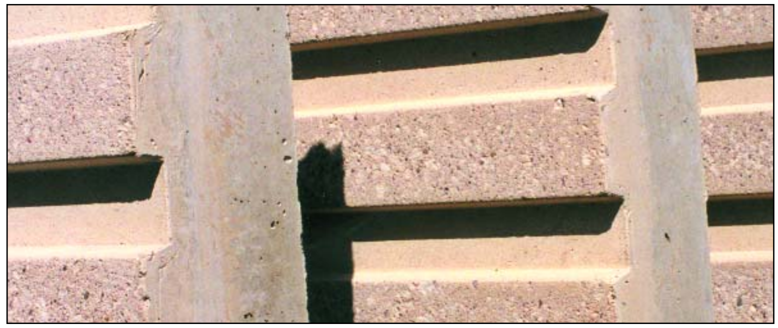
It is advisable to use a matrix colour, which will match or blend with the aggregate colour. This can be done by careful selection of cement, pigments and sand colours. This technique with a good matrix to aggregate colour match will prevent “blotchy” (minor segregation of aggregate) areas from becoming apparent.

Although exposed aggregate panels are primarily made by casting the finished surface face down, chemical retarders are also available for the finishing of face up surfaces. In order to achieve the same quality finish of an exposed panel cast face down, a fabricator will “seed” the surface with additional coarse aggregates following the initial finishing of the surface to ensure a dense coarse aggregate distribution.

The size of aggregate used has a definite effect on the success of an exposed aggregate finish. The use of coarse aggregates less than 9 mm in size requires exacting control over the design mix, plant humidity, temperature, correct retarder selection and application. Because the amount of depth of the retardation is so small, even a very minor variation in depth of retardation will cause “blotchy” areas to become apparent. This same minor variation in exposure would not be apparent on a surface with larger coarse aggregates using a deeper retardation to expose the stone.



Exposed aggregate finishes are the easiest to repair and mold surfaces are not critical as is the case in other finishes.



Sandblast Finish

Sandblasting removes the cement sand matrix by abrasion, a result of the impact of sand on the panel surface.

Varying degrees of sandblasting, light, medium and heavy provide different visual effects to a panel's finish.

A light sandblast can be specified for use on a panel with buff coloured sand and cement for the purpose of obtaining a sand finish simulating natural limestone. As the sandblasting depth increases, more of the coarse aggregates are exposed and the coarse aggregate colour plays a greater role in the panel colour, however the impact of the sandblast sand on the coarse aggregates tends to mute the natural colour of the stone with the stone colour not as pronounced as one would find had the stone been used in an exposed aggregate finish. To ensure colour uniformity, select cement and sand colours that will be similar in colour and blend with the sandblasted "muted" colour of the coarse aggregate.

Sandblasting of a panel initially fabricated with an exposed aggregate finish can be done to achieve a specific colour or depth of exposure, but at an additional cost. Some areas on a panel can be sandblasted, while other areas are left with the original exposed aggregate colour.

The lighter the sandblasting, the more critical the skill of the sandblast operator to achieve a uniform texture on a panel and from panel to panel. It is important to avoid minor variances in concrete strength when sandblasting. Sandblasting all units after an equal curing time after stripping will ensure similar concrete strengths at time of sandblasting. As was the case with exposed aggregate finishes, sculptured panels with returns are prone to air holes on those returns and will likely show up strongly in light sandblast finishes.

Acid Etch Finish

Acid etching is a process, which dissolves the surface cement paste to reveal the sand and a minimal amount of coarse aggregate. Acid etch finishes are commonly used to produce a fine sand texture closely resembling natural stones such as limestone.

Acid etch finishes can be achieved by wetting the surface and then brushing the surface with a stiff bristled fibre brush previously immersed in the acid solution; by spraying an acid and water mixture onto the panel surface; or by immersing the precast unit itself into a tank containing a solution of hydrochloric acid. Subsequent thorough washing of the panel to flush the acid residue from the panel surface must be done to prevent a continued reaction of acid with panel components.

It is important to select appropriate aggregates for this type of finish, aggregates which are acid resistant (siliceous type aggregates) whereas softer aggregates such as limestone and marble will be adversely affected by exposure to acid.

Acid etched surfaces have a clean bright look initially but with weathering this look will diminish.

The use of earth tone colours when acid etching is preferred as they offer the best likelihood of a better colour match from panel to panel. Grey panels acid etched have greater variation in colour due to cement and aggregate colour variations.

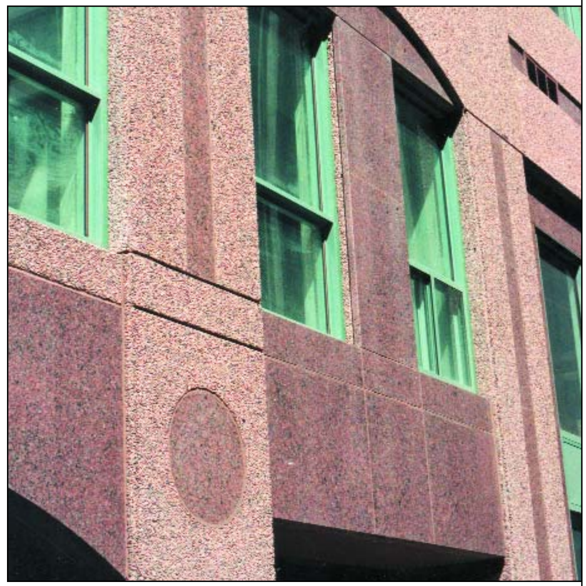
Environmental issues have reduced the popularity of this finishing technique with precast fabricators. Check with your local fabricators for availability.

Bushammered Finish

This type of finish makes use of hand and power tools to mechanically spall or chip and remove a layer of the hardened concrete surface. The resulting finish has its own distinctive character and is unlike exposed or sandblasted textures. Both flat and ribbed panels can be bushammered.

The process for bushammering is labour intensive making this finish the most expensive of all finishing techniques. This finish can be replicated with specifically made form liners.

Stone Veneered Precast Panels



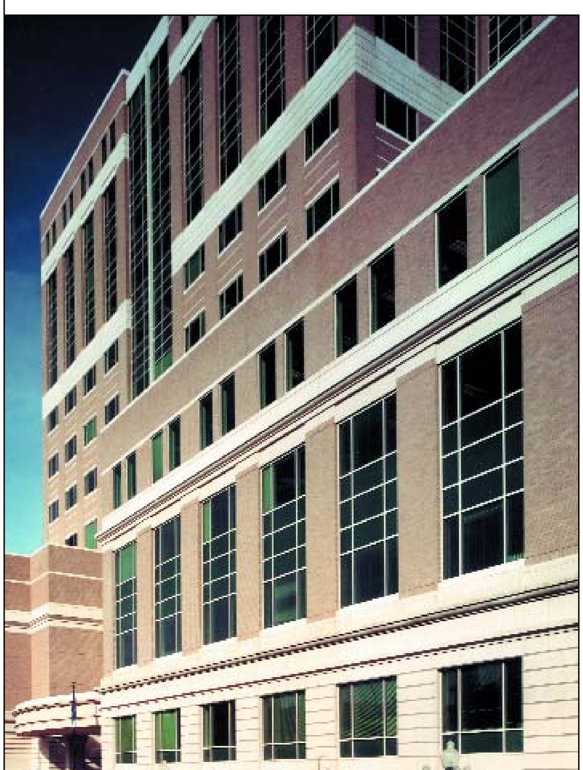
Stone veneer-faced precast concrete panels offer many benefits. These include:

- Veneer stock can be used in thinner sections because anchoring points to precast panel may be placed closer together.

- Multiplane units such as column covers, spandrels with integral soffit and sill sections, deep reveal window frames, inside and outside corners, projections and setbacks, and parapet sections are more economically assembled as veneer units on precast concrete panels.

- Veneered precast concrete panel systems permit faster enclosure, allowing earlier work by other trades and subsequent earlier occupancy, because each large panel incorporates a number of veneer pieces.

- Veneered precast concrete panels can be used to span column-to-column, thereby reducing floor-edge loading and eliminating elaborate temporary scaffolding.



- Smaller stone inserts can be cast as "highlights" in larger precast panels.

General Considerations

The purchaser of the stone should appoint a qualified individual to be responsible for coordination. This person should oversee the manufacturing, delivery and scheduling responsibility and should ensure acceptable colour uniformity. Colour control or blending of the stone veneer should take place at the stone fabricator's plant, where ranges of colour and shade, finishes and markings such as veining, seams and intrusions are viewed most easily. Acceptable stone colour should be judged for an entire building elevation rather than as individual panels. The responsibility for stone coordination should be written into the specifications so its cost can be allowed for in the bid. The owner, architect and precast manufacturer should visit the stone fabricator's plant to view the stone veneer and if required, establish criteria and methods for colour range blending on the project.

Separate subcontracts and advance awards often occur in projects with stone-veneered panels. While these procedures may affect normal submission routines, it is not intended that responsibilities for accuracy should be transferred or reassigned. The precaster is responsible for precast concrete details and dimensions, while the stone-veneer fabricator is responsible for fabrication to set tolerances including drilling of anchor holes in accordance with shop drawings provided by the precaster.

The production of stone veneer panels requires adequate lead-time in order to avoid construction delays. Therefore, it is important that approvals of shop drawings are obtained expeditiously. Furthermore, it is recommended that the designer allow the submission of shop drawings in predetermined stages so manufacturing can begin as soon as possible and ensure there is a steady and timely flow of approved information to allow uninterrupted fabrication and delivery of stone-veneer to the precast fabricator's production facility.

The precast concrete producer must provide the stone quantity and sequence requirements to meet the manufacturing and erection sequences. The precaster and stone fabricator should coordinate packaging requirements to minimize handling and breakage. Extra stone (approximately 2 to 5 percent) should be supplied to allow immediate replacement of damaged stone pieces, particularly if the stone is not supplied from a local source.

Suitability of Stone

The purchaser of the stone should ensure the properties of the stone comply with use in a precast application.

The strength of natural stone depends on several factors: the size, rift and cleavage of crystals, the degree of cohesion, the interlocking geometry of crystals, the nature of natural cementing materials present and the type of crystal. The stone's properties will vary with the locality from which it is quarried. Therefore, it is important that current testing is performed for stone quarried for a specific project.

Sedimentary and metamorphic rocks, such as limestone and marble, will exhibit different strengths when measured parallel and perpendicular to their original bedding planes. Igneous rocks, such as granite, may or may not exhibit relatively uniform strength characteristics on the various planes. In addition, the surface finish, freezing and thawing, and large temperature fluctuations will affect the strength and in turn influence the anchorage system.

Information on the durability of the specified stone should be obtained through current testing in conjunction with observations of existing installations of that particular stone. This information should include such factors as tendency to warp, reaction to weathering forces, resistance to chemical pollutants, resistance to chemical reaction from adjacent materials and reduction in strength from the effects of weathering or wetting and drying.

Stone Sizes

Stone veneers used for precast facing are usually thinner than those used for conventionally set stone, with the maximum size generally determined by the stone strength. Granite veneers are generally 32mm thick and no greater in size than 2.8 sq. meters. Limestone veneer panels are generally 50mm thick and no greater in size then 1.4 sq. meters.

The length and width of veneer materials should be sized to a tolerance of +0 - 3mm, since a plus tolerance can present problems on precast concrete panels. This tolerance becomes important when trying to line up the stone joints on one panel with those on the panel above or below, particularly when there are a large number of pieces of stone on each panel. Tolerance allowance for out-of-square is ±1.5mm difference in length of the two diagonal measurements.

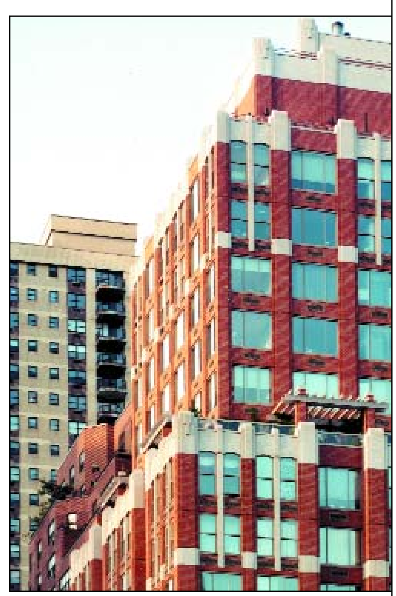
Thickness variations are less important, since concrete will provide a uniform back face except at corner butt joints.

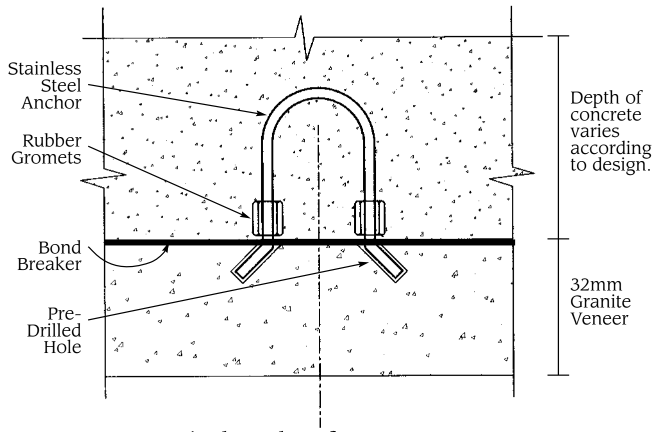
Anchorage of Stone Facing

It is recommended that the precaster detail all precast units to the point where the fabricator of the veneer is able to incorporate details, sizes and anchor holes for the individual stone pieces.

It also is recommended that there be no bonding between stone veneer and concrete backup in order to minimize bowing, cracking and staining of the veneer, and to accommodate the different properties of the stone and the precast concrete backing.

Two methods may be used to prevent a bond between the veneer and concrete to allow for independent movement: 6-mil polyethylene sheets or a closed-cell, 3mm to 6mm polyethylene foam pad. Using the compressible foam bond breaker is preferred because it allows movement of stones with uneven surfaces, either of individual pieces or between stone pieces on a panel.





Typical Anchor for Stone Veneer

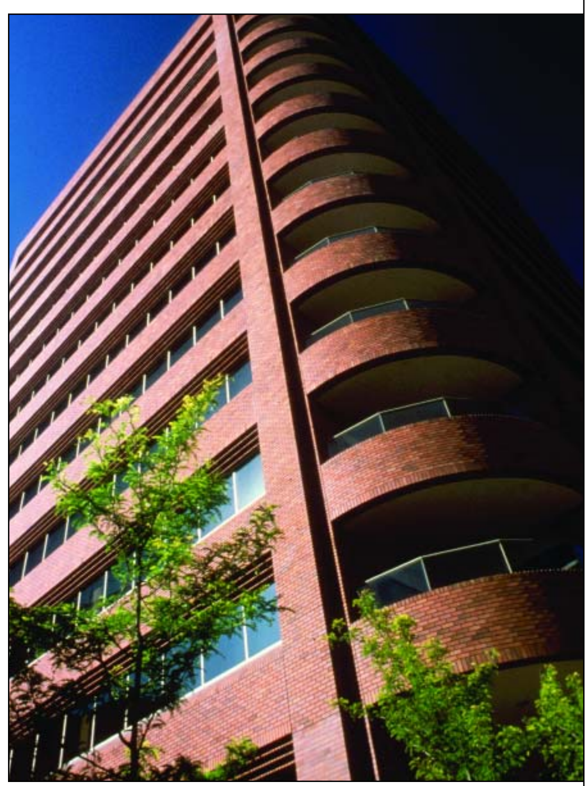
Flexible mechanical anchors should be used to secure the veneer. It is the responsibility of the precast fabricator to supply preformed anchors, 3mm to 16mm in diameter, fabricated from Type 304 stainless steel for the attachment of the stone veneer panels. Four anchors usually are used per stone piece, with a minimum of two recommended. The number of anchors per veneer stone panel is generally one anchor per .18 to .28 square meters. Anchors should be 150mm to 175mm from an edge with not more than 600mm to 750mm between anchors depending on the local building code. A rubber washer is used at the anchor/stone interface to allow minor movement. The anchor hole in the stone is filled with epoxy to keep out water.

Brick Faced Precast Panels

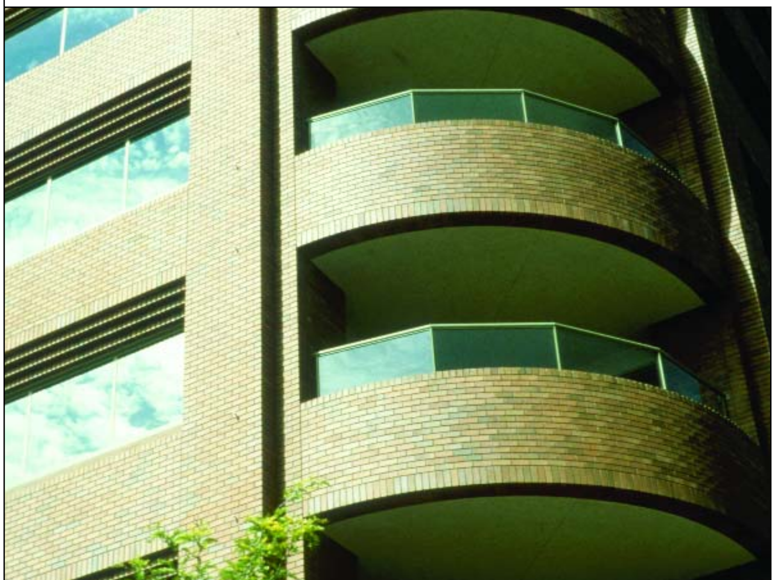
Brick faced precast concrete panels are gaining popularity in more building construction projects where the structural advantages of architectural precast are combined with the aesthetics of clay masonry products.

Brick facings can cover the entire exposed precast panel surface or be used to create accents on any part of the panel. Complex and intricate details such as arches, radii and corbels with various bonding patterns can be incorporated into finished precast panels.

The combination of precast concrete and brick products offers important benefits when compared to conventional masonry construction. Brick faced precast concrete wall panels are self supporting and can be readily attached to the building structure. This eliminates the need for structural steel lintels, metal studs and/or a block back up to support field set brick veneer. Precast panels will provide the exterior air barrier without any additional sealing or membranes. Two stage seals between panels will complete the assembly.



For example, the installation of 150 m^2 of precast wall (10 - 15 m^2 brick faced panels) in one day would contain 10,500 metric modular bricks - the equivalent of thirty brick-setting days if the same area was field set. Brick faced precast panels also eliminate the need for costly on-site scaffolding, winter heat and protection needed for field set masonry.



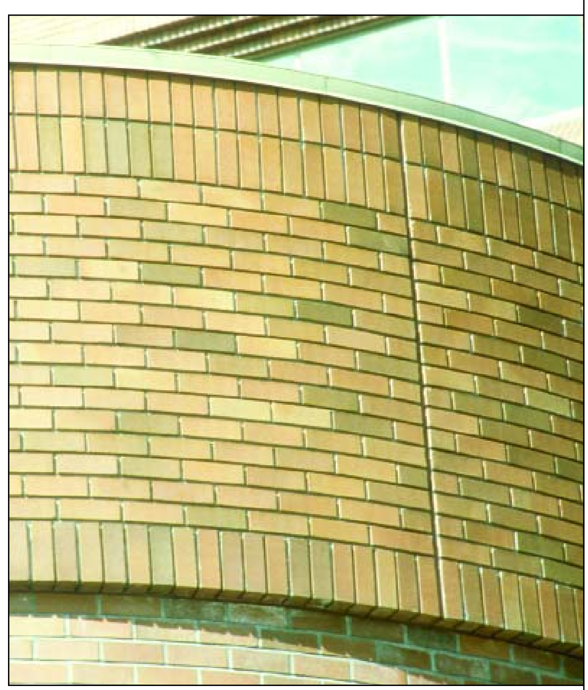
The erection of large brick faced precast panels will have a dramatic effect on the speed of installation of a complete building facade. Brick faced precast panels can be produced under controlled conditions in a precast plant while foundation work progresses. Precast panels can be erected directly from the delivery trucks in any weather. This allows the building structure to be enclosed earlier with finishing trades also able to complete their work much sooner. Faster better quality construction benefits everyone both at the time of construction and throughout the life of the building.

Integration of masonry units (bricks) has been successfully completed on many projects. Techniques for this type of panel construction vary in each industry marketplace.

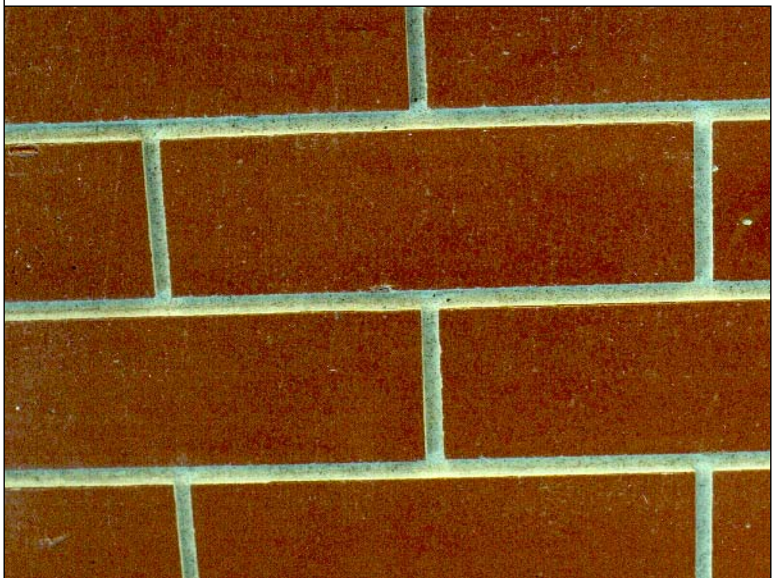
The use of "thin bricks" has become a popular method to face precast panel systems by using 41mm thin brick with the back surface kerfed to ensure bonding with the concrete, however the use of half bricks is the most common method. Full sized bricks set and mechanically held in place with tiebacks is another method used for brick facings.

