



Standard Practice for Specifying Standard Sizes of Stone for Erosion Control¹

This standard is issued under the fixed designation D6092; 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 covers size designations and maximum ranges in mass or gradation for standard sizes for riprap, spalls, or bedding, or both, used for slope protection of dam embankments, streambank erosion control, bridge piers and abutments. Sizes used for outer harbor structures such as breakwalls, revetments, confined diked disposal structures (heretofore described as armor stone, cover stone, or dimension stone) for which stone sizes range between 5 and 25 tons, or that require cut dimensions for layed-up structures are beyond the scope of this practice.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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.*

1.4 *This practice offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

¹ This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.17 on Rock for Erosion Control.

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2. Referenced Documents

2.1 ASTM Standards:²

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D4992 Practice for Evaluation of Rock to be Used for Erosion Control

D5519 Test Methods for Particle Size Analysis of Natural and Man-Made Riprap Materials

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

3. Terminology

3.1 *Definitions*—For definitions of common technical terms in this practice, refer to Terminology D653.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *filter/bedding stone/spalls*—stone, filter stone consisting of crushed stone ranging in size from minus 2.0 in. (50 mm) to No. 100 (150 μ m) and bedding stone, often referred to as “spalls,” consisting of crushed stone ranging in size from minus 6½ in. (163 mm) to No. 16 (1.18 mm). Filter and bedding may be placed in two layers prior to the riprap placement, that is, a filter layer 8 to 10 in. (200 to 250 mm) thick and a bedding layer of 6 to 8 in. (150 to 200 mm) thick.

3.2.2 *geotextiles*—suitable geotextile fabrics that meet the design requirements may be used instead of, or in conjunction with, the above filter/bedding stone. Suitable cover thickness may be required.

3.2.3 *gradation*—the proportions by mass of stones distributed within specified ranges between maximum and minimum limits.

3.2.4 *prolate spheroid*—a spheroid in which the polar axis is greater than the equatorial diameter.

3.2.5 *riprap*—stone materials generally less than 3000 lb in mass (1400 kg), specially selected and graded, and when

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

properly placed prevents erosion through minor wave action, or strong currents and thereby preserves the shape of a surface, slope, or the underlying structure.

3.2.6 *standard size designation*—one of a group of stones with specified gradation limits.

4. Summary of Practice

4.1 The design team shall establish the size and mass of graded quarry stone using acceptable design criteria. If design criteria and economic factors permit, standard gradations shown in **Tables 1 and 2** should be selected. If using standard sizes, the design team shall select the appropriate gradation; this might require selecting the next larger size, thereby creating an over-designed structure, but one which is economically a cheaper structure. Added cost may result due to the increased volume of stone required, and in transporting and placing the additional stone at the project site. The cost effectiveness of using “standard grading” versus “non-standard grading” always should be evaluated, and standard gradings used whenever possible.

5. Significance and Use

5.1 The standard size designations listed in this practice are provided so that the design team, consumer, and the producer have a common reference in sizing stone materials used in erosion control. The design team should assign a materials survey, and rock quality testing series to determine which quarry sources may have suitable in-place rock and perform suitable blasting and processing procedures to produce the required gradations. The design team must recognize the fact that not all sources are capable of or willing to produce the required gradations. Only those sources listed by the design team should be considered for construction of the project.

5.2 The standard size designations provided in this guide are suitable for protective surfacing and structures designed for erosion control. These sizes are for typical structures such as jetties, revetments, groin baffles, bulkheads, lining for drainage/irrigation ditches and for intake or outlet facilities,

TABLE 2 Standard Sizes for Spalls and Filter/Bedding Stone

Size Designation		FS-3 Spalls	FS-2 Bedding	FS-1 Bedding
Sieve Sizes		Percent Finer by Weight		
Alternative ^A	Standard ^A			
6½ in.	163 mm	100	...	...
4½ in.	113 mm	85 to 100	...	...
2½ in.	63 mm	15 to 50	...	...
2 in.	50 mm	...	100	...
¾ in.	19.5 mm	...	85 to 100	...
⅝ in.	9.5 mm	...	...	100
No. 4	4.75 mm	...	15 to 50	85 to 100
No. 16	1.18 mm	0 to 15	...	...
No. 30	600 µm	...	...	15 to 50
No. 100	150 µm	...	...	0 to 15

^A Sieve sizes in this table are designated by Specification **E11** up to the 2½ in. (63 mm) size. Specification **E11** addresses neither the 4½ in. (113 mm) nor the 6½ in. (163 mm) sizes; however, consistent nomenclature is used for those sizes.

bridges and stream channel banks, gabions, and slope protection for earth embankment and rock-fill dams.

5.3 The design selection of stone sizes, durability, placement, filter/bedding materials, or geotextiles, steepness of slopes for placement, and layer thickness are beyond the scope of this guide.

6. Manufacture

6.1 The standard size designations of quarried stone for erosion control in this guide may be produced by any suitable commercial quarrying method, and by the use of any type of sizing device, shape or size of plant grizzly or screen openings, or combinations thereof, necessary to produce the required sizes within the gradation limits specified in Section 7.

6.2 Stones shall be hard, angular to subangular, and of such quality that they will not disintegrate on exposure to water or weathering during the designed life of the structure. The stone shall be free from fractures, shale partings, deleterious materials, and overburden soil. The design team shall specify acceptance criteria based on the requirements for the individual

TABLE 1 Standard Sizes for Riprap^A

Size Designation		R-1500	R-700	R-300	R-150	R-60	R-20
Particle Mass		Percent Lighter Than the Mass Specified ^C					
Pounds	(Kilograms) ^B						
3000	(1400)	100	...	...	...	...	...
1500	(680)	50 to 100	100	...	...	...	...
1000	(450)	...	...	...	...	...	...
700	(320)	15 to 50	50 to 100	100	...	...	...
500	(230)	...	...	...	...	...	...
300	(140)	...	15 to 50	50 to 100	100	...	...
250	(110)	0 to 15	...	...	...	...	...
150	(68)	...	...	15 to 50	50 to 100	100	...
60	(27)	...	0 to 15	...	15 to 50	50 to 100	...
45	(20)	...	...	0 to 15	...	...	100
30	(14)	...	...	...	...	15 to 50	...
20	(9.1)	...	...	...	0 to 15	...	50 to 100
10	(4.5)	...	...	...	...	0 to 15	15 to 50
2	(0.9)	...	...	...	...	...	0 to 15

^A Revised Nov 14, 1995, and modified to conform to the gradations proposed by the producers and the National Crushed Stone Association.

^B Rounded to two figures from conversion of inch-pound (U.S. Customary) units.

^C Established by determining the mass of the individual stone particles.

project. Additional guidance may be found in Practice **D4992** and Test Methods **D5519**.

7. Standard Sizes

7.1 Standard size designations of stone for erosion control are defined on the basis of mass or equivalent sieve size. The sizes are separated into riprap [R-1500 through R-20], spalls [FS-3] and filter/bedding stone [FS-2 and FS-11].

7.1.1 Graded riprap sizes are shown in **Table 1**, and are based on mass. Graded spalls and filter/bedding stone sizes are shown in **Table 2**, and are based on alternative sieve sizes.

7.1.2 Equivalent dimensions are not shown. Any calculated dimensions would have to assume shapes such as a cube, a sphere, a prolate sphere, or a combination of shapes. **Table 3** provides additional information on converting to approximate dimensions for graded stone.

7.1.3 Gradation curves for each stone size are presented in **Figs. 1-9**.

7.1.3.1 Gradation curves for riprap are presented in **Figs. 1-6**.

7.1.3.2 Gradation curves for spalls and filter/bedding stone are presented in **Figs. 7-9**.

7.2 The stone shall be reasonably well-graded and fall within the limits of the gradation curve for each size designation. Gradation test results that begin on the coarse side of the curve and end up on the fine side of the curve are considered as “skip-graded” and will not be accepted.

8. Keywords

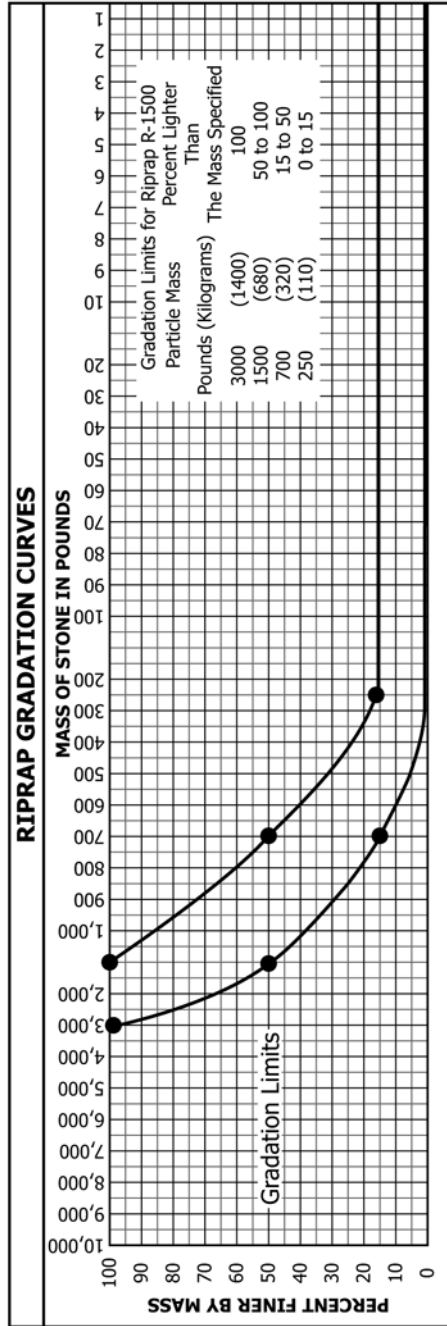
8.1 erosion control; filter/bedding stone; gradation; quarried stone; riprap; standard size designation

TABLE 3 Effect of Specific Gravity on the Mass of Stone of Various Shapes

Maximum Dimension	Cube								Sphere							
	Specific Gravity								Specific Gravity							
in. (cm) ^A	2.60		2.65		2.70		2.75		2.60		2.65		2.70		2.75	
	Approximate Mass of Stone, lb (kg)															
42 (105)	6950 (3160)	7090 (3223)	7225 (3284)	7350 (3341)	3640 (1655)	3712 (1687)	3780 (1718)	3850 (1750)								
30 (75)	2535 (1152)	2584 (1175)	2635 (1198)	2680 (1218)	1325 (602)	1353 (615)	1380 (627)	1405 (639)								
20 (50)	750 (341)	766 (348)	780 (355)	390 (177)	390 (177)	401 (182)	410 (186)	415 (189)								
12 (30)	160 (73)	165 (75)	168 (76)	172 (78)	85 (39)	87 (40)	88 (40)	90 (41)								
6 (15)	20 (9.1)	20.5 (9.3)	21 (9.5)	21.5 (9.8)	10 (4.5)	11 (5)	11 (5)	11 (5)								

Maximum Dimension	Prolate Sphere								Average of Cube and Sphere							
	Specific Gravity								Specific Gravity							
in. (cm) ^A	2.60		2.65		2.70		2.75		2.60		2.65		2.70		2.75	
	Approximate Mass of Stone, lb (kg)															
42 (105)	3238 (1472)	3300 (1500)	3362 (1528)	3424 (1556)	5300 (2409)	5401 (2455)	5500 (2500)	5600 (2545)								
30 (75)	1180 (536)	1202.5 (547)	1225 (490)	1248 (567)	1930 (877)	1968 (895)	2005 (911)	2845 (1293)								
20 (50)	350 (159)	356 (162)	363 (165)	370 (168)	570 (259)	583 (265)	595 (270)	405 (184)								
12 (30)	75 (34)	77 (35)	78 (35)	80 (36)	123 (56)	126 (57)	128 (58)	131 (60)								
6 (15)	9.4 (4.3)	9.6 (4.4)	9.8 (4.5)	10 (4.5)	15 (6.8)	16 (7.3)	16 (7.3)	16 (7.3)								

^A Rounded to two figures from conversion of inch-pound (U.S. Customary) units.



NOTE 1—Gradations curves for each of the riprap types are plotted on the following pages. Test results for each gradation performed in the field should be plotted on the appropriate curve. Acceptable products will plot somewhat parallel to the gradation limits. Test results of the products that start on the coarse side of the curve and end on the finer side of the curve shall be deemed as skip graded and are unacceptable.

FIG. 1 Gradation Limits for Riprap R-1500

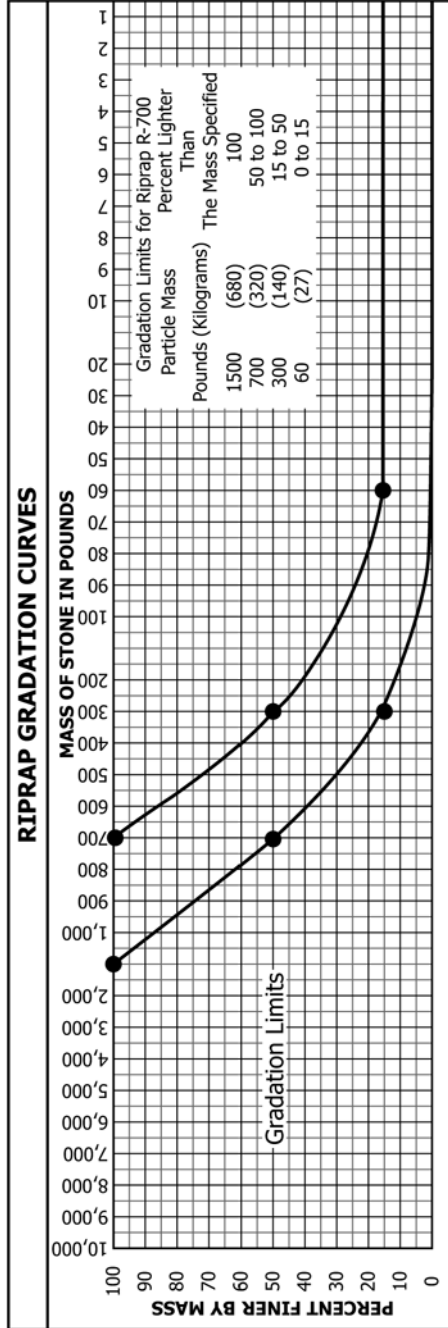


FIG. 2 Gradation Limits for Riprap R-700

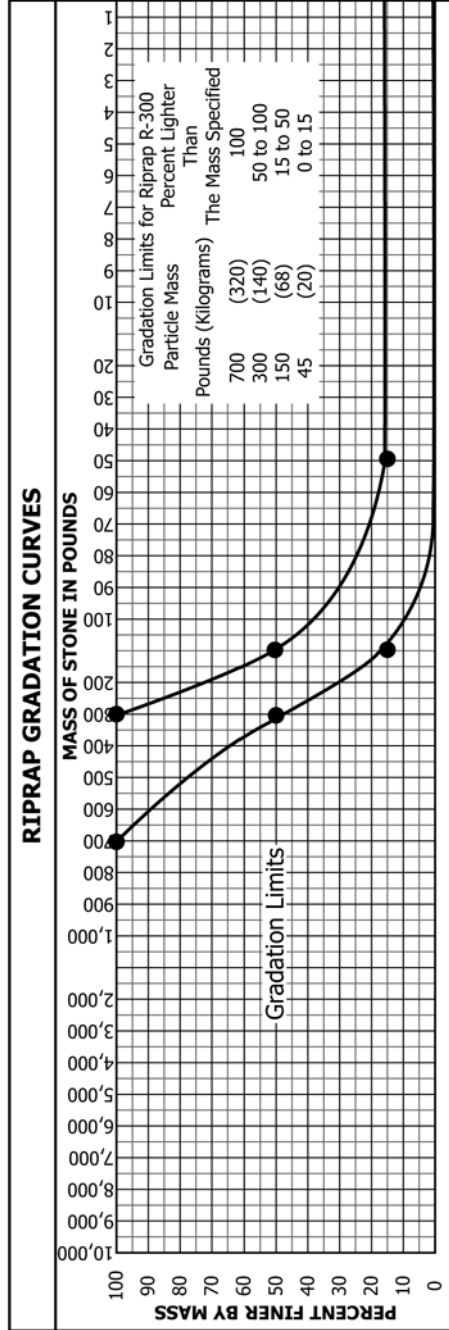


FIG. 3 Gradation Curve for Riprap R-300

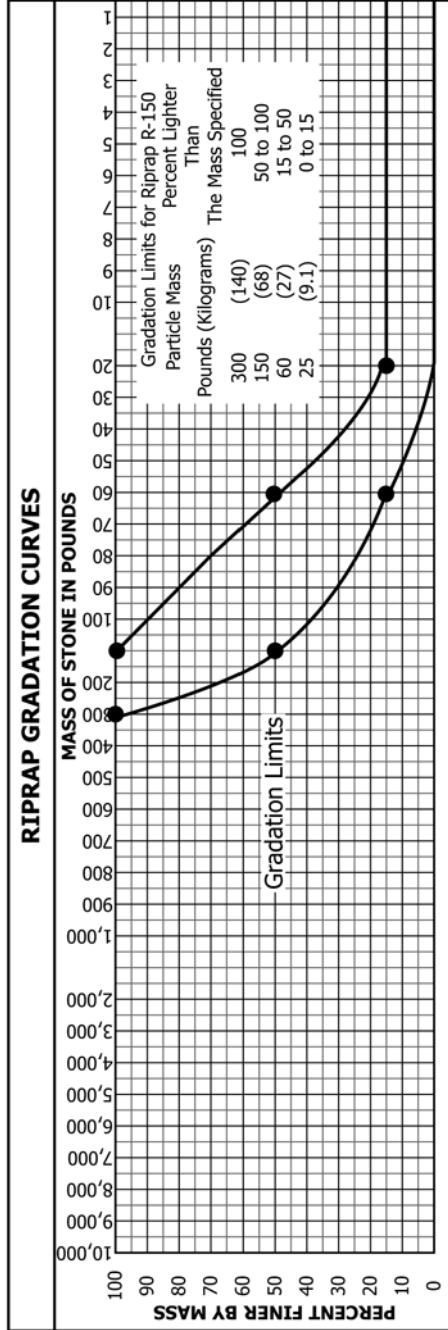


FIG. 4 Gradation Limits for Riprap R-150

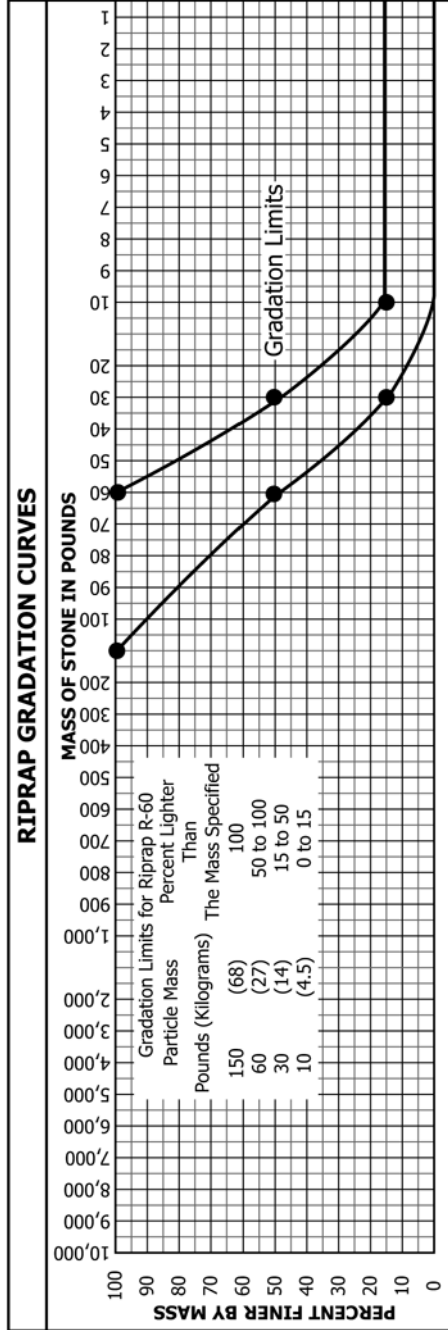


FIG. 5 Gradation Limits for Riprap R-60

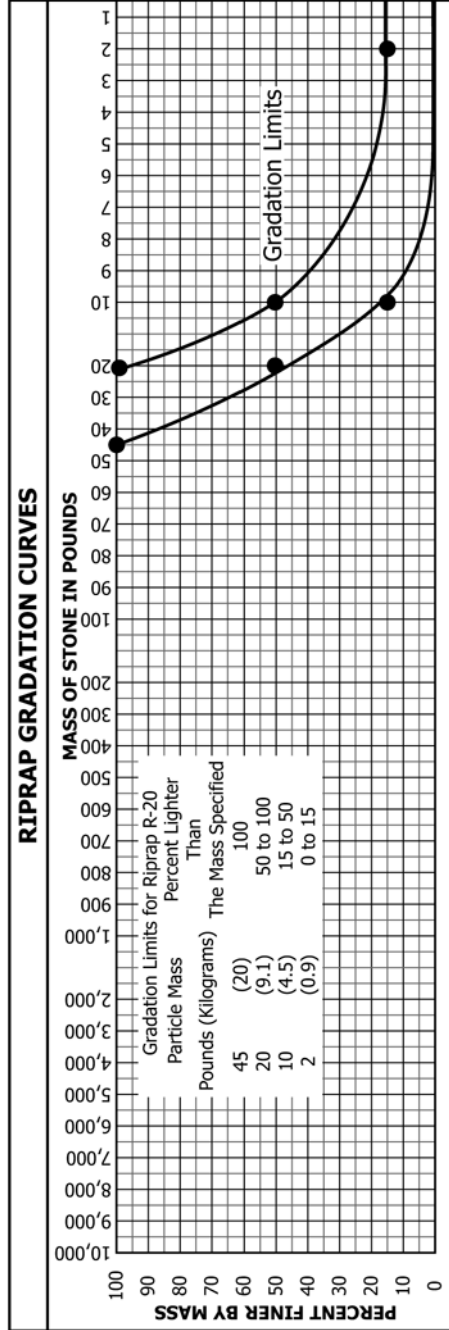


FIG. 6 Gradation Limits for Riprap R-20

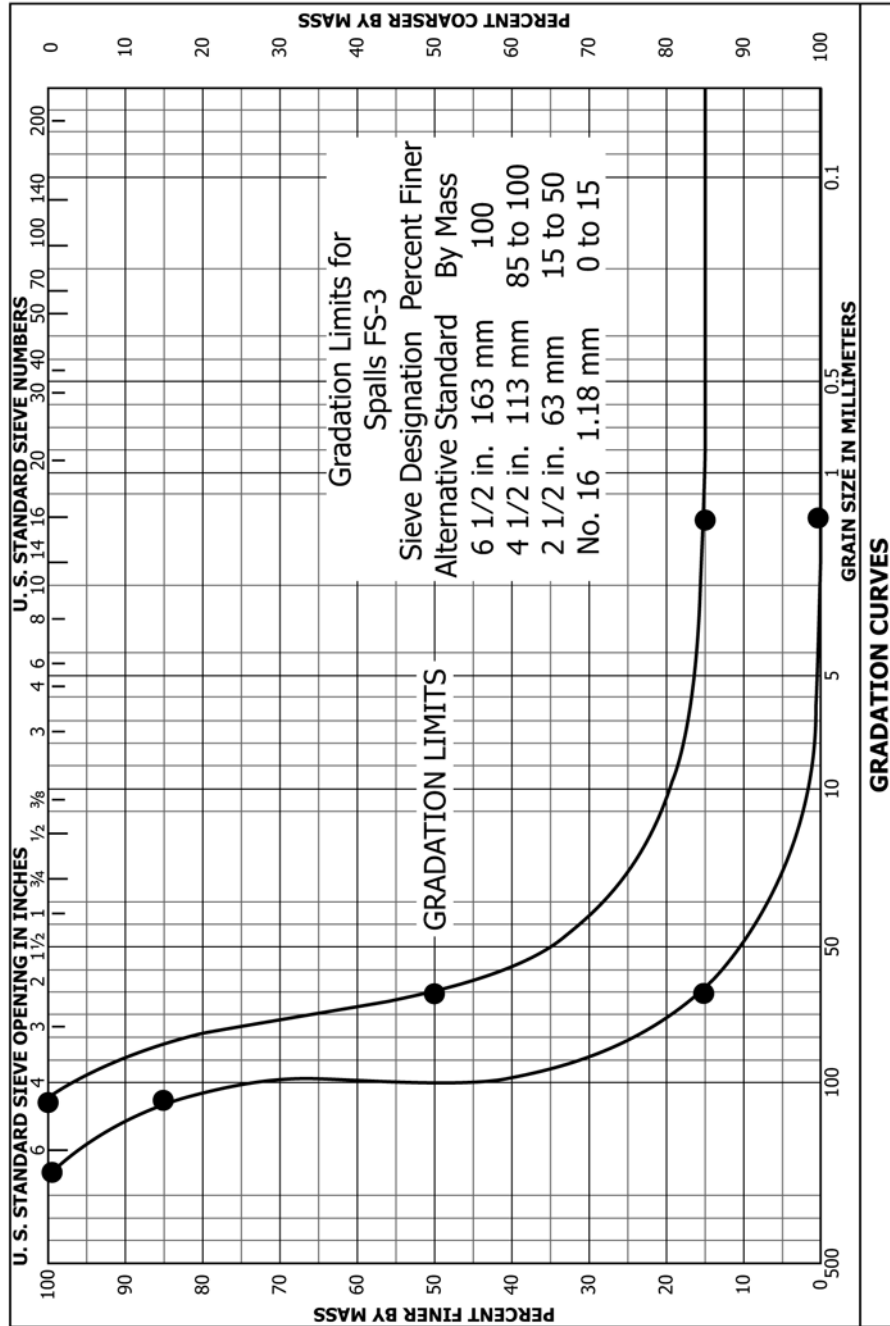


FIG. 7 Gradation Limits for Spalls FS-3

