

# ARCHITECTURAL PRECAST CONCRETE REPAIR GUIDE



CANADIAN PRECAST/PRESTRESSED CONCRETE INSTITUTE

# TABLE OF CONTENTS

Introduction .....	2
Aesthetic Defects .....	3
Structural Defects .....	6
Repair Techniques and Procedures .....	7
Definitions .....	10
Appendix 1: Checklist .....	12

## On the Cover

The complex consists of two, 19-storey towers referred to as St. Gabriel Village, 23 townhouses in a grouping called St. Gabriel Lane, and 169 condominiums known as St. Gabriel Terraces. This was the latest representation of a 35-year pursuit by the developer to shine a light on the need for energy conservation and sustainable development.

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With nearly 50 member plants, CPCI serves as the voice of the precast concrete industry in Canada. The industry includes a diverse mix of companies, from small single-plant manufacturers to multinational vertically integrated companies that operate in many sectors of the construction industry. CPCI provides an array of services to these manufacturers that include technical engineering support, the industry's premier certification program, safety programming, educational courses and a suite of print and online publications. In addition to services to members, CPCI provides specialized technical information to designers, owners, contractors, engineers and designers on precast concrete products.

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# INTRODUCTION

This guide is not meant to be all inclusive, but rather is a collection of best practices commonly used to repair precast concrete. The guide explains procedures and time-proven techniques used to make a multitude of precast concrete repairs. Precast concrete product repairs can be related to engineering and design, production, handling, shipping, erection, other trades (typically on the job site), job site conditions and environment. While it would be impossible to address every possibility where a repair may be needed, this guide will address some of the most common situations. It covers the basics and common methodologies of repairs. Unique situations will require you to develop repair techniques based on the appropriate methodology.

This guide is not a replacement for good quality concreting practices, which will reduce the amount of production-related repairs. For more information see the CPCI 4th Edition Manual for Precast and Prestressed Concrete Plants.

It is important to note that the existence of this guide does not suggest that precast products require frequent repairs. Precast concrete products are among the most durable products available in today's construction environment. However, as with any building material or product, occasional repairs are a fact of life and should be performed with the highest standards in mind.

## Objectives

This guide addresses:

- Common repair techniques for precast concrete products
- Potential causes that may lead to repairs and possible remedies
- Recommended procedures for handling and documenting repairs

This guide should be used for:

- Developing proper repair techniques and procedures
- Training of employees
- A basis to develop a plant-specific repair manual (PSRM)
- General reference guide for repairs

## The Plant Specific Repair Manual

Each plant should have a plant-specific repair manual (PSRM) that describes the proper procedures for making repairs to products, communicating status of products and instituting quality control. Your PSRM should be readily accessible and available in a notebook or binder. At a minimum, the manual should address the following:

- Personnel responsible for making the repairs
- Safety
- Equipment
- Definition of minor repairs
- Definition of major repairs
- Communication
- Documentation and retention
- Reporting
- Inspecting
- Description of repairs procedures
- Training of personnel performing repairs
- Process to minimize reoccurring repairs

## Plant Operations

Every precast concrete plant should have a well-established quality control program. This will reduce the potential of having to make costly repairs. The QC program should address good quality concreting practices, documentation and all requirements listed in the CPCI Fourth Edition Design Manual for Precast and Prestressed Concrete Plants.

The QC program should include a series of product inspections to ensure quality and compliance with specifications. A system to communicate the status of each product should be defined. At each phase of inspection, a mark or some method of communicating status should be evident. Damaged or poorly repaired product should not be shipped and repairs made on the truck should be avoided.

All repairs should be documented. Post-pour reports should be completed daily for every product (see Appendix A for sample). Documentation of repairs enables the QC manager to investigate the cause and implement changes to reduce or eliminate the practice causing the damage.

A training program should be required for all employees responsible for making repairs and should be detailed in the PSRM.

Any needed repairs should be made in the plant, because repairing a product on the job site:

- will cost two to three times more than repairs at the plant;
- is more difficult due to inconsistent job site conditions such as weather, access and other trades;
- can compromise confidence and credibility with the project owner and contractor.



