



California Groundwater Association

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CGA STANDARD PRACTICE SERIES

ARTICLE 210

DEFINITION OF SAND AS USED IN SAND-CEMENT

MIXTURES FOR ANNULAR SEALS

BACKGROUND

There have been recent instances when “ready-mix” loads of sand-cement mixtures arriving on a job site for emplacement in the annular seal have been rejected by regulatory inspectors for visually apparently containing too many large particle sizes or even containing apparent “rock-size” particles, that do not conform with a perceived definition of “sand” in sand-cement mixtures. In some cases, the offending larger rock particles can be “screened-out” and eliminated before the cement mixture is emplaced. This condition may be caused by insufficient cleaning of the truck mixing barrel by the supplier from a previous job. In other situations, the larger particles are more pervasive, and lead to plugging of tremie pipes and other delays during the process of cementing. This may be caused by a misunderstanding between the contractor and supplier concerning the sand specification for the sand-cement mixture, before it is delivered.

There is some uncertainty in use of the terminology of “concrete” vs. “sand-cement” sealing mixtures that is the focus of discussion in this article. Concrete commonly contains “coarse aggregate” with particle sizes usually in excess of 1/4-inch, and is suitable for general construction purposes. In wells, concrete is used in the construction of surface features such as pads, and well-head or turbine pump pedestals in larger wells. Sand-cement mixtures contain “fine aggregate”, and are used as the sealing materials in the annular space.

The content and purpose of this Standard is to review some commonly used definitions of “sand” as used in sand-cement mixtures, discuss the definition of sand as the particle size used in “fine aggregate” following the ASTM Standard, and recommend the ASTM definition as a practical standard in determining the suitability of sand in sand-cement mixtures for annular seals.

DISCUSSION

The Dictionary of Geological Terms defines sand as “a detrital particle smaller than a granule, and larger than a silt grain, having a diameter in the range of 1/16 to 2 mm” (Bates and Jackson, 1983). Another definition from the Unified Soil Classification System specifies that sand is where “more than half of the coarse fraction is smaller than No. 4 (3/32 inch) sieve” (U.S. Department of the Interior, Bureau of Reclamation, 1963). Such definitions are useful in a general sense, but do not necessarily have practical application as discussed here. California Department of Water Resources Bulletin 74-81 does discuss the use of “sand” in sand-cement grout mixtures as used in sealing materials (p. 34, paragraph D-2) but does not define the appropriate particle sizes. Particle size is further defined in discussion of “concrete” mixtures in the following paragraph D-3, that in turn refers to latest revisions of ASTM C-33 “Standard Specification for Concrete Aggregates” (ASTM, 2003). This ASTM Standard brings clarity to the definition of “sand” for use in sand-cement mixtures, being classed as “fine aggregate”, with a gradation as follows:

Fine Aggregate Grading (ASTM C33-03)

Sieve	Percent Passing
3/8"	100
No. 4 (3/16")	95-100
No. 8 (.094")	80-100
No. 16 (.047")	50-85
No. 30 (.023")	25-60
No. 50 (.012")	5-30
No. 100 (.006")	0-10

In California, if “fine aggregate” is specified from “ready mix” suppliers, they generally follow Caltrans Gradation Specifications, particularly if a Certificate of Compliance” (CC) is called for with each delivery.

Fine Aggregate Grading (CALTRANS)

Sieve	Percent Passing
3/8"	100
No. 4 (3/16')	93-100
No. 8 (.094")	60-99
No. 16 (.047")	55-75
No. 30 (.023")	34-56
No. 50 (.012")	16-29
No. 100 (.006")	1-15

From the above gradation, a good working practical definition of “sand” as used in sand-cement mixtures, is that it is classed as “fine aggregate”; all particles should be 3/8-inch or smaller, and nearly 100 percent of the particles should be 3/16-inch in diameter and smaller.

RECOMMENDATIONS

The California Groundwater Association recommends the following practices when specifying sand as “fine aggregate” for use in sand-cement sealing materials:

1. Maximum particle size should conform to gradation of ASTM C 33-03 “Standard Specification for Concrete Aggregates” (or latest revisions thereof) or CALTRANS gradation specifications for “fine aggregate”. Custom blends of finer sands are also acceptable.
2. If the gradation of the sand in the sand-cement mixture is questionable from past experience with a given supplier, a certificate of compliance should be requested.
3. Sand shall be clean, hard, dense, and durable, consisting of uncoated rock particles, and shall not contain injurious amounts of dirt, organic matter, or other deleterious substances.
4. Naturally occurring “sand” as fine aggregate may not be available in quantity in some areas, and crushed rock having suitable gradation as noted above may need to be substituted. However, users should be aware that the angular nature of such materials may lead to difficulty in pumping the sand-cement mixture in place during sealing operations.

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SELECTED REFERENCES

ASTM, 2003: Standard Specification for Concrete Aggregates, Designation C 33-03.

Bates, R.L. and Jackson, J.A., 1983: Dictionary of Geological Terms, Anchor Press/Doubleday, Garden City, New York, 571 p.

CALTRANS, 2011: CALTRANS Gradation Specifications
http://www.dot.ca.gov/hq/esc/soe/section90/S1-Q20H_E_A04-21-10c_trng.pdf.

California Department of Water Resources, 1981: California Well Standards, Bulletin 74-81, 92 p.

U.S. Department of the Interior, Bureau of Reclamation, 1963: Earth Manual, 783 p.

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