Designation: C856 – 18

Standard Practice for Petrographic Examination of Hardened Concrete[1]

This standard is issued under the fixed designation C856; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This practice outlines procedures for the petrographic examination of samples of hardened concrete. The samples examined may be taken from concrete constructions, they may be concrete products or portions thereof, or they may be concrete or mortar specimens that have been exposed in natural environments, or to simulated service conditions, or subjected to laboratory tests. The phrase "concrete constructions" is intended to include all sorts of objects, units, or structures that have been built of hydraulic cement concrete.

NOTE 1—A photographic chart of materials, phenomena, and reaction products discussed in Sections 8 – 13 and Tables 1–6 are available as Adjunct C856 (ADJCO856).

1.2 The petrographic procedures outlined herein are applicable to the examination of samples of all types of hardened hydraulic-cement mixtures, including concrete, mortar, grout, plaster, stucco, terrazzo, and the like. In this practice, the material for examination is designated as "concrete," even though the commentary may be applicable to the other mixtures, unless the reference is specifically to media other than concrete.

1.3 The purposes of and procedures for petrographic examination of hardened concrete are given in the following sections:

1.4 The values stated in inch-pound units are to be regarded as the standard. The SI units in parentheses are provided for information purposes only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* A specific hazard statement is given in 6.2.10.1.

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C125 Terminology Relating to Concrete and Concrete Aggregates
C215 Test Method for Fundamental Transverse, Longitudinal, and Torsional Resonant Frequencies of Concrete Specimens
C227 Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
C342 Test Method for Potential Volume Change of Cement-Aggregate Combinations (Withdrawn 2001)[3]
C441 Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
C452 Test Method for Potential Expansion of Portland-Cement Mortars Exposed to Sulfate
C457 Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete
C496/C496M Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
C597 Test Method for Pulse Velocity Through Concrete
C803/C803M Test Method for Penetration Resistance of Hardened Concrete
C805 Test Method for Rebound Number of Hardened Concrete

[1] This practice is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.65 on Petrography.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

***A Summary of Changes section appears at the end of this standard**

C823 Practice for Examination and Sampling of Hardened Concrete in Constructions
C1012 Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution
C1260 Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
C1723 Guide for Examination of Hardened Concrete Using Scanning Electron Microscopy
E3 Guide for Preparation of Metallographic Specimens
E883 Guide for Reflected–Light Photomicrography

2.2 *ASTM Adjuncts:*
Adjunct C856 (ADJCO856) A chart of 27 photos[4]

3. Terminology

3.1 *Definitions:* For definitions of terms used in this practice, refer to Terminology C125.

4. Qualifications of Petrographers and Use of Technicians

4.1 All petrographic examinations of hardened concrete described in this practice shall be performed by or under the technical direction of a full time supervising petrographer with at least 5 years experience in petrographic examinations of concrete and concrete-making materials. The supervising concrete petrographer shall have college level courses that include petrography, mineralogy, and optical mineralogy, or 5 years of documented equivalent experience, and experience in their application to evaluations of concrete-making materials and concrete products in which they are used and in cementitious-based materials. A resume of the professional background and qualifications of all concrete petrographers shall be available.

4.2 A concrete petrographer shall be knowledgeable about the following: concrete-making materials; processes of batching, mixing, handling, placing, and finishing of hydraulic-cement concrete; the composition and microstructure of cementitious paste; the interaction of constituents of concrete; and the effects of exposure of such concrete to a wide variety of conditions of service.

4.3 Sample preparation shall be performed by concrete petrographers or trained technicians pursuant to instructions from and under the guidance of a qualified concrete petrographer. Aspects of the petrographic examination, such as the measurement of sample dimensions, photography of as-received samples, staining of sample surfaces, that do not require the education and skills outlined in 4.1, shall be performed by concrete petrographers or by trained technicians pursuant to instructions and under the guidance of a qualified concrete petrographer. The analysis and interpretation of the features that are relevant to the investigation and evaluation of the performance of the materials represented by the sample shall be made solely by concrete petrographers with qualifications consistent with those outlined in 4.1.

4.4 A concrete petrographer shall be prepared to provide an oral statement, written report, or both that includes a description of the observations and examinations made during the petrographic examinations, and interpretation of the findings insofar as they relate to the concerns of the person or agency for whom the examination was performed. Supplementary information provided to the petrographer on the concrete and concrete materials, conditions of service, or other features of the concrete construction may be helpful in interpreting the data obtained during the petrographic examinations.