## Disclaimer

This guide discusses primarily non-structural repairs. Structural repairs shall always be examined by a licensed engineer. These types of repairs are situation specific and may require approval from the purchaser or appropriate representative. This guide is not intended to supersede project specifications, contract documents or engineering recommendations.

This guide does not claim to address all the safety concerns, if any, associated with its use. It is the responsibility of the user of this guide to establish the appropriate safety and health practices and determine the applicable regulatory limitations prior to its use. The user should comply with all federal, provincial and local safety regulations and requirements.

## AESTHETIC DEFECTS

Aesthetic defects are considered minor defects. They are usually production related and can be fixed quickly at the plant. Some examples include bugholes, small chips, crazing cracks or others described in this guide.

Aesthetic defects do NOT impact the structural integrity or intended service life of the product.

The procedures used for aesthetic repairs should be documented in the PSRM. All employees expected to perform these repairs should be adequately trained. Most minor repairs are made routinely as part of the everyday processing of the product. This usually does not require review by an appointed person, but rather routine inspection in accordance with your plant's Quality Control Manual.

The occurrence of minor repairs should be documented and investigated. Usually the need for these types of repairs can be greatly reduced or eliminated by making adjustments in the production process. For example, bugholes are often caused by improper consolidation or form release application. Keeping thorough daily records will allow you to track the problem by determining which form was involved and which employees were working on that form.

## Bugholes

Surface voids can be a common surface blemish on precast concrete. These are usually small voids found in clusters and commonly referred to as bugholes. While these do not compromise the structural integrity of the product, they can be considered unsightly, especially with architectural finishes. The common causes of bugholes include entrapped air, water pockets or the improper application of form release agent.



## Release Agents

When a release agent is applied too heavily to the surface of a form, it can pool at the base of the mold or form droplets. When the concrete is placed into the form, the pools or droplets prevent the concrete from occupying that space so that when the form is removed a bughole is left behind where the droplet or pooling occurred.

## Water

Water in concrete can be classified in three categories:

- Water required for hydration in concrete
- Water absorbed by aggregates
- Free water

Much of the free water finds its way to the top surface and is considered bleed water. Free water that remains trapped along form surfaces will eventually evaporate. The void left behind after the water evaporates is typically considered a bughole.

## Air

When concrete is placed into a form it is common for air to be entrapped between the side of the form and the placed concrete. Proper consolidation of concrete using internal or external vibrators typically removes the majority of entrapped air. However, if concrete is not adequately consolidated excessive bugholes will occur.

## Fine Cracks

Fine cracks occur at the surface and are very small, with a width typically less than 0.01 inches.



## Shrinkage Cracks

Shrinkage cracks occur when water is removed too quickly from fresh concrete. The loss of water causes a volume change in the concrete, and since the concrete is still fresh, the tensile strength is not adequate to resist the volume-changing force. Shrinkage cracks can be avoided by placing concrete in a controlled environment where relative humidity, concrete temperature and wind velocity are favorable for concrete curing. When necessary, shrinkage cracks can be repaired using epoxy injection methods.

## Crazing Cracks

Crazing cracks usually occur very soon after the concrete has been placed. The cracks are shallow and typically do not cause wear resistance or durability issues. Crazing cracks are often attributed to a lack of hydration on the surface of the concrete during the curing process. Crazing can be avoided by using curing compounds, covering the product during curing, refraining from "over-finishing" the surface of the concrete, and not finishing the product while bleed water is still present on the surface. Crazing cracks are typically not repaired because they are not structural and they are so small that it would be nearly impossible to fill them with any material.



## Chips

Chips are relatively small sections of products that have been removed, typically as a result of impact. Chips may be as large as 8 in. (203mm) in diameter by 1 in. (25mm) deep and are usually of irregular shape. As chips become larger they require a different approach to repair. This may include adding reinforcement (also known as pinning) and using a build-up application technique. This will be discussed under the section on spalls. Most chips can be repaired in one application with the appropriate patching material.



## Efflorescence

Efflorescence occurs when soluble salts come to the surface of concrete. All concrete and mortars will experience some level of efflorescence. This natural phenomenon is most prevalent in moist environments and low- temperature conditions.

