

Guide to Recommended Format for Concrete in Materials Property Database

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This guide presents recommended formats for concrete materials property data for entry into computerized databases. The purpose of this guide is to facilitate efficient storage and retrieval of information about concrete and its constituents with a computer and allow meaningful comparison of data from different sources. It is intended for use by those responsible for planning and maintaining a concrete materials property database as well as those who enter data. Recommended formats are provided for organizing and subdividing information about hydraulic cements, aggregates, chemical admixtures, mineral admixtures, fibers, water, concrete processing, and concrete properties and performance suitable for use in developing a computerized database. ACI Committee 126 developed this guide to be consistent with the principles of ASTM Committee E-49, Computerization of Material and Chemical Property Data. Before computers can replace laboratory notebooks and published reports as a more efficient means for storing and retrieving concrete materials property data, recording standards are needed. The recommended formats in this guide are a first step toward fulfilling this need.

Keywords: admixtures; aggregates; cements; concretes; database management; fibers; materials property database; recommended format.

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Concrete has been used worldwide as a construction material for at least 100 years. Scientific research, new discoveries, and in-service experience have contributed to many advances in the

state of the art. The key to continued advancement in this field is to provide a means of accurately reporting and widely distributing new information about concrete in an organized and rapid manner. The means to this end is a computerized database of concrete material properties.

Currently, printed materials, such as journals and textbooks, are the most prevalent means of sharing information regarding concrete. Comprehensive reports, such as the Portland Cement Association's report on long-term performance of cement in concrete (Klieger 1957, Wood 1992) are published from time to time, but too infrequently to be an efficient way of disseminating information. The information in notebook databases (Rumble 1993) developed in laboratories is invaluable to the specific project for which they are developed, but is not always sufficiently detailed, or even published at all, for use in future projects. As a result, the information recorded in these databases is often used only once, and is not as useful as it could be to the industry as a whole.

A computerized database can provide ready access to countless analyses of concrete materials property data, thereby eliminating the need for lengthy testing and analysis that may have already been performed by another group. This guide addresses the task of developing a standard format for recording and retrieving information in a database that would most benefit its users and the concrete industry at large.

1.2—Objective

A concrete materials property database is a collection of data files in which properties of concretes and their constituents are organized and stored. Each data file is unique because it only contains information for one particular concrete. For example, ACI Committee 207, Mass Concrete, has developed such a collection. ACI 207.1R contains data files for 30 concretes used in dams located throughout the world. The usefulness of such databases depends on the types and amount of data that they contain.

Accessing the information in a concrete materials property database can be difficult or impossible if the database management system poses constraints or if there are inconsistencies in format and completeness among data files. To consistently report all of the properties that may be available for a particular concrete, a comprehensive set of guidelines should be followed. The guidelines should address concrete identification and include guidance for presenting constituent information; processing parameters; and data on mechanical, thermal, and physical properties.

This document is a guide for establishing the content of a comprehensive concrete materials property database. Recommended formats for categorizing information about concrete constituents including hydraulic cements, aggregates, chemical admixtures, mineral admixtures, fibers, and water; concrete processing; and concrete properties and performance are provided. The information is organized into data segments and data elements suitable for use in developing a computerized database. If needed, data segments and data elements for other constituents may be developed using the recommended formats presented in this guide. Some of the constituents that may be used in concrete production but are

not covered in this guide include binders such as asphalt, gypsum, sulfur, and polymers; solids such as metal shot, pigments, carbon black, and redispersible powders; and liquids such as latex and other chemical solutions.

Recommendations in this guide are consistent with the principles of ASTM Committee E-49, Computerization of Material and Chemical Property Data. Guides prepared by ASTM E-49 for metals (ASTM E 1309 and E 1338); composite materials (ASTM E 1471); database terminology (ASTM E 1443); and data records (ASTM E 1313) were used in preparing this document. Although compliance with the recommended formats is considered essential for efficient computerization of concrete properties, this guide is not intended to replace reporting requirements established in consensus standards or contractual agreements, nor is it intended to serve as a step-by-step manual for use in database management or computer implementation.

1.3—Use of guide

This guide is intended for use by those responsible for planning a database management system, entering data into a concrete materials property database, or preparing tables of concrete properties for use by others. It should be of particular use to those who wish to share data with others, either within the same organization or between organizations. When necessary, users of this guide may expand the number of data segments or create different data elements so that the required information is included in the database. The order of the data elements is not rigid and can be varied, depending on the protocol of the database management system. It is important, however, that the relationships among the data elements and data segments be considered during the database development process.

Database development begins with a list of essential and desirable data elements to be included in the database. These data elements form the basis for a data dictionary. A data dictionary is a guide for understanding the information in a database and has features similar to those in a language dictionary (Begley 1993). In the data dictionary, one can find a description, the origin, and the usage of each specific piece of data presented in the database. It also provides information describing the relationship of a given piece of data to all other pieces of data, including the format that best fits the data. The data dictionary is a framework on which the database schema is built. A database schema is a perspective, a way of seeing the information in the database (Begley 1993). The schema provides a transition from the data elements to the user's viewpoint.

CHAPTER 2—GENERAL DATABASE TERMINOLOGY

A concrete materials property database consists of data files that are composed of data segments and data elements. These terms, along with others used to describe the components of a concrete materials property database, are presented in this section. It is essential that standardized terminology related to materials databases be developed (Newton 1993). Terms and definitions provided here are intended to complement those already provided in ACI 116R

and ASTM C 125, C 219, E 1013, and E 1443. Relationships among the individual components of a concrete materials property database are shown in Fig. 2.1.

Concrete materials property database—A collection of data files in which properties of concretes and its constituents are organized and stored.

Data—The set of scientific or technical measurements, observations, or facts that can be represented by numbers, tables, graphs, models, text, or symbols used as a basis for reasoning or calculation.

Data dictionary—A guide for understanding all of the essential and desirable data about concrete and its constituents that are included in the database.

Data element—One individual piece of information used in describing a material or to record test results; for example, a variable name or test parameter (ASTM E 1313). Each data element in this guide is represented by a data element number, data element name, data element type, and data element format. Certain data elements included in this guide are essential for unique concrete identification. Entries for these particular data elements may be recorded at various locations throughout a data file.

Data element format—The presentation style used to report information or data. Alphanumeric, floating-point, and special-entry formats are specified in this guide for use in reporting information, unit designations, numerical values, and text. Details concerning date and time are presented in Section 3.4.

Data element name—A descriptive term or title that designates the type of information or data to be reported in the data element.

Data element number—A four- or six-digit number used to denote an individual data element. These numbers represent the entire set of information in a particular data element. Data element numbers are considered a functional part of the database and may be used for data element reference. Data element numbers are not, however, considered data. The first digit in the data element number is used as a cross reference. Assigned ranges of data element numbers are presented in Table 2.1.

Data element type—A designation that reflects the significance of the data element entry. All data element entries are considered either essential or desirable. Data elements are considered essential if they are required to make a meaningful comparison of property data from different sources. A comparison of data from different sources may still be possible if essential information is omitted, but the value of the comparison may be greatly reduced. Nonessential or desirable data elements are used to report supplementary information.