When bricks are incorporated into a precast concrete panel, the bricks are placed into a mold with a grid mat or spacer strips. Backing concrete is coloured to give the required mortar joint colour.

Many bricks which are used for site laid-up masonry construction are too dimensionally inaccurate for use in a preformed grid used to position the brick for precast concrete panel fabrication. Suitable Type FBX brick dimensional tolerances are required for precast production.



Bricks from different suppliers and different geographic locations will behave differently when used in a brick face precast panel. Aside from selecting a particular brick for it's aesthetic consideration, moisture absorption of the brick must be taken into account as soft brick will absorb more moisture and perhaps create freeze-thaw problems at the brick/precast interface. Consult with your local brick and precast fabricator on brick quality for use in brick faced precast panels.



Form Liners

A variety of attractive patterns, shapes and surface textures can be achieved by using pre-shaped plastic or rubber form liners as the casting surface. The faithful reproduction of the form shape is due to the plasticity of the freshly placed concrete. The precast panel can be left as cast or subsequent finishing by sandblasting or acid etching can further enhance the aesthetics of the selected form liner pattern. A designer can select from liners that will provide fluted textures, stucco, rough sawn board, grooved barn board, fractured stone face, simulated brick, or flagstone.

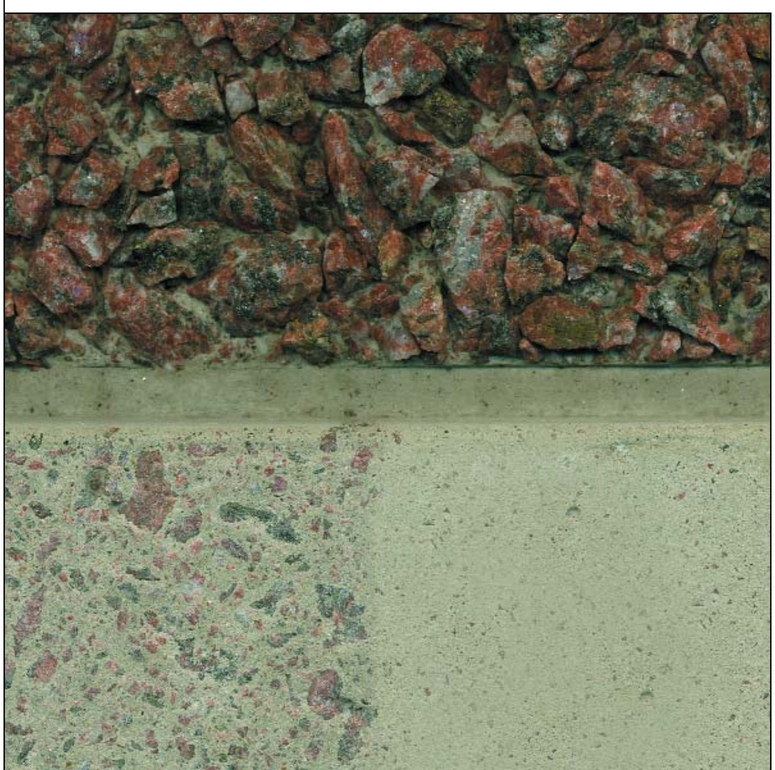
Entire panels or areas within a panel can be formed with a liner. Panel sizes may need to be adjusted to suit the width and height of the liner.

Colour Sample Plates

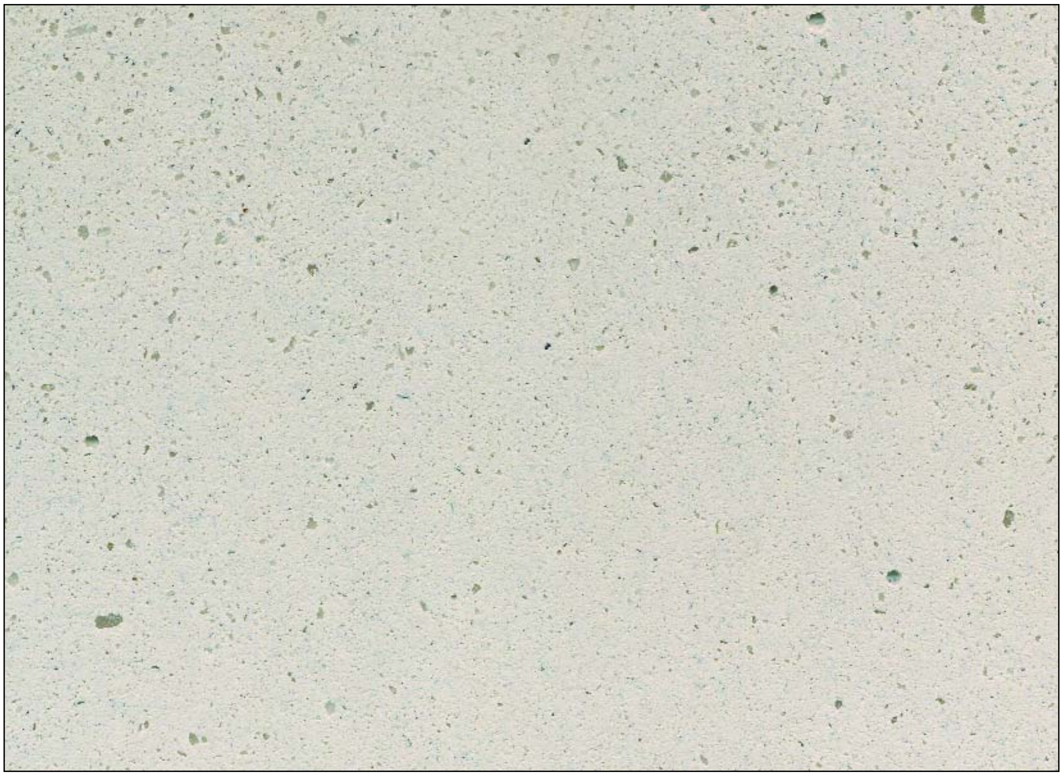
The photographs in this brochure serve as a visual guide for the initial selection of colour and texture for architectural precast concrete. The designer should not expect to select a photographic sample and obtain an exact match by all precast producers due to different material sources or different techniques in various plants. Samples are required to ensure that the desired colours and textures can be satisfactorily matched.

Colour selection should be made under lighting conditions similar to those under which the precast concrete will be used, such as the strong light and shadows of natural daylight. Muted colours usually look best in subdued northern light. Locations with strong sunlight require much harder and brighter colours.

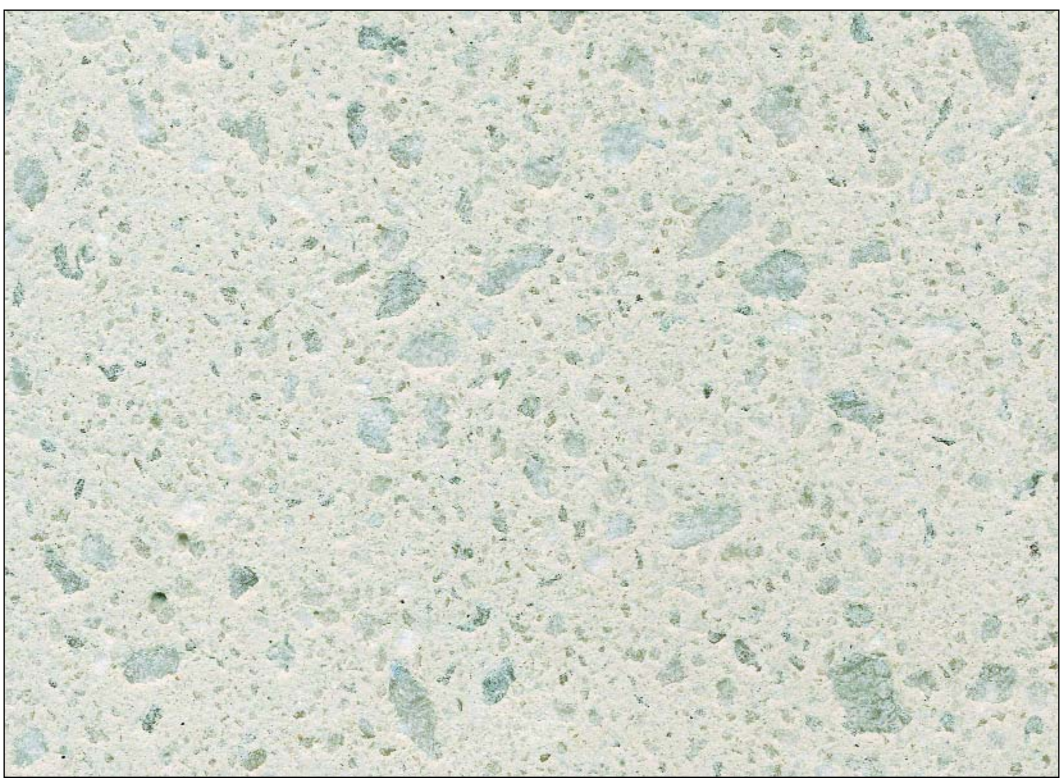
Surface texture also affects colour. A matte finish will result in a different colour panel than a smooth finish. The colour sample to the left is a good example how colour changes with increased texture or progressive amounts of sandblasting. A very light sandblast removes very little of the surface. The result is a primary colour of cement and sand. If white cement is used the colour is very light with colour tones of the sand. With increased sandblasting, more of the fine aggregates are exposed and as these fine aggregates are darker in colour the sample becomes darker. With even deeper sandblasting (or an exposed/washed finish), the coarse aggregates are now being exposed and little of the matrix is visible. The sample now shows the true colours of the fine and coarse aggregates in the concrete mix. Feel free to mix and match, but it is best to stay with the same concrete mix throughout.



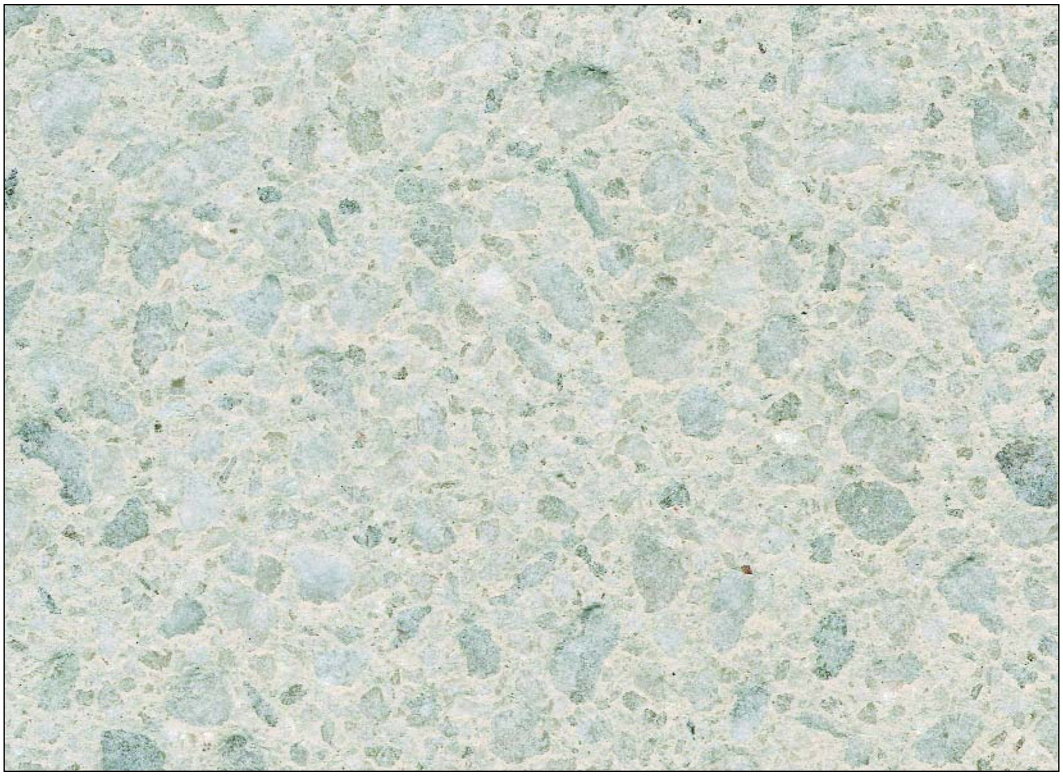
Texture helps to determine the visual importance of a wall and hence the colour. For example, moderately rough finishes usually are less obtrusive than shiny surfaces. The building's appearance is a function of the designer's success in the use of light, shadow, texture and colour.



CPCI 101 *calcite, white sand, white cement, light sandblast*

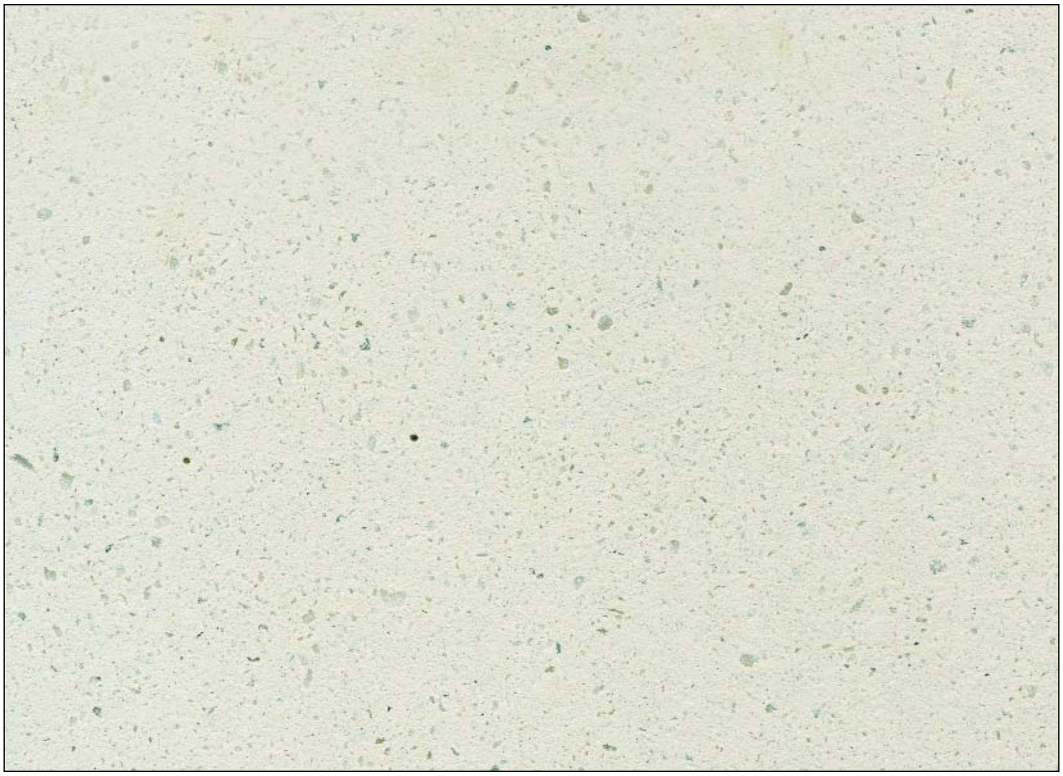


CPCI 102 *calcite, white sand, white cement, medium sandblast*

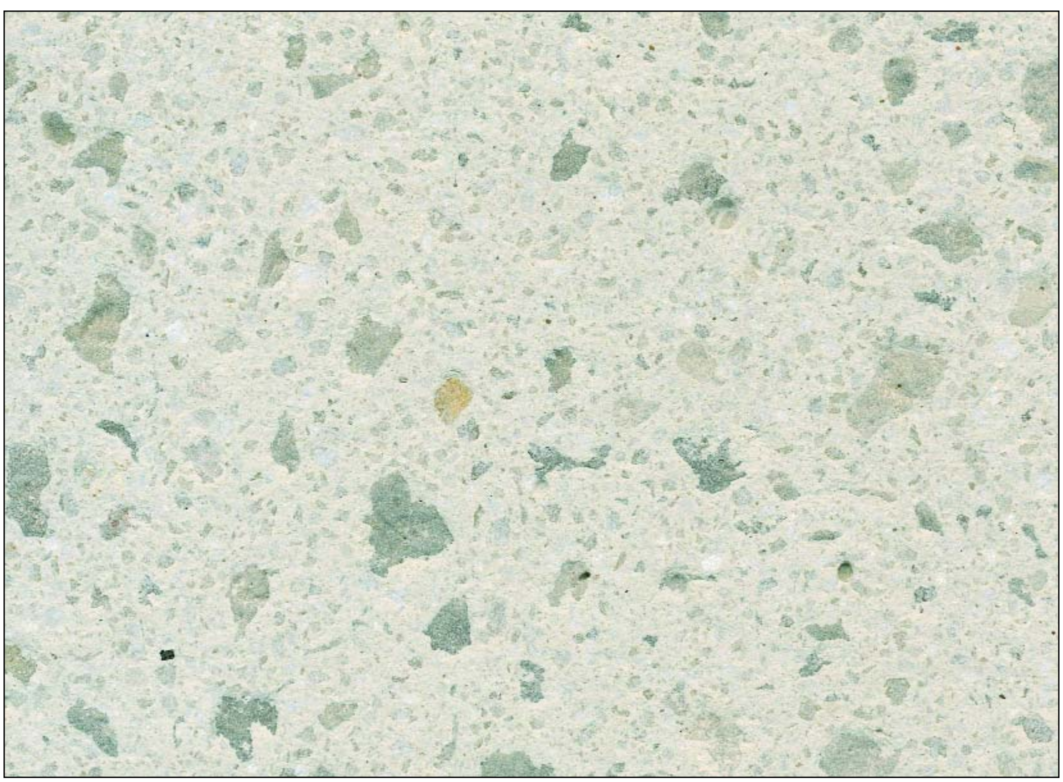


CPCI 103 *calcite, white sand, white cement, heavy sandblast*

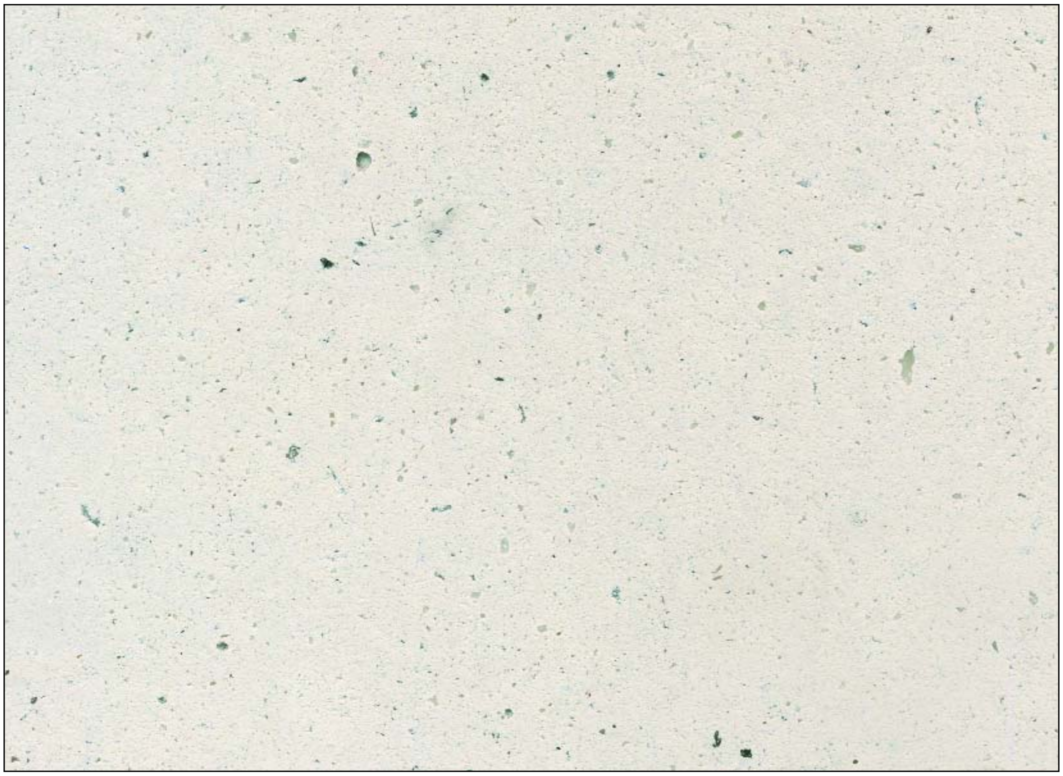
CPCI 104 *calcite, white sand, white cement, exposed aggregate*



