MANUAL FOR
QUALITY CONTROL
For Plants and Production of
ARCHITECTURAL PRECAST CONCRETE PRODUCTS

MNL–117–13

FOURTH EDITION

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FOREWORD

This manual has been prepared as a guideline for quality assurance of architectural concrete. Since the products are custom designed, the many combinations of shape, size, color and texture require a great degree of craftsmanship. Therefore it is important to implement and maintain the quality control standards as given in this Manual to achieve the specific performance and aesthetic requirements of a project.

Materials and performance requirements for the architectural precast concrete should be clearly stated in the plans and specifications. These requirements should neither be open to interpretation nor unduly restrictive for the project, but should be written to conform with the intended use of the architectural precast concrete. Personnel in the manufacturer's organization should be thoroughly trained and competent in order to achieve quality architectural precast concrete products.

The first edition of the Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products was prepared by the PCI Plant Certification Subcommittee for plant production of Architectural Precast Concrete Products. Subsequent to the publication and use of the first edition, a plant certification program was established for the precast and prestressed concrete industry. The inspection of architectural precast concrete production facilities, carried out under this program, was based on the recommended practices and criteria outlined in that manual. Experience by both the manufacturers and the inspection teams led to the second edition in 1977 and the third edition in 1996.

The fourth edition which is even more demanding of a high standard of industry practice was prepared by the PCI Architectural Precast Concrete Services Committee and the PCI Plant Certification Committee. It represents state-of-the- art procedures and is the industry standard for achieving consistently high quality. Committee members working on this manual were as follows:

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INTRODUCTION

MNL-117, Fourth Edition

The Standards and Commentary are presented in a side-by-side column format; with the Standards placed in the left column and the corresponding Commentary text aligned in the right column. The Standards have been printed in the same typeface as shown in this paragraph.

The Commentary is printed in the same typeface as shown in this paragraph. Additionally, a "C" precedes Commentary article numbers to help further distinguish the Commentary from the Standards.

Architectural precast concrete panels, through the application of finish, shape, color or texture, contribute to the architectural form and finished effect of a structure. Not generally included are the so-called industrialized precast products (standard shapes), such as double or single tees, channel sections, and flat or hollow -core slabs usually produced in fixed, long -line forms. Architectural precast concrete units may be manufactured with conventional mild steel reinforcement, or they can be prestressed. Design flexibility in surface appearance is possible by incorporating various texture and finishes and through the use of different cement, coarse and fine aggregate, and pigments into the concrete mix. Natural stone or clay products may be used as a veneer finish or alternatively, panels may be painted or stained to achieve the required colors.

This manual is divided into two parts. The first part contains Divisions 1 though 7 which form the basis for PCI Plant Certification in product Group A1- Architectural precast concrete products. It is conformance to these Standards which is audited during each PCI plant inspection and provides the criteria for evaluation of the plant's capabilities.

The final part- Appendices- contains summaries of useful information for both the manufacturer and specifier.

The information in this manual is intended to serve as standards for quality control for the manufacture of architectural precast concrete products and as a complete guide for the development of an internal manufacturing quality control program. The Standard portion serves as a specification reference document, while the Commentary provides additional information and discussions of the Standards.

The fundamental intent of this manual is to provide a basis for establishing a satisfactory quality control program for architectural precast concrete operations. It should be augmented, as required by the specifier or producer, for addressing specialized products and operations. The value of the manual, in regard to establishing a standard of quality that will be recognized and respected by the general public, is dependent on the appropriate application by the owner, designer, specifier, and producer

Routine conformance to the requirements of the Standards should result in products of consistent and optimum quality when used with proven procedures. Optimum quality is considered the level of quality, in terms of appearance, strength, and durability that appropriately satisfies the project requirements for intended use and economics of the product.

The dimensional tolerances contained in Division 7 were developed by the PCI Tolerances Committee and approved by the PCI Technical Activities Committee and PCI Board of Directors.

This manual incorporates proven standards of practice that provide an acceptable level of quality, but there is no intent to place a ceiling on excellence. The degree of success in specifying and obtaining optimum quality for products will depend on the combined efforts of designers and manufacturers to define and coordinate their individual requirements, responsibilities and expectations.