Data file—A complete set of concrete materials property database entries or data records that contain information and properties for a particular concrete.

Data record—The collection of data elements used to describe a material or the results of a specified test in their entirety (ASTM E 1313).

Data segment—A category of information that is used to subdivide and designate sets of data elements. Certain

data segments may be used a number of times to report constituent information and properties for a particular concrete.

Database scheme—A way of representing the information in the database so that the data are meaningful and useful.

Desirable data element—A data element in a record that provides supplementary information necessary to make the record comprehensive or complete.

Essential data element—A data element in a record that must be completed to make the record meaningful in accordance with the pertinent guidelines. Failure to complete an essential data element may render the record unusable in a database or in data exchange. Comparison may still be possible if essential information is omitted, but the value of the comparison may be greatly reduced.

Material class—Any of several broad groups of materials into which a given material may be classified; for example, metals, ceramics, composites, or energetic materials (ASTM E 1443). The class of materials covered by this guide is concrete.

Property—A measurable or derivable attribute of a material. A property of a given material may take different values as influenced by one or more independent variables. It is therefore often referred to as a dependent variable (ASTM E 1443). In this guide, a concrete property is any property of the concrete. A constituent property is any property determined by testing to quantify the effects a constituent has on the properties and performance of concrete made using the constituent.

Property class—Any of several broad groups of properties; for example, physical, mechanical, or chemical properties (ASTM E 1443).

CHAPTER 3—GENERAL FORMATS

The recommended formats for concrete in this guide are represented by individual data elements that cover all aspects of concrete materials technology. Data elements that address similar topics are grouped together to form data segments. The following chapters identify the data segments and data elements developed specifically for hydraulic cements, aggregates, chemical admixtures, mineral admixtures, fibers, water, processing, properties and performance, and concrete identification. Each of these data categories includes a table that contains sets of data elements that, together, create the recommended format for concrete.

This chapter defines general formats that are used repeatedly for each category of the database.

3.1—Units

Numerical values that represent data, such as length and stress, have historically been reported using units that reflect local customs and practices. To minimize the possibility for misunderstanding and confusion associated with use of customary units, use of the International System of Units (SI) is essential. The following three data elements are recommended for use whenever a numerical value representing such measurement is reported in a concrete materials property database.

Customary units designation—The customary units that correspond to the reported numerical value. Example entries include in. and psi.

SI units designation—The units in the International System of Units (SI) that correspond to the reported numerical value. These designations should conform to requirements provided in IEEE/ASTM SI 10. Example entries include mm and MPa.

Customary to SI units conversion factor—A conversion factor required to convert customary units to SI units. This number is reported as a floating point decimal. For example, the conversion factors for in. to mm and psi to MPa are 25.4 and 0.006894757, respectively.

3.2—Standards-producing organization information

Requirements for concrete constituents and techniques for determining concrete properties are routinely provided in standardized material specifications and test methods. These documents may be issued by companies and industries as well as national and international organizations. Information that identifies and defines an applicable standard is a meaningful part of a concrete materials property database. The following four data elements are recommended for use whenever a standard specification, material property, or test result is reported in a concrete materials property database.

Standards organization—A name or title of the company, industry, or national or international organization that issued the applicable standard. ASTM is an example of an organization that issues standard specifications and test methods for concrete.

Standard number—The number of the standard issued by the organization reported previously. C 39, C 78, C 138, C 143, C 173, and C 293 are examples of ASTM test method standard numbers that correspond to test methods for determining properties of concrete.

Standard designation—A designation, if any, within the standard reported. Type I, Type A, and Class F are examples of standard designations for certain ASTM material specifications. Standard designation entries may not be applicable for test methods and standard specifications that do not include such designations.

Standard version—A version is usually a number that represents the year of issue.

3.3—Temperature

Although the SI unit for temperature is Kelvin (K), wide use is also made of degrees Celsius (C), which is the SI unit used for expressing Celsius temperature and temperature intervals. To minimize the possibility for misunderstanding and confusion, it is recommended that temperature and temperature interval values be reported in a concrete materials property database using degrees Celsius (C). If temperature and temperature interval values are reported using degrees Fahrenheit (F), then equivalent values in degrees Celsius (C) should also be reported.

3.4—Date and time

For consistency, special formats are provided for use in reporting date and time-of-day data in a concrete materials property database. The YYYY-MM-DD (year:month:day)

format should be used to report the date. The first four digits of this format represent the year, the next two digits represent the month, and the last two digits represent the day. For example, 19941024 represents October 24, 1994.

The HH:MM (hour:minute) format should be used to report the time of day. The first two digits represent the hour of the day and is based on a 24 hr clock. The last two digits represent minutes. For example, a data entry of 14:30 represents 2:30 p.m.

CHAPTER 4—CONCRETE IDENTIFICATION

Essential and desirable data elements necessary for the unique identification of a concrete in a materials property database are provided herein. Distinguishing one concrete from another is difficult to accomplish with a single database entry. Most data elements for concrete identification serve a dual role as concrete identifiers and data elements for other data categories. Data elements for the concrete designation data segment, however, are used solely for concrete identification. Data segments and corresponding data elements for concrete identification are listed in Table 4.1. Although it is not necessary for every data element to be used for every concrete, it is suggested that entries be provided for each essential data element.

Data elements for concrete identification are organized into six data segments. The corresponding data elements are listed following each data segment description.

4.1—Concrete designation

The concrete designation data segment includes descriptive identifiers for each concrete in a concrete materials property database. These identifiers are based on a multilevel classification system that uses established terminology and designations to categorize the concrete.

- *Material class*—The class of materials covered by this guide is concrete.
- *Binder type*—Suggested entries for this data element are provided in Table 4.2.
- *Concrete category*—These entries are based on bulk density. Suggested entries for this data element are provided in Table 4.2.
- *Concrete group*—These entries indicate the end use or application of the concrete or other types of unique features or characteristics. Suggested entries for this data element are provided in Table 4.2.
- *Processing group*—These entries distinguish concretes from the same class, type, category, and group from one another. The processing group identifier generally reflects the procedure or manufacturing technique used to process the concrete. Suggested entries for this data element are provided in Table 4.2.
- *Concrete identification number*—A unique alphanumeric concrete identifier generally established by the organization that prepares the concrete specification and may be used by the database manager to represent the concrete in the materials property database. A unified numbering system (UNS) for metals and alloys has been developed and is described in ASTM E 527, but a standardized numbering system for concrete has not yet been developed.

- *Common name*—The common name is often provided by the concrete supplier and may be used by the database manager to represent the concrete in the materials property database. Mixture A, Lightweight Concrete, and 3000 psi Concrete are examples of commonly used concrete names.
- *Concrete designation notes*—These entries contain any additional information that may be useful in establishing a unique identifier for the concrete. A similar data element is used in each constituent category.

4.2—Concrete supplier

The concrete supplier data segment is used to report information that reflects the origin of the concrete. This data segment is included in concrete processing described in Chapter 11.