Efflorescence will typically appear as a white substance so it will be more noticeable on dark-colored concrete. Efflorescence can be removed by pressure washing before it reacts chemically to form calcium carbonate. Once the calcium carbonate reaction occurs, the use of a mild acid solution is often required to remove efflorescence. After application of the mild acid it is important to rinse all acid and remaining calcium carbonate from the concrete to prevent discoloration of concrete or a relapse of the efflorescence cycle.



## Missing Architectural Details

Missing architectural details such as false joints, quirks and miters occasionally can occur in the manufacturing of architectural precast concrete. The use of a thorough quality control program and a highly skilled design and detailing firm should greatly limit those occurrences, however. Omissions of this type can often be saw-cut into the finished precast product. The saw-cutting should occur at the precast plant if possible, but can be done at the job site if the error is found on site. Care should be taken to locate any reinforcement that may be affected by saw-cutting. All necessary safety and environmental precautions should be considered when altering precast in this manner.

## Finish Problems

It's obvious, but should be stated: architectural precast must look good and meet the intended aesthetic purpose. Aesthetics can be subjective in nature, however, so this is always a potential area for dispute. One suggestion to help set the expectations of your customer and help quantify variability is to cast a mock up. This is discussed more in the Repair Techniques and Procedures section. Some potential finish problems and remedies are discussed below.



## Blending

Precast products are cast over many days using several batches of concrete. The best way to minimize batch-to-batch variations is to follow good concreting procedures:

Purchase all materials needed for a project from the same lot or run. Blend materials when more than one lot is used. Do not change from approved sources midstream in project.

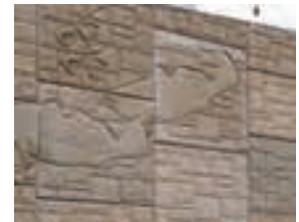
Maintain the specified water/cement ratio and mix design, control variations.

Maintain proper placement and consolidation techniques.

Follow consistent and proper curing procedures.

## Discoloration

Discoloration can be caused by a multitude of factors. These factors include changing cement lots, varying aggregate properties, inconsistent mixing, inconsistent finishing or a change in curing conditions. Virtually any change in the concreting process can lead to a change in coloration.



The following techniques have been used to lighten a precast surface:

- Abrasive blasting
- Bleaching chemicals
- Drying out the product and using a penetrating sealer
- Applying a cementitious rub

The following techniques have been used to darken a precast surface:

- Acid washing with a dilute solution of muriatic acid
- Applying a "wet look" surface sealer
- Increasing the moist cure time
- Applying a cementitious rub

# STRUCTURAL DEFECTS

Major repairs are more unique in nature and should not happen routinely. Each plant should designate a qualified person to evaluate all major or structural repairs. In many cases, the suggested repair procedure for major repairs must be submitted for approval to the owner and engineer of record, with both of them also inspecting the completed repair. This may be required by the contract documents.

Major repairs are those that impact any of the following:

- The structural integrity of the product
- The intended use or application of the product
- The intended service life of the product

## Cracks

It is nearly impossible to completely eliminate the cracking of concrete. When it does occur, a qualified individual must evaluate the crack. The evaluation should include an attempt to discover the cause of the cracking and determine the service condition of the precast piece. The inspector should indicate whether the crack is acceptable, needs remediation or cannot be repaired. Cracks should be sealed when necessary to prohibit premature deterioration or shorten service life of the product.



## Spalls

Spalls in concrete are larger than chips and may or may not cause structural damage to a precast product. That is why a qualified individual should evaluate spalls in concrete. Spalls can occur for various reasons, including:



## Mishandling of Products

When care is not taken during the yarding, shipping and handling processes, concrete can undergo extreme stresses that could cause spalling. Care should be taken to avoid bumping into surrounding obstacles and when placing concrete on bunking or dunnage.

## Pull-out of Inserts

Inserts are placed in precast structures for a specific purpose and are removed when the concrete has achieved a specific strength. Use of inserts for unintended purposes can cause the insert to spall out of the structure. Also, improper

assumptions made during the design process can result in inserts that are insufficient for their intended purpose. This may also cause spalling of concrete.