4.5 This practice may form the basis for establishing arrangements between a purchaser of the consulting service and the consulting petrographer. In such cases, the purchaser of the consulting service and the consulting petrographer should together determine the kind, extent, and objectives of the examinations and analyses to be made, and may record their agreement in writing. The agreement may stipulate specific determinations to be made, observations to be reported, funds to be obligated, or a combination of these and other conditions.

5. Purposes of Examination

5.1 Examples of purposes for which petrographic examination of concrete is used are given in 5.2 – 5.5. The probable usefulness of petrographic examination in specific instances may be determined by discussion with an experienced petrographer of the objectives of the investigation proposed or underway.

5.2 *Concrete from Constructions:*

5.2.1 Determination in detail of the condition of concrete in a construction.

5.2.2 Determination of the causes of inferior quality, distress, or deterioration of concrete in a construction.

5.2.3 Determination of the probable future performance of the concrete.

5.2.4 Determination whether the concrete in a construction was or was not as specified. In this case, other tests may be required in conjunction with petrographic examination.

5.2.5 Description of the cementitious matrix, including qualitative determination of the kind of hydraulic binder used, degree of hydration, degree of carbonation if present, evidence of unsoundness of the cement, presence of supplementary cementitious materials, the nature of the hydration products, adequacy of curing, and unusually high water–cement ratio of the paste.

5.2.6 Determination whether alkali–silica or alkali–carbonate reactions, or cement–aggregate reactions, or reactions between contaminants and the matrix have taken place, and their effects upon the concrete.

5.2.7 Determination whether the concrete has been subjected to and affected by sulfate attack, or other chemical attack, or early freezing, or to other harmful effects of freezing and thawing.

5.2.8 Part of a survey of the safety of a structure for a present or proposed use.

5.2.9 Determination whether concrete subjected to fire is essentially undamaged or moderately or seriously damaged.

5.2.10 Investigation of the performance of the coarse or fine aggregate in the structure, or determination of the composition of the aggregate for comparison with aggregate from approved or specified sources.

[4] Available from ASTM International Headquarters. Order Adjunct No. ADJC0856. Original adjunct produced in 1995.

5.2.11 Determination of the factors that caused a given concrete to serve satisfactorily in the environment in which it was exposed.

5.2.12 Determination of the presence and nature of surface treatments, such as dry shake applications on concrete floors.

5.3 *Test Specimens from Actual or Simulated Service*—Concrete or mortar specimens that have been subjected to actual or simulated service conditions may be examined for most of the purposes listed under Concrete from Constructions.

5.4 *Concrete Products:*

5.4.1 Petrographic examination can be used in investigation of concrete products of any kind, including masonry units, precast structural units, piling, pipe, and building modules. The products or samples of those submitted for examination may be either from current production, from elements in service in constructions, or from elements that have been subjected to tests or to actual or simulated service conditions.

5.4.2 Determination of features like those listed under concrete from constructions.

5.4.3 Determination of effects of manufacturing processes and variables such as procedures for mixing, molding, demolding, consolidation, curing, and handling.

5.4.4 Determination of effects of use of different concrete-making materials, forming and molding procedures, types and amounts of reinforcement, embedded hardware, etc.

5.5 *Laboratory Specimens*—The purposes of petrographic examination of laboratory specimens of concrete, mortar, or cement paste are, in general, to investigate the effects of the test on the test piece or on one or more of its constituents, to provide examples of the effects of a process, and to provide the petrographer with visual evidence of examples of reactions in paste or mortar or concrete of known materials, proportions, age, and history. Specific purposes include:

5.5.1 To establish whether alkali–silica reaction has taken place, what aggregate constituents were affected, what evidence of the reaction exists, and what were the effects of the reaction on the concrete.

5.5.2 To establish whether one or more alkali–carbonate reactions have taken place, which aggregate constituents were affected and what evidence of the reaction or reactions exists, and the effects of the reaction on the concrete properties.

5.5.3 To establish whether any other cement– aggregate reaction has taken place. In addition to alkali–silica and alkali–carbonate reactions, these include hydration of anhydrous sulfates, rehydration of zeolites, wetting of clays and reactions involving solubility, oxidation, sulfates, and sulfides (see Refs (**1-3**)).[5]

5.5.4 To establish whether an aggregate used in a test has been contaminated by a reactive constituent when in fact the aggregate was not reactive.

