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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core[1]

This standard is issued under the fixed designation D 6032; 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 test method covers the determination of the rock quality designation (RQD) as a standard parameter in drill core logging.

1.2 The values stated in SI units are to be regarded as the standard. The values stated in inch-pound units are approximate.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 2113 Practice for Diamond Core Drilling for Site Investigation[2]

D 5079 Practices for Preserving and Transporting Rock Core Samples[3]

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[4]

3. Summary of Test Method

3.1 The RQD denotes the percentage of intact rock retrieved from a borehole. All pieces of intact rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run, as shown in Fig. 1. Engineering judgement may be necessary to determine if a piece of core qualifies as being intact.

4. Significance and Use

4.1 The RQD was first introduced in the mid 1960's to provide a simple and inexpensive general indication of rock mass quality to predict tunneling conditions and support requirements. The recording of RQD has since become virtually standard practice in drill core logging for a wide variety of geotechnical investigations.

4.2 The RQD values provide a basis for making preliminary design decisions involving estimation of required depths of excavation for foundations of structures. The RQD values also can serve to identify potential problems related to bearing capacity, settlement, erosion, or sliding in rock foundations. The RQD can provide an indication of rock quality in quarries for concrete aggregate, rockfill, or large riprap.

4.3 The RQD has been widely used as a warning indicator of low-quality rock zones that may need greater scrutiny or require additional borings or other investigational work.

4.4 The RQD is a basic component of many rock mass classification systems for engineering purposes.

4.5 Used alone, The RQD is not sufficient to provide an adequate description of rock mass quality. The RQD does not account for joint orientation, tightness, continuity, and gouge material. The RQD must be used in combination with other geological and geotechnical input.

4.6 The RQD is sensitive to the orientation of joint sets with respect to the orientation of the core. That is, a joint set parallel to the core axis will not intersect the core, unless the drill hole happens to run along the joint. A joint set perpendicular to the core axis will intersect the core axis at intervals equal to the joint spacing. For intermediate orientations, the spacing of joint intersections with the core will be a cosine function of angle between joints and the core axis.

4.7 Core sizes from BQ to PQ with core diameters of 36.5 mm (1.44 in.) and 85 mm (3.35 in.), respectively, are normally acceptable for measuring RQD as long as proper drilling techniques are used that do not cause excess core breakage or poor recovery, or both. The NX-size (54.7 mm [2.16 in.]) and NQ-size (47.5 mm [1.87 in.]) are the optimal core sizes for measuring RQD. The RQD is also useful for large core diameters provided the core diameter is clearly stated. The RQD calculated for core smaller than BQ may not be representative of the true quality of the rock mass.

5. Procedure

5.1 Drilling of the rock core should be done in accordance with Practice D 2113. It is important that proper drilling techniques are used to minimize core breakage or poor core recovery, or both.

5.2 There are several ways to define a core run. Three of these are: (*1*) a core run is equal to a drill run; (*2*) a change in formation or rock type could constitute an end of a core run; and (*3*) a core run can be a selected zone of concern. In determining a core run it is important to be consistent throughout a drill hole and to document how the core run was defined.

[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Ground Water and Vadose Zone Investigations.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

[4] *Annual Book of ASTM Standards*, Vol 14.02.