No Manual of this type can be all-inclusive. The requirements and recommendations given herein are a general presentation of the important factors governing the quality of architectural precast concrete. Their value is dependent on rational application and a determination on the part of the individual producer to establish a standard of quality that will be recognized and respected by the specifier.

Quality assurance begins when the architect determines shape, size, color and texture for the architectural precast concrete products for a specific project. These characteristics may then determine the methods of manufacture, as well as the handling and installation techniques. Consultation with qualified representatives of experienced manufacturers will be of great value in achieving high quality products at a reasonable cost to the owner.

The Standard indicates the requirements to obtain an acceptable level of quality, but not the means or methods for doing so. It is not the intention of the Manual to restrict individual plant techniques. For example, a manufacturer's methods for mixing, placement, consolidation and curing of concrete will be acceptable, provided these methods can consistently result in uniform and durable concrete of the specified quality.

The information contained in the Commentary is not part of the Standards and shall not be used in judging quality control or production procedures.

The Commentary contains suggestions to help in carrying out the requirements or intent of the Standard.

This Manual has been prepared on the basis of current good practice. As significant changes in materials or process technology occur, revisions will be made to this Manual.

> Note: The production of architectural precast concrete may involve hazardous materials, operations, and equipment. This manual does not purport to address the safety issues associated with production. It is the responsibility of the producer to establish appropriate safety and health practices and determine the applicability of regulatory limitations.

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DEFINITIONS

Accelerated curing – The intentional addition of heat to the concrete environment to expedite curing. For the systems described in this Manual, all curing is at atmospheric pressure.

Admixture – A material other than water, aggregates and cement used as an ingredient in concrete, mortar, or grout to impart special characteristics.

Aggregate – Granular material, such as sand, gravel, and crushed stone, used with a cementing medium to form a hydraulic-cement concrete or mortar.

Aggregate, structural lightweight – Aggregate with a dry, loose weight of 70 lbs/ft^3 (1121 kg/m^3) or less.

Air-entraining admixture – A chemical added to the concrete for the purpose of providing minute bubbles of air (generally smaller than 1 mm) in the concrete during mixing to improve the durability of concrete exposed to cyclical freezing and thawing in the presence of moisture.

Ambient temperature – The temperature of the air surrounding the forms/molds into which concrete is to be cast, or of the air surrounding an element during curing.

Anchorage – The means by which the prestressing force is permanently transmitted from the prestressing steel to the concrete. In post-tensioning applications, a mechanical device comprising all components required to anchor the prestressing steel and transmit the prestressing force to the concrete.

Architectural precast concrete – A product with a specified standard of uniform appearance, surface details, color, and texture.

Architectural precast concrete trim units – Wet cast products with a high standard of finish quality and of relatively small size that can be installed with equipment of limited capacity, such as sills, lintels, coping, cornices, quoins, medallions, bollards, benches, planters, and pavers.

Backup mixture – The concrete mixture cast into the mold after the face mixture has been placed and consolidated.

Batching - The process of weighing or volumetrically measuring, and introducing into the mixer, the ingredients for a batch of concrete.

Bingham fluid – A fluid characterized by a non-null yield stress and a constant viscosity regardless of flow rate.

Bleeding – A form of segregation in which some of the water in a mixture rises to the surface of freshly placed concrete; also known as water gain.

Blocking – Materials used for keeping concrete elements from touching each other or other materials during storage and transportation.

Blocking—(SCC)The condition in which pieces of coarse aggregate combine to form elements large enough to obstruct the flow of the fresh concrete between the reinforcing steel or other obstructions in the concrete form/mold. This property is of increased importance in SCC because of the absence of vibration energy to dislodge these blockages.
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Bondbreaker – A substance placed on a material to prevent it from bonding to the concrete, or between a face material such as natural stone and the concrete backup.

Bonding agent – A substance used to increase the bond between an existing piece of concrete and a subsequent application of concrete such as a patch.

Bull float – A tool comprising of a large, flat, rectangular piece of wood, aluminum, or magnesium usually 8 in. (200 mm) wide and 42 to 60 in. (1.0 to 1.5 m) long, and a handle 4 to 16 ft. (1 to 5 m) in length used to smooth the unformed surfaces of freshly placed concrete.

Bugholes – Small holes on formed concrete surfaces formed by air or water bubbles, sometimes called blowholes.