- *Concrete supplier name*—The name of a concrete producer, research organization, or contractor may be used as an entry in this data element.
- *Concrete supplier address*
- *Concrete supplier plant location*—An address, batch plant designation, or other type of identifier may be entered in this data element.
- *Concrete supplier identification number*—This entry is an alphanumeric designation provided by the concrete supplier to distinguish one concrete batch or mixture from another.

4.3—Constituent designation

The constituent designation data segment includes descriptive identifiers for a constituent in a concrete mixture. This data segment is repeated for each constituent used in the concrete. Data elements for a generic constituent are listed in Table 4.1. Data elements that provide descriptive identifiers intended specifically for hydraulic cement, aggregate, chemical admixture, mineral admixture, fibers, and water designation are presented in Chapters 5 to 10, respectively.

- *Constituent class*—Cement, aggregate, chemical admixture, mineral admixture, fibers, and water are examples of constituent classes.
- *Constituent common name*—Portland cement, crushed limestone (coarse), crushed limestone (fine), fly ash, air-entraining admixture, water-reducer, and water are examples of common names for constituents.
- *Constituent producer name*
- *Constituent producer plant location*
- *Constituent producer identification number*—This alphanumeric designation is assigned by the producer or supplier.
- *Constituent designation notes*—This entry includes any additional information that may be useful to create an identifier for the constituent.

4.4—Concrete mixture proportions

The concrete mixture proportions data segment is used to report the amount of each constituent in a given volume of concrete. Data elements in this data segment are included in concrete processing described in Chapter 11. Because this

data segment is used repeatedly for each constituent in the concrete, entries should be consistent with corresponding entries in the constituent designation data segment.

- *Constituent quantity per unit volume of concrete*—This quantity may be expressed as mass or volume.

4.5—Concrete processing

The concrete processing data segment is used to report information related to batching, mixing, transporting, placing, consolidating, finishing, and curing of concrete. Data elements in this data segment are included in concrete processing described in Chapter 11.

- *Batching process*—Manual weight batching, semiautomatic weight batching, automatic weight batching, cumulative automatic weight batching, individual automatic weight batching, and volumetric batching are examples of concrete batching processes.
- *Mixing equipment*—Colloid mixer, horizontal shaft mixer, non-tilting mixer, open-top mixer, pan mixer, paddle mixer, continuous mixer, tilting mixer, transit mixer, and vertical shaft mixer are examples of types of mixers used to prepare a batch of concrete.
- *Processing date*—Use the YYYYMMDD format described in Section 3.4 to indicate the date the concrete was mixed (or batched).
- *Transporting equipment*—Wheelbarrow, buggy, chute, dump bucket, truck with agitator, truck without agitator, conveyor belt, portable conveyor, feeder or series conveyor, spreading conveyor, radial spreader, straight line spreader, piston pump, pneumatic pump, and squeeze pressure pump are examples of transporting equipment.
- *Placing equipment*—Scoops, shovels, buckets, hoppers, chutes, tremie, paving equipment, and slipforming equipment are examples of placing equipment.
- *Consolidating equipment*—Spades, hand tampers, rods, power tampers or rammers, internal vibrators, external vibrators, surface vibrators, and table vibrators are examples of consolidating equipment.
- *Surface finish*—Exposed aggregate, trowelled, broomed, rubbed, floated, screeded, polished, grooved, and formed are examples of surface finishes.
- *Curing technique*—Curing with water and curing by moisture retention are two techniques that are typically used to cure concrete members. Wet burlap, damp sand, sprinkling, soaking, and ponding are examples of curing materials or procedures used in the wet curing technique. Polyethylene film, plastic membranes, waterproof paper, and curing compounds are examples of curing materials used in the moisture retention curing technique.

4.6—Concrete property

The concrete property data segment is used to report any property of freshly mixed or hardened concrete that provides information essential to the identification of the concrete. Data elements in this data segment are included in properties and performance described in Chapter 12.

- *Concrete property*—Water-cement ratio, unit weight, air content, slump, compressive strength, modulus of rup-

ture, and splitting tensile strength are examples of properties that could be considered properties of concrete.

- *Concrete property value*—This is the property value of freshly mixed or hardened concrete that provides reference information essential to the identification of the concrete, data useful in making meaningful comparisons between concretes with similar compositions and characteristics, or results for use in establishing acceptability in accordance with project or material specification requirements, such as those described in Section 11.2.
- *Concrete phase*—Fresh or hardened are examples of concrete phase.
- *Concrete age*—This entry represents the time elapsed between the start of mixing and end of testing of the concrete.

CHAPTER 5—HYDRAULIC CEMENT

Data segments and corresponding data elements for reporting information about hydraulic cement in a materials property database are listed in Table 5.1 and defined here. Data elements for hydraulic cement information are organized into four data segments.

5.1—Hydraulic cement designation

Many types of binders are used to produce concrete and mortar. Materials such as asphalt, gypsum, hydraulic cement, polymers, and sulfur are used for this purpose. Hydraulic cements including portland cement, calcium-aluminate cement, blended cement, expansive cement, and natural cement are used most often. These materials are called hydraulic cements because they set and harden by chemical interaction with water. The hydraulic cement designation data segment includes descriptive terms used to establish a unique identifier for each hydraulic cement in the concrete mixture. Data elements in this data segment are used repeatedly for each hydraulic cement. As described in Chapter 4, data elements for this data segment serve a dual role as concrete identifiers. If needed, data elements for other types of binders used in the concrete may be developed using the recommended formats for hydraulic cement as an example.

- *Constituent class*—The class of constituents covered by this data category is hydraulic cement.
- *Hydraulic cement common name*—Aluminate, blended, expansive, natural, and portland cement are examples of common names for hydraulic cements.
- *Hydraulic cement producer name*
- *Hydraulic cement producer plant location*
- *Hydraulic cement producer identification number*—An alphanumeric designation assigned by the producer or supplier to distinguish one lot or batch of the hydraulic cement from another.
- *Hydraulic cement designation notes*

5.2—Hydraulic cement processing

The hydraulic cement processing data segment is used to report information about the equipment used to produce the hydraulic cement. Two data elements are used primarily to identify the constituents used to produce the hydraulic

cement, and two are used repeatedly to report their chemical composition.

- *Processing date*
- *Kiln system*
- *Grinding mill*
- *Grinding mill manufacturer*
- *Grinding mill manufacturer address*
- *Hydraulic cement constituent*—Clinker, calcium sulfate (gypsum), and additives such as limestone and fly ash are commonly used constituents in hydraulic cement production.
- *Hydraulic cement constituent percent by mass*
- *Chemical compound*—The name or chemical formula for a chemical compound in the hydraulic cement constituent.
- *Chemical compound percent by mass*
- *Hydraulic cement constituent composition test method*
- *Hydraulic cement processing notes*

5.3—Hydraulic composition and characteristics

The hydraulic cement composition and characteristics data segment is used to report information that defines the chemical composition and characteristics of the hydraulic cement. Four data elements are used repeatedly to report the oxide and phase contents and two are used repeatedly to report sieve analysis results.

