

ACI 211.5R-14

Guide for Submittal of Concrete Proportions

Reported by ACI Committee 211



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This guide is intended to assist both the submitter and reviewer by providing a description of necessary information to ensure that the appropriate information is provided. Information required for the preparation and review of a concrete mixture submittal is contained in reference documents such as codes and standards, project drawings and specifications, and other contract documents. These requirements depend on the intended use of the concrete, the available information, and the size of the project. Use of this guide may be limited when contract documents define the submittal format. This guide emphasizes that the concrete mixture is a unique combination of specific ingredients, from particular sources, and in quantities necessary to achieve the intended purpose.

Special note on mass versus weight: The mass of an object is defined as the amount of matter that is present. Mass is independent of any other property; weight is the force arising from particular gravitational field or other acceleration acting on a mass. The weight is thus dependent on both the mass and the acceleration due

to gravity rotation. In the common engineering system, a pound of mass is accelerated by gravity to be 1 lb of force. There is no need for distinction, and mass and weight are often used interchangeably in that the units are the same. A mass of 1 lb exerts a weight of 1 lb. There is a hidden gravitational constant. In the SI system, mass is expressed in grams and weight in Newtons. A mass of 1 kg exerts a weight of 9.81 N. It is correct, therefore, to use the term “mass” when determining how much material is being loaded into the plant, and when the mixtures are designed and proportioned. The industry, however, conventionally uses weight for these items. In the common measurement system, this creates no confusion. Thus, the vernacular term for the massing elements of the concrete plant is the weigh hopper. The batch record showing masses of materials in the concrete mixture are collectively referred to as batch weights. In an acknowledgement of this widespread industry practice, and in order to make the document as widely useable as possible, the term “weight” is used throughout to represent mass in the text. This is technically incorrect but is in line with common practice. In all conversions, both mass and weight are given (kilograms and Newtons).

Keywords: admixtures; aggregates; cementitious materials; durability; fine aggregates; fly ash; metakaolin; mixture proportioning; pozzolans; quality; silica fume; slag; slag cement; slump tests; water-cement ratio.

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Reference to this document shall not be made in contract documents. If items found in this document are desired by the Architect/Engineer to be a part of the contract documents, they shall be restated in mandatory language for incorporation by the Architect/Engineer.

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CHAPTER 1—INTRODUCTION AND SCOPE

1.1—General

Project specifications, reference publications, drawings, and other contract documents contain the requirements for concrete materials, proportions, and characteristics. Concrete mixtures intended to satisfy these requirements are usually submitted based on field test results, laboratory trial mixture data, or both. The purchaser's acceptance of materials and mixtures is based on conformance of the submitted details to the criteria contained in the contract documents.

This guide provides information to assist in the submittal and review of materials and concrete mixture proportions. It is intended to benefit both the submitter and the reviewer.

1.2—Scope

This guide is limited to the preparation and review of the submittal of proposed materials or concrete mixture proportions for conformance with the requirements of the contract documents. Quantitative proportions need only to be submitted when required by the contract documents. There are two types of submittals: prescriptive and performance.

CHAPTER 2—NOTATION AND DEFINITIONS

2.1—Notation

f_c' = specified compressive strength of concrete
 f_{cr}' = required average compressive strength of concrete, used as the basis for selection of concrete proportions

2.2—Definitions

performance submittal—data provided by the concrete supplier to confirm the subject concrete mixture meets all plastic and hardened state properties specified in the contract documents; mixture constituents are not included in these data.

prescriptive submittal—data provided by the concrete supplier to confirm the subject concrete mixture meets all mixture constituent and proportion requirements of the contract documents.

CHAPTER 3—MATERIALS AND PRODUCTION

3.1—Quality of constituent materials

Cementitious materials, aggregates, admixtures, fibers, and water should comply with the requirements stipulated in the contract documents. If a substitution is deemed necessary or desired from the specified material, such deviation will be elaborated along with appropriate documentation that the concrete will be of equal or better performance.