5.5.5 To establish the effects of a freezing and thawing test or other physical or mechanical exposure of concrete on the aggregate and the matrix.

5.5.6 To establish the extent of reaction, the nature of reaction products, and effects of reaction produced in exposure to a chemically aggressive environment such as in Test Method C452 or Test Method C1012.

5.5.7 To determine the characteristics of moist-cured concrete that has not been subjected to chemical attack or cement–aggregate reaction or freezing and thawing.

5.5.8 By comparison with appropriate laboratory specimens, a petrographer may be able to substantiate the existence of a particular reaction in concrete or determine that the reaction cannot be detected.

6. Apparatus

6.1 The apparatus and supplies employed in making petrographic examinations of hardened concrete depend on the procedures required. The following list includes the equipment generally used. Equipment required for field sampling is not listed. Any other useful equipment may be added.

6.2 *For Specimen Preparation:*

6.2.1 *Diamond Saw*—Slabbing saw with an automatic feed and blade large enough to make at least a 7-in. (175-mm) cut in one pass.

6.2.2 *Cutting Lubricant,* for diamond saw.

6.2.3 *Horizontal Lap Wheel or Wheels,* steel, cast iron, or other metal lap, preferably at least 16 in. (400 mm) in diameter, large enough to grind at least a 4 by 6-in. (100 by 152-mm) area.

6.2.4 *Free Abrasive Machine,* using abrasive grit in lubricant, with sample holders rotating on a rotating table. This type of grinding machine greatly increases the speed of preparation of finely ground surfaces.

6.2.5 *Polishing Wheel,* at least 8 in. (200 mm) in diameter and preferably two-speed, or a vibratory polisher.

6.2.6 *Hot Plate or Oven,* thermostatically controlled, to permit drying and impregnating specimens with resin or wax for preparing thin sections, ground surfaces, and polished sections.

6.2.7 *Prospector's Pick or Bricklayer's Hammer,* or both.

6.2.8 *Abrasives*—Silicon carbide grits, No. 100 (150-µm), No. 220 (63-µm), No. 320 (31-µm), No. 600 (16-µm), No. 800 (12-µm); optical finishing powders, such as M-303, M-204, M-309; polishing powders as needed.

6.2.9 *Plate-glass Squares,* 12 to 18-in. (300 to 450-mm) on an edge and at least ⅜ in. (10 mm) thick for hand-finishing specimens.

6.2.10 *Suitable Medium or Media,* for impregnating concrete and mounting thin sections plus appropriate solvent. Canada balsam, Lakeside 70 cement, and flexibilized epoxy formulations have been used.

6.2.10.1 **Warning—**Flexibilized epoxies form strong bonds but have higher indexes of refraction than Canada balsam or Lakeside 70 and are toxic. Do not allow to touch the skin; plastic gloves shall be worn, and the work shall be done under a hood so as not to breathe the fumes.

6.2.11 *Microscope Slides*—Clear, noncorrosive, glass approximately 24 mm wide and at least 45 mm long. Thickness may need to be specified to fit some thin section machines.

6.2.12 *Cover Glasses,* noncorrosive and preferably No. 1 (0.18-mm) thickness.

6.3 *For Specimen Examination:*

[5] The boldface numbers in parentheses refer to a list of references at the end of this standard.

6.3.1 *Stereomicroscope,* providing magnifications in the range from 7× to 70× or more.

6.3.2 *Dollies*—Small, wheeled dollies with flat tops and with tops curved to hold a section of core assist in manipulating concrete specimens under the stereomicroscope.

6.3.3 *Petrographic Microscope or Polarizing Microscope,* for examinations in transmitted light, with mechanical stage; low-, medium-, and high-power objectives such as 3.5×, 10×, and 20 to 25×; 43 to 50× with numerical aperture 0.85 or more; assorted eyepieces having appropriate corrections and magnifications for use with each of the objectives; micrometer eyepiece; condenser adjustable to match numerical aperture of objective with highest numerical aperture to be used; full-wave and quarter-wave compensators, quartz wedge, and other accessories.

6.3.4 *Metallographic Microscope,* with vertical illuminator, mechanical stage, metallographic objectives of low, medium, and high magnification, and appropriate eyepieces to provide a range of magnifications from about 25× to 500×. Reflected polarized light should be available and appropriate compensators provided. Some polarizing microscopes can be equipped with accessories for metallographic examination, if the tube can be raised or the stage lowered to give adequate clearance for the vertical illuminator and the thicker specimens usually employed.