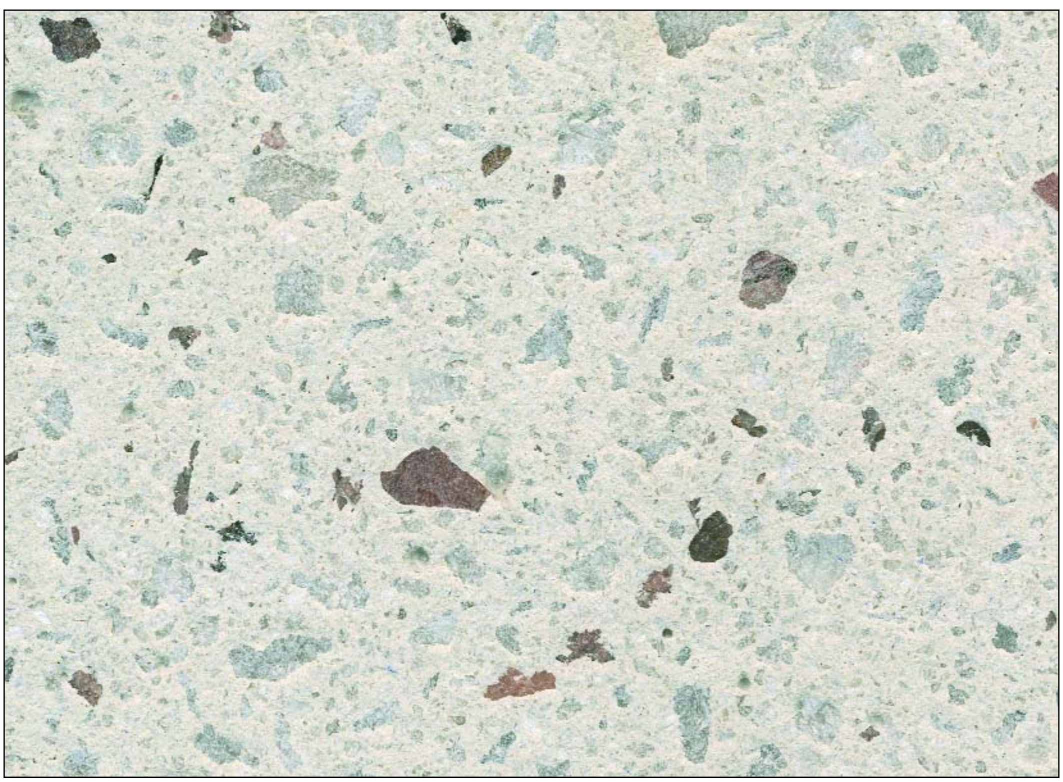
CPCI 105 *limestone, white sand, white cement, light sandblast*



CPCI 106 *limestone, white sand, white cement, medium sandblast*



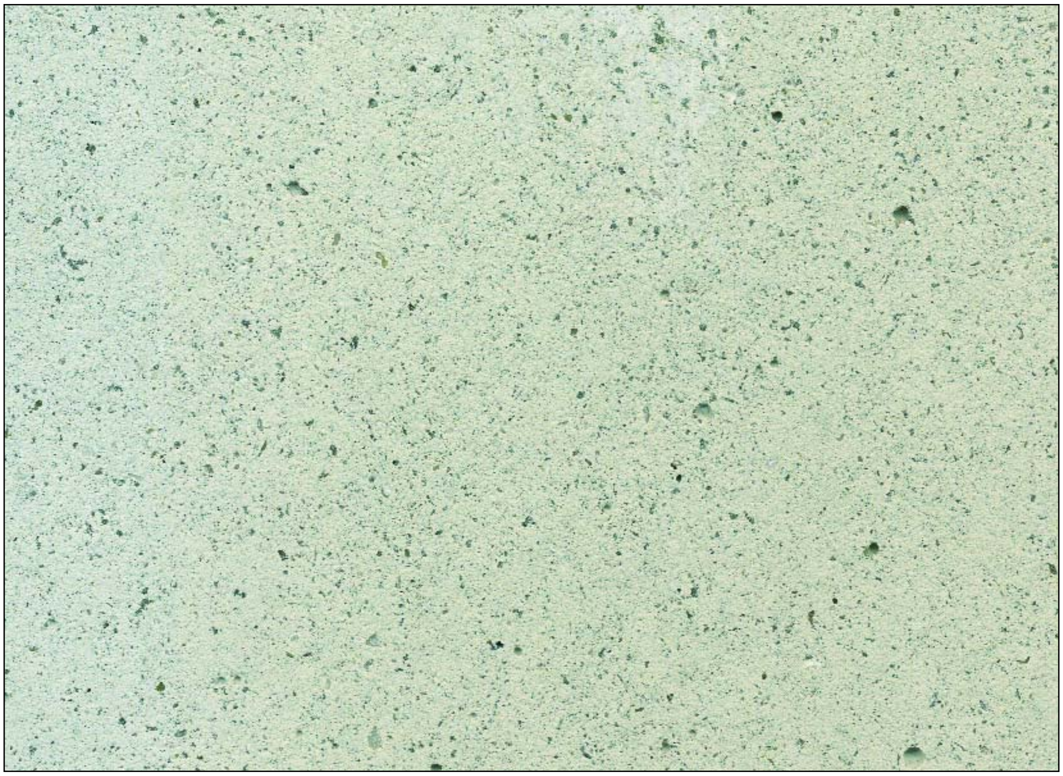
CPCI 107 *75% calcite, 25% northern pink granite, white sand, white cement, light sandblast*



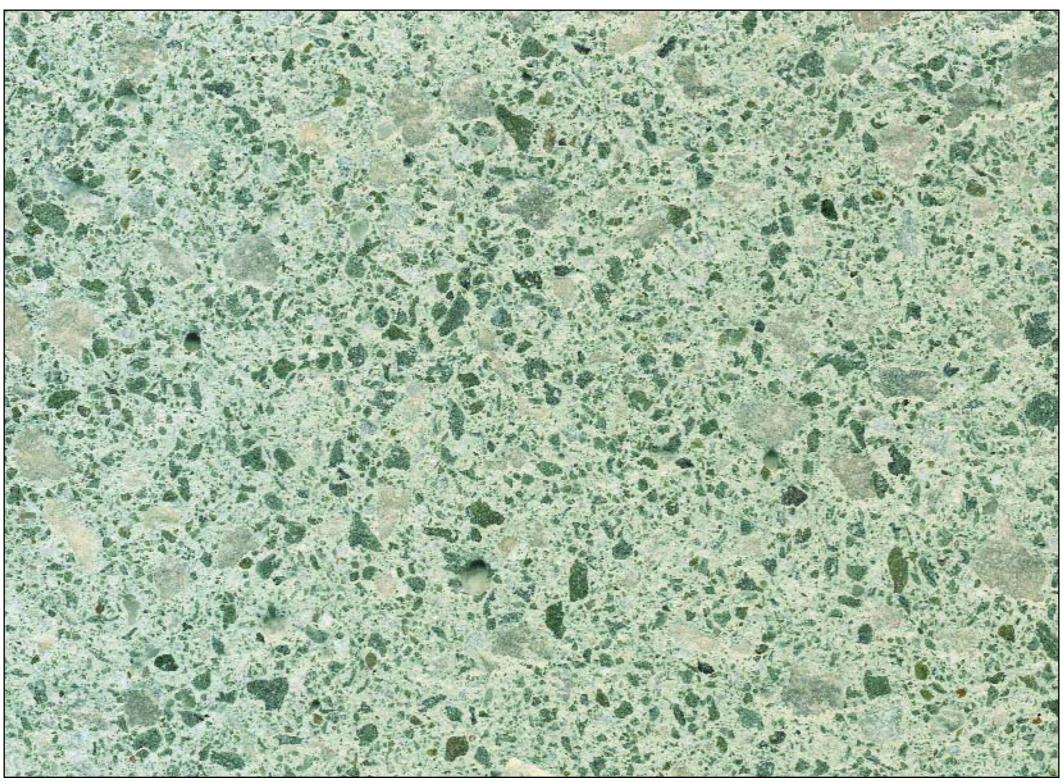
CPCI 108 *75% calcite, 25% northern pink granite, white sand, white cement, medium sandblast*

CPCI 109 *75% calcite, 25% northern pink granite, white sand, white cement, exposed aggregate*

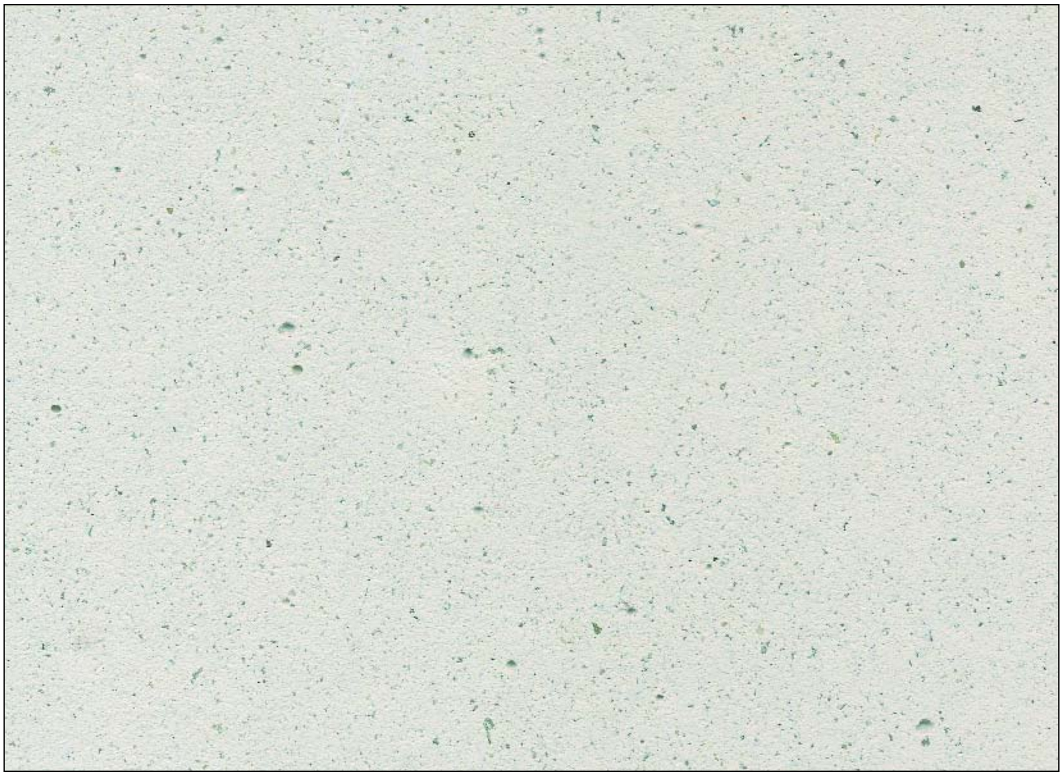
CPCI 110 *calcite, light grey granite, empire red granite, northern pink granite, concrete sand, grey cement, exposed aggregate*



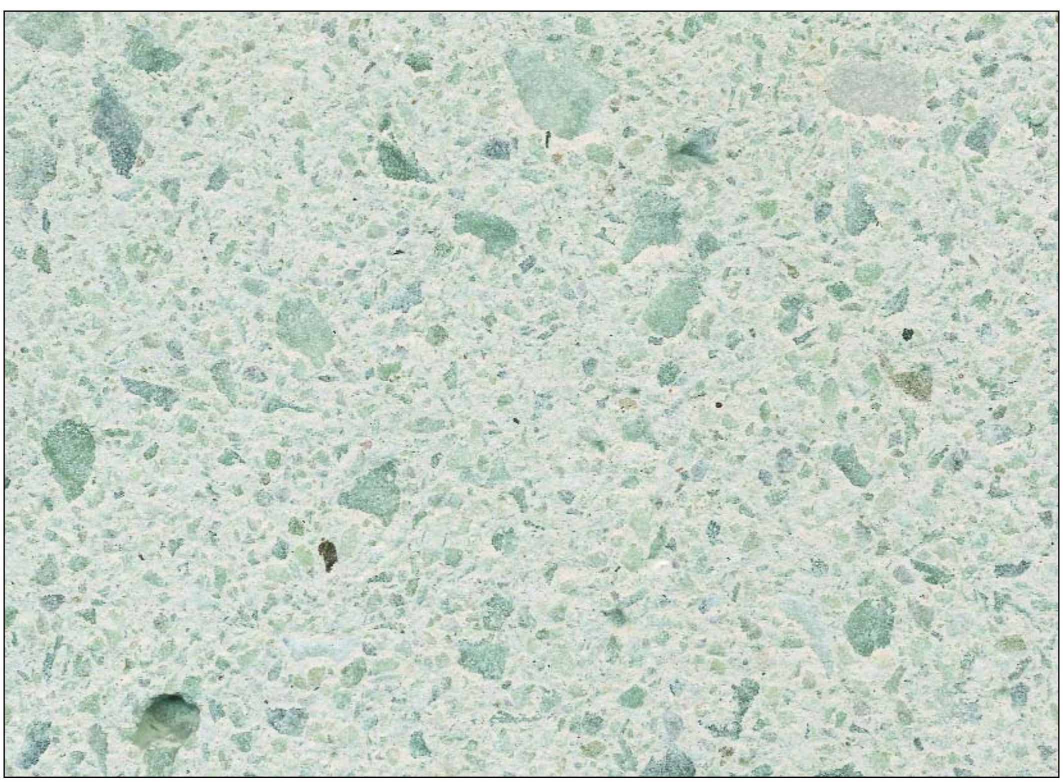
CPCI 111 *limestone, white sand, pine green sand, white cement, light sandblast*



CPCI 112 *limestone, white sand, pine green sand, white cement, medium sandblast*

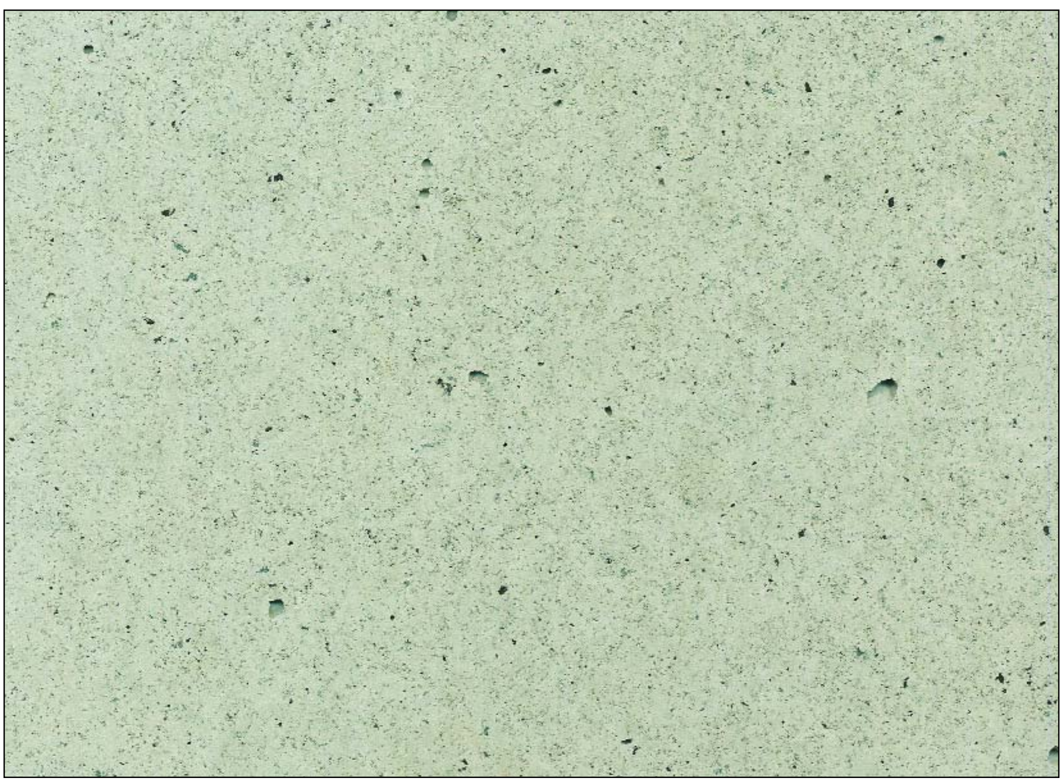


CPCI 113 *royal green marble, royal green marble sand, white cement, light sandblast*

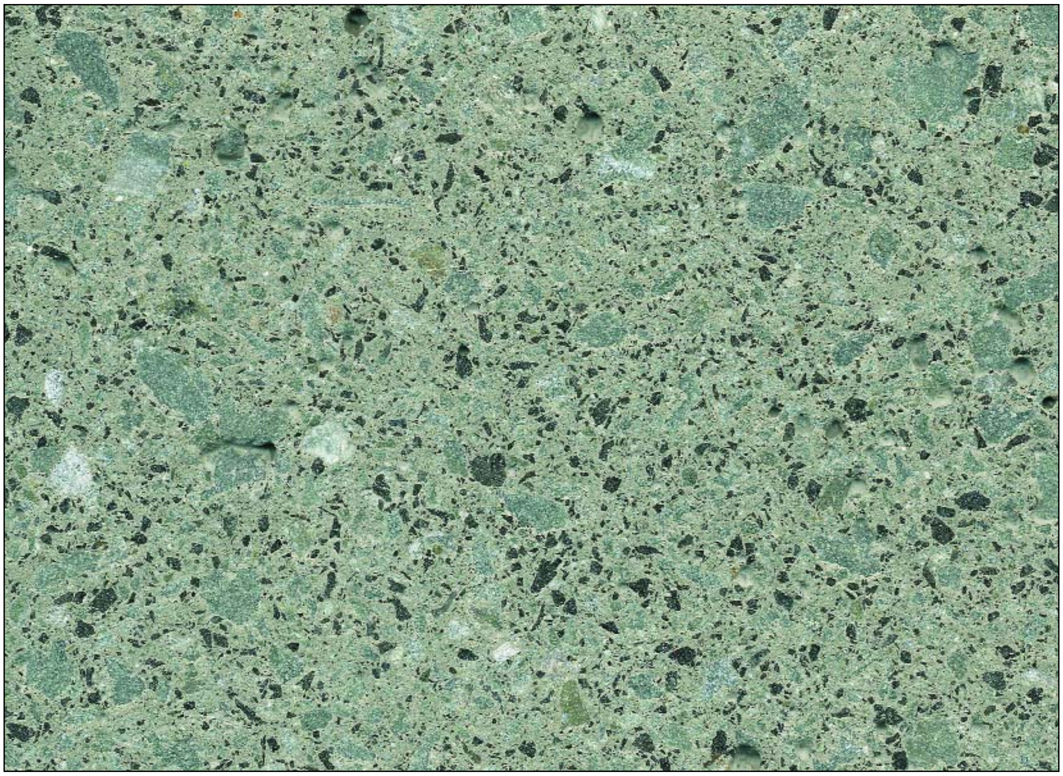


CPCI 114 *royal green marble, royal green marble sand, white cement, medium sandblast*

CPCI 115 *royal green marble, royal green sand, white cement, exposed aggregate*

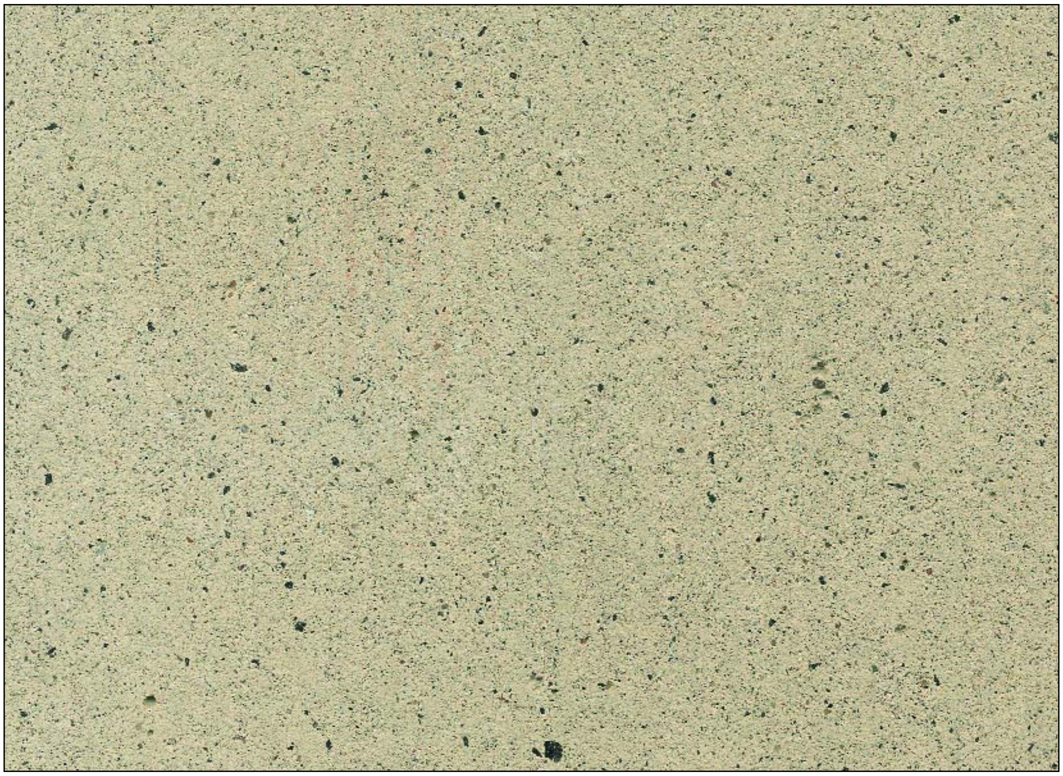


CPCI 116 *pine green granite, pine green sand, < ¼ inch black granite, yellow sand, grey cement, light sandblast*