Bundled strand – Strands that are grouped together in a bundle to concentrate the prestressing force. Bundled strand are in contact with each other and must be splayed out to the end of the member to allow bond to develop each strand from the end to the bundle point.

Camber – (1) The deflection that occurs in prestressed concrete elements due to the net bending resulting from application of a prestressing force (It does not include dimensional inaccuracies); (2) A built-in curvature to improve appearance.

Central-Mixed Concrete – Concrete mixed in a central stationary mixer and delivered to the casting area by buckets, truck mixer, truck agitator or non-agitating truck.

Certification – Assurance by a competent third party organization, operating on objective criteria and which is not subject to undue influences from the manufacturer or purchaser or to financial considerations, that elements are consistently produced in conformity with a specification. It not only proclaims compliance of a product with a specification, but also that the manufacturer's quality control arrangements have been approved and that a continuing audit is carried out.

Clearance – Interface space (distance) between two items.

Coarse aggregate – Aggregate predominately retained on the U.S. Standard No. 4 (4.75 mm) sieve; or that portion of an aggregate retained on the No. 4 (4.75 mm) sieve.

Cold weather - A period when, for more than three consecutive days, the following conditions exist: 1) the average daily air temperature is less than 40°F (5°C) and 2) the air temperature is not greater than 50°F (10°C) for more than one-half of any 24-hr period. The average daily temperature is the mean of the highest and lowest temperature occurring during the period from midnight to midnight.

Cohesiveness – The tendency of the SCC concrete constituent materials to stick together, resulting in resistance to segregation, settlement, and bleeding.

Compaction – The process whereby the volume of the concrete is reduced to the minimum practical space by the reduction of voids usually obtained through vibration, tamping, or a combination of both.

Connection – A device for the attachment of precast concrete units to each other or to the building or structure.

Covermeter – See R-meter.

Crazing – A network of visible, fine hairline cracks in random directions breaking the exposed face of a panel into areas from 1/4 in. to 3 in. (6 to 75 mm) across.

Creep – The time dependent deformation (shortening) of prestressing steel or concrete under sustained loading.

Curing – The maintenance of moisture and temperature within freshly placed concrete during some defined period following placing, casting, or finishing to assure satisfactory hydration of the cementitious materials and proper hardening of the concrete.

Detensioning (of strand or wire) – The transfer of strand or wire tension from the bed anchorage to the concrete.

Draft – The slope of concrete surface in relation to the direction in which the precast concrete element is withdrawn from the mold; it is provided to facilitate stripping with a minimum of mold breakdown.

Dunnage – See Blocking.

Dynamic stability - That characteristic of a fresh concrete mixture that ensure uniform distribution of all solid particles and air voids as the concrete is being transported and placed. Dynamic stability provides an indication of passing ability and blocking resistance. It also provides a measure of segregation resistance to prevent segregation resulting from energy inputs during placement and transport (i.e., free fall, etc.). Dynamic stability also provides a measure of resistance to flow separation over distance and around corners in the form/mold.

Ease of placement – Characterizes the amount of labor required to place the concrete during casting operations.

Elastic shortening – The shortening of a member that occurs immediately after the application of the prestressing force.

Elongation – Increase in length of the prestressing steel (strand) under the applied prestressing force.

Exposed aggregate concrete – Concrete manufactured so that the aggregate on the face is left protruding.
Face mixture – The concrete at the exposed face of a concrete unit used for specific appearance purposes.

Filling Capacity – A combination of fluidity and stability (passing ability) characteristics. It is the ability of the concrete to completely fill intricate form/mold or form/mold containing obstacles, such as reinforcement.

Fine aggregate – Aggregate passing the 3/8 in. (9.5 mm) sieve and almost entirely passing the No. 4 (4.75 mm) sieve and predominately retained on the No. 200 (75μm) sieve; or that portion of an aggregate passing the No. 4 (4.75 mm) sieve and predominately retained on the No. 200 (75μm) sieve.

Flowability – The ability of a fresh concrete to flow in a confined or unconfined form/mold of any shape, reinforced or not, under gravity and/or external forces, and assume the shape of that container.

Fluidity – The ability of a concrete mixture to flow. Inherent in this ability is the mixture's rheological characteristics of yield stress and plastic viscosity.

Fly ash – A finely divided residue with pozzolanic properties that results from the combustion of ground or powdered coal and that is transported by flue gasses. Due to its spherical shape and fineness, it can improve the rheology of SCC.