## Product Alterations

Product alteration refers to revisions to the dimensions, block outs and/or connection hardware of the product.

## Reducing Dimensions

Cutting precast concrete to change the overall dimensions of the piece is possible, however care must be taken with regard to the reinforcing steel, hardware and protective cover of the steel. An engineer should evaluate the impact of cutting through or removing reinforcing steel. Any exposed reinforcement, (quite commonly this will be reinforcement perpendicular to the cut) must be protected by recessing the steel and patching over it, applying epoxy to the exposed ends or some other form of acceptable protection.

## Increasing Dimensions

When a product requires an increase greater than one-half inch, it is typically better to cast a filler piece. Filler pieces must be attached to the primary piece by approved means. For increases of a one-half inch or less, patch material may be added in accordance with the build-up method described in this repair guide.

## Blockouts

Moving or cutting blockouts (openings) should be done using the "reducing dimensions" method described above before casting the piece. When eliminating the reinforcement from the center or edge of a piece to create the blockout (such as for a window, vent or door), the reinforcement around the blockout will be reduced, therefore, additional design considerations need to be addressed. Sometimes this situation may require additional external connections to relieve stress on the piece, strong backs or modification to the piece.



## Hardware

Alterations of hardware typically consists of moving or adding connections such as weld plates, inserts or bearing connections and must be done according to the approved specifications for the repair.

## Delamination

Precast concrete can delaminate when there is insufficient strength within the member to transfer shear stresses across a given plane. Delamination typically occurs when removing the green precast from forms, as this is a volatile state for the member. However, it is possible for a precast member to delaminate under service conditions as well. A qualified person should investigate the member if delamination is suspected.

# REPAIR TECHNIQUES AND PROCEDURES

## PATCHING

### Developing a Patch Mixture

Patching typically refers to the replacement and repair of concrete. This can be difficult due to the many colors and textures that exist and the fact that concrete is forever curing and changing. If the patch is to be hidden, commercially available (off-the-shelf) mixes may be purchased and used. Otherwise, you must develop one or several patch mixtures yourself.

### Materials

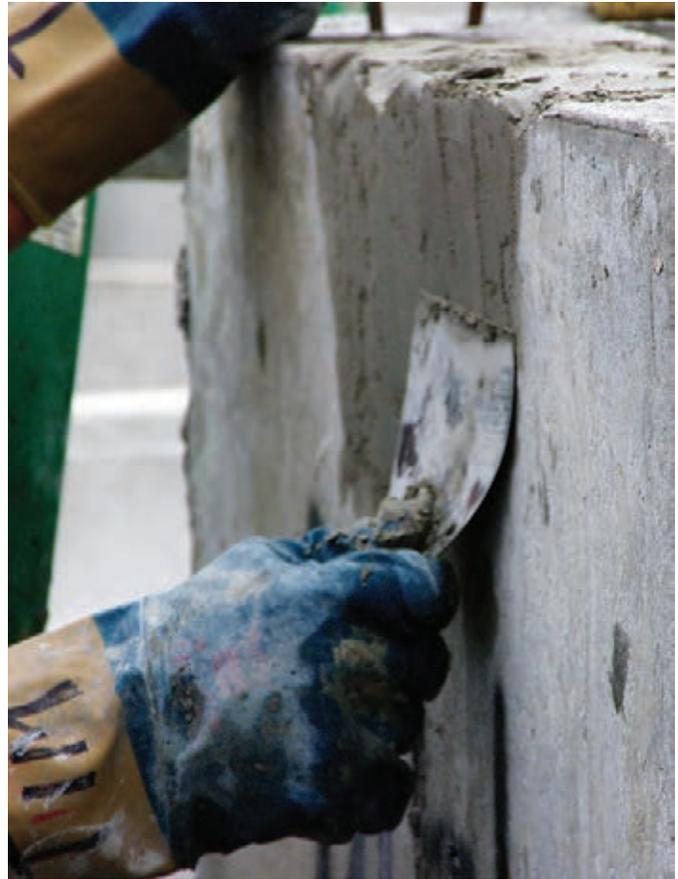
Always secure additional material used in production of a job as soon as possible. Collect a relative sample and store it. The size of the sample depends on how size of the job and the probability of repairs. A 200 pound sample should be a minimum. This can be collected in clean, 5 gallon pails with lids to protect the sample from contamination. If the source changes, which is not recommended, you should collect another sample. Keep all materials labeled clearly. You may also want to collect another sample if the job is in production for a long time, as natural materials may vary.