6.3.5 *Eyepiece Micrometer*—Eyepiece micrometers calibrated using a stage micrometer are useful for measuring particles of aggregate, cement grains, calcium hydroxide and other crystals, and crack widths.

6.3.6 *Stage Micrometer,* to calibrate eyepiece micrometers.

6.3.7 *Microscope Lamps*—Many modern polarizing microscopes have built-in illuminators which are convenient and satisfactory if, with the condenser, they can be adjusted to fill the back lens of the objective of highest numerical aperture with light. If the microscope requires a separate illuminator, tungsten ribbon-filament bulbs in suitable adjustable housings are satisfactory. Many kinds of illuminators are available for stereomicroscopes; some can be mounted on the microscope, some stand on their own bases; choice is a question of adequacy of illumination for the tasks intended. Focusable illuminators are preferred.

6.3.8 *Needleholders and Points*—In addition to pin vises and needles from laboratory supply houses, a No. 10 sewing needle mounted in a handle or a selection of insect pins from size 00 to size 4 are useful for prying out reaction products.

6.3.9 *Bottles with Droppers,* for acid, water, and other reagents applied during examination.

6.3.10 *Assorted Forceps,* preferably stainless steel, including fine-pointed watchmaker's forceps.

6.3.11 *Lens Paper.*

6.3.12 *Refractometer, and Immersion Media,* covering the range of refractive indexes from 1.410 to at least 1.785, in steps not larger than 0.005. Stable immersion media, calibrated at a known temperature and of known thermal coefficient, are preferable and should be used in a temperature-controlled room. A thermometer graduated in tenths of a degree Celsius should be used to measure air temperature near the microscope stage so that thermal corrections of refractive index can be made if needed.

7. Selection and Use of Apparatus

7.1 Laboratories should be equipped to provide photographs, photomacrographs, and photomicrographs to illustrate significant features of the concrete. While ordinary microscope lamps are sometimes satisfactory for photomicrography in transmitted and reflected light, lamps providing intense point or field sources, such as tungsten ribbon-filament bulbs, or zirconium or carbon arcs, are highly desirable. For much useful guidance regarding photomicrography, especially using reflected light, see Guide E883.

7.2 The minimum equipment for petrographic examination of concrete where both specimen preparation and examination are completed within the laboratory consists of a selection of apparatus and supplies for specimen preparation, a stereomicroscope preferably on a large stand so that 6-in. (152-mm) diameter cores can be conveniently examined, a polarizing microscope and accessories, lamps for each microscope, and stable calibrated immersion media of known thermal coefficient. Specimens for petrographic examination may be obtained by sending samples to individuals or firms that offer custom services in preparing thin or polished sections and finely ground surfaces. It is more convenient to prepare specimens in house, and their prompt availability overrides their probably greater cost.

7.3 X-ray diffraction, X-ray emission, differential thermal analysis, thermogravimetric analysis, analytical chemistry, infrared spectroscopy, scanning electron microscopy, energy or wavelength dispersive analysis, and other techniques may be very useful in obtaining quick and definite answers to relevant questions where microscopy will not do so. Some undesirable constituents of concrete, some hydration products of cement, and some reaction products useful in defining the effects of different exposures, and many contaminating materials may not be identified unless techniques that supplement light microscopy are used. (**4**, **5**).

8. Samples

8.1 The minimum size of sample should amount to at least one core, preferably 6 in. (152 mm) in diameter and 1 ft (305 mm) long for each mixture or condition or category of concrete, except that in the case of pavement the full depth of pavement shall be sampled with a 4 or 6-in. (102 or 152-mm) core. Broken fragments of concrete are usually of doubtful use in petrographic examination, because the damage to the concrete cannot be clearly identified as a function of the sampling technique or representative of the real condition of the concrete. Cores smaller in diameter than 6 in. can be used if the aggregate is small enough; in deteriorated concrete, core recovery is much poorer with 2⅛-in. (54-mm) diameter core than with 6-in. diameter core. While it is desirable in examination and testing to have a core three times the maximum size of aggregate, this circumstance is a rare occurrence when concrete with aggregate larger than 2 in. is sampled, because of the cost of large bits and the problems of handling large cores.

8.2 *Samples from Constructions*—The most useful samples for petrographic examination of concrete from constructions are diamond-drilled cores with a diameter at least twice (and preferably three times) the maximum size of the coarse aggregate in the concrete. If 6-in. (152-mm) aggregate is used, a core at least 10 in. (250 mm) in diameter is desirable; usually a 6-in. diameter core is the largest provided.