- *Oxide*—The name or chemical formula for an oxide in the hydraulic cement.
- *Oxide content*—(Percent by mass)
- *Phase*—The name or chemical formula for a phase in the hydraulic cement.
- *Phase content*—(Percent by mass)
- *Carbon dioxide content*—(Percent by mass)
- *Water content*—(Percent by mass)
- *Insoluble residue*—(Percent by mass)
- *Hydraulic cement composition test method*
- *Sieve analysis test method*
- *Sieve designation*—The nominal size or number of the sieve used during the sieve analysis to establish hydraulic cement particle size distribution.
- *Sieve opening dimension*
- *Total percentage of material passing sieve*—A floating point numerical value between 0 and 100 that represents the percentage of material that passes the sieve.
- *Total percentage of material retained on sieve*—A floating point numerical value between 0 and 100 that represents the percentage of material retained on the sieve.
- *Cement property*—The name of the cement property, such as specific surface area, being reported.
- *Hydraulic cement property value*
- *Color*
- *Color test method*
- *Composition and characteristics notes*

5.4—Hydraulic cement performance in concrete

The hydraulic cement performance in concrete data segment is used to report test results that quantify the effect a hydraulic cement has on the properties and performance of concrete made using the material. Results that could be re-

ported include, but are not limited to, rheological properties, setting time, compressive strength, and flexural strength. These results may be obtained from tests performed using concrete, cement paste, or mortar. Twelve data elements are used repeatedly for each constituent property being reported. Data elements for reporting additional information about the test method used to determine the property are provided in Section 12.2. Recommended formats for reporting information about processing of the concrete that was prepared to determine hydraulic cement performance in concrete are presented in the processing data category provided in Chapter 11. To eliminate repetition and minimize redundancy, data elements for processing data are not included in this data segment. For the hydraulic cement portion of a concrete materials property database to be considered comprehensive and complete, however, they need to be included as part of this data segment.

- *Constituent property*—The name of the property being reported to quantify the effect the hydraulic cement has on the properties and performance of concrete made using the hydraulic cement. Heat of hydration, compressive strength, and flexural strength are examples of constituent properties.
- *Constituent property value*
- *Concrete phase*
- *Concrete age*
- *Constituent property notes*

CHAPTER 6—AGGREGATES

Data segments and corresponding data elements for reporting information about aggregates in a materials property database are listed in Table 6.1 and defined here. Data elements for aggregates are organized into three data segments.

6.1—Aggregate designation

Aggregate is a granular material consisting of individual particles that range in size, shape, composition, and density. It is the principle constituent in concrete. Fine aggregate includes materials that pass the 9.5 mm (3/8-in.) sieve and predominantly retained on the 75 μ m (No. 200) sieve; or that portion that passes the 4.75 mm (No. 4) sieve and predominantly retained on the 75 μ m (No. 200) sieve. Coarse aggregate is material that is predominantly retained on the 4.75 mm (No. 4) sieve. Common names for aggregate include sand, gravel, crushed stone, crushed hydraulic-cement concrete, or iron blast-furnace slag. Lightweight materials such as perlite, normalweight materials such as limestone, and heavyweight materials such as magnetite may be used as aggregates in concrete. Most normalweight concrete is produced using a combination of coarse and fine aggregate particles that have a density comparable to that of limestone (specific gravity equals approximately 2.7). Lightweight and heavyweight concretes, however, may also be produced by using combinations of aggregate particles with either low, normal, or high density. The aggregate designation data segment includes descriptive terms used to establish a unique name for each aggregate in the concrete mixture. Data elements in

this data segment are used repeatedly for each aggregate. They also serve a dual role as concrete identifiers.

- *Constituent class*—The class of constituents covered by this data category is aggregate.
- *Aggregate common name*—Coarse and fine aggregate are examples of common names for aggregates.
- *Aggregate producer name*
- *Aggregate producer plant location*
- *Aggregate producer identification number*—An alphanumeric designation assigned by the producer or supplier to distinguish one lot or production run of aggregate from another.
- *Aggregate designation notes*

6.2—Composition and characteristics

The composition and characteristics data segment is used to report information that defines the chemical or mineralogical composition and characteristics of the aggregate. Two data elements are used repeatedly to report information about the mineralogical composition of the aggregate, and two are used repeatedly to report results of the sieve analysis.

- *Material*—The name of the material used to produce the aggregate. Aggregate may be produced from natural materials such as granite, limestone, and magnetite or manufactured materials such as iron blast-furnace slag.
- *Mineralogical name*—The name of a chemical compound or mineral constituent present in the aggregate.
- *Percent by mass*—The amount (percent by mass) of the chemical compound or mineral constituent present in the aggregate.
- *Shape*—Flat, elongated, and cubical are terms that may be used to describe the shape of aggregate particles.
- *Angularity*
- *Surface texture*
- *Sieve analysis test method*
- *Sieve designation*
- *Sieve opening dimension*
- *Total percentage of material passing sieve*
- *Total percentage of material retained on sieve*
- *Aggregate property*—Specific gravity, absorption, moisture content, surface moisture, maximum nominal size, size number (coarse aggregate), clay lumps and friable particles, inorganic impurities, fineness modulus, unit weight, and voids are examples of aggregate properties.
- *Aggregate property value*
- *Petrographic notes*—Information obtained from a petrographic examination of a representative sample of the aggregate.
- *Composition and characteristics notes*

6.3—Aggregate performance in concrete

The aggregate performance in concrete data segment is used to report test results that quantify the effect an aggregate has on the properties and performance of concrete made using the material. These results may be obtained from tests performed using concrete or mortar. This data segment is represented by 12 data elements that are used repeatedly for

each constituent property being reported. Data elements for reporting additional information about the test method used to determine the property are provided in Section 12.2. Recommended formats for reporting information about processing of the concrete that was prepared to determine aggregate performance in concrete are provided in Chapter 11. To eliminate repetition and minimize redundancy, data elements for processing data are not included in this data segment. For the aggregate portion of a concrete materials property database to be considered comprehensive and complete, however, they need to be included as part of this data segment.

- *Constituent property*—The name of the property being reported to quantify the effect the aggregate has on the properties and performance of concrete made using the aggregate. Potential volume change and potential alkali reactivity are examples of constituent properties.
- *Constituent property value*
- *Concrete phase*
- *Concrete age*
- *Constituent property notes*

CHAPTER 7—CHEMICAL ADMIXTURES

Data segments and corresponding data elements for reporting information about chemical admixtures in a materials property database are listed in Table 7.1 and defined here. Data elements for chemical admixture information are organized into four data segments.

7.1—Chemical admixture designation

Chemical admixtures are either liquids or water-soluble solids that are added to concrete, grout, or mortar to modify the properties and performance of the fresh or hardened product. These materials may be added before or during mixing. Guidelines for use of chemical admixtures in concrete are generally provided by the manufacturer. The chemical admixture designation data segment includes descriptive terms used to establish a unique identifier for each chemical admixture in the concrete mixture. Data elements in this data segment are used repeatedly for each chemical admixture. They also serve a dual role as concrete identifiers.