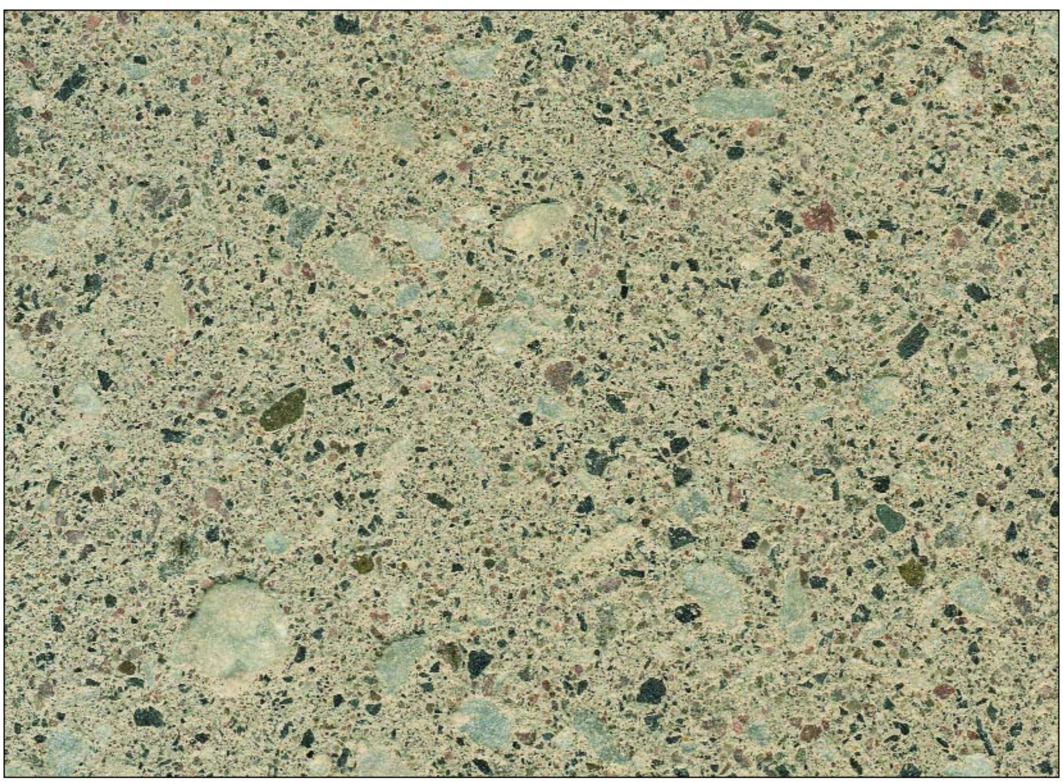


CPCI 117 *pine green granite, pine green sand, < ¼ inch black granite, yellow sand, grey cement, medium sandblast*

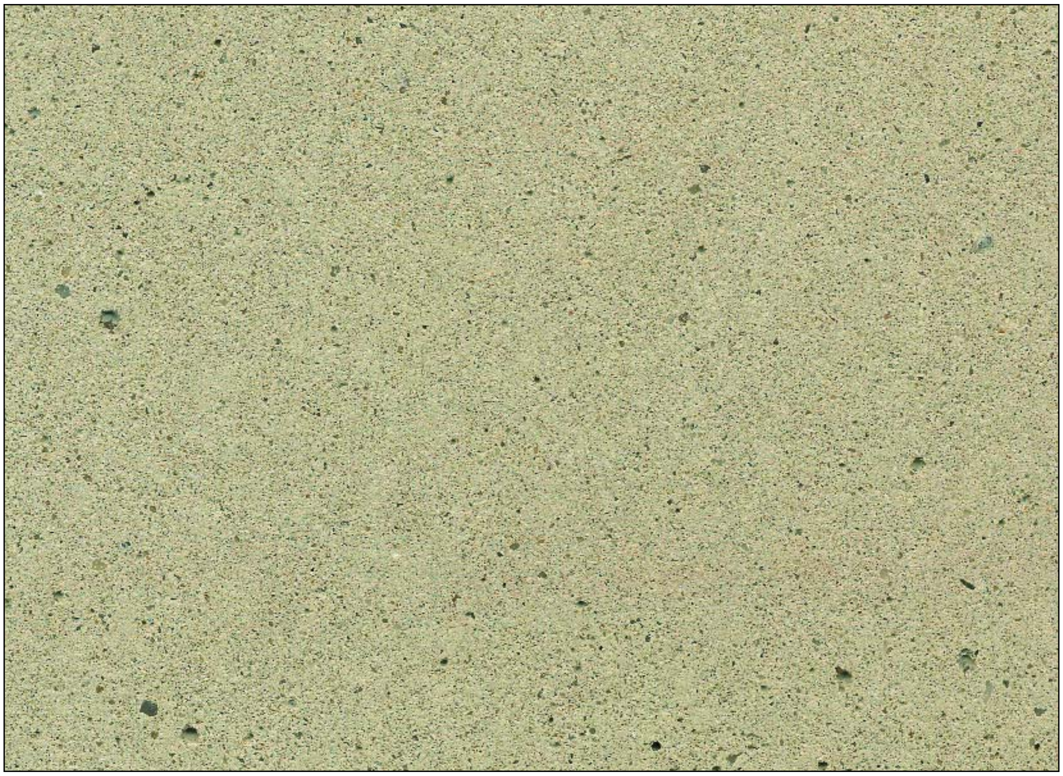
CPCI 118 *pine green granite, pine green sand, < ¼ inch black granite, yellow sand, grey cement, exposed aggregate*



CPCI 119 *buff limestone, Ottawa red coarse sand, < ¼ inch black granite, white cement, light sandblast*

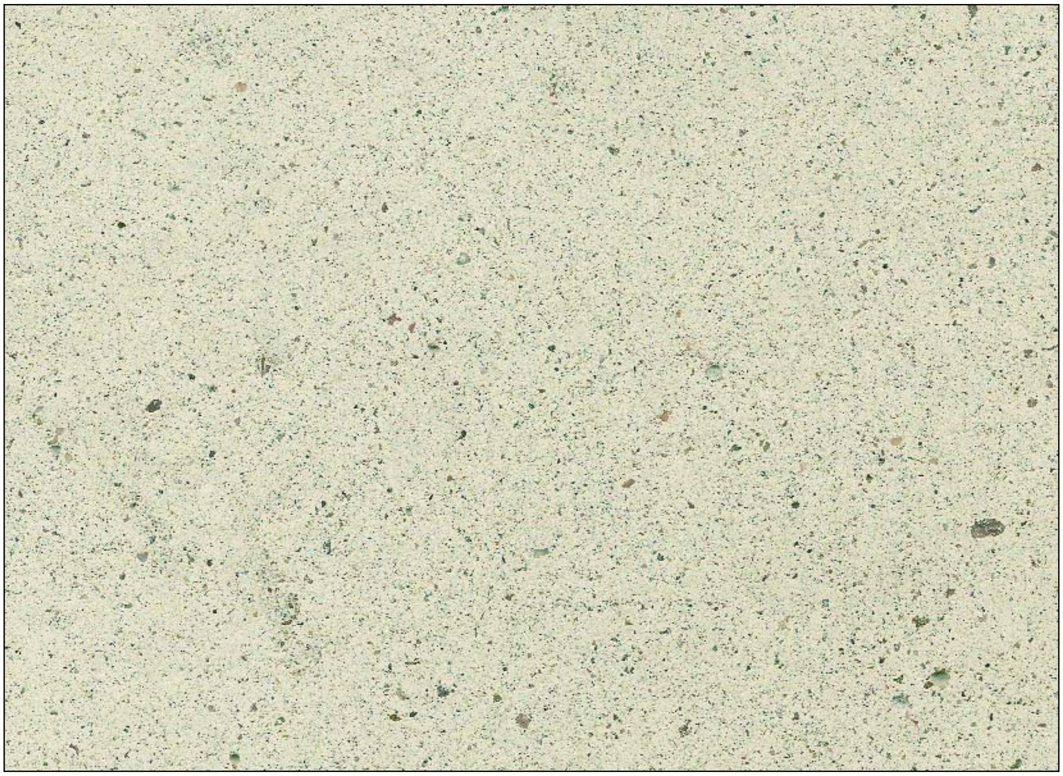


CPCI 120 *buff limestone, Ottawa red coarse sand, < ¼ inch black granite, white cement, medium sandblast*

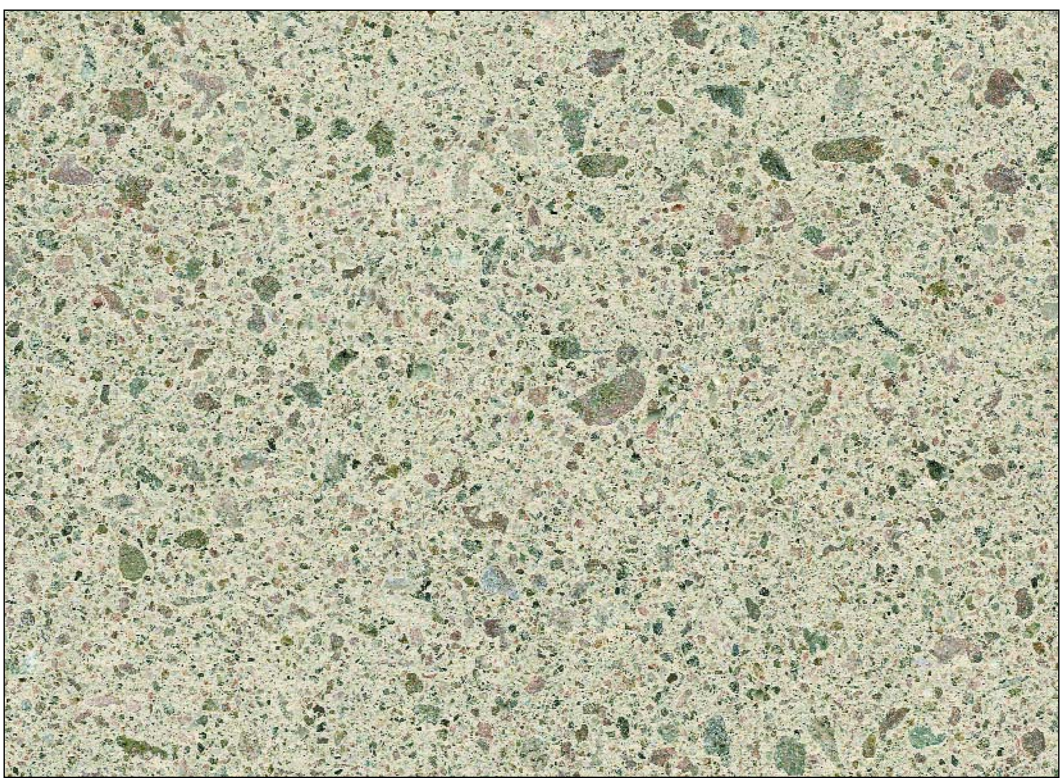


CPCI 121 *Oriskany gravel, 400 Bell sand, 80% white cement, 20% grey cement, light sandblast*

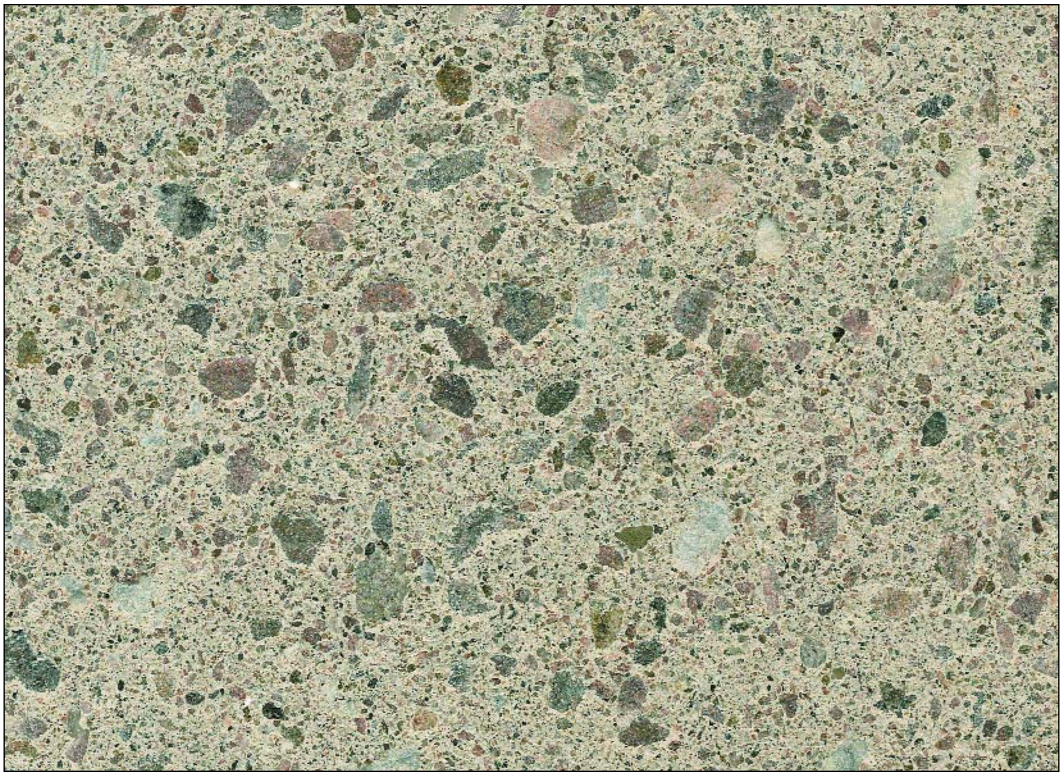
CPCI 122 *Oriskany gravel, 400 Bell sand,80% white cement, 20% grey cement, medium sandblast*



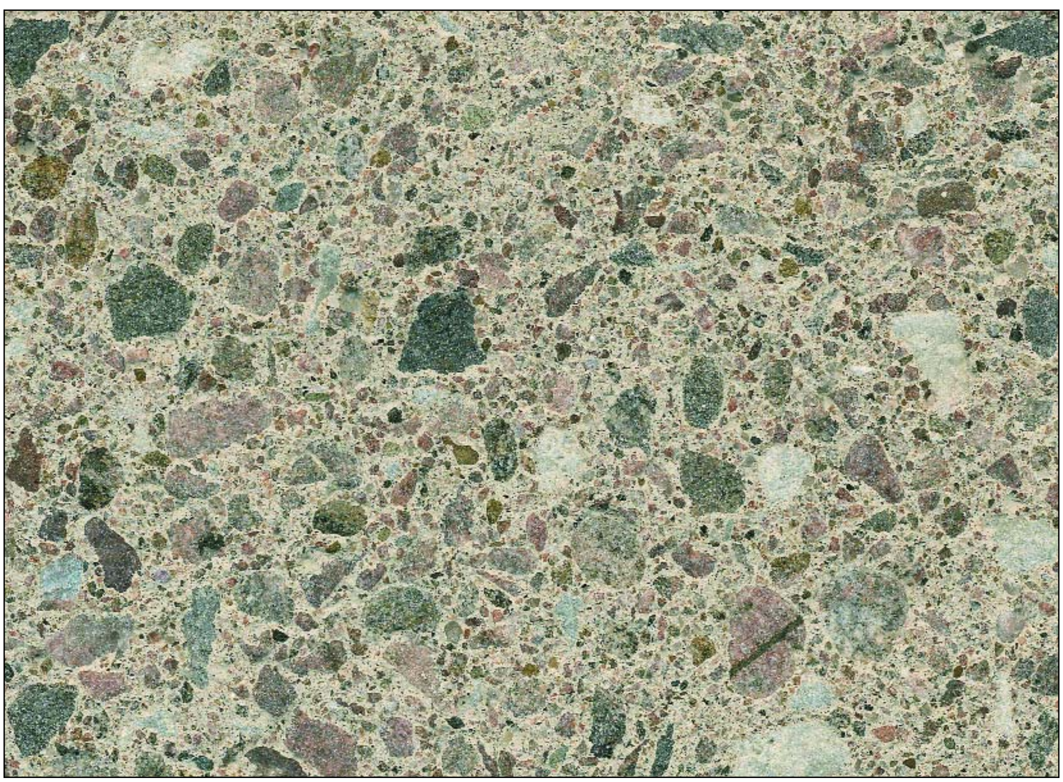
CPCI 123 *Ottawa red granite, Ottawa red coarse sand, white cement, light sandblast*



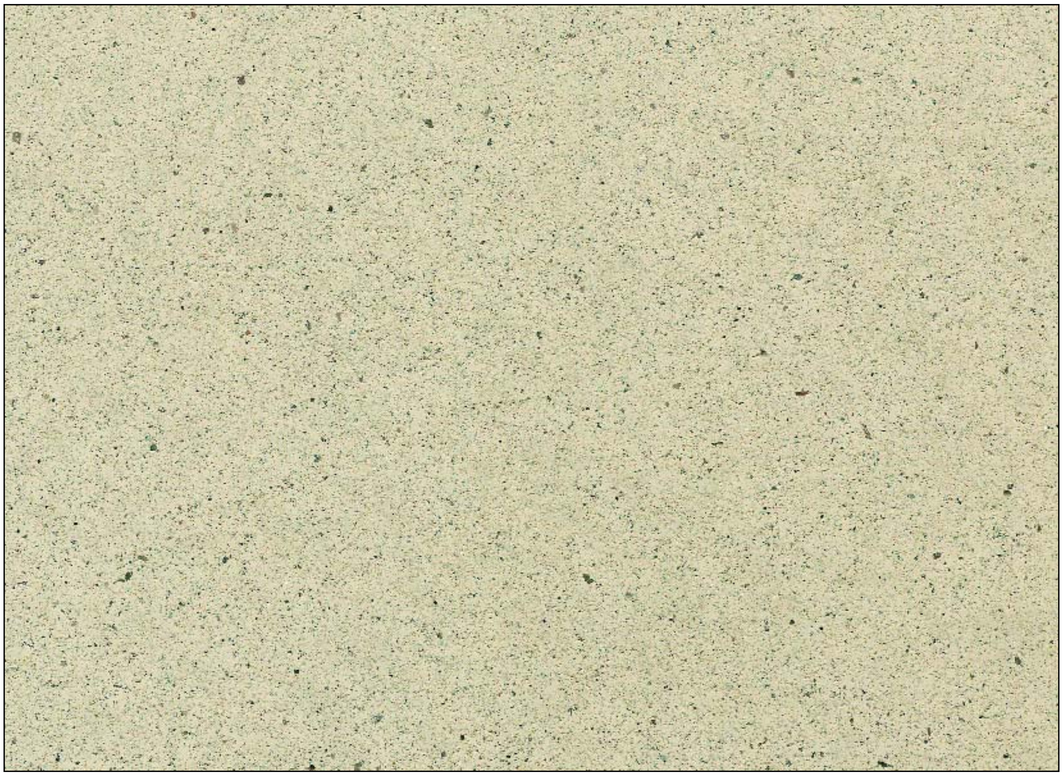
CPCI 124 *Ottawa red granite, Ottawa red coarse sand, white cement, medium sandblast*



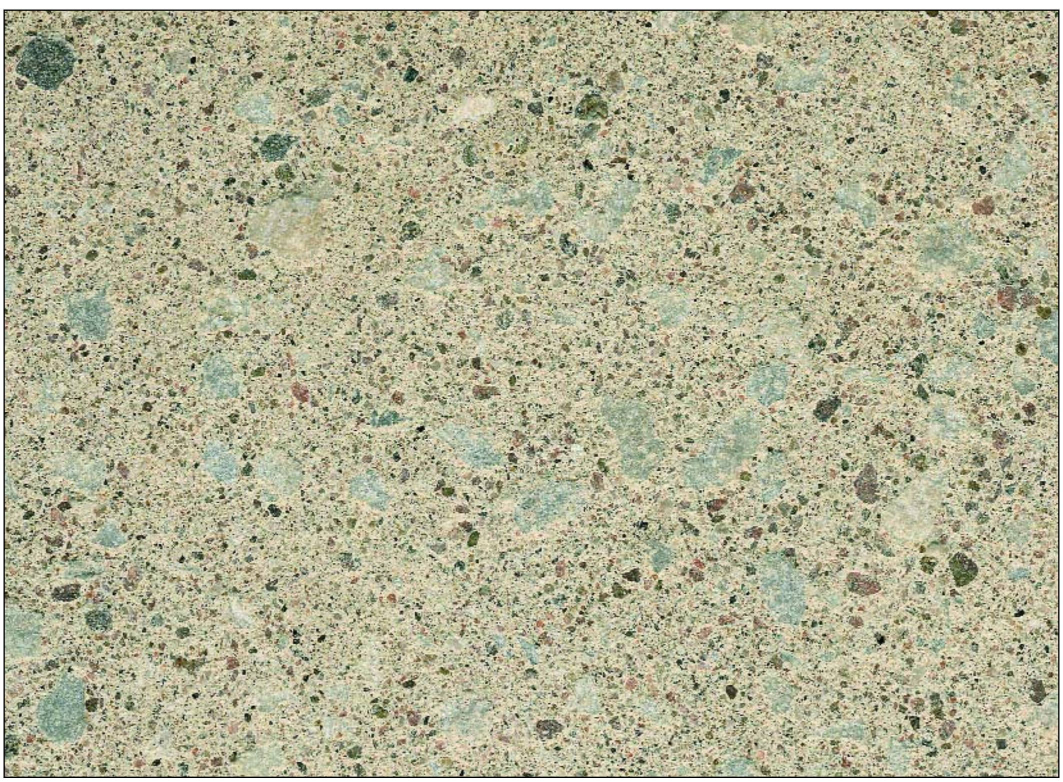
CPCI 125 *buff limestone, Ottawa red granite, Ottawa red coarse sand, white cement, medium sandblast*