### When to Develop Patches

Development of patch mixtures should begin as soon as the job is awarded – even before production begins. It is good to have as much time as possible to observe patch mixtures and how they change with time, weather and other variables.

### Where to start

The first step is to develop one or many patch mixtures. The most common types of patch samples are small cast samples and the “patty” sample. Small square or rectangular samples



can be cast from molds that can be made or purchased. The molds help with consistency. In fact, it is recommended to use ASTM C109 ([www.astm.org/Standards/C109.htm](http://www.astm.org/Standards/C109.htm)) as a procedure for making the samples. It is very important to reduce the number of variables in the process in order to accurately reproduce the casting that is being sampled. The patty is what results when patching material is spread out and flattened with the trowel into a one-half inch thick patty that is roughly the size of a hamburger. Some people feel this is more realistic of a typical repair, since many repairs will not be cast against a formed surface.

Different concrete finishes will dictate slightly different approaches to the patching technique, which will be discussed in greater detail below. The first patch mix should start with a mix proportion that is similar to the mix design, with the goal of creating one darker and one lighter patch mix. This allows for upper and lower boundaries that can be modified as needed. The patch mix should include coarse aggregate for large patches and only the matrix for smaller patches. Patch material should be weighed just like a concrete batch with two or three samples made from each batch.

Weight is the most accurate way to obtain the same amount of materials each time. A small scale may be used in the field and all information including temperature and mixing proportions should be documented. The more information collected, the easier it will be to obtain the desired results.

The w/c ratio of the patch mix must be maintained and documented. Most aggregates used in patching are completely dried, creating a similar starting point and eliminating the need to take moisture tests each day. Aggregate absorption should be accounted for in mix proportioning. Variation in the w/c ratio will change the color and strength of the patch mix so if possible measure water by weight as well.

Once samples are cast, the curing process must be as close to the production process as possible and should be well documented. At a minimum, patches should be evaluated for color and texture after 24 hours, 3 days, 7 days and 28 days, recording observations at each point.

After patch mix designs are roughly established, the samples need to be placed on an actual precast piece for final evaluation. Initial samples may be handled this way also, if a larger piece exists at that time. Typically 12 in. by 12 in. (305mm by 305mm) mockups are shown to the owner as a representative sample of the colors and textures that the completed project will exude.

Patches consist of color and texture. Both must be taken into account to achieve a well-blended repair. Color is based on a combination of aggregate and paste. The paste is very sensitive to both w/c ratio and mixing procedures, especially if the finished surface is as-cast or lightly exposed. As the aggregate exposure increases, so does the aggregate dominance in contributing to the repair blending.

## Adjusting Patch Mixtures

Patches will often need to be adjusted to obtain the appropriate color. If the patch is aggregate controlled, variations should be minimal. However, the process used to create the finish may need to be duplicated in order to create the same look and finish. For example, a deep sand-blasted finish will most likely require the use of sand-blasted aggregate in the patch in to create a match. The patch itself may also be sandblasted after it is installed and cured. This depends on the circumstances of the job. Sandblasting typically dulls and mats the finish. It also wears away aggregates and reduces aggregate protrusion.

## Adjusting Paste Color

Adding gray or white cement can darken or lighten a paste. The rule of halves technique can be used to bring about convergence quickly. Increase or decrease the gray or white cement by 50% based on the desired direction and then adjust by 50% of the previous change. Repeat the process until the desired color is achieved.

## Important Things to Remember

**Matching** – Patches should not match when initially applied. If they do, most likely they will not match as time continues.

**Materials** – Use the same materials for patching that were used in the original casting. It is especially important to use raw materials of the same type and brand and obtained from the same sources and the same lot to minimize color variation.