- *Constituent class*—The class of constituents covered by this data category is chemical admixture.
- *Chemical admixture common name*—Air-entraining admixture and water reducer are examples of common names for chemical admixtures.
- *Chemical admixture producer name*
- *Chemical admixture producer plant location*
- *Chemical admixture producer identification number*—An alphanumeric designation assigned by the producer or supplier to distinguish one lot or batch of the chemical admixture from another.
- *Chemical admixture designation notes*

7.2—Composition and characteristics

The composition and characteristics data segment is used to report information that defines the chemical composition and characteristics of the chemical admixture. Two data ele-

ments are used repeatedly to report the chemical constituents in the admixture.

- *Chemical constituent*—The name of a chemical compound used in the manufacture of the chemical admixture.
- *Percent by mass*—The amount (percent by mass) of the chemical constituent used in the manufacture of the chemical admixture.
- *Total active agent*—The mass of the active agent per unit mass of the chemical admixture.
- *pH*
- *Density*
- *Composition and characteristics notes*

7.3—Manufacturer recommendations

The manufacturer recommendations data segment is used to report information provided by the manufacturer about the chemical admixture including guidelines for its use in concrete. If necessary, additional data elements can be developed to report other recommendations provided by the manufacturer.

- *Safety information*—Any known hazard linked to the use of the chemical admixture. References to a material safety data sheet (MSDS) may be sufficient.
- *Dosage*—The amount of a chemical admixture per unit mass of cement or unit volume of concrete recommended by the chemical admixture manufacturer.
- *Time of addition*—The recommended time after the first contact of the water and the cement that the chemical admixture is to be added to the concrete.
- *Method of addition*—The method recommended for adding the chemical admixture to the concrete. Methods that may be recommended include mechanical (a metering pump) or manual (pouring the chemical admixture into the mixer) techniques.
- *Recommended use*—Directions to the user on obtaining the desired result.
- *Temperature limit for use, high*—The maximum recommended temperature limit for use of the chemical admixture in concrete.
- *Temperature limit for use, low*—The minimum recommended temperature limit for use of the chemical admixture in concrete.
- *Shelf life*—The length of time that the chemical admixture can be stored without losing its effectiveness.
- *Storage temperature limit, high*—The maximum ambient temperature (C) recommended for storage of the chemical admixture during its shelf life.
- *Storage temperature limit, low*—The minimum ambient temperature (C) recommended for storage of the chemical admixture during its shelf life.
- *Freezing point*
- *Boiling point*
- *Modification mechanism*—A brief description of the mechanism by which the chemical admixture modifies the properties and performance of the concrete.
- *Compatibility with other constituents*—Information about the potentially deleterious effect on concrete that

could occur when the chemical admixture is used in combination with other chemical admixtures or concrete constituents.

- *Manufacturer recommendations notes*

7.4—Chemical admixture performance in concrete

The chemical admixture performance in concrete data segment is used to report test results that quantify the effect a chemical admixture has on the properties and performance of concrete made using the admixture. Results that could be reported include, but are not limited to, rheological properties, setting time, air content, compressive strength, flexural strength, length change, and freeze-thaw resistance. These results may be obtained from tests performed using concrete, cement paste, or mortar.

This data segment is represented by 12 data elements that are used repeatedly for each constituent property being reported. Data elements for reporting additional information about the test method used to determine the property are provided in Section 12.2. Recommended formats for reporting information about processing of the concrete that was prepared to determine chemical admixture performance in concrete are provided in Chapter 11. To eliminate repetition and minimize redundancy, data elements for processing data are not included in this data segment. For the chemical admixture portion of a concrete materials property database to be considered comprehensive and complete, however, they need to be included as part of this data segment.

- *Constituent property*—The name of the property being reported to quantify the effect the chemical admixture has on the properties and performance of concrete made using the chemical admixture. Slump and air content are examples of constituent properties.
- *Constituent property value*
- *Concrete phase*
- *Concrete age*
- *Constituent property notes*

CHAPTER 8—MINERAL ADMIXTURES

Data segments and corresponding data elements for reporting information about mineral admixtures in a materials property database are listed in Table 8.1 and defined herein. Data elements for mineral admixture information are organized into four data segments.

8.1—Mineral admixture designation

Mineral admixtures are finely divided natural or byproduct materials that are added to concrete before mixing to modify the properties of the fresh or hardened product. Coal fly ash, raw or calcined natural pozzolans, and silica fume are commonly used as mineral admixtures when cementitious or pozzolanic action is necessary or when other properties attributed to mineral admixtures are desired. The mineral admixture designation data segment includes descriptive terms used to establish a unique identifier for each mineral admixture in the concrete mixture. Data elements in this data segment are used repeatedly for each mineral admixture. They also serve a dual role as concrete identifiers.

- *Constituent class*—The class of constituents covered by this data category is mineral admixture.
- *Mineral admixture common name*—Fly ash and silica fume are examples of common names for mineral admixtures.
- *Mineral admixture producer name*
- *Mineral admixture producer plant location*
- *Mineral admixture producer identification number*—An alphanumeric designation assigned by the producer or supplier to distinguish one lot or batch of the mineral admixture from another.
- *Mineral admixture designation note*

8.2—Composition and characteristics

The composition and characteristics data segment is used to report information that defines the chemical composition and characteristics of the mineral admixture. Two data elements are used repeatedly to report the chemical constituents in the admixture.

- *Chemical constituent*—The name of a chemical compound in the mineral admixture.
- *Percent by mass*—The amount (percent by mass) of the chemical constituent in the mineral admixture.
- *Mineral admixture property*—The name of the mineral admixture property being reported. Density, moisture content, fineness, specific surface area, and loss on ignition are examples of mineral aggregate properties.
- *Mineral admixture property value*
- *Composition and characteristics notes*

8.3—Manufacturer recommendations

The manufacturer recommendations data segment is used to report information provided by the manufacturer about the mineral admixture including guidelines for its use in concrete. If necessary, additional data elements can be developed to report other recommendations provided by the manufacturer.

- *Safety information*
- *Dosage*
- *Storage conditions*—The environmental conditions recommended by the mineral admixture manufacturer for storage of the mineral admixture.
- *Manufacturer recommendations notes*

8.4—Mineral admixture performance in concrete

The mineral admixture performance in concrete data segment is used to report test results that quantify the effect a mineral admixture has on the properties and performance of concrete made using the admixture. Results that could be reported include, but are not limited to, rheological properties, setting time, air content, compressive strength, flexural strength, length change, and freeze-thaw resistance. These results may be obtained from tests performed using concrete, cement paste, or mortar.

This data segment is represented by 12 data elements that are used repeatedly for each property being reported. Data elements for reporting additional information about the test method used to determine the concrete property are provided

in Section 12.2. Recommended formats for reporting information about processing of the concrete that was prepared to determine mineral admixture performance in concrete are provided in Chapter 11. To eliminate repetition and minimize redundancy, data elements for processing data are not included in this data segment. For the mineral admixture portions of a concrete materials property database to be considered comprehensive and complete, however, they need to be included as part of this data segment.