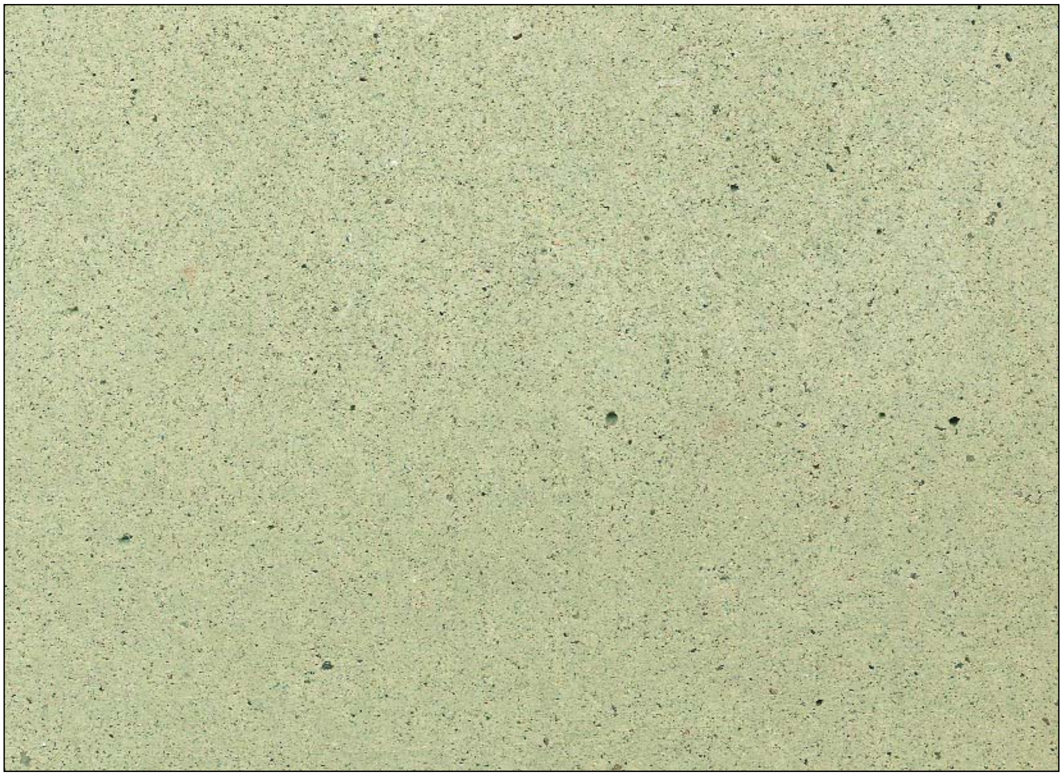
CPCI 126 *buff limestone, Ottawa red granite, Ottawa red coarse sand, white cement, heavy sandblast*



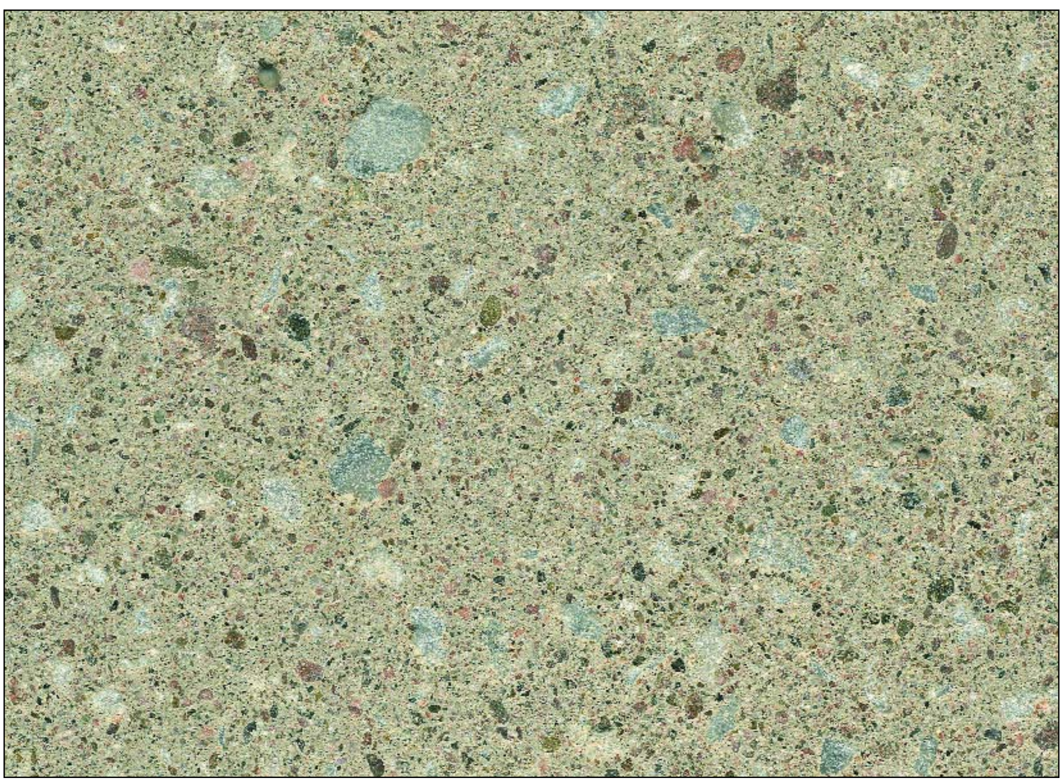
CPCI 127 *Dufferin limestone, Ottawa red coarse sand, white cement, light sandblast*



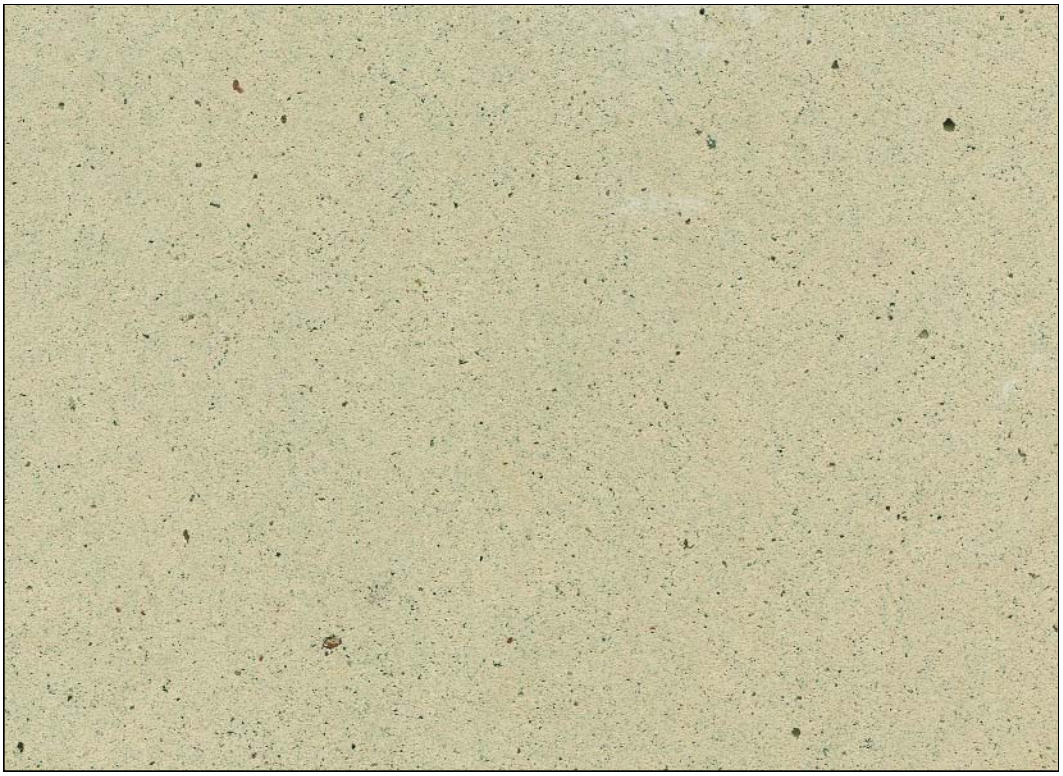
CPCI 128 *Dufferin limestone, Ottawa red coarse sand, white cement, medium sandblast*



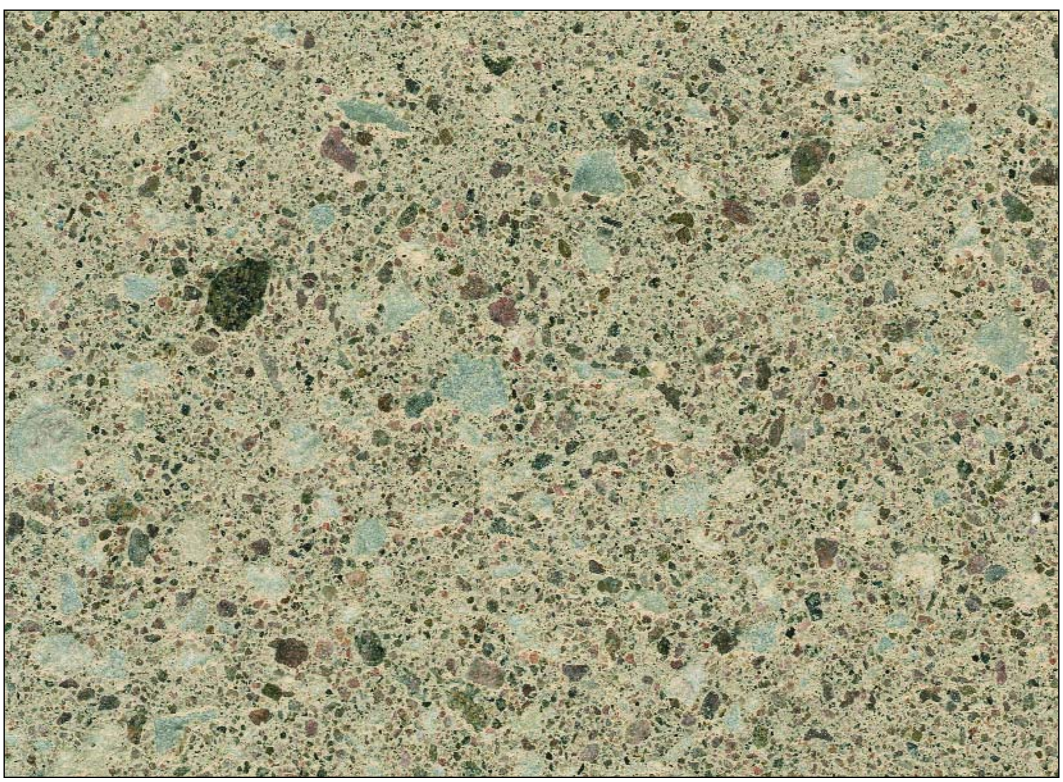
CPCI 129 *Dufferin limestone, Ottawa red coarse sand, 70% white cement, 30% grey cement, light sandblast*



CPCI 130 *Dufferin limestone, Ottawa red coarse sand, 70% white cement, 30% grey cement, medium sandblast*

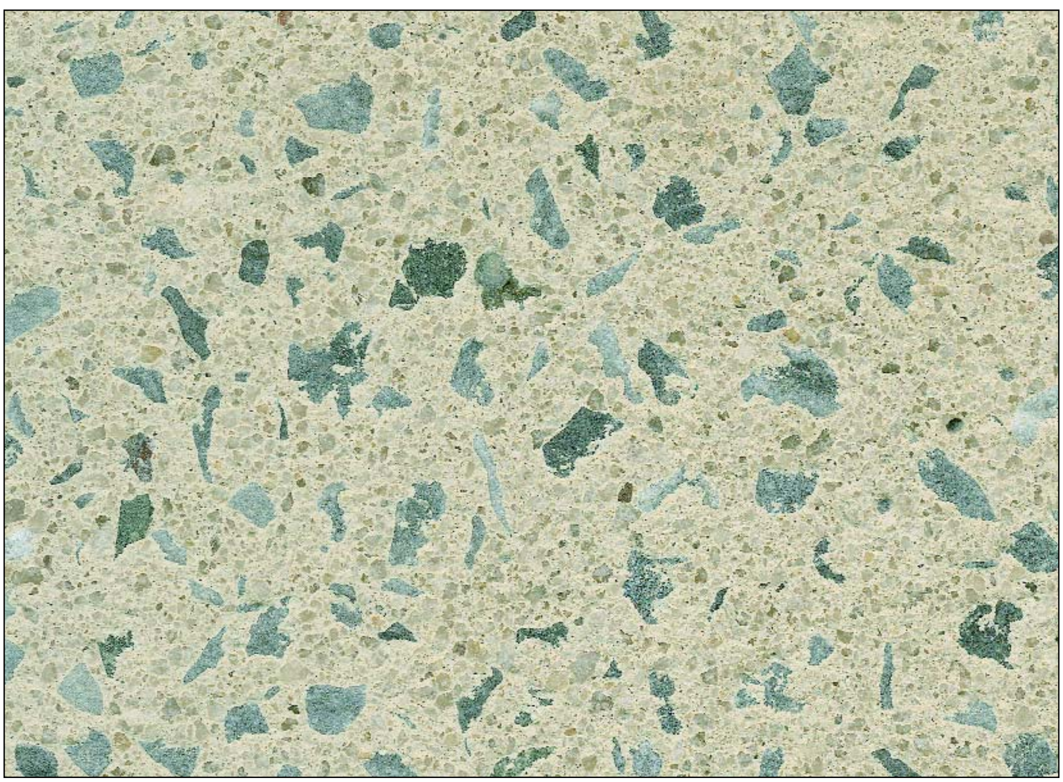


CPCI 131 *buff limestone, Ottawa red coarse sand, white cement, light sandblast*

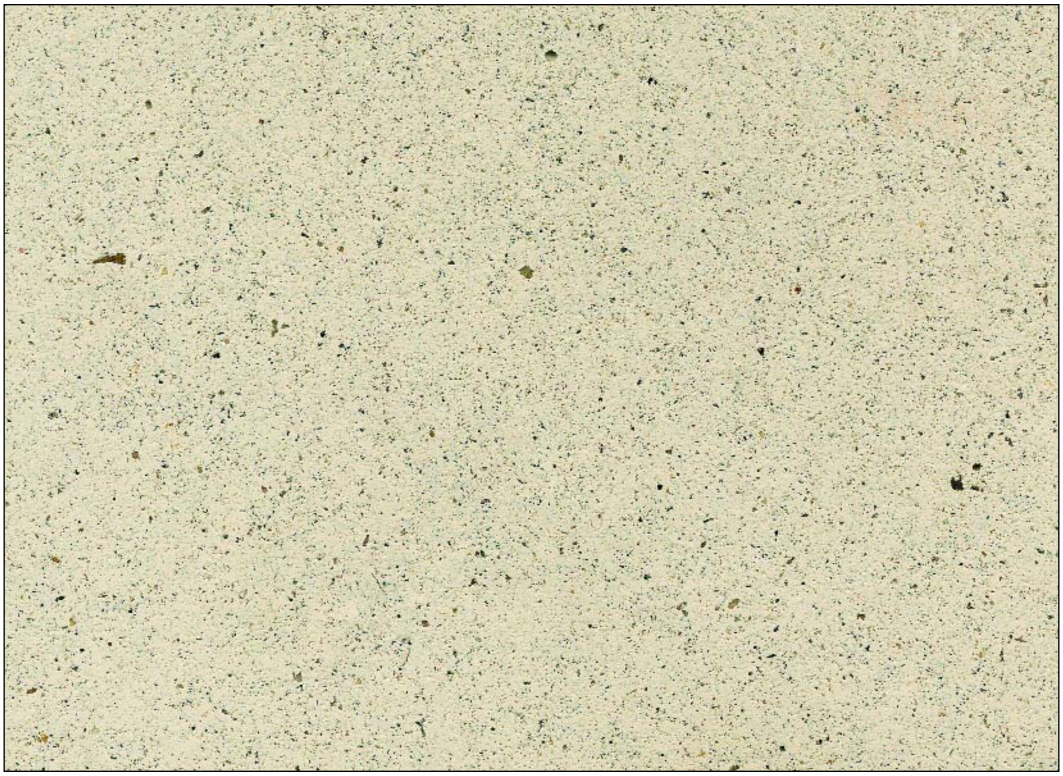


CPCI 132 *buff limestone, Ottawa red coarse sand, white cement, medium sandblast*

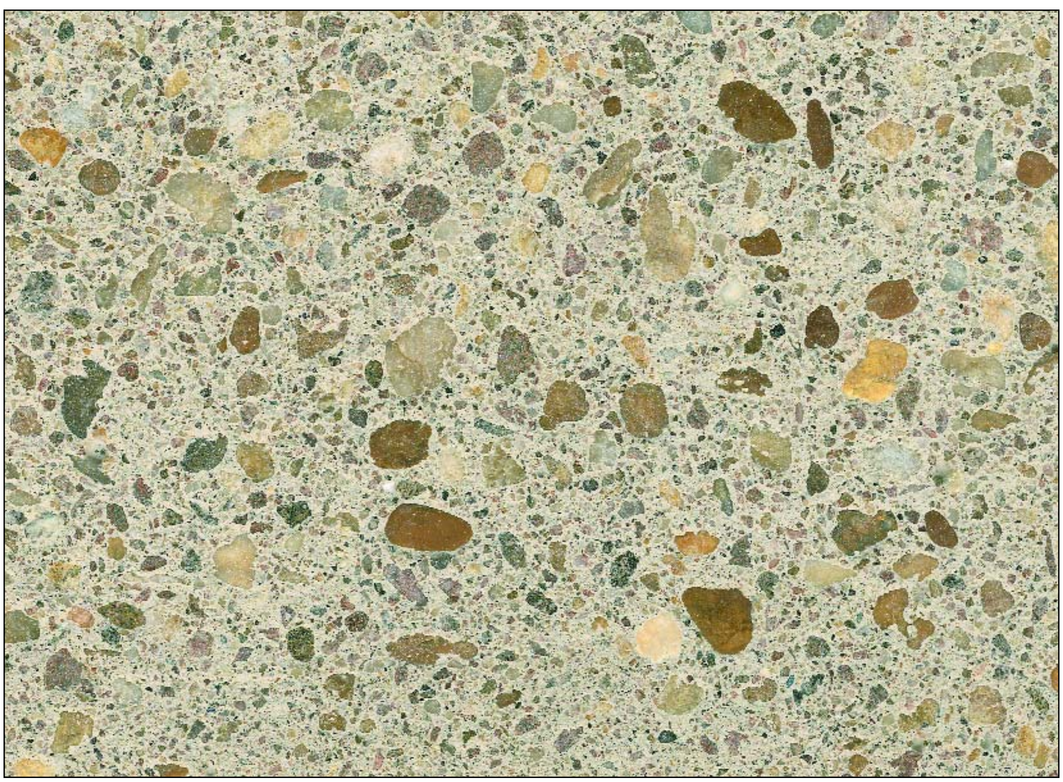
CPCI 133 *grey limestone, white silica sand, white cement, tan pigment, light sandblast*



CPCI 134 *grey limestone, white silica sand, white cement, tan pigment, medium sandblast*



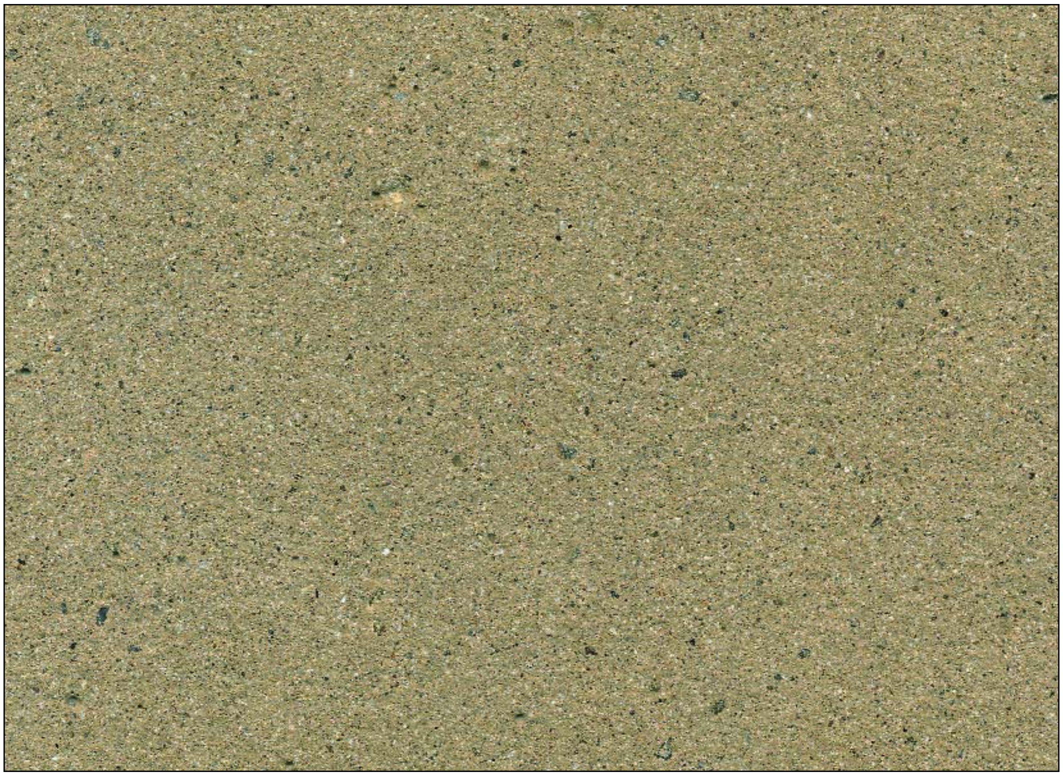
CPCI 135 *Alabama brown river gravel, Ottawa red coarse sand, white cement, light sandblast*