8.2.1 The location and orientation of all cores, including cores or core lengths not sent to the laboratory, should be clearly shown; and each core should be properly labeled. For vertically drilled cores, the elevation or depth at top and bottom of each section should be shown, and core loss and fractures antedating the drilling should be marked. For cores taken horizontally or obliquely, the direction of the vertical plane and the tops and bottoms should be marked. A field log should be provided.

8.2.2 Broken pieces of concrete from extremely deteriorated structures or pieces removed while preparing for repair work are sometimes used for petrographic examination. The samples will be more useful if their original locations in the structure are clearly described or indicated in a sketch or photographs.

8.2.3 The information provided with the samples should include:

8.2.3.1 The location and original orientation of each specimen (see Practice C823),

8.2.3.2 The mixture proportions of the concrete or concretes,

8.2.3.3 Sources of concrete-making materials and results of tests of samples thereof,

8.2.3.4 Description of mixing, placing, consolidation, and curing methods,

8.2.3.5 Age of the structure, or in case of a structure that required several years to complete, dates of placement of the concrete sampled,

8.2.3.6 Conditions of operation and service exposure,

8.2.3.7 The reason for and objectives of the examination,

8.2.3.8 Symptoms believed to indicate distress or deterioration, and

8.2.3.9 Results of field tests such as measurements of pulse velocity (Test Method C215), rebound hammer numbers (Test Method C805) or probe readings (Test Method C803/C803M).

8.3 *Samples from Test Specimens from Natural Exposures, Concrete Products, and Laboratory Specimens:*

8.3.1 Information provided should include: materials used, mixture proportions, curing, age of concrete when placed in service or test, orientation in exposure, present age, condition surveys during exposure, characteristics of the natural or laboratory exposure, and method of manufacture of concrete products. Large concrete products may be sampled like constructions; smaller ones may be represented by one or more showing the range of condition from service or fabrication or both.

8.3.2 The exposure of laboratory specimens should be described with test results, age at test and available test results on the aggregates, hydraulic binders, and admixtures used. This information should accompany test specimens from natural exposures and concrete products or samples therefrom, if available.

9. Examination of Samples

9.1 *Choice of Procedures*—Specific techniques and procedures employed in examination of a sample depend on the purpose of the examination and the nature of the sample. Procedures to be used should be chosen after the questions that the examination is intended to answer have been clearly formulated. The procedures should be chosen to answer those questions as unequivocally and as economically as possible. The details that need to be resolved will be dictated by the objectives of the examination and will vary for different situations. Consequently, the selection and location of specimens from the samples submitted for examination should be guided by the objectives of the study. Test Method C457 should be referred to for those relevant subjects not described here.

9.2 *Visual Examination and Outline of Additional Examination*—The petrographic examination should begin with a review of all the available information about the submitted samples followed by a visual examination of each sample. An outline of information that can be obtained is given in Table 1. That study should be followed by an examination using a stereomicroscope (see Table 2 and the section on Visual and Stereomicroscopic Examination). In some cases, further study is unnecessary, and a report can be prepared. In other cases, specimens are chosen during the visual and stereomicroscope examination for further processing and additional stereomicroscope study, more detailed examination using the petrographic or metallographic microscopes, scanning electron microscope (SEM), or by X-ray diffraction and other instrumental methods, and for other chemical or physical tests. Methods for specimen preparation are outlined in the Specimen Preparation Section. Table 2 and Table 3 summarize characteristics of concrete conveniently observed with stereomicroscopic, petrographic, and metallographic microscopes. Examination using a stereomicroscope is outlined in the Visual and Stereomicroscopic Examination Section. Examination using a polarizing microscope is outlined in the Polarizing Microscope Examination Section; examination using a metallographic microscope is outlined in the Metallographic Microscope Examination Section. Examination using a scanning electron microscope is outlined in Guide C1723. Observations possible using different kinds of microscopes are shown in Table 4; properties of some relevant compounds are listed in Table 5.

9.3 *Photographs*—Photographs and images should be maintained to illustrate features of the examined specimens, such as as-received conditions before they are altered, and important macro-and micro-features of prepared lapped sections, polished sections, fractured surfaces, thin sections, and immersion mounts. Photographs should have a scale or reference to scale.