- *Constituent property*—The name of the property being reported to quantify the effect the mineral admixture has on the properties and performance of concrete made using the mineral admixture. Slump and air content are examples of constituent properties.
- *Constituent property value*
- *Concrete phase*
- *Concrete age*
- *Constituent property notes*

CHAPTER 9—FIBERS

Data segments and corresponding data elements for reporting information about fibers in a materials property database are listed in Table 9.1 and defined here. Data elements for fibers are organized into four data segments.

9.1—Fiber designation

Fibers are slender discontinuous elements in the form of bundles, networks, or strands of any natural or manufactured material that can be distributed throughout freshly mixed concrete. Each element is usually less than approximately 64 mm (2.5 in.) in length. Fibers can have either a round, oval, rectangular, or crescent-shaped cross section, depending on the raw materials used in the manufacturing process. Many types of metallic and nonmetallic materials are used to manufacture fibers for use in fiber-reinforced concrete and shotcrete. Guidelines for use of fibers in concrete are generally provided by the manufacturer. The fiber designation data segment includes descriptive terms used to establish a unique identifier for each type of fiber in the concrete mixture. Data elements in this data segment are used repeatedly for each type of fiber. They also serve a dual role as concrete identifiers.

- *Constituent class*—The class of constituents covered by this data category is fibers.
- *Fiber common name*—A product number or trade name may be used as a common name for the fibers.
- *Fiber producer name*
- *Fiber producer plant location*
- *Fiber producer identification number*—An alphanumeric designation assigned by the producer or supplier to distinguish one lot or production run of fibers from another.
- *Fiber designation notes*

9.2—Composition and characteristics

The composition and characteristics data segment is used to report information that defines the materials used to produce the fibers and the characteristics of individual fibers.

- *Material*—The name of the material used to manufacture

the fibers. Carbon steel, stainless steel, glass, polymeric, and natural materials are commonly used to manufacture fibers.

- *Nonfiber constituents*—A description of the nonfiber constituents, if any, that are added to the concrete mixture along with the fibers. These constituents may be adhesives, cellulose products, or other items used to package the fibers for delivery to the concrete mixture.
- *Configuration*—A description of the shape of an individual fiber. Terms that may be used to describe the configuration of a fiber include deformed, hooked, mesh, monofilament, and variable length.
- *Cross-sectional area*—(of individual fiber)
- *Surface area*—(of individual fiber)
- *Length*—(of individual fiber)
- *Width*—(of individual fiber)
- *Diameter*—(of individual fiber)
- *Aspect ratio*—The length or nominal length of an individual fiber divided by the diameter or equivalent diameter of the fiber.
- *Delivery method*—A description of the method used to package, contain, or confine the fibers before their addition to the concrete mixture. Terms that may be used to describe the delivery method include loose, collated, box, bag, and bundled.
- *Fiber property*—The name of the fiber property being reported. Tensile strength, specific gravity, and density are examples of fiber properties.
- *Fiber property value*
- *Composition and characteristics notes*

9.3—Manufacturer recommendations

The manufacturer recommendations data segment is used to report information provided by the manufacturer about the fibers including guidelines for its use in concrete. If necessary, additional data elements can be developed to report other recommendations provided by the manufacturer.

- *Safety information*
- *Dosage*
- *Storage conditions*
- *Manufacturer recommendations notes*

9.4—Fiber performance in concrete

The fiber performance in concrete data segment is used to report test results that quantify the effect fibers have on the properties and performance of concrete made using the fibers. This data segment is represented by 12 data elements that are used repeatedly for each constituent property being reported. Data elements for reporting additional information about the test method used to determine the property are provided in Section 12.2. Recommended formats for reporting information about processing of the concrete that was prepared to determine fiber performance in concrete are provided in Chapter 11. To eliminate repetition and minimize redundancy, data elements for processing data are not included in this data segment. For the fiber portion of a concrete materials property database to be considered

comprehensive and complete, however, they need to be included as part of this data segment.

- *Constituent property*—The name of the property being reported to quantify the effect the fibers have on the properties and performance of concrete made using the fibers. Setting time, Vebe time, and slump are examples of constituent properties.
- *Constituent property value*
- *Concrete phase*
- *Concrete age*
- *Constituent property notes*

CHAPTER 10—WATER

Data segments and corresponding data elements for reporting information about water in a materials property database are listed in Table 10.1 and defined here. Data elements for water are organized into three data segments.

10.1—Water designation

Water is an essential part of concrete mixtures whose binding medium is hydraulic cement. The amount of water included in the mixture and its properties strongly affect the quality of the concrete produced. The water designation data segment includes descriptive terms used to establish a unique identifier for the water used in the concrete mixture. Data elements in this data segment serve a dual role as concrete identifiers and should be used repeatedly whenever water is provided by more than one supplier.

- *Constituent class*—the class of constituents covered by this data category is water.
- *Water common name*—municipal, tap, distilled, and potable are examples of common names for water.
- *Water supplier name*
- *Water supplier plant location*
- *Water supplier identification number*—an alphanumeric designation assigned by the producer or supplier to distinguish one lot or production run of water from another.
- *Water designation notes*

10.2—Composition and characteristics

Although distilled and demineralized water can be used to produce concrete, most water used for this purpose contains additional solids or liquids. Chemicals, substances, and impurities are terms often used to describe these constituents. The composition and characteristics data segment is used to report information about solid or liquid constituents in the water. Two data elements are used repeatedly to identify each constituent in the water.

- *Chemical constituent*
- *Percent by mass*—The amount (percent by mass) of the chemical constituent in the water.
- *Water composition test method*
- *Water property*—The name of the water property being reported. Chloride ion concentration, sulfate ion concentration, pH, and total solids are examples of water properties.

- *Water property value*
- *Composition and characteristics note*

10.3—Water performance in concrete

The water performance in the concrete data segment is used to report test results that quantify the effect a water has on the properties and performance of concrete made using the water. This data segment is represented by 12 data elements that are used repeatedly for each constituent property being reported. Data elements for reporting additional information about the test method used to determine the property are provided in Section 12.2. Recommended formats for reporting information about processing of the concrete that was prepared to determine water performance in concrete are provided in Chapter 11. To eliminate repetition and minimize redundancy, data elements for processing data are not included in this data segment. For the water portion of a concrete materials property database to be considered comprehensive and complete, however, they need to be included as part of this data segment.

- *Constituent property*—The name of the property being reported to quantify the effect the water has on the properties and performance of concrete made using the water. Time of setting and air content are examples of constituent properties.
- *Constituent property value*
- *Concrete phase*
- *Concrete age*
- *Constituent property note*

CHAPTER 11—CONCRETE PROCESSING

Concrete processing represents a broad category of project-specific information and production data related to mixture proportions, batching, mixing, transporting, placing, consolidating, finishing, and curing of the concrete placement or batch. Data segments and corresponding data elements for reporting information about concrete processing in a materials property database are listed in Table 11.1 and defined herein. As described in Chapter 4, selected data elements in this data category serve a dual role as concrete identifiers. Data elements for concrete processing are organized into 12 data segments.