Form/Mold – The container or surface against which fresh concrete is cast to give it a desired shape.

Formed surface – A concrete surface that has been cast against a form/mold.

Form/mold release agent – A substance applied to the form/mold for the purpose of preventing bond between the mold and the concrete cast in it.

Friction loss – In post-tensioning applications, the stress (force) loss in a prestressing tendon resulting from friction created along the tendon profile during stressing.

Gap-graded concrete – A mixture with one or a range of normal aggregate sizes eliminated, and/or with a heavier concentration of certain aggregate sizes over and above standard gradation limits. It is used to obtain a specific exposed aggregate finish.
Ground (granulated) blast furnace slag (GGBFS) – A fine granular, mostly latent hydraulic binding material that can be added to SCC to modify the rheological properties of the material.

Grout – A mixture of cementitious materials and water, with or without sand or admixtures.

Hardware – Items used in connecting precast concrete units or attaching or accommodating adjacent materials or equipment. Hardware is normally divided into three categories:

> **Contractor's hardware –** Items to be placed on or in the structure in order to receive the precast concrete units, e.g., anchor bolts, angles, or plates with suitable anchors.
>
> **Plant hardware –** Items to be embedded in the concrete units themselves, either for connections and precast concrete erector's work, or for other trades, such as mechanical, plumbing, glazing, miscellaneous iron, masonry, or roofing trades.
>
> **Erection hardware –** All hardware necessary for the installation of the precast concrete units.

Homogeneous mixture – A uniform concrete mixture used throughout a precast concrete element.

Hot weather – A period when, for more than three consecutive days, the following conditions exist: 1) the average daily air temperature is greater than 77^{o}F (25^{0}C) and 2) the air temperature for more than one – half of any 24-hr period is not less than 85^{o}F (30^{o}C). The average daily temperature is the mean of the highest and the lowest temperatures occurring during the period from midnight to midnight

Initial prestress – The stress (force) in the tendon immediately after transferring the prestressing force to the concrete.

Jacking force – The maximum temporary force exerted by the jack while introducing the

prestressing force into the concrete through the prestressing strand.

Jig – A template or device to align parts of an assembly, usually for pre-assembling reinforcing steel and hardware cages, with a minimum of measurement to attain consistent accuracy from one cage to the next.

J-Ring test – Test used to determine the passing ability of SCC, or the degree to which the passage of concrete through the bars of the J-ring apparatus is restricted. A J-Ring is an apparatus consisting of a rigid ring supported on sixteen 5/8 inch (16 mm) diameter rods equally spaced on a 12 inch (300 mm) diameter circle 4 inches (100 mm) above a flat surface. See ASTM C1621/C1621M.

Laitance – Residue of weak and nondurable material consisting of cement, aggregate fines, or impurities brought to the surface of plastic concrete by bleed water.

L-Box test – A test used to test the horizontal and confined flowability of SCC and/or to check that the placement of SCC will not be compromised by unacceptable segregation and jamming or blocking of aggregates. See Appendix 1 TR-6-03.

Lifting frame (or beam) – A rigging device designed to provide two or more lifting points of a precast concrete element with a predictable load distribution and pre-arranged direction of pulling force during lifting.

Mark number – The individual identifying mark assigned to each precast concrete unit designating its position in the building.

Master mold – A mold which allows a maximum number of casts per project; units cast in such molds need not be identical, providing the changes in the units can be simply accomplished as pre-engineered mold modifications.

Matrix – The portion of the concrete mixture containing only the cement and fine aggregates (sand).

Miter – An edge that has been beveled to an angle other than 90 deg.

Passing ability – The ability of SCC to flow under its own weight (without vibration) and completely fill all spaces within intricate forms/molds, containing obstacles, such as reinforcement.

Paste – The fraction of the concrete mixture comprising powder plus water and air and admixture.

Pattern or positive – A replica of all or part of the precast element sometimes used for forming the molds in concrete or plastic.

Placeability – The ability to place the SCC mixture in the time span associated with the typical production mixing, transport, and placement such that the material remains homogeneous while exhibiting all of the required SCC fresh concrete properties.

Plastic cracking – Short cracks often varying in width along their length that occur in the surface of fresh concrete soon after it is placed and while it is still plastic.