10. Specimen Preparation

10.1 *Preparation for Visual and Stereomicroscope Examination:*

10.1.1 Diamond-drilled cores, formed or finished surfaces, freshly broken surfaces, or old crack surfaces should be examined in the condition received. It is sometimes helpful to have drilled surfaces and formed and finished surfaces wetted to increase contrast.

TABLE 1 Visual Examination of Concrete (1)[5]

Coarse Aggregate	+ Fine Aggregate	+ Matrix	+ Air	+ Embedded Items
Composition:				
Maximum dimension,[A] in. or mm, in the range> d>				
Type:	Type:	color, by comparison with National Research Council *Rock Color Chart* (1963)	more than 3 % of total,	Type, size, location; kinds of metal; other items
1 Gravel 2 Crushed stone 3 Mixed 1 and 2 4 Other (name) 5 Mixed 1 + /or 2 + /or 4 If Type 1, 2, or 4, homogeneous or heterogeneous	1 Natural sand 2 Manufactured sand 3 Mixed 4 Other (name) 5 Mixed 1 + /or 2 + /or 4 If Type 1, 2, or 4, homogeneous or heterogeneous	color distribution: 1 mottled 2 even 3 gradational changes	predominantly in spherical voids? less than 3 % of total, abundant nonspherical voids? color differences between voids and mortar?	
Lithologic types Coarse aggregate more than 20, 30, 40, or 50 % of total			voids empty, filled, lined, or partly filled	
Fabric:				
Shape Distribution Packing Grading (even, uneven, excess, or deficiency of size or sizes) Parallelism of flat sides or long axes of exposed sections, normal to direction of placement + /or parallel to formed and finished surfaces[B]	distribution particle shape grading preferred orientation } as perceptible	distribution	shape distribution grading (as perceptible) parallelism of long axes of irregular voids or sheets of voids: with each other; with flat sides or long axes of coarse aggregate	voids below horizontal or low-angle reinforcement
Condition:				
Does it ring when hit lightly with a hammer or give a dull flat sound? Can you break it with your fingers? Cracks? How distributed? Through or around coarse aggregate? With cores or sawed specimens, did the aggregate tear in drilling or sawing? Crack fillings? Surface deposits? If air dry, are there unusually wet or dry looking areas? Rims on aggregate?				clean or corroded? Are cracks associated with embedded items?

[A] A substantial portion of the coarse aggregate has maximum dimensions in the range shown as measured on sawed or broken surfaces.
[B] Sections sawed or drilled close to and parallel to formed surfaces appear to show local turbulence as a result of spading or rodding close to the form. Sections sawed in the plane of bedding (normal to the direction of placement) are likely to have inconspicuous orientation. Sections broken normal to placement in conventionally placed concrete with normal bond tend to have aggregate knobs abundant on the bottom of the upper piece as cast and sockets abundant on the top of the lower piece as cast.

10.1.2 Diamond saw cuts should be oriented with relation to significant features of the concrete, either normal to the bedding directions in conventional concrete, or normal to a formed or finished surface, or to a crack or crack system, in order to reveal the structure and fabric of the concrete and the extent of alteration outward from the crack.

10.1.3 It is useful to prepare at least one sawed surface by grinding it with progressively finer abrasives (as described in Test Method C457) until a smooth matte finish is achieved and to select areas on the matching opposing surface for preparation of thin sections and specimens for optical, chemical, X-ray diffraction, or other examinations.

10.1.4 Specimens obtained by diamond drilling are not ordinarily damaged in the process; however, weak concrete damaged by chemical attack, an alkali–aggregate reaction, freezing and thawing, or several of these, will give poor core recovery with many fractures if it is drilled with a 2⅛-in. or 54-mm bit and barrel while it will give essentially complete recovery if drilled with a 6-in. (152-mm) diameter bit and barrel. This difference is particularly important in petrographic examinations made during condition surveys of old structures. Weakened concrete may also break during sawing. The removal and preparation of specimens for laboratory studies usually involves the application of force and sometimes the application of heat to the specimen.

10.1.5 The effects of force can be minimized during specimen preparation by using thicker slices and making only one cut parallel to the long axis of a core section. Fractured or fragile concrete can be supported by partially or completely encasing it in plaster, epoxy resin, or other reinforcing media before sawing.

10.1.6 Heat used while impregnating concrete with thermoplastic wax or resin will cause cracking if the concrete is heated while it is wet, and will alter the optical properties of some compounds, such as ettringite. Artifacts may therefore be produced and compound identification made difficult. These