11.1—Project information

The project information data segment is used to report relevant facts pertaining to the project in which the concrete is used. Applicable data elements can be used repeatedly, if necessary. Data elements in addition to those included in this data segment may need to be developed to report other project-specific information that may be available.

- *Project owner*—The owner of the project for which the concrete was produced.
- *Project identifier*—The name of the project.
- *Project location*
- *Concrete component*—A term that identifies a component that was constructed using the concrete.
- *Concrete component support*—A description of the type of subgrade or formwork used to support the con-

crete component identified above.

- *Project contractor*
- *Project contractor address*
- *Processing procedure*—The procedure should be a written and approved document that identifies the specification requirements and acceptance criteria for the concrete processing activities. An alphanumeric designation or procedure number may be a suitable processing procedure identifier.
- *Processing procedure title*
- *Processing procedure date*
- *Project information notes*

11.2—Concrete specification

The concrete specification data segment is used to report information about the specified concrete mixture and property requirements. Selected data elements are used repeatedly for each constituent in the concrete and each specified concrete property. Specified concrete properties include those provided in project or material specifications for use in establishing limits of acceptability. Data elements, in addition to those included in this data segment, may need to be developed to report additional requirements that may be available.

- *Specified constituent quantity*—The quantity (mass or volume) of a constituent specified in the concrete mixture design. This data element is used repeatedly for each constituent in the concrete mixture.
- *Specified minimum constituent quantity*—The minimum quantity (mass or volume) of a constituent permitted for use in the production of the concrete. This data element is used repeatedly for each constituent in the concrete mixture.
- *Specified maximum constituent quantity*—The maximum quantity (mass or volume) of a constituent permitted for use in the production of the concrete. This data element is used repeatedly for each constituent in the concrete mixture.
- *Specified property*
- *Specified property value*—The property value of freshly mixed or hardened concrete obtained from a project or material specification and used to establish limits of acceptability.
- *Specified minimum property value*
- *Specified maximum property value*
- *Concrete phase*
- *Concrete age*
- *Specified property notes*

11.3—Concrete supplier

The concrete supplier data segment is used to report information that reflects the origin of the concrete.

- *Concrete supplier name*
- *Concrete supplier address*
- *Concrete supplier plant location*
- *Concrete supplier identification number*

11.4—Concrete mixture proportions

The concrete mixture proportions data segment is used to report the amount of each constituent in a given volume of concrete. Selected data elements are used repeatedly for each constituent in the concrete. To ensure consistency and thereby minimize possible confusion, each set of constituent quantity data entries should be related to the corresponding constituent which is identified using recommended formats provided in Chapters 5 to 10.

- *Constituent quantity*—The quantity (mass or volume) of a constituent that was measured and used to prepare the concrete. This data element is used repeatedly for each constituent in the concrete mixture.
- *Constituent addition location*—Locations where constituents are typically added include the batch plant and the project site. Entries for this data element should correspond to the constituent quantity reported previously.
- *Constituent total quantity*—The total quantity (mass or volume) of a constituent that was used to prepare the concrete. This data element is used repeatedly for each constituent in the concrete mixture.
- *Constituent quantity per unit volume of concrete*
- *Volume of concrete produced*—The reported value should reflect the total volume of all constituents as well as the volume of entrained and entrapped air.
- *Mixture proportions notes*

11.5—Concrete batching

The concrete batching data segment is used to report information about the equipment and technique used to batch the concrete.

- *Batching process*
- *Batch controller manufacturer*—The name of the manufacturer of the equipment used to control batching functions such as opening and closing hoppers, bins, and admixture dispenser containers.
- *Batch controller manufacturer address*
- *Batch controller operator identifier*—The name or alphanumeric identifier for the operator of the batch controller.
- *Aggregate storage equipment*
- *Cementitious material storage equipment*
- *Chemical admixture storage equipment*
- *Bulk material storage equipment*—A description of the equipment or method used to store bulk materials, such as fibers, before batching.
- *Moisture meter*—The general class of moisture meter used to determine the moisture content of the aggregates used in the concrete. Types of moisture meters that are available include electrical resistance, nuclear, and microwave. Moisture content may also be determined using a manual test method.
- *Moisture meter manufacturer*
- *Moisture meter calibration date*
- *Moisture meter probe location*
- *Aggregate surface moisture condition*—Oven dry and saturated surface dry (SSD) are terms that may be used

as entries for this data element.

- *Batch plant certification*—Data entries may consist of the batch plant prequalification certification number and date of issuance.
- *Scale*—The type of scale used to weigh the concrete constituents.
- *Scale manufacturer*
- *Scale manufacturer address*
- *Scale calibration date*
- *Batching sequence*—The order and timing sequence in which the constituents were introduced into the mixing equipment.
- *Batching start time*—The time the first constituent was introduced into the measurement device using the HH:MM format described in Section 3.4.
- *Batching discharge time*—The time the last constituent was discharged from the measurement device and into the mixing equipment using the HH:MM format described in Section 3.4.
- *Batching air temperature*—The air temperature (C) near the batching equipment at the batching discharge time.
- *Batching relative humidity*—The relative humidity (%) near the batching equipment at the batching discharge time.
- *Batching notes*

11.6—Concrete mixing

The concrete mixing data segment is used to report information about the equipment and technique used to mix the concrete. Applicable data elements may be used repeatedly, if necessary.

- *Mixing equipment*
- *Mixing equipment manufacturer*
- *Mixing equipment manufacture address*
- *Mixing equipment uniformity test*
- *Mixing equipment uniformity test result*—A data entry of either pass or fail may be sufficient.
- *Mixer start time*
- *Mixer discharge time*
- *Mixing equipment revolutions*—The number of revolutions or cycles that occurred between the time the first constituent was added to the mixer (start time) and the time the fresh concrete was discharged from the mixer (discharge time). Revolutions are reported as an integer.
- *Mixing equipment speed*—The time required for the mixing equipment to complete one revolution or cycle. Speed is reported in units of seconds.
- *Concrete mixing time*—Concrete mixing time represents the difference between the time the first constituent was added to the mixer (start time) and the time the fresh concrete was discharged from the mixer (discharge time).
- *Mixing equipment amperage*—The amperage at which the mixing equipment operated immediately before discharge of the concrete in units of amperes.
- *Processing date*
- *Mixing notes*

11.7—Concrete transportation

The concrete transportation data segment is used to report information about the equipment and technique used to transport the concrete from the mixer to the point of placement. Applicable data elements may be used repeatedly, if necessary.