3.2—Submittal information

A submittal is the means by which the concrete supplier confirms that the subject concrete mixture meets all mixture constituent and proportion requirements of the contract documents. Specific data to be submitted will be identified in the contract documents. This section lists items for which a submittal is often required.

3.2.1 Cement or cementitious materials—The class, grade, or type of each material proposed for use on the project should be listed. Mill test reports, manufacturer's certification of compliance, or both, should be submitted. The cement or cementitious materials should comply with the appropriate ASTM requirements.

3.2.2 Aggregates—The types, sources, and individual gradings for each aggregate fraction should be identified. The aggregates should comply with either ASTM C33/C33M or C330/C330M, or have evidence of satisfactory performance. The combined gradings of the total blended aggregate should be provided when required. For coarse aggregates, the size designation (as described in ASTM C136)

C29M, C33/C33M, C330/C330M, or D448) or the nominal maximum size is needed.

3.2.3 Admixtures—The type of all admixtures proposed for use should be identified in accordance with ASTM C260/C260M, C494/C494M, C1017/C1017M, or another governing standard. Admixtures not governed by ASTM standards are subject to prior approval. These admixtures should be of the same type as those used in the trial mixtures from which strength data are obtained. If admixtures are to be added at a point other than the concrete batching facilities, the location should be identified.

3.2.4 Water—Water should meet ASTM C1602/C1602M. Nonpotable water requires evidence of satisfactory use in mortar or concrete in accordance with ASTM C1602/C1602M.

3.2.5 Fibers, color pigments, and other additions—The type of specific additions required by the project documents should be identified in accordance with governing standards. Materials identified in the submittal as alternates to products specified by name should include evidence of satisfactory performance and compliance to appropriate material standards.

CHAPTER 4—CONCRETE MIXTURE PROPORTIONS

4.1—Proportioning

For a prescriptive-based mixture, the concrete mixture proportions expressed in terms of quantity of each component per unit volume of concrete, combined with the freshly mixed concrete properties and the hardened concrete characteristics, constitute the submittal. The mass, the absolute volume, or both, contributed by each material in the mixture should be included in the submittal of the mixture proportions. Omission of components, quantities, or properties by the submitter may result in rejection of the submittal.

For a performance mixture submittal, concrete mixture proportions are not provided. Instead, the materials used; the class, grade, or type; and their ASTM specifications as listed in 3.2 are provided. In addition, the freshly mixed concrete properties and the hardened concrete characteristics constitute the submittal. Sections 4.2 and 4.3 apply only for a prescriptive mixture submittal.

4.2—Quantities by weight

The quantity of cementitious material added in the powder state should be expressed as lb/yd³ (kg/m³). The quantity of each separately batched size of coarse aggregate and fine aggregate should be expressed as lb/yd³ (kg/m³) in a saturated surface-dry (SSD) condition. Admixtures dispensed as liquids should be expressed as floz/yd³ or floz/cwt (L/m³) and, where applicable, the expected dosage range should be stated. The quantity of any premeasured, prepacked additives, such as fibers or color pigments, should be expressed in incremental units (sacks, bags, boxes, or tins) and lb/yd³ (kg/m³). The quantity of water batched, after aggregate moisture corrections, should be expressed as lb/yd³ (kg/m³).

4.3—Quantities by volume

The absolute volume of each material, air content, and the total sum of the absolute volumes of all materials should be provided in ft³ (m³).

CHAPTER 5—DOCUMENTATION OF SPECIFIED PROPERTIES

5.1—Freshly mixed concrete properties

Slump, unit weight, temperature, and air content should be reported for each mixture intended for use in accordance with ACI 301. Placement methods, such as pumping and slip forming, associated with each proposed mixture should be indicated where appropriate. Sometimes, different freshly-mixed concrete properties will be needed for different placement procedures and conditions; these should be consistent with the limits set in the contract documents. When the concrete is to be delivered to the point of placement by concrete pump or other conveyance, the location at which the properties mentioned previously are to be tested should be clarified in advance. Sampling of the concrete should be in accordance with ASTM C172/C172M.