Plastic viscosity – A material's internal resistance to flow under an applied shearing stress. Once the yield stress of a mixture is overcome, the plastic viscosity dominates flow.

Powder – Material of particle size passing the No. 100 sieve (0.15mm).

Powder additions – Finely divided inorganic material used in SCC in order to improve certain properties or to achieve special properties. These are additions to the current content of the SCC mixture.

Post-tensioning – A method of prestressing concrete whereby the tendon is kept from bonding to the fresh concrete, then elongated and anchored directly against the hardened concrete, imparting stresses through end bearing.

Precast engineer – The person or firm that designs precast concrete members for specified loads and may direct the preparation of the shop drawings.

Pretensioning – A method of prestressing concrete whereby the tendons are elongated, anchored while the concrete in the member is cast, and released when the concrete has gained sufficient strength to receive the forces transferred from the tendon through bond of the hardened concrete.

Production drawings – A set of instructions in the form of diagrams and text that contain all the information necessary for the manufacturer to produce the unit.

Quality – (1) The appearance, strength, and durability which are appropriate for the specific product, particular application, and expected performance requirements. (2) The totality of features and characteristics of a product that bear on its ability to satisfy stated or implied needs.

Quality assurance (QA) – The planned activity and systematic actions necessary to provide adequate confidence to the Owner and other parties that the products or services will perform their intended functions. Quality assurance is a management tool.

Quality control (QC) – Those actions related to the physical characteristics of the materials, processes, and services, which provide a means to measure and control the characteristics to predetermined quantitative criteria. Quality control is a production tool.

Quirk miter – A corner formed by two chamfered members to eliminate sharp corners and ease alignment.

R-meter – An electronic device used to locate and size reinforcement in hardened concrete.

Retarder – An admixture which delays the setting of cement paste and therefore of concrete.

Retarder, surface – A material used to produce exposed aggregate concrete by retreating or delaying the hardening of the cement paste on a concrete surface within a time period and to a depth to facilitate removal of this paste after the concrete element is otherwise cured.

Retempering – The addition of water or admixture and remixing of concrete which has started to stiffen in order to make it more workable.

Return – A projection that angles away from the main face or plane of view.

Reveal (1) Groove in a panel face generally used to create a desired architectural effect; and (2) The depth of exposure of the coarse aggregate in the matrix after production of an exposed aggregate finish.

Rheological properties – Properties dealing with the deformation and flow of fluids, primarily in relation to a fresh SCC mixture.

Rustication – A groove in a panel faces for architectural appearance; also reveal.

Sandwich wall panel – A prefabricated panel, which is a layered composite, formed by attaching two wythes or skins of concrete separated by an insulating core.

Scabbing – A finish defect in which parts of the form/mold face, including release agent, adhere to the concrete. Some probable causes are an excessively rough form/mold face, inadequate application of release agent, or delayed stripping.

Scouring – Irregular eroded areas or channels with exposed stone or sand particles. Some probable causes of this finish defect are excessively wet concrete mixture, insufficient fines, water in the form/mold when placing the concrete, poor vibration practices, and low temperature when placing concrete.

Sealer – A clear chemical compound applied to the surface of precast concrete units for the purpose of improving weathering qualities or reducing water absorption.

Segregation – The unintentional separation of the constituents of concrete or aggregate particles. In concrete, the coarse aggregate and drier material remaining behind and the mortar and wetter material flowing ahead. This also occurs in a vertical direction when wet concrete is overvibrated or dropped vertically into the forms/molds, the mortar and wetter material rise to the top. In aggregate, the coarse particles roll to the outside edges of the stockpile. In SCC, segregation may occur during transport, movement of the SCC within the forms/molds, or after placement.

Segregation resistance (stability)—The ability of SCC to remain homogeneous in composition during transport, placement, and after placement.

Self–consolidating concrete (SCC) – Concrete that can flow around reinforcement and consolidate under its own weight without additional effort and without exceeding specified limits of segregation.

Self-leveling concrete – A subset of SCC for horizontal applications (slabs, floors, surfaces that

will only be minimally finished). This type of SCC will seek a level grade in confined forms/molds and will reach maximum density without vibration.

Self-stressing form/mold – A form/mold provided with suitable end bulkheads and sufficient strength to resist the total prestressing force.