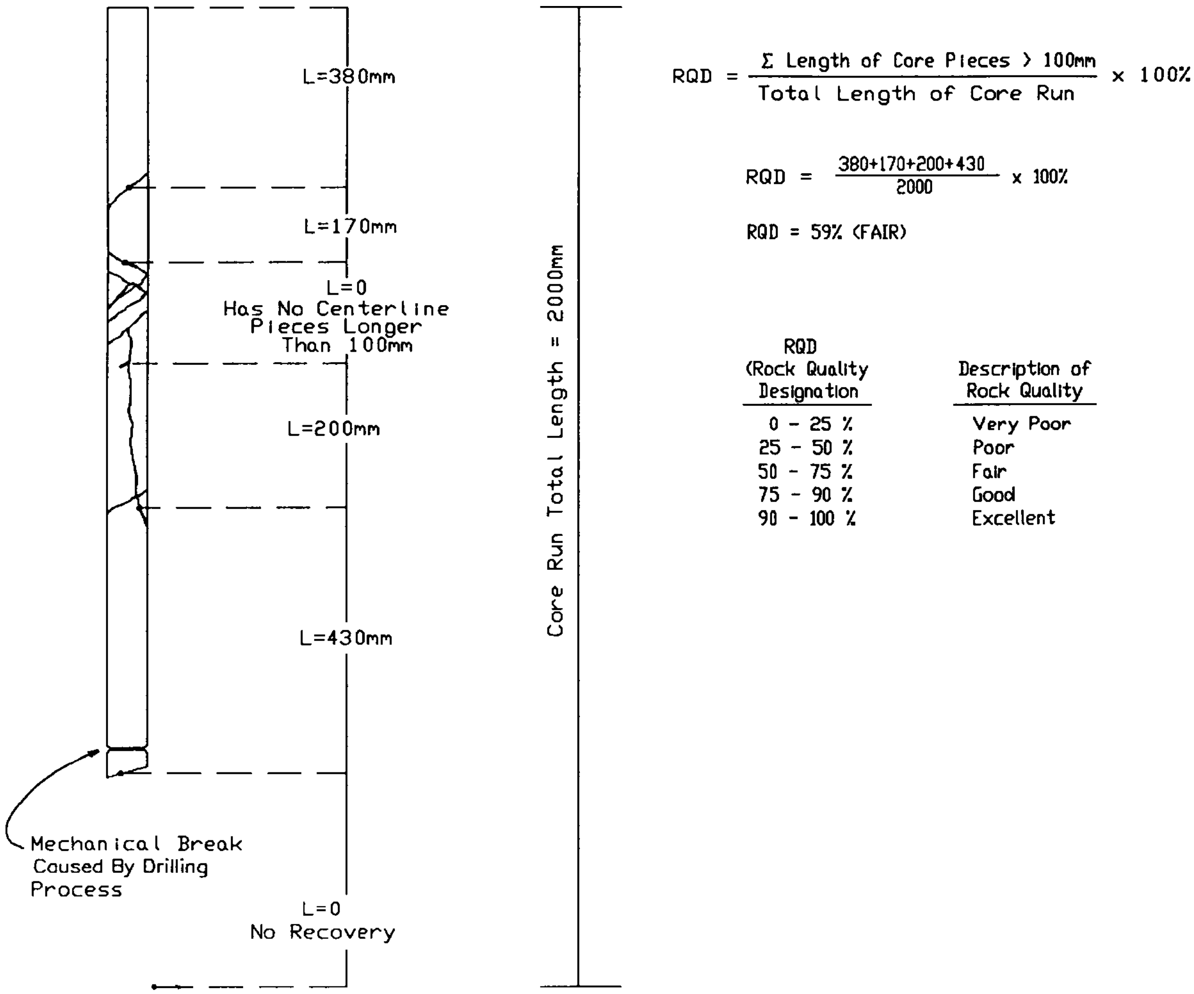

FIG. 1 RQD Logging[5]

5.3 Retrieval, preservation, transportation, storage, and cataloging of the rock core should be done in accordance with Practices D 5079. The RQD should be logged on site when the core is retrieved because some rocks can disintegrate, due to slaking, desiccation, stress relief, or swelling, with time. For these rocks it is recommended that the RQD be measured again after 24 h to assist in determining durability.

5.4 Close visual examination of core pieces is required for assessing the type of fracture (that is, natural or drill break). Pieces of core that are moderately or intensely weathered, contain numerous pores, or are friable, or combination thereof, should not be included in the summation of pieces greater than 100 mm (4 in.) for the determination of the RQD. Any rejected piece of core is still included as part of the total length of core run and should be noted in the report.

5.5 Measure all core piece lengths that are intact and greater than 100 mm (4 in.) to the nearest 1 mm (0.04 in.) and record on a RQD data sheet (Fig. 2). Measure such pieces along the centerline of the core as illustrated in Fig. 1[5]

NOTE 1—Centerline measurements ensure that the RQD value resulting from the measurements is not dependent on the core diameter. Centerline measurements also avoid unduly penalizing resulting RQD values for cases where fractures parallel the core axis (that is, vertical fractures).

5.6 Only those pieces of rock formed by natural fractures (that is, joints, shear zones, bedding planes, or cleavage planes that result in surfaces of separation) shall be considered for RQD purposes. The core pieces on either side of core breaks caused by the drilling process shall be fitted together and counted as one piece. Drilling breaks are usually evident by rough fresh surfaces. In some cases it may be difficult to differentiate between natural fractures and drilling breaks. When in doubt, count a fracture as a natural fracture. If for some reason there is not 100 % core recovery for a drill run, the length of core left in the borehole should be taken into account by adding it to the run in which it was cored rather than the run in which it was retrieved.

5.7 Record the top and bottom depths of each core run.

5.8 Sketch core features such as natural fractures, drilling breaks, lost core, highly weathered pieces, and so forth.

5.9 Include remarks concerning judgement decisions such as whether a break in a core is a natural fracture or a drilling break or why a piece of core longer than 100 mm (4 in.) was not considered to be intact.

[5] Deere, D. U., and Deere, D. W., "The Rock Quality Designation (RQD) Index in Practice," *Rock Classification Systems for Engineering Purposes, ASTM STP 984*, 1988, pp. 91–101.

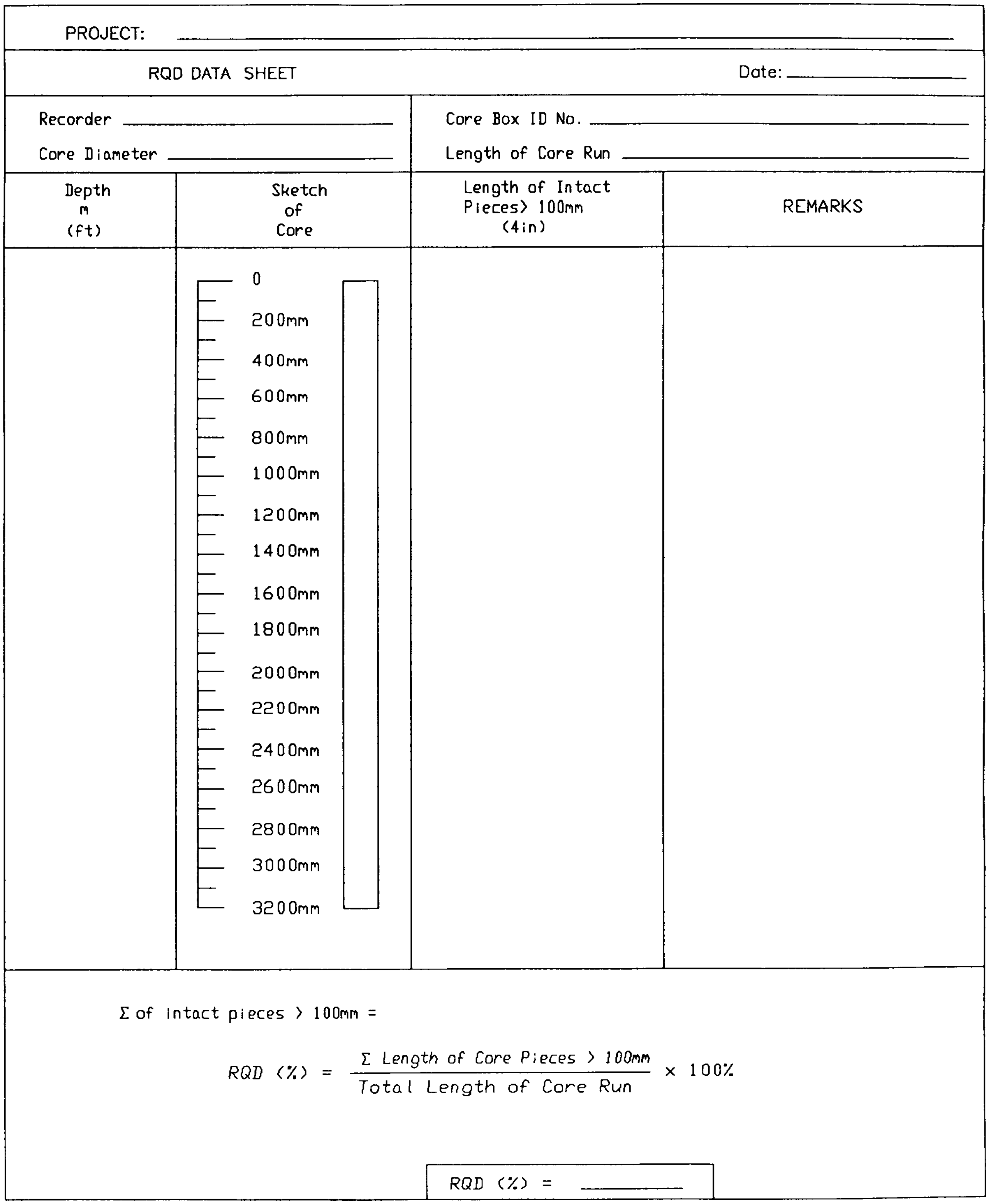

FIG. 2 RQD Data Sheet

5.10 Record the sum of intact core pieces longer than 100 mm (4 in.) long, and calculate the RQD value for the core run evaluated.

5.11 Indicate the rock quality description for the core run using the rock quality table in Fig. 1.

6. Calculation

6.1 Calculate as a percentage, the RQD of a core run as follows:

$$\text{RQD} = \frac{[\Sigma\text{length of intact core pieces} > 100\text{ mm (4 in.)}] \times 100\ \%}{\text{total core run length}} \quad (1)$$

7. Precision and Bias

7.1 *Precision*—A round-robin study of the RQD index of cores of four selected types of sedimentary rock (anhydrite/calcite, calcareous shale, limestone, and anhydrite) with four replications per rock type was conducted in accordance with Practice E 691 by eight experienced participants.[6] The repeatability and reproducibility statistics reported in Table 1 refer to within-participant and between-participant precision, respectively. The probability is approximately 95 % that two results obtained by the same participant on the same material will not differ by more than the repeatability limit *r*. Likewise, the probability is approximately 95 % that two results obtained by different participants on the same material will not differ by more than the reproducibility limit *R*. The precision statistics are calculated from the following equation:

[6] Pincus, H. J., and Clift, S. J., *Interlaboratory Testing Program for Rock Properties: Repeatability and Reproducibility of RQD Values for Selected Sedimentary Rocks*, PCN: 33-000011-38, ASTM Institute of Standards Research, 1994.

TABLE 1 RQD Index of Cores of Sedimentary Rock

Material (Rock Type)	Mean RQD, $\bar{x}$, %	Repeatability, *r*, % [A]	Reproducibility, *R*, % [A]
Anhydrite/calcite	86	28	28
Calcareous shale	60	32	40
Limestone	92	14	14
Anhydrite	86	20	20

[A] The numbers in the *r* and *R* columns are not to be taken as percentages of the means, but are applied as plus or minus terms to the respective means.

$$r = 2(\sqrt{2})s_r \quad (2)$$

where s_r = repeatability standard deviation, and

$$R = 2(\sqrt{2})s_R \quad (3)$$

where s_R = reproducibility standard deviation.

NOTE 2—Some combinations of the means and *r* and *K* can result in KQD limits that exceed 100 % because the RQD values have been assumed to be normally distributed which may not reflect the actual underlying distribution of the RQD values.

7.2 *Bias*—There is no accepted reference value for this test method; therefore, bias cannot be determined.

8. Keywords

8.1 classification; index; logging; quality; rock; rock core