**Color** – Evaluate the long-term color of repairs since they will change with time.

**Variance** – Patches may vary from original pieces and may vary in color from the original piece for several reasons.

- The longer concrete is cured, the darker it becomes. Conversely, the more concrete dries out, the lighter it becomes. The patch may initially appear to be a different color but will blend in over time.
- Precast in a yard or onsite may become stained or dirty due to rain, dust, atmospheric pollution and handling.
- Concrete holds moisture, which may magnify the difference in color between the patch and the original piece. It may take the piece several days to dry out after a heavy rain.
- Depending on the size of the original piece, the color may vary due to the heat of hydration. For a large piece, a lot of heat may be generated in the mold, causing a quicker rate of hydration with slightly different products formed. When a smaller patch is installed, that greater heat is not generated, resulting in a different color.



## Applying Patches

The application of the patching material is very important. The first step is to prepare the substrate of the product with these steps:

Remove all loose material, chiseling edges to at least ¼ in. depth. Avoid using very thin patches often referred to as feather finishes. These typically will deteriorate quickly.

Ensure that the substrate is at proper temperature (usually between 50 F (10 C) and 90 F (30 C)). Be aware that the patch will be affected by the surface temperature. Colder temperatures will slow down hydration. At no time should patches be applied to substrate below freezing.

Wet the substrate to Saturated Surface Dry conditions. A dry substrate will pull moisture from the patch material, altering its color and possibly resulting in a weakened patch.

## For Larger Patches

If the patch area is greater than 6 in. (152mm) or deeper than 1 in. (25mm), a layered technique should be used. The idea is to not create a heavy patch so that the weight of the patch material causes a disbanding from the substrate. This is often viewed as a “sagging” patch while it’s wet.

When a patch is larger than 12 in. (304mm) or 1.5 in. (38mm) deep, it should be reinforced to resist tensile force generated from shrinkage. Also, reinforcement (pinning) will secure the patch to the substrate. Since all patches are cold joints, this is important so that the patch remains attached over time.

## Curing of Repairs

Proper curing is necessary for a successful patching procedure. All exposed surfaces of a repair patch should be cured under controlled temperatures and humidity by either applying a curing compound, continuous misting of water or wet burlap covered with plastic sheeting to prevent dehydration of the applied patch. The patch should be kept moist under controlled temperatures until full hydration, coloration and hardening of the patching material are ensured. Curing compounds should comply with ASTM CASTM F309 - 04(2010) ([www.astm.org/Standards/F309.htm](http://www.astm.org/Standards/F309.htm).)

Dehydration of the patching surface due to wind, temperature gradients or exposure to the elements will lead to shrinkage cracks, discoloration of the patched area or possible failure of the patched area. The patched area should be cured above freezing temperatures until the patching material has fully hydrated.

When using commercially available cementitious repair materials, the recommended curing procedures of the supplier must be followed.

## Acceptance of Repairs

Acceptance of repairs should be described in the contract documents. The accepting authority is typically the owner, architect or general contractor. Acceptability of repairs should be reviewed during the sample and mock-up approval process. A small area of the accepted precast concrete sample can be damaged and then repaired by the precaster. The sample repair should be reviewed by the accepting authority and an acceptable range of color and shading of the repair should be agreed upon at that time.

All repair issues should be identified and corrected quickly. Minor repairs are usually cosmetic and the repair procedure should be agreed upon during the sample/mock-up approval process. Major repairs usually follow a procedure described in the contract and must be submitted for approval by the owner’s representative /engineer of record on the project.

Repairs should be completed only when conditions exist to ensure that the repaired area will provide a close match and that the repair will be high quality and durable.

Slight color variations are to be expected between the repaired area and the rest of the panel. This is due to the difference in time between the date of panel fabrication, time of repair and differences in curing. Over time, the repair will blend into the rest of the panel and become less noticeable.