- *Transporting equipment*
- *Transporting equipment manufacturer*
- *Transporting equipment manufacturer address*
- *Transporting equipment features*—Terms used to describe features about the equipment used to transport the concrete. The model number assigned by the manufacturer may be an appropriate entry.
- *Transporting equipment identifier*—The name or alphanumeric identifier assigned to the transporting equipment for identification purposes.
- *Transporting equipment operator*—The name or alphanumeric identifier for the operator of the transporting equipment.
- *Transportation start time*
- *Transportation discharge time*—The time when the concrete was completely discharged from the transporting equipment using the HH:MM format described in Section 3.4.
- *Transportation notes*

11.8—Concrete placement

The concrete placement data segment is used to report information about the equipment and technique used to place the concrete. Applicable data elements may be used repeatedly, if necessary.

- *Placing equipment*
- *Placing equipment manufacturer*
- *Placing equipment manufacturer address*
- *Placing equipment identifier*—This data element is used to report an alphanumeric identifier for the placing equipment.
- *Placing equipment operator*—The name or alphanumeric identifier for the operator of the placing equipment.
- *Placing supervisor*—The name or alphanumeric identifier for the supervisor responsible for placing the concrete.
- *Placement location*
- *Placement volume*
- *Placement start time*
- *Placement finish time*
- *Placement notes*

11.9—Concrete consolidation

The concrete consolidation data segment is used to report information about the equipment and technique used to consolidate the concrete. Applicable data elements may be used repeatedly, if necessary.

- *Consolidating equipment*
- *Consolidating equipment manufacturer*
- *Consolidating equipment manufacturer address*
- *Consolidating equipment operator*—The name or alphanumeric identifier for the operator of the consolidating equipment.
- *Consolidation supervisor*—The name or alphanumeric identifier for the supervisor of the concrete consolidation activities.

- *Consolidating equipment spacing*—The distance between locations where the consolidating equipment was used or installed. Consolidating equipment spacing could be based on the distance between locations where an internal vibrator was inserted or correspond to the distance between locations where external vibrators were attached to the formwork or screed.
- *Internal vibration depth*—The distance the internal vibrator was inserted below the surface of the fresh concrete, if applicable.
- *Consolidation time*—The length of time that the concrete was consolidated.
- *Consolidation notes*

11.10—Concrete finishing

The concrete finishing data segment is used to report information about the equipment and technique used to finish the concrete. Applicable data elements may be used repeatedly, if necessary.

- *Surface finish*
- *Surface finish material*—A description of the type of material, if any, applied to the concrete surface as part of the finishing operation. Floor hardeners, coloring matter (pigment), and special aggregates are examples of materials that may be applied to a concrete surface during finishing to produce a desired property or characteristic in the finished surface.
- *Surface finish material manufacturer*
- *Surface finish material manufacturer address*
- *Surface finish material application rate*—The amount of surface finish material that was applied per unit surface area of finished concrete.
- *Surface finish material installer*—The name or alphanumeric identifier for the installer of the surface finish material.
- *Concrete finishing supervisor*—The name or alphanumeric identifier for the concrete finishing supervisor.
- *Strike-off technique*
- *Strike-off tool*
- *Strike-off start time*
- *Strike-off stop time*
- *Finishing tool*
- *Finishing start time*
- *Finishing stop time*
- *Finishing notes*

11.11—Concrete curing

The concrete curing data segment is used to report information about the materials and technique used to cure the concrete. Applicable data elements may be used repeatedly, if necessary.

- *Curing technique*
- *Curing material*
- *Curing material manufacturer*
- *Curing material manufacturer address*
- *Curing material application rate*
- *Curing material application time*
- *Curing notes*



11.12—Concrete processing environment

The concrete processing environment data segment is used to report information about the environment in the vicinity where the concrete component is located or stored. For consistency, entries for individual data elements should be related to a corresponding time-of-day entry. Applicable data elements may be used repeatedly, if necessary.

- *Concrete temperature*
- *Air temperature*
- *Relative humidity*—The relative humidity (%) near the location where the fresh concrete was placed or the hardened concrete was stored.
- *Wind velocity*—The wind velocity near the location where the fresh concrete was placed or the hardened concrete was stored.
- *Weather*—A description of the weather conditions and other relevant environmental factors near the location where the fresh concrete was placed or the hardened concrete was stored.
- *Time of day*—The time when the processing environment parameters listed previously were obtained using the HH:MM format described in Section 3.4.
- *Processing environment notes*

CHAPTER 12—PROPERTIES AND PERFORMANCE OF CONCRETE

Data segments and corresponding data elements for reporting properties and performance data in a concrete materials property database are listed in Table 12.1 and defined here. A list of selected properties that could be reported in a concrete materials property database is presented in Table 12.2. Data elements for properties and performance of concrete are organized into two data segments.

12.1—Concrete property

The concrete property data segment is used to report:

- Any property of freshly mixed or hardened concrete that provides information essential to the identification of the concrete;
- Data useful in making meaningful comparisons between concretes with similar compositions and characteristics; or
- Test results for use in establishing acceptability in accordance with project or material specification requirements such as those described in Section 11.2.

Results obtained from a test conducted on either the fresh or hardened concrete or derived values obtained using the mixture proportions and related test results may be considered concrete property data. Selected data elements in this data segment serve a dual role as concrete identifiers.

- *Concrete property*—A concrete property is any property of the concrete.
- *Concrete property value*
- *Testing organization*—The name of the organization responsible for determining the concrete property.
- *Testing organization address*
- *Testing organization certification*—The title or description of qualifications or certification records held by the

testing organization.

- *Testing location*—Testing is routinely performed in the field or a laboratory that is at a different location from the address identified previously.
- *Testing equipment*
- *Testing equipment calibration date*
- *Testing equipment manufacturer*
- *Testing equipment manufacturer address*
- *Testing equipment operator*—The name or alphanumeric identifier for the operator of the testing equipment.
- *Testing supervisor*—The name or alphanumeric identifier for the supervisor of the concrete testing activities.
- *Test specimen size*—A description of the concrete test specimen configuration.
- *Test specimen conditioning*—A description of the procedure used to prepare or condition the concrete specimen for testing. For example, some test methods require concrete specimens to be stored under water for 24 h before testing.
- *Concrete phase*
- *Concrete age*
- *Test date*
- *Test time*
- *Concrete temperature*—The temperature (C) of the concrete at the time the specimen was tested.
- *Air temperature*—The temperature (C) of the air in the vicinity of the test specimen at the time the specimen was tested.
- *Concrete property notes*

12.2—Constituent property

The constituent property data segment is used to report any property of freshly mixed or hardened concrete that provides information about constituent performance in concrete. This data segment is used repeatedly for each constituent property reported. Selected data elements in this data segment are an integral part of the constituent data segments described in Chapters 5 to 10.

- *Constituent property*—A constituent property is any property determined by testing to quantify the effects a constituent has on the properties and performance of concrete made using the constituent.
- *Constituent property value*
- *Testing organization*
- *Testing organization address*
- *Testing organization certification*
- *Testing location*
- *Testing equipment*
- *Testing equipment calibration date*
- *Testing equipment manufacturer*
- *Testing equipment manufacturer address*
- *Testing equipment operator*
- *Testing supervisor*
- *Test specimen size*
- *Test specimen conditioning*
- *Concrete phase*
- *Concrete age*
- *Test date*



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