Set-up – The process of preparing forms/molds for casting, including installation of materials (reinforcement and hardware) prior to the actual placing of concrete.

Sheathing – A covering that forms an enclosure around the prestressing steel to avoid temporary or permanent bond between the prestressing steel and the surrounding concrete.

Shrink-Mixed Concrete – Concrete that is partially mixed in a stationary mixer then mixed completely and delivered to the casting site in a truck mixer.

Shrinkage – The volume change in precast concrete units caused by drying normally occurring during the hardening process of concrete.

Shop drawings – (1) Collective term used for erection drawings, production drawings, and hardware details; and (2) Diagrams of precast concrete members and the connecting hardware, developed from information needed for both field assembly (erection) and manufacture (production) of the precast concrete units.

Slump flow – Test method used to measure the unconfined flow and stability of SCC. See ASTM C1611/C1611M.

Specially finished structural precast concrete – A product fabricated using forms/molds and techniques common to the production of structural elements as defined in MNL-116, Appendix F and having specified surface finishes that require uniformity and detailing more demanding than typically required for structural elements. These surface finish requirements should be clearly specified and verified with appropriate samples and mockups.

Spread – The distance of lateral flow of concrete determined as the average diameter of the circular deposit of SCC at the conclusion of the slump flow test. See ASTM C1611/C1611M.

Spreader beam – A frame of steel channels or beams attached to the back of a panel, prior to stripping, for the purpose of evenly distributing loads to inserts and for lifting the panel about its center of gravity.

Stability – Resistance to segregation and/or settlement of aggregates during transport, placement, and subsequent to placement. The ability of SCC to remain homogeneous in composition by resisting actions which tend to cause the paste and aggregates to separate during transport, placement, and subsequent to placement.

Static Stability – The characteristic of a fresh concrete mixture that ensures uniform distribution of all solid particles and air voids once all placement operation are complete and until the onset of setting. Static stability provides a measure of resistance to the tendency to segregate due to gravity effects. This includes resistance to the tendency to settle, air migration within the mixture, and bleeding.

Stickiness – The property of concrete that relates to its propensity to adhere to finishing tools and other surfaces.

Strand – A group of wires laid helically over a central-core wire. A seven-wire strand would thus consist of six outer wires laid over a single wire core.

Strand anchor – A device for holding a strand under tension, sometimes called a strand chuck or vise.

Static segregation resistance – That characteristic of a fresh SCC mixture that ensures uniform distribution of all particles and air voids once all placement operations are complete and until the onset of setting, without excessive settlement or bleeding. See ASTM C1610/C1610M.

Stripping – The process of removing a precast concrete element from the form/mold in which it was cast.

Strongback/stiffback – A steel or wooden member that is attached to a panel for the purpose of adding stiffness during handling, shipping, and/or erection.

Structural lightweight concrete – Structural concrete made with lightweight aggregate with an air-dry unit weight of the concrete in the range of 90 to 115 lb/ft^3 (1440 to 1850 kg/m^3) and a 28-day compressive strength of more than 2500 psi (17.24 MPa).

Superplasticizer – A high-range water-reducing (HRWR) admixture that produces concrete of significantly higher slump without addition of water.

Surface retarder – A material used to retard or prevent the hardening of the cement paste on a concrete surface to facilitate removal of this paste after curing. This is primarily used to produce an exposed aggregate finish.

T-50 – A test to determine a relative measure of viscosity of SCC. Measured while performing a slump flow test, T-50 is the time it takes the concrete to reach a 500 mm (19.68 inches) diameter circle. See ASTM C1611/C1611M. Also referred to as the T-20 test when measurements are made in inches.

Tendon – A high strength steel element consisting of one or more wires, strands, or bars, or a bundle of such elements, used to impart prestressing forces to the concrete. In post-tensioned applications, a complete assembly consisting of anchorages, prestressing steel (strand), corrosion-inhibiting coating, and sheathing. It imparts the prestressing force to the concrete.

Thixotropic behavior – The property of a material that will allow it to exhibit a low viscosity while flowing, but stiffen and resist flowing after a short period at rest.

Tolerance – Specified permissible variations from stated requirements such as dimensions, location, alignment, strength, and air entrainment, etc.

Product tolerances – Those variations in dimensions relating to individual precast concrete members.

Erection tolerances – Those variations in dimensions required for acceptable matching of precast members after erection.

Interfacing tolerances – Those variations in dimensions associated with other materials in contact with or in close proximity to precast concrete.

Transfer strength – The minimum concrete strength specified for the individual concrete elements before transfer of the prestressing force. This is sometimes called detensioning strength or release strength.

Truck-Mixed Concrete – Concrete that is completely mixed in a truck mixer as it is delivered to the casting site.

Unbonded tendon – A tendon in which the prestressing steel (strand) is prevented from bonding to the concrete. When unbonded tendons are used, prestressing force is permanently transferred to the concrete only by the anchorage.

Unconfined Fluidity – The mixture's capacity to flow into and completely fill open form/mold, characterize ease of placement (ACI 304).

Veneered construction – The attachment of other materials, such as natural stone or clay products, to a concrete panel.

Viscosity – One of the rheological constants of fresh concrete, fresh mortar, and fresh paste when they are regarded as Bingham fluids. The magnitude of the change in the applied stress required for changing the unit flow velocity.

Viscosity modifying agent (VMA) – A material that, when added to concrete, changes the viscosity and improves the stability of the mixture at a constant fluidity.

Visual Stability Index (VSI) Rating – A qualitative visual assessment of the stability of an SCC mixture after performing a slump flow test. See ASTM C1611/C1611M.

Water to cementitious material ratio (w/cm) – The ratio of the amount of free water to the amount of cementitious material.

Water to powder volume – The ratio of the amount of free water to the amount of solids comprising the paste (material passing the No. 100 [0.15 mm] sieve) in a concrete or mortar mixture.

Wedges – Pieces of tapered metal with teeth that bite into the prestressing steel (strand) during transfer of the prestressing force. The teeth are beveled to assure gradual development of the tendon force over the length of the wedge. These are standard internal portions of a strand chuck assembly.

Wedge set – The relative movement of the wedges into the anchorage cavity during the transfer of the prestressing force to the anchorage.

Workability – That property of freshly mixed concrete or mortar that determines the ease and homogeneity, with which it can be mixed, placed, consolidated, and finished. It is a complex combination of aspects of fluidity, cohesiveness, transportability, compactability, and stickiness.

Yield stress – One of the rheological constants of fresh concrete, fresh mortar, and fresh paste when they are regarded as Bingham fluids. The minimum stress required to make the concrete flow.

DIVISION 1 – QUALITY SYSTEM

Standard

1.1 Objective

Quality control shall be an accepted and functioning part of the plant operation. Plant management must make a commitment to quality before quality programs can be effectively adopted or implemented at the operational level. Management shall establish a company standard of quality based on uniform practices in all stages of production, and shall require strict observance of such practices by all levels of personnel. Quality control personnel shall serve to confirm and oversee these practices, and shall report to the General Manager, Chief Engineer, or other non-Production management.

1.2 Plant Quality Assurance Program

1.2.1 General

The plant shall implement and maintain a

Commentary

C1.1 Objective

The general objective of this manual is to define the required minimum practices for the production of architectural precast concrete units and for a program of quality control. Overall product quality results from individual as well as company efforts.

Construction project specifications and manuals can prescribe and explain proper quality control criteria for all phases of production consistent with producing products of the highest quality. However, to ensure that such criteria are followed, inspection personnel and a regular program of auditing all aspects of production should be provided.

The individuals in control of operations should have the commitment to produce products of proper quality, and should delegate authority for assignment of the responsibilities necessary to achieve the desired results. Consistent quality can only be achieved if proper procedures are established and then carried out.

While the guidelines in this division address the quality control function, it is recognized that the primary responsibility for quality rests with production personnel. Accordingly, the production personnel should understand the role of quality control and work to ensure effective monitoring, timely responses, corrective actions, and improvement.

Although production personnel are responsible for the quality of products, it is necessary to have a system of checks and balances. Quality control inspections provide this check-and-balance system and consequently are a vital tool for management. The number of persons required to effectively perform the quality control functions will vary with the size and extent of plant operations.

Supervisory personnel are an integral part of the process and should be committed to the quality standards. The production of quality products requires uniformity of management's expectations for all areas of operations and types of products.

C1.2 Plant Quality Assurance Program

C1.2.1 General

The use of a written QSM requires an initial effort by