## Cleaning of Architectural Precast

Cleaning of architectural precast concrete may be required due to discoloration of the panel that could occur during production, shipping, installation or after the panel is installed at the construction site. Discoloration can occur due to many reasons, some of which are:

- Dirt and dust can stain the face of a panel during handling and storage at the precast plant.
- Dirt, dust and road salts may accumulate on the face of a panel during transportation, especially if shipping a long distance to the job site or during inclement weather.
- Oil and grease stains could appear on the panel from leaky handling equipment (cranes) or from handprints made by installation personnel.
- Mud from the site may splash on panels at the base of the building, or from rust, dirt or other debris draining from nearby buildings on to the face of the panel.
- Insulation, sealants, oils and other materials may be inadvertently placed on the face of the panel during the installation of the support structure.
- Efflorescence or pollution may discolor or stain the panels after installation.
- Discoloration and staining will not affect the long-term performance of precast concrete. Proper handling methods and protection of the products at the job site will

ensure that cleaning of dirty architectural precast panels is kept to a minimum. Cleaning of architectural precast concrete panels can take place at the precast concrete plant prior to shipment, or at the job site if needed.

## Surface testing

Before cleaning the precast panel, a small area should be tested to make sure that there is not an adverse effect on the surface finish of the panel or on adjacent materials. If there is a possibility of adversely affecting adjacent materials, then the material adjacent to the precast panel should be protected. At a minimum, the adjacent material should be flushed with water before and immediately after cleaning. Take care to ensure that cleaning the architectural precast concrete panel does not damage adjacent materials, even if they are flushed with water prior to cleaning the precast panel.

## Cleaning different types of stains

Dust, dirt and simple stains may be cleaned by scrubbing the stain with a fiber brush, using a mild detergent and water. After scrubbing, the area should be thoroughly rinsed with clean water.

Deeper stains that have penetrated the surface of the panel may be cleaned using chemical cleaning compounds such as muriatic or phosphoric acid or other commercial cleaners. Follow manufacturer's recommendations.

Areas to be cleaned should be thoroughly rinsed with water prior to, and after application of the chemical compound.

A diluted solution of acid should be tested prior to the cleaning of the entire surface of the panel to ensure that the solution doesn't adversely affect the treated area. An undiluted concentration of acid could etch the panel more deeply affecting the color and texture of the cleaned area.

Abrasive blasting (dry or wet using sand) may be used to clean the panel if this was the same method used to finish the panel. Care should be taken to minimize the difference in the depth of the abrasive blasting from the original depth. Differences in blast depth will result in a different color or texture compared with the original finish.

For more specific information on removing specific stains from concrete, see "Removing Stains and Cleaning Concrete Surfaces" (IS214), published by the Portland Cement Association ([www.cement.org](http://www.cement.org)).

# DEFINITIONS

**Architectural precast concrete** – A precast concrete product with a specified standard of uniform appearance, surface details, color and texture. Architectural concrete has a high standard of finish quality with more stringent tolerances than other precast products.

**Batch line** (pour line) – A visible demarcation that shows where one pour stopped and a secondary pour begins.

**Blockout** – Used to stop the concrete from entering into an area to form a voided space or opening in the product. Blockouts are commonly used for windows, doors and louvers.

**Bugholes** – Small holes or voids seen on the surface of the panel usually found in clusters. Bugholes can be caused by entrapped air, water pockets or form release agent. Although bugholes can be unsightly, they do not compromise the structural integrity of the product.

**Chip** – A section of a finished product that has been removed, typically caused by an impact to the product. Chips may be as large as 8 in. in diameter and 1 in. deep.

**Cold joint** – A point of connection between two pours of concrete where the first pour is partially set, then a connecting pour is made. A cold joint could be a weak spot that should be avoided if possible.

**Consolidation** – The process of inducing a closer arrangement of the solid particles in freshly mixed concrete or mortar during placement by vibration, centrifugation, rodding, tamping or some combination of these actions.

**Crack** – An incomplete separation on the surface of the product. Cracks can be classified by direction, width and depth. Three width ranges are suggested:

- fine – less than 0.01 in. (0.254mm)
- medium – between 0.01 in. (0.254mm) and 0.04 in. (1.016mm)
- wide – more than 0.04 in. (1.016mm)

Pattern cracking is fine openings on the surface that forms a pattern, resulting from a decrease in volume of the material near the surface or below the surface, or both.

**Crazing** – A network of visible fine hairline cracks in random directions breaking the exposed face of a panel.

**Curing** – A method of retaining moisture and heat after pouring concrete to develop stripping or release strength. Hardening of the concrete.