5.2—Required average strength f_{cr}'

A concrete mixture submittal should demonstrate a compressive strength equal to or exceeding the required average strength f_{cr}' . Provisions for calculating f_{cr}' are contained in ACI 211.1, 214R, 301, and 318.

5.3—Past performance record submittal

When compressive strength data are available from concrete production using the proposed materials and batching facilities, the statistical analysis of the data should be performed in accordance with ACI 214R, 301, or 318. A data summary should be part of the submittal. These records become the basis for verifying the required average strength and validation of the proposed mixture. Concrete sampled and tested under conditions more stringent than those imposed by the contract documents may be excluded from use in calculation of the required average strength based on past performance.

5.4—Trial batch record submittal

If past performance records for the proposed mixture proportions are not available, trial batches may be required by the specification. When trial batches are used to establish strength relationships, the required fresh concrete properties should comply with ACI 318 or 301. Trial batch data and corresponding fresh concrete properties should be included in the submittal.

5.5—Specific properties other than strength

Performance properties other than strength required by the contract documents should be documented in accordance with applicable standards.

5.6—Resubmittals

A resubmittal may be required when changes are made to the concrete mixture, as outlined in ACI 318-11 Section 5.6. During the conduct of work, any changes to the mixture should demonstrate a compressive strength equal to or exceeding the current required average strength established by project records.

CHAPTER 6—ADDITIONAL SUGGESTED DOCUMENTATION

6.1—Transmittal letter

Each submittal should be introduced by an original transmittal letter identifying the proposed concrete mixture(s) to be furnished, the project for which it is submitted, and the method used to select proportions. The transmittal should be signed and dated by the person who prepared the submittal and the person selecting the mixture proportions. If more than one party contributed to the submittal, each contributor's role should be identified.

6.2—Submittal forms

The concrete mixture submittal, as described in Chapter 4, should be prepared as an independent document suitable for distribution. There are formats available that conveniently handle the required information. For this reason, a specified format is discouraged because it can either preclude the use of commercial computerized submittals, be repetitive in nature, or both. All of the information identified herein should be included on the submittal form(s) or in the documentation submitted.

Additional data summarizing the past performance records or trial batch data should be integral parts of the submittal, including special certification test data of materials. The form should be signed and dated by the person compiling or verifying the tabulation.

CHAPTER 7—REFERENCES

American Concrete Institute

ACI 211.1-91—Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete (Reapproved 2009)

ACI 214R-11—Guide to Evaluation of Strength Test Results of Concrete

ACI 301-10—Specifications for Structural Concrete

ACI 318-11—Building Code Requirements for Structural Concrete

ASTM International

ASTM C29/C29M-09—Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate

ASTM C33/C33M-11—Standard Specification for Concrete Aggregates

ASTM C94/C94M-13—Standard Specification for Ready Mixed Concrete

ASTM C150/C150M-12—Standard Specification for Portland Cement

ASTM C172/C172M-10—Standard Practice for Sampling Freshly Mixed Concrete

ASTM C260/C260M-10—Standard Specification for Air-Entraining Admixtures for Concrete

ASTM C330/C330M-13—Standard Specification for Lightweight Aggregate for Structural Concrete

ASTM C494/C494M-13—Standard Specification for Chemical Admixtures for Concrete

ASTM C618-12—Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

ASTM C989-10—Standard Specification for Slag Cement for Use in Concrete and Mortars

ASTM C1017/C1017M-07—Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete

ASTM C1240-12—Standard Specification for Silica Fume Used in Cementitious Mixtures

ASTM C1602/C1602M-12—Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

ASTM D448-12—Standard Classification for Sizes of Aggregate for Road and Bridge Construction