CPCI 136 *Alabama brown river gravel, Ottawa red coarse sand, white cement, medium sandblast*

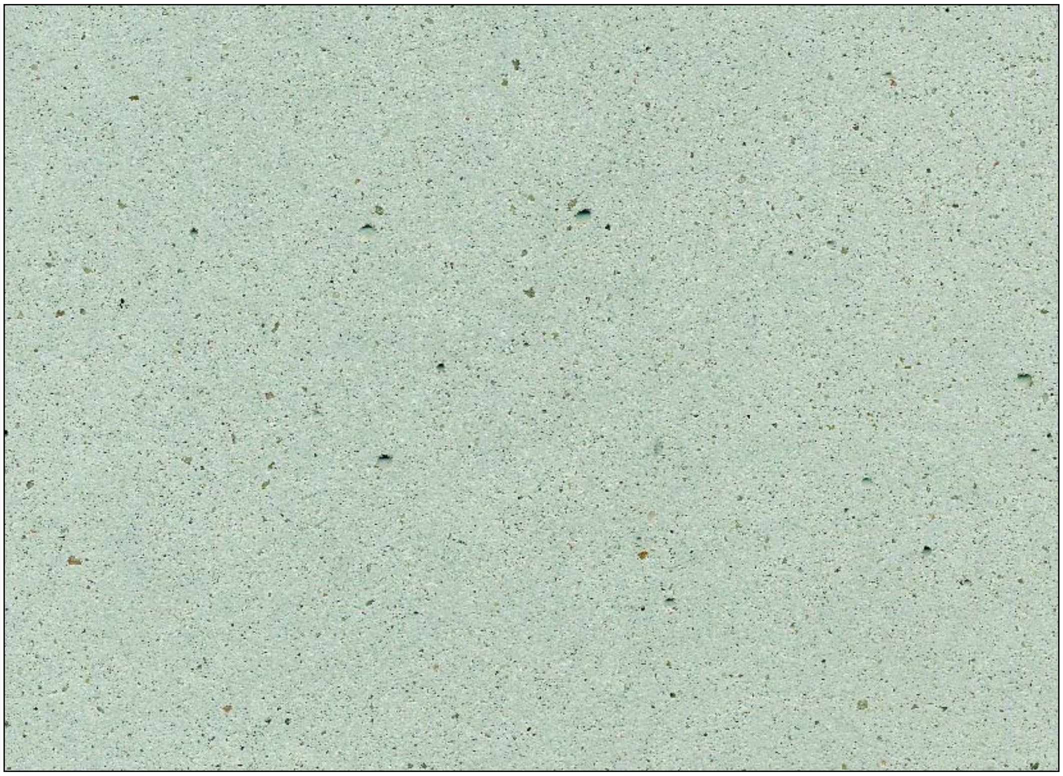
CPCI 137 *Alabama brown river gravel, Ottawa red coarse sand, white cement, heavy sandbast*

CPCI 138 *Oriskany river gravel, 400 Bell sand, white cement, exposed*

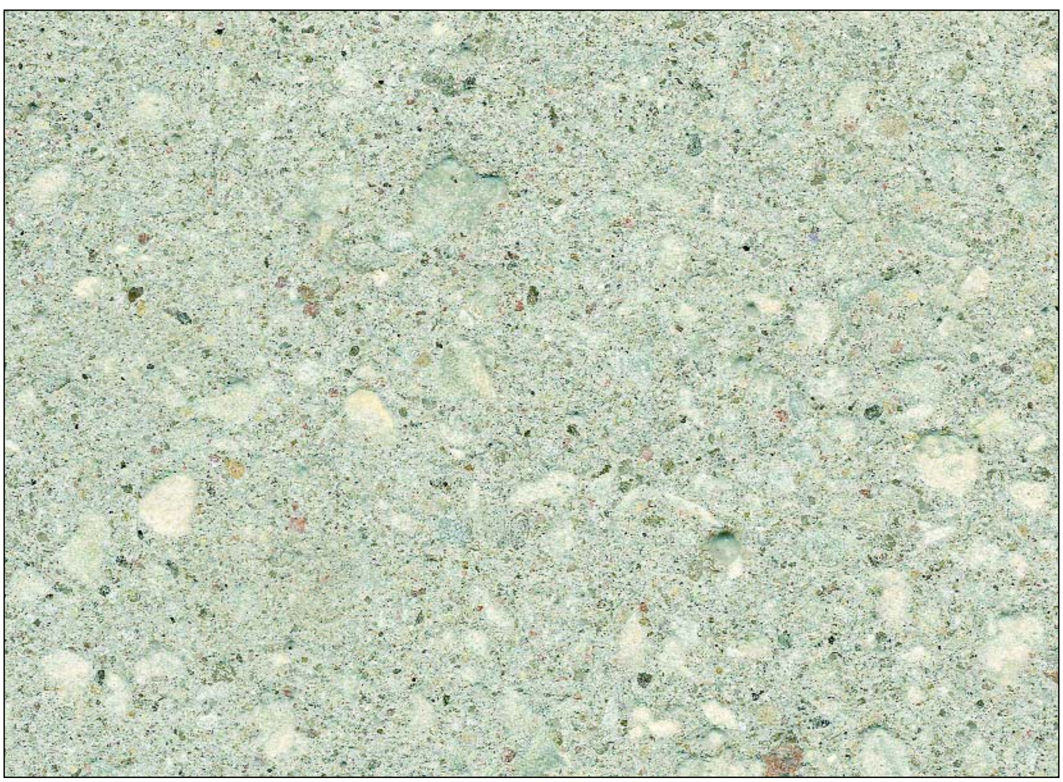


CPCI 139 *3/8- 5/8 inch multicoloured river gravel, natural brown sand, grey cement, dark yellow pigment, light sandblast*

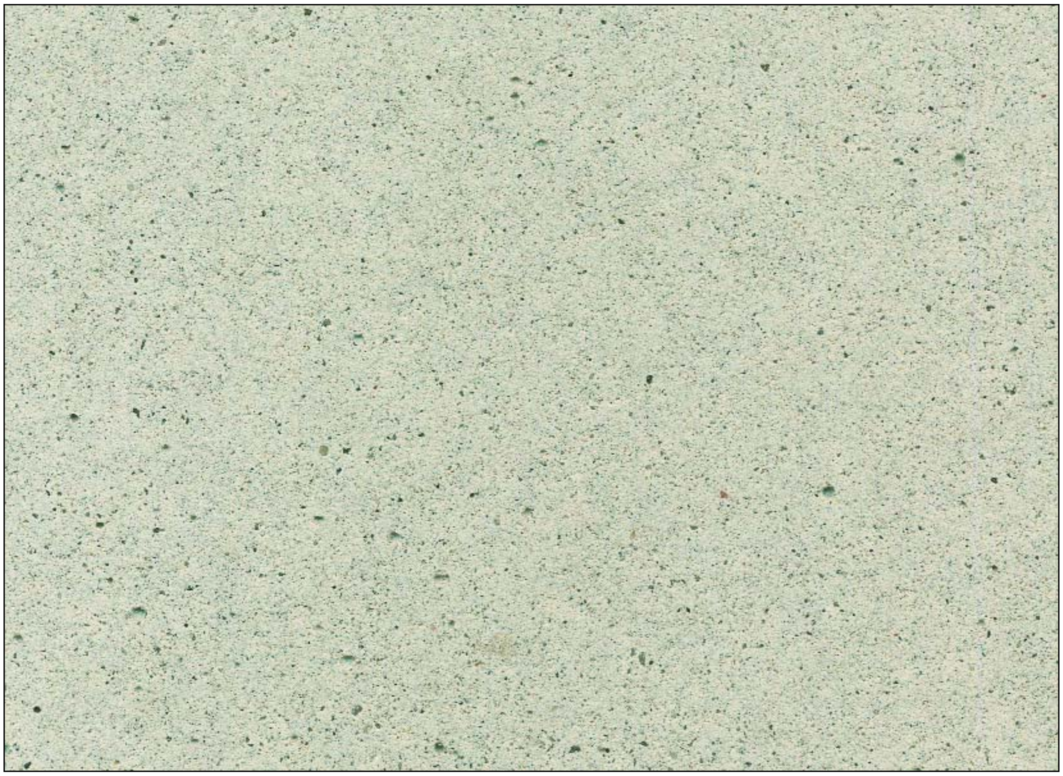
CPCI 140 *3/8- 5/8 inch multicoloured river gravel, natural brown sand, grey cement, dark yellow pigment, medium sandblast*



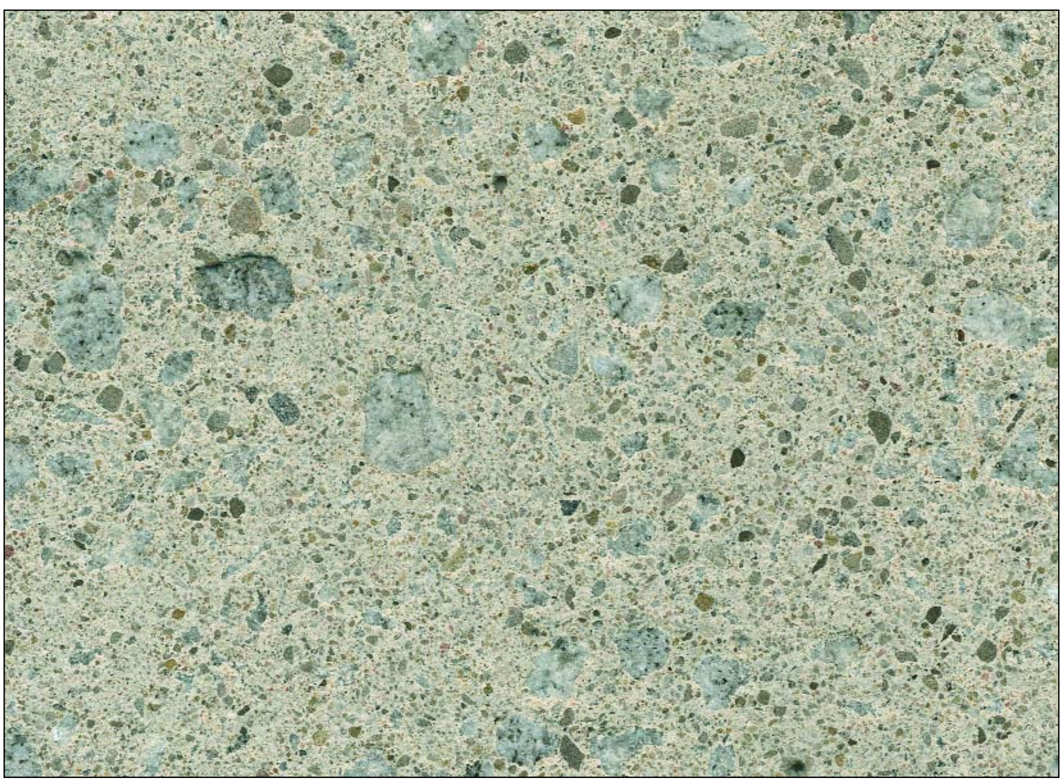
CPCI 141 *limestone, concrete sand, white cement, grey pigment, light sandblast*



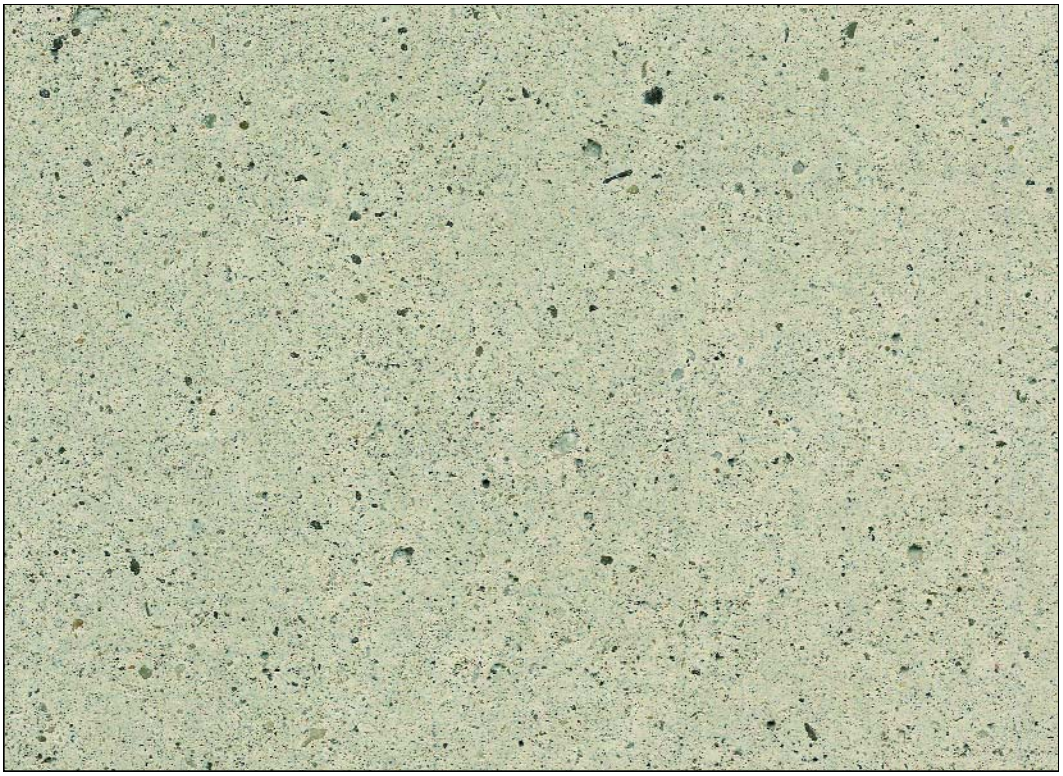
CPCI 142 *limestone, concrete sand, white cement, grey pigment, medium sandblast*



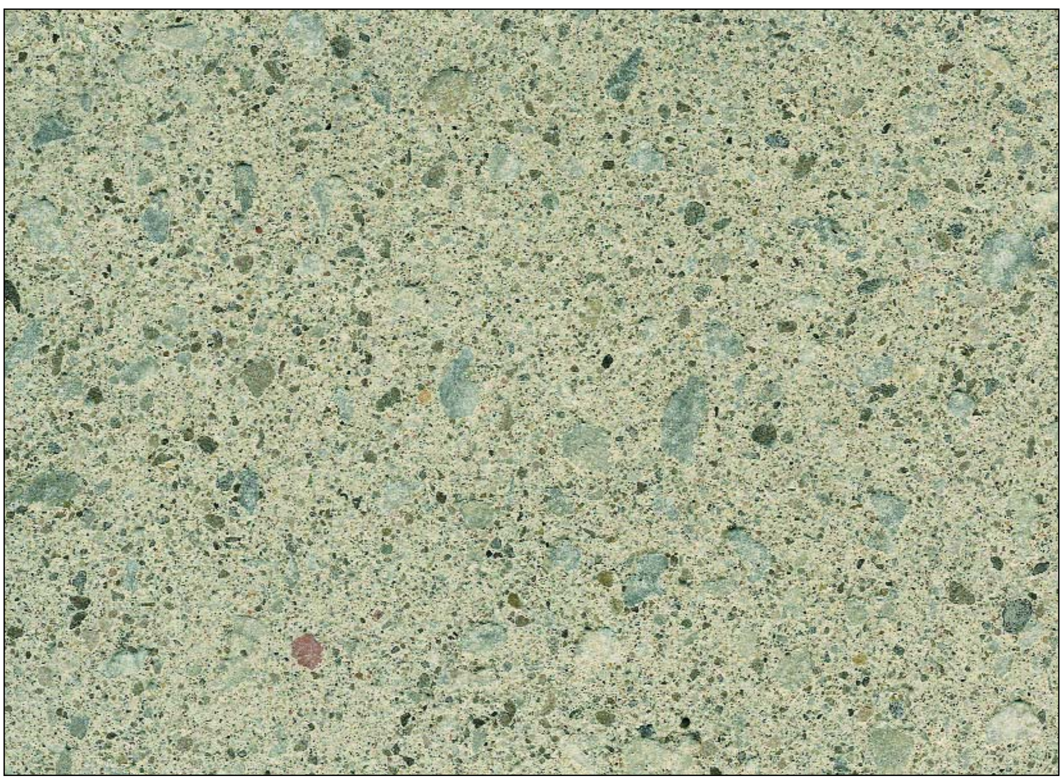
CPCI 143 *light grey granite, Guelph sand, white cement, light sandblast*



CPCI 144 *light grey granite, Guelph sand, white cement, medium sandblast*



CPCI 145 *limestone, Guelph sand, white cement, light sandblast*

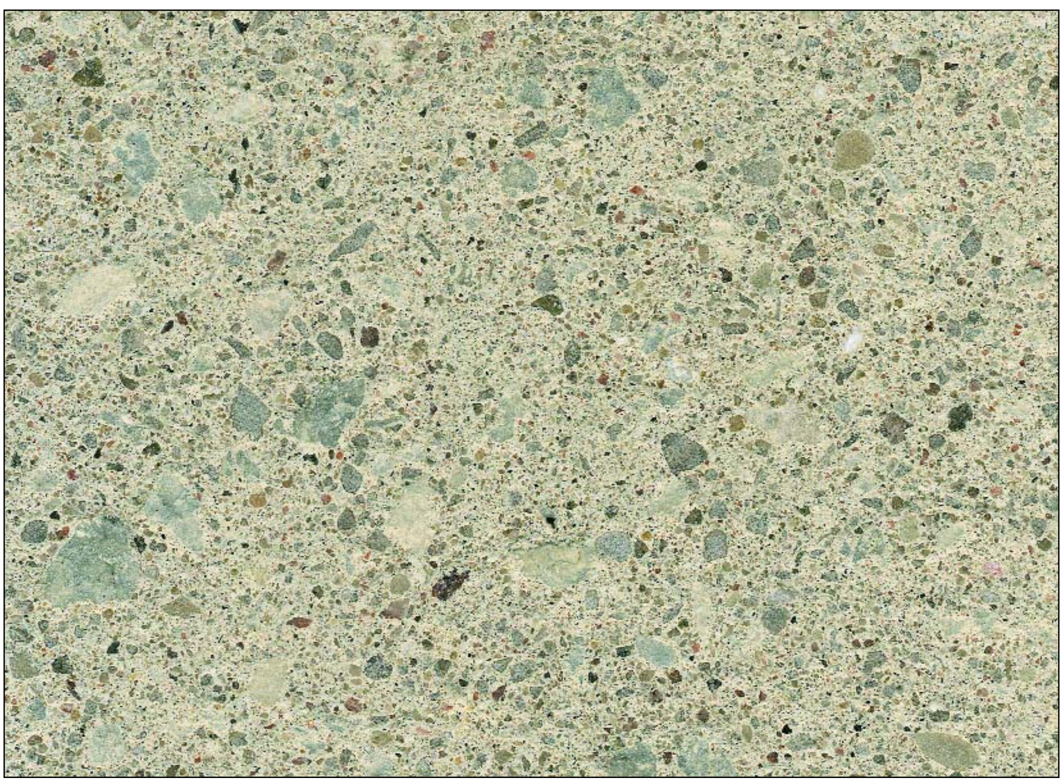


CPCI 146 *limestone, Guelph sand, white cement, medium sandblast*

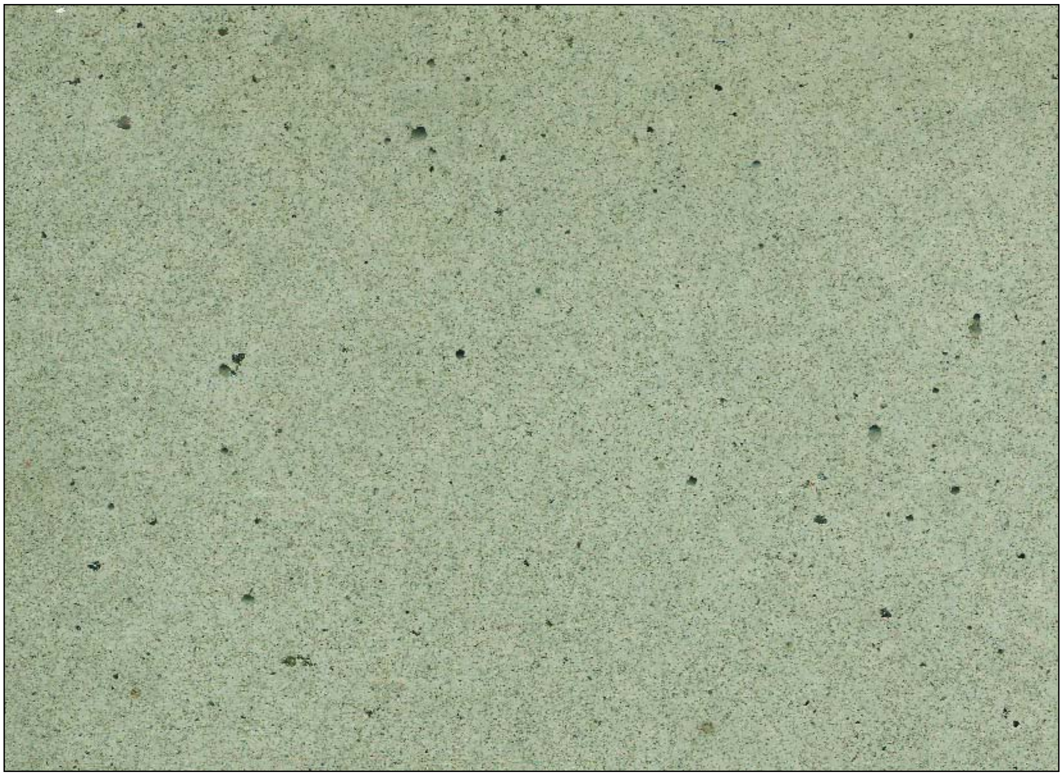
CPCI 147 3/8 - 5/8 *inch crushed white marble, natural brown sand, white cement, light sandblast*

CPCI 148 3/8 - 5/8 *inch crushed white marble, natural brown sand, white cement, medium sandblast*

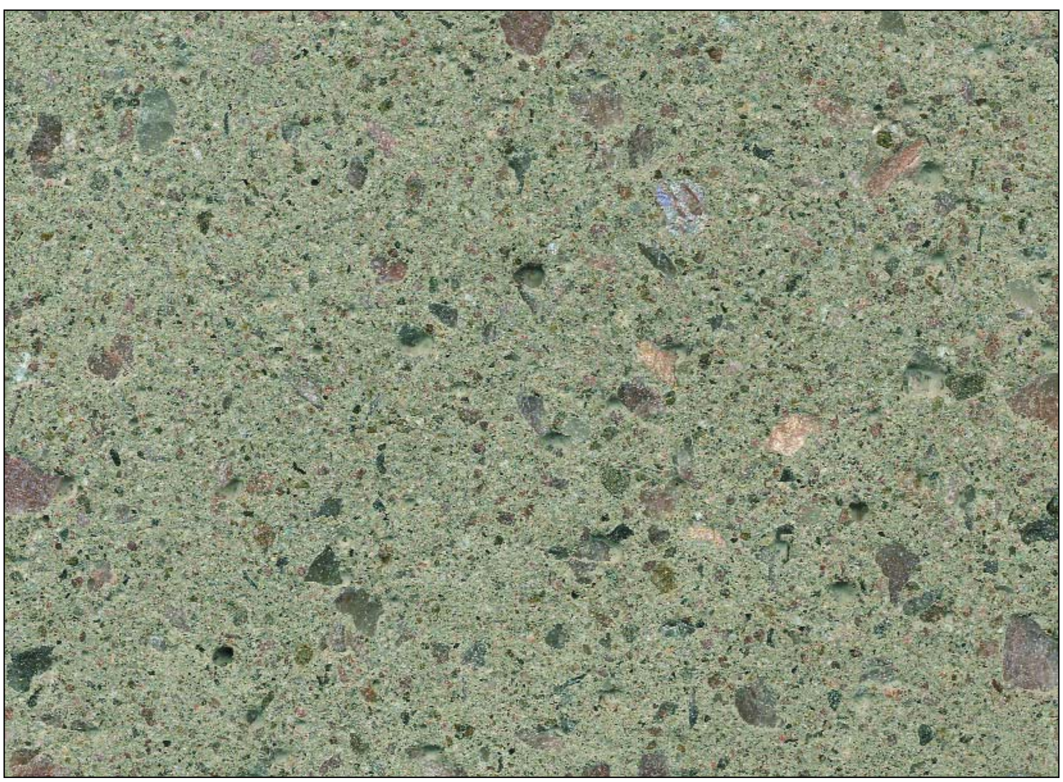
CPCI 149 *limestone, concrete sand, white cement, light sandblast*



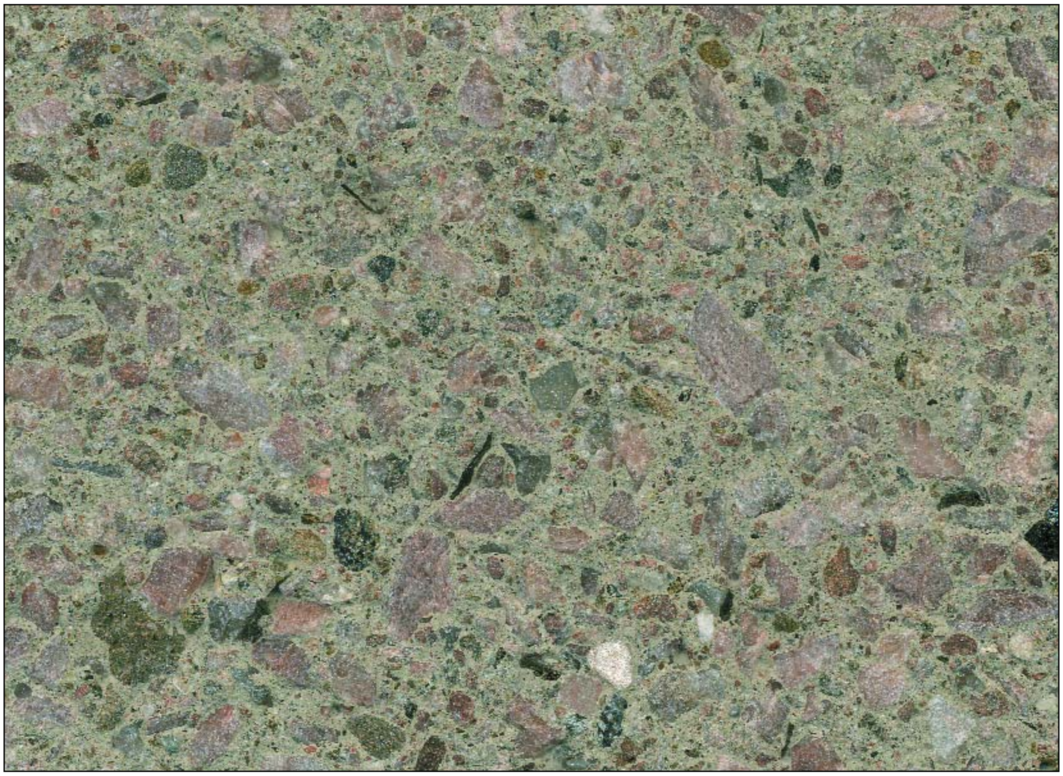
CPCI 150 *limestone, concrete sand, white cement, medium sandblast*



CPCI 151 *northern pink granite, empire red granite, Ottawa red coarse sand, grey cement, light sandblast*

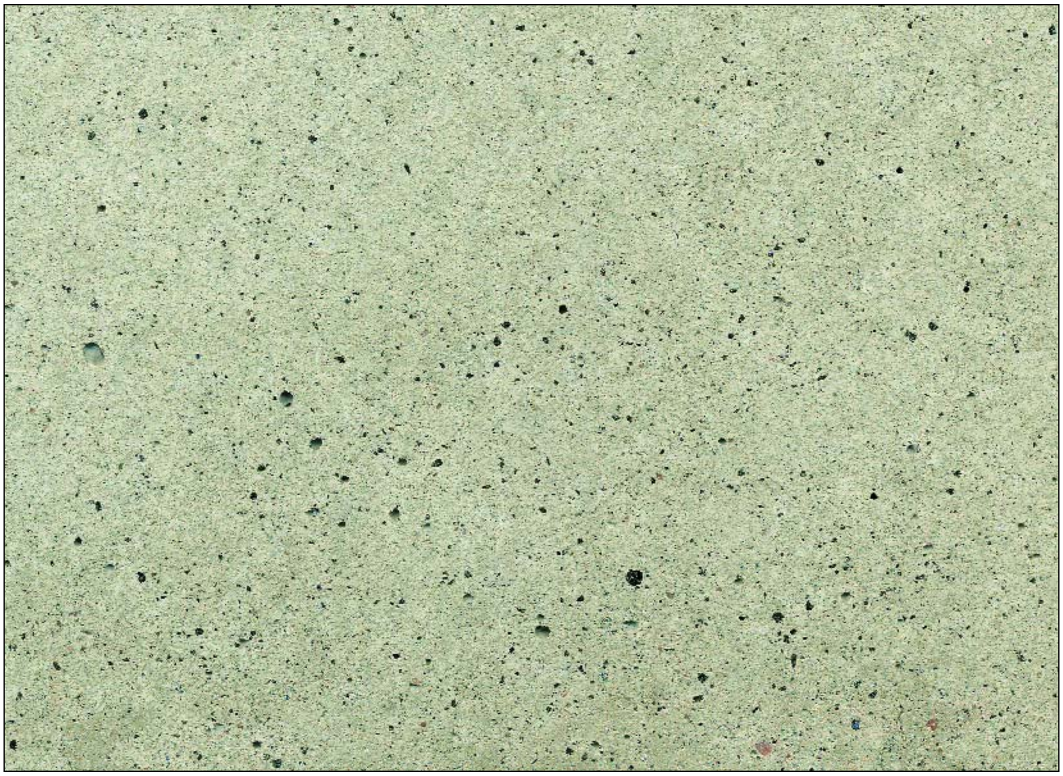


CPCI 152 *northern pink granite, empire red granite, Ottawa red coarse sand, grey cement, medium sandblast*

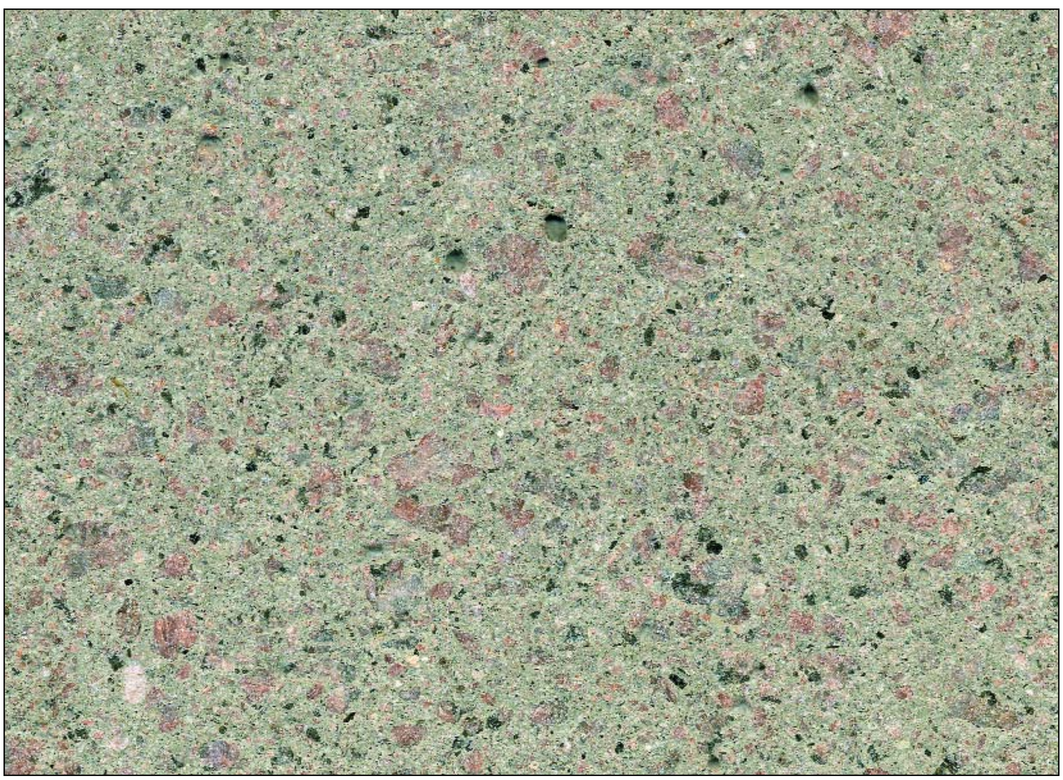


CPCI 153 *northern pink granite, empire red granite, Ottawa red coarse sand, grey cement, heavy sandblast*

CPCI 154 *northern pink granite, empire red granite, Ottawa red coarse sand, grey cement, exposed aggregate*



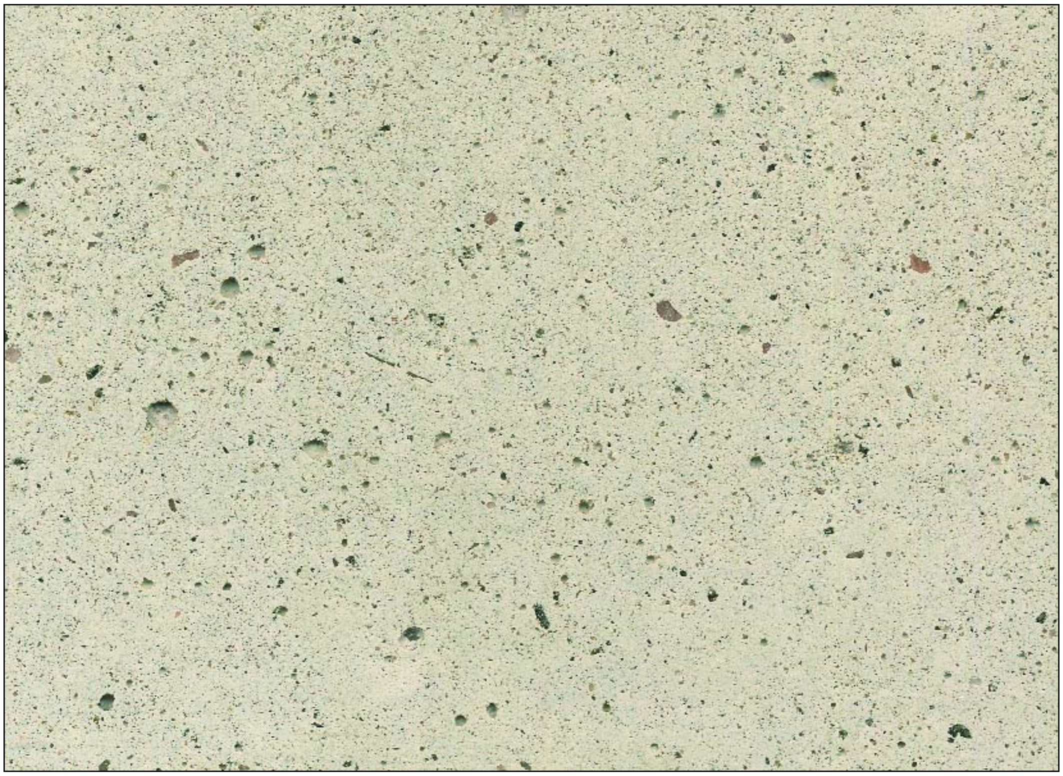
CPCI 155 *Belmont rose granite, Belmont rose granite sand, grey cement, light sandblast*



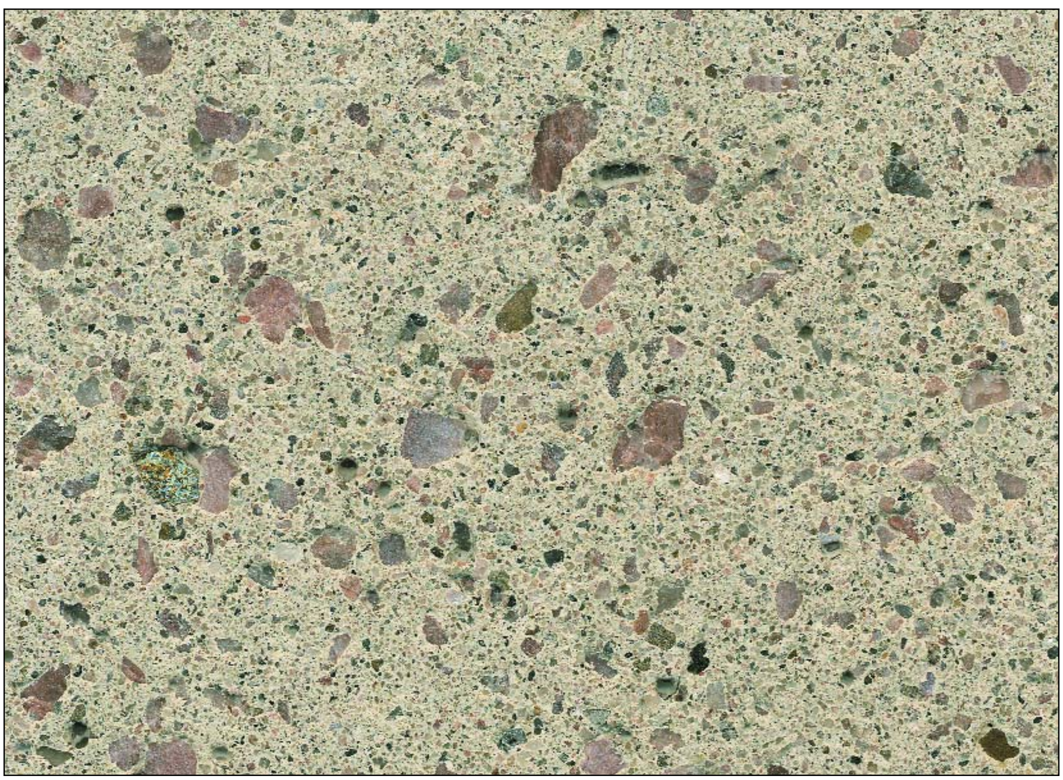
CPCI 156 *Belmont rose granite, Belmont rose granite sand, grey cement, medium sandblast*

CPCI 157 *Belmont rose granite, Belmont rose granite sand, grey cement, exposed aggregate*

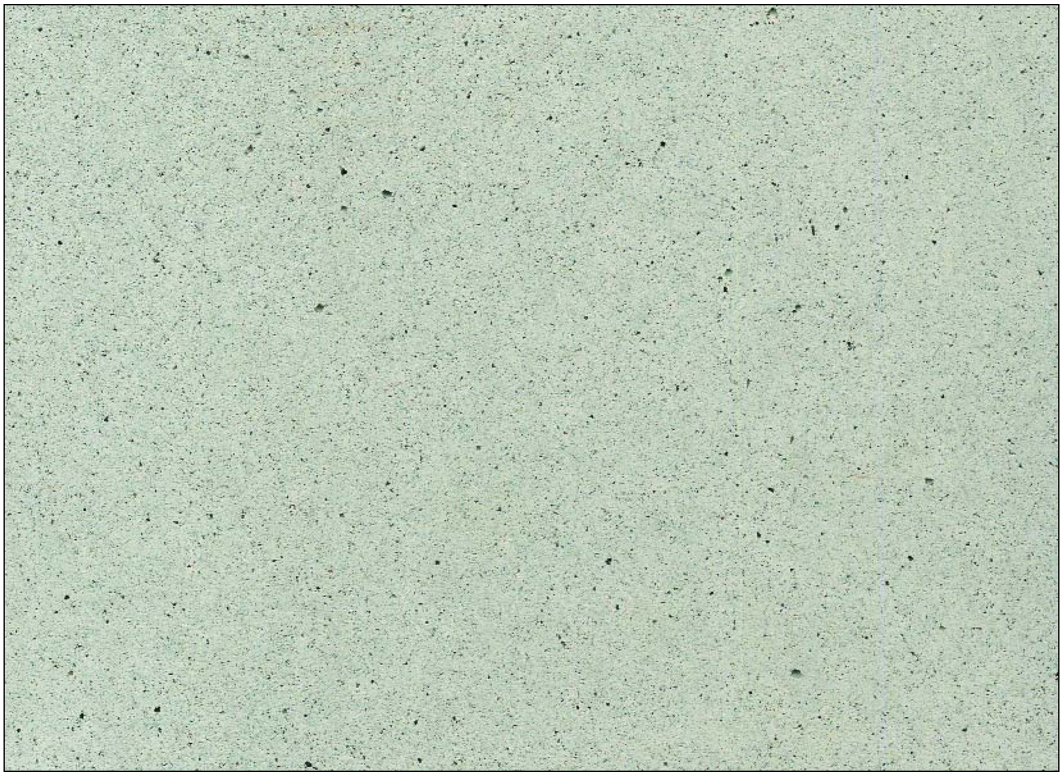
CPCI 158 *northern pink granite, ¼-⅜ inch black granite, brick sand, grey cement, exposed aggregate*



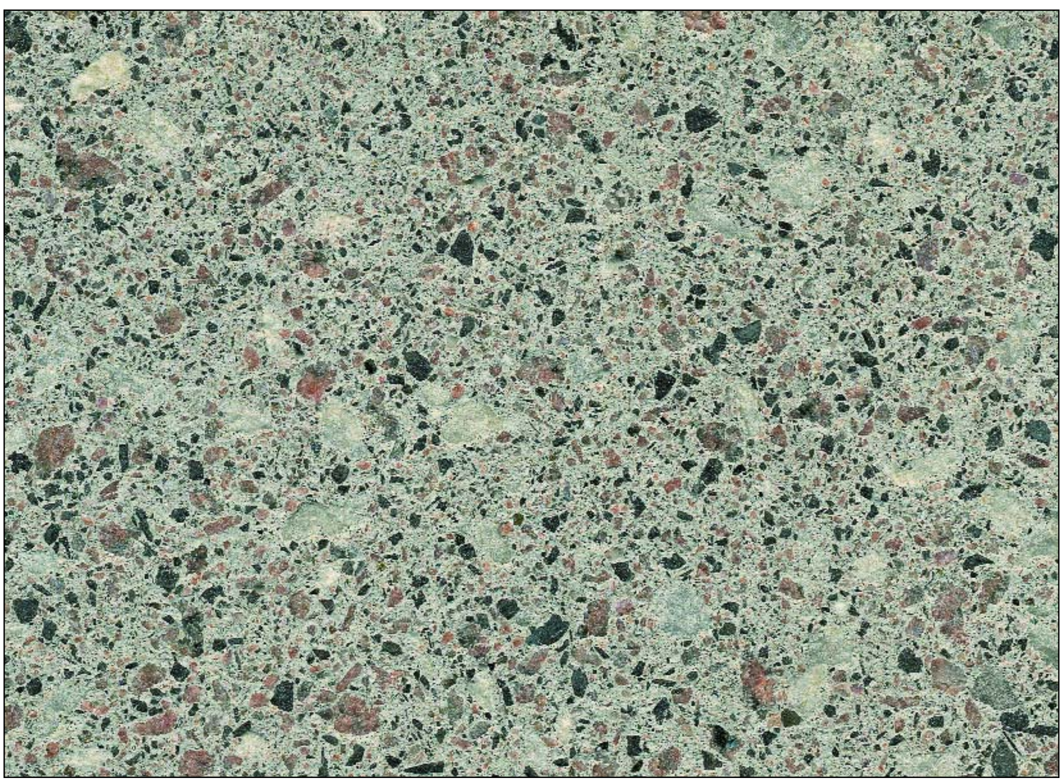
CPCI 159 *northern pink granite, pinto pink sand, white cement, light sandblast*



CPCI 160 *northern pink granite, pinto pink sand, white cement, medium sandblast*

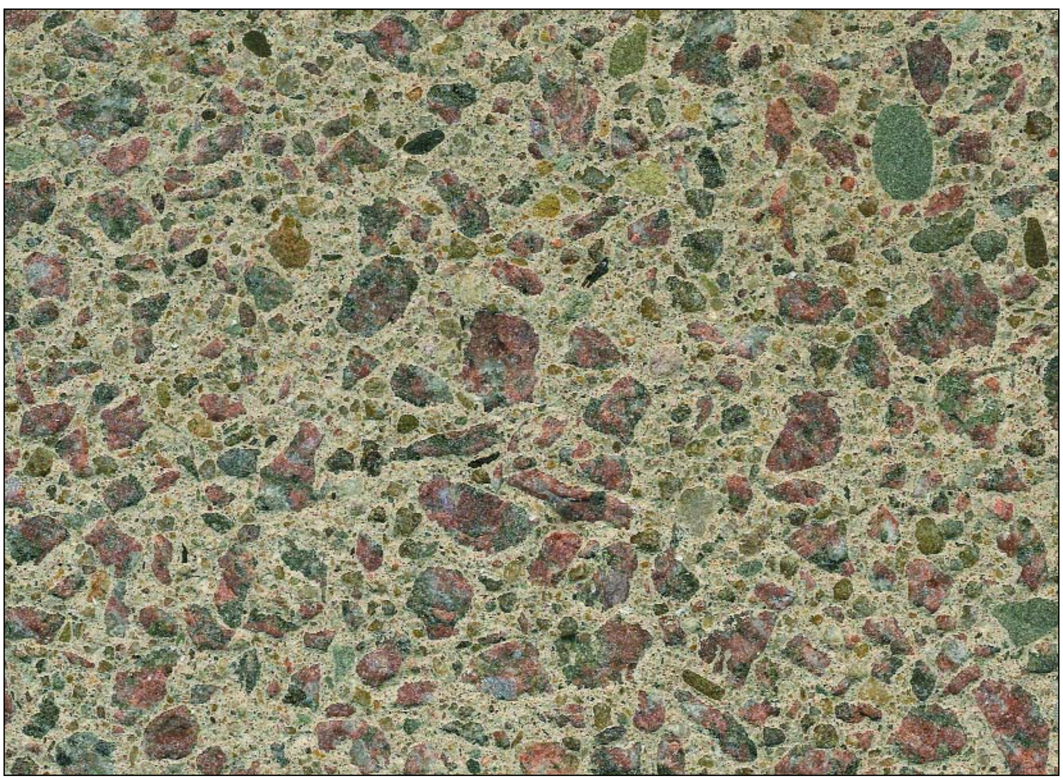


CPCI 161 *limestone, Belmont rose granite, < ¼ inch black granite sand, Belmont rose granite sand, white cement, light sandblast*

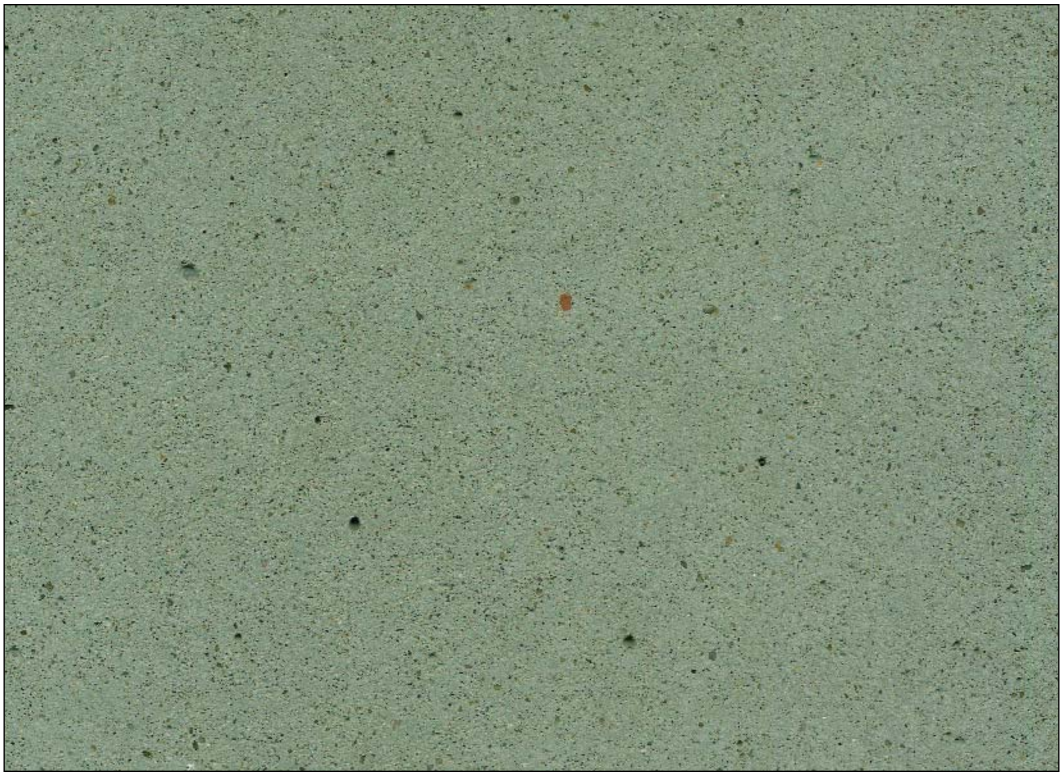


CPCI 162 *limestone, Belmont rose granite, < ¼ inch black granite sand, Belmont rose granite sand, white cement, medium sandblast*

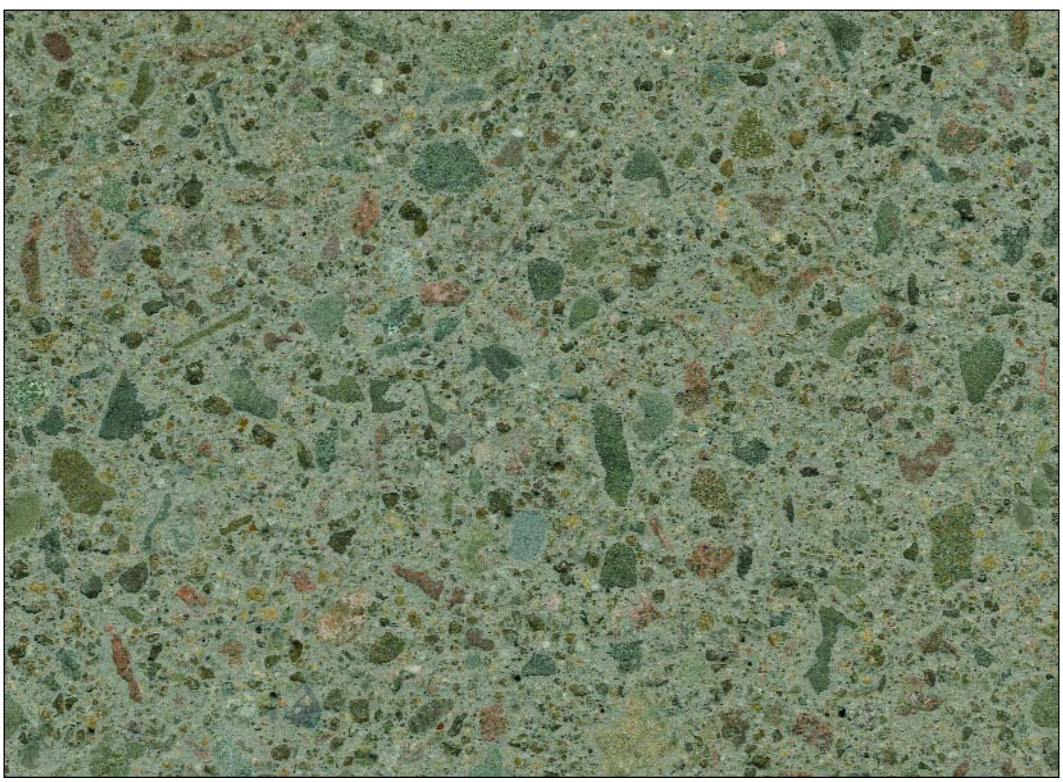
CPCI 163 *red granite, Shaws red sand, 60% white cement, 40% grey cement, light sandblast*



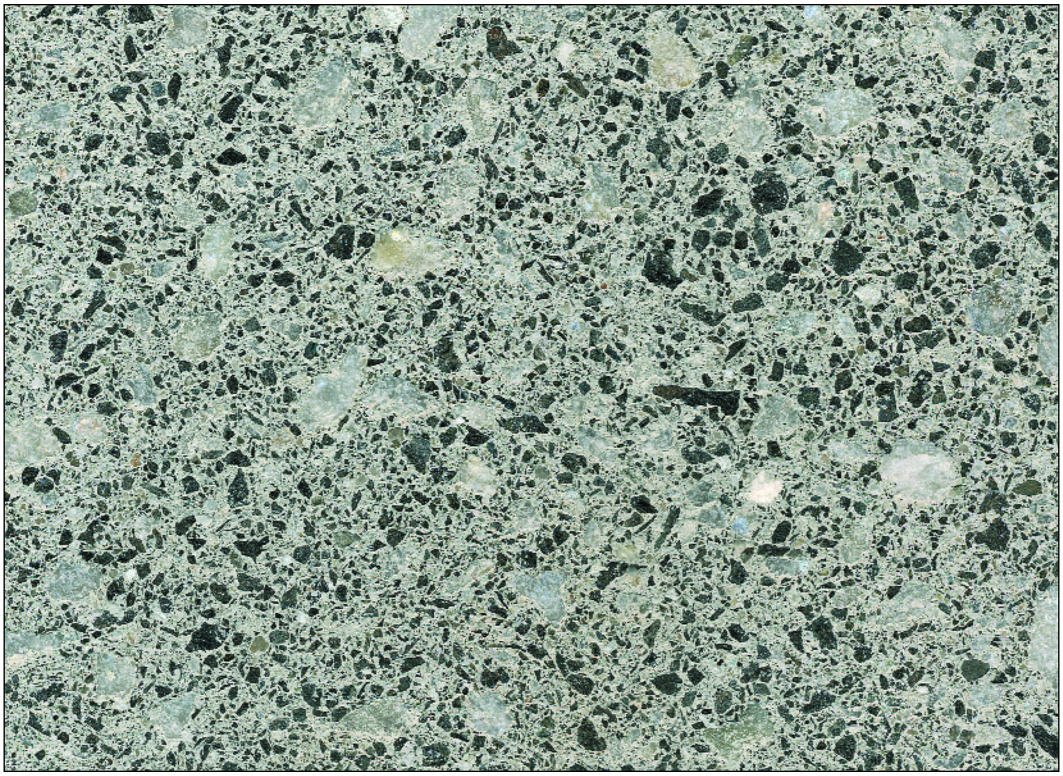
CPCI 164 *red granite, Shaws red sand, 60% white cement, 40% grey cement, heavy sandblast*



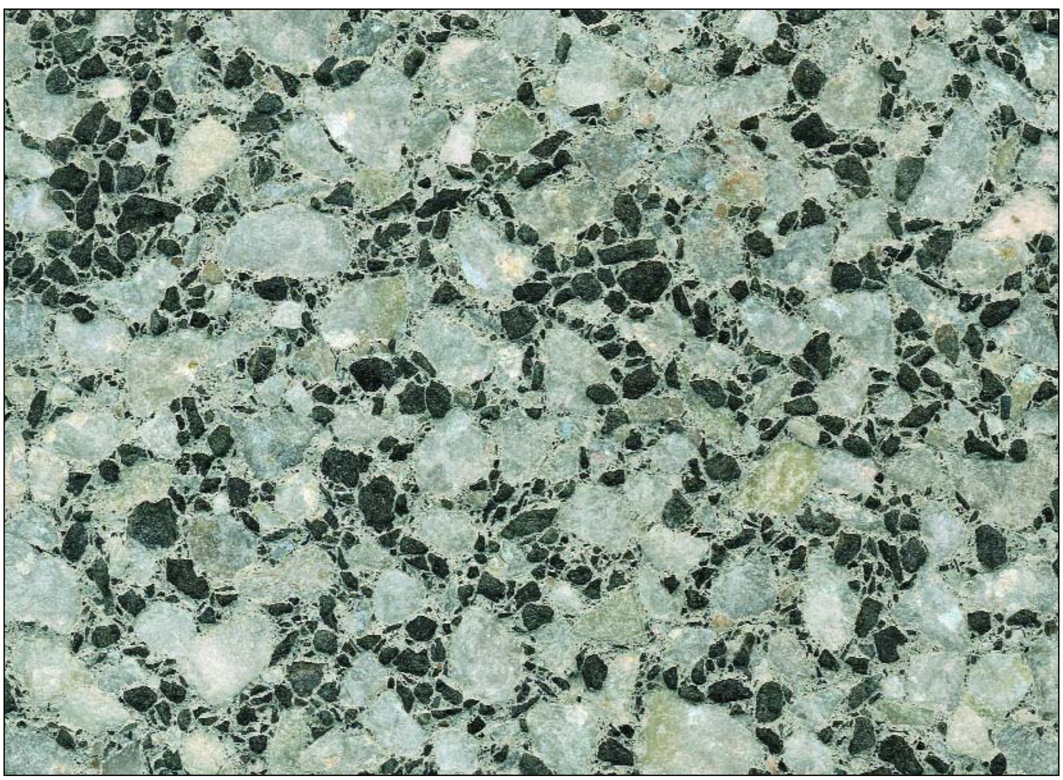
CPCI 165 *natural multi coloured stone, Shaws red sand, grey cement, light sandblast*



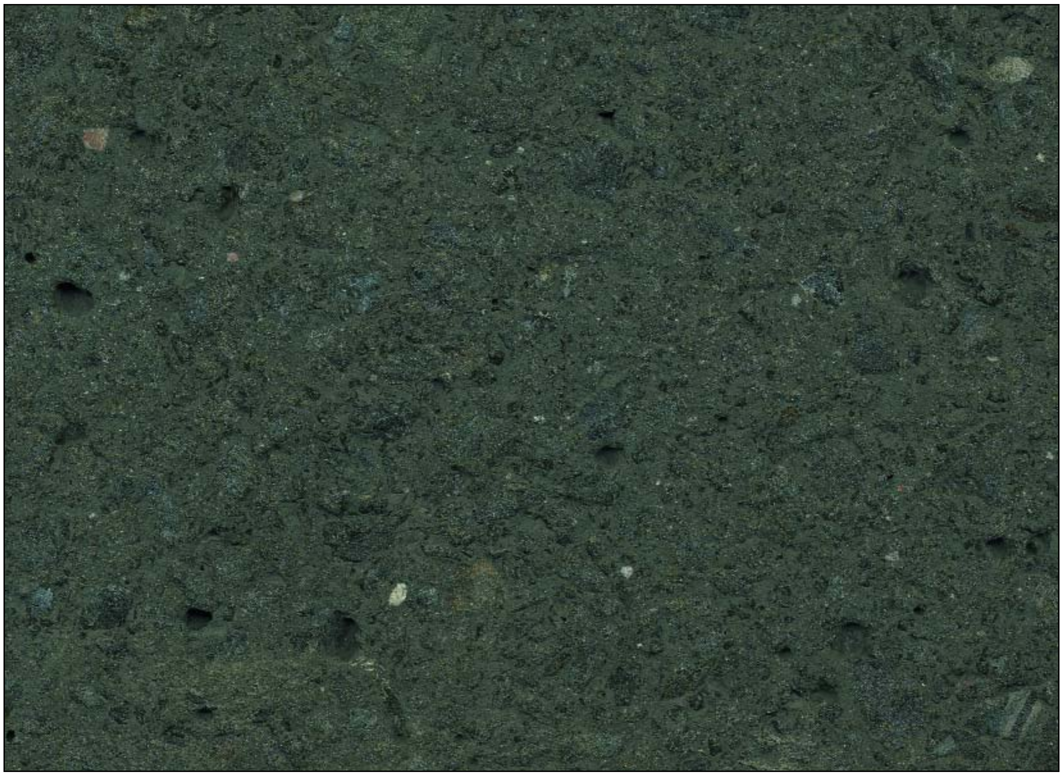
CPCI 166 *natural multi coloured stone, Shaws red sand, grey cement, medium sandblast*



CPCI 167 *white dolomite, 5% white sand, 95% < ¼ inch black granite sand, white cement, medium sandblast*



CPCI 168 *white dolomite, 5% white sand, 95% < ¼ inch black granite sand, white cement, heavy sandblast*

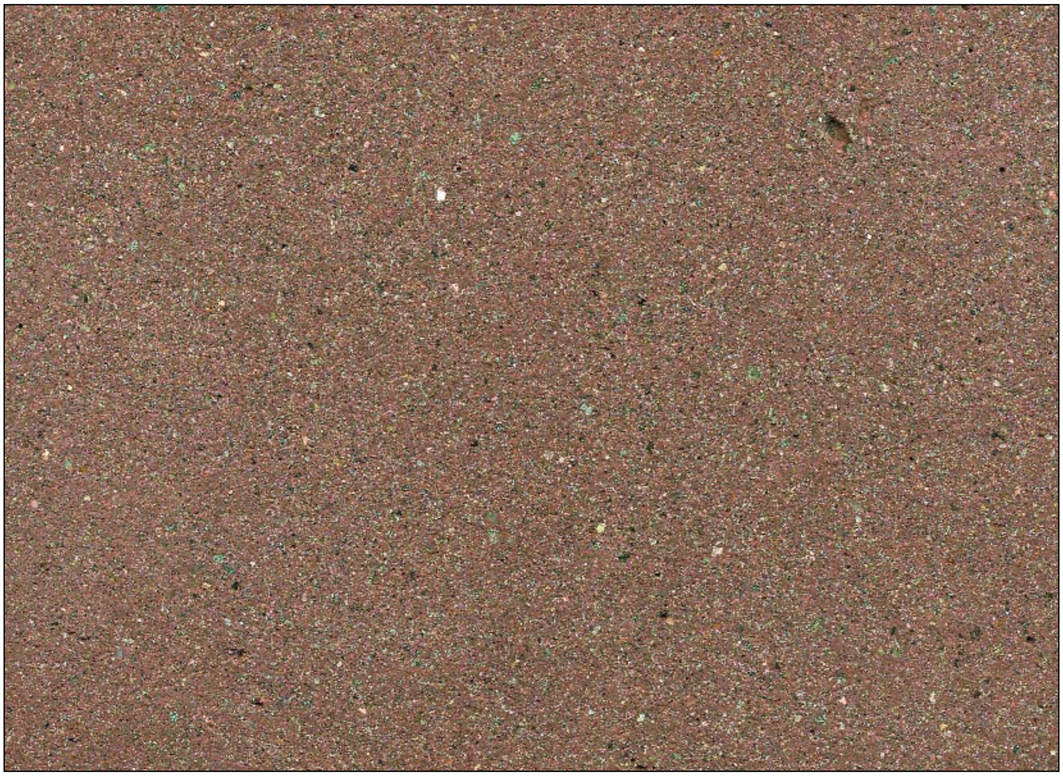


CPCI 169 *black granite, < ¼ inch black granite sand, grey cement, black pigment, medium sandblasted*

CPCI 170 *black granite, < ¼ inch black granite sand, grey cement, black pigment, exposed aggregate*

CPCI 171 *rustic brown stone 25%, red granite 75%, Shaws red sand, white cement, tan pigment, light sandblast*

CPCI 172 *rustic brown stone 25%, red granite 75%, Shaws red sand, white cement, tan pigment, very heavy sandblast*



CPCI 173 *red granite, natural concrete sand, grey cement, red pigment, light sandblast*

CPCI 174 *red granite, natural concrete sand, grey cement, red pigment, heavy sandblast*

For More Information:

CPCI Design Manual,
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