**Efflorescence** – Efflorescence occurs when soluble salts come to the surface of concrete. All concrete and mortars will experience some level of efflorescence. This natural phenomenon is most prevalent in moist and low temperature conditions. Efflorescence will typically be white and shows up more prominently on dark colored concretes than light.

**Exposure** – A groove or reveal in a panel face generally used to create a desired architectural effect.

**Finish** – To complete the surface to achieve a desired final appearance.

**Grout** – Mortar or filling used to fill-in or close gaps.

**Honeycombing** – Voids left in concrete due to failure of the mortar to effectively fill the spaces among coarse aggregate particles. A pattern of stony or void areas in concrete due to incomplete consolidation or paste that leaked from the form.

**Matrix** – The portion of the concrete containing only the cement and fine aggregates.

**Major repair** – Larger than a minor repair. This type of repair may affect the structural integrity of a product. Qualified personnel should evaluate this type of repair.

**Mix design** – A set of proportions, under absolute conditions, of a concrete mixture to meet project specification and desired results.

**Mix proportioning** (batch weights) – The adjusted mix design for moisture, air, admixtures and other variables so that a concrete batch meets the yield and performance requirements of the mix design.

**Minor Repair** – A small, typically aesthetic issue that can be fixed relatively quickly.

**Mortar** – A sand and cement mixture that typically may be exposed to weather. A workable paste made from sand and cement used to bind pieces together or used to fill voids.

**Paste** – Product generated from the hydration of Portland cement.

**Precast concrete** – A product that is cast in a form designed to a specific shape, allowed to harden, then stripped from the form. Precast concrete products can be stored and transported as needed to job sites.

**Processing** – All the activities and procedures required to create the final finish of the product after the product has been cast and stripped (such as acid etching or abrasive blasting).

**Sand streaking** – A streak of exposed fine aggregate in the surface of formed concrete caused by bleeding.

**Service life** – A specified or expected duration of time a product could potentially remain in service.

**Shrinkage cracking** – Cracking due to failure in tension caused by internal or external restraints that occurs as reduction in moisture content develops or carbonation occurs.

**Spall** – Spalls in concrete are larger than chips and may or may not cause structural damage to a precast product. Spalls commonly occur during handling or erection.

**Structural integrity** – The ability of the product to withstand – without failure or exceeding specified limits of safety – the forces imposed upon it.

**Structural precast concrete** – Precast concrete members intended to support external structural loads in addition to their own weights; fabricated to specified structural properties. Precast concrete that transfers additional loads other than environmental (wind, seismic) and self-weight.

**Texture** – Surface feel or appearance that is not smooth.

**W/C ratio** – The total weight of water divided by the total weight of cementitious materials.

# APPENDIX A: CHECKLIST

- Mix Qualification Design (*consistent mix with optimized mix design*)
- Pre-pour inspection
- Curing procedures
- Post-pour inspection
- If repair is noted, flag the piece
- When repair is completed, re-inspect and mark when approved
- Processing inspection
- Final (before shipping) inspection
- Proper mix design (control w/c/ ratio)
- Proper placement and consolidation
- Proper placement of hardware, blockouts, dimensional checks
- Proper curing environment/techniques
- Maintain temperature and protection

## Post-pour

- Post-pour inspection
- Proper stripping strength
- Process correctly
- Store correctly and use required protection

## Shipping

- Proper load out, bearing, dunnage, binding
- Protect from weather and road dirt – load the product so that the exposure side faces in or down
- Erection
- Job Site

## Areas that can lead to repairs

### Engineering

- Omissions
- Incorrect or incomplete drawings
- Designed incorrectly

### Production

- Quality raw materials
- Avoid contamination

## CPCI TECHNICAL SUPPORT HELP DESK

CPCI technical help desk services are designed to provide technical information about the use of precast and prestressed concrete products, through investigations and research relative to applications of precast and prestressed concrete and engineering processes for improvement of the design, manufacture and installation of precast products.

CPCI help desk support and customer support are part of a comprehensive CPCI customer support program. Please email us at [helpdesk@cpci.ca](mailto:helpdesk@cpci.ca) or call us at **1.877.YES.CPCI (1.877.937.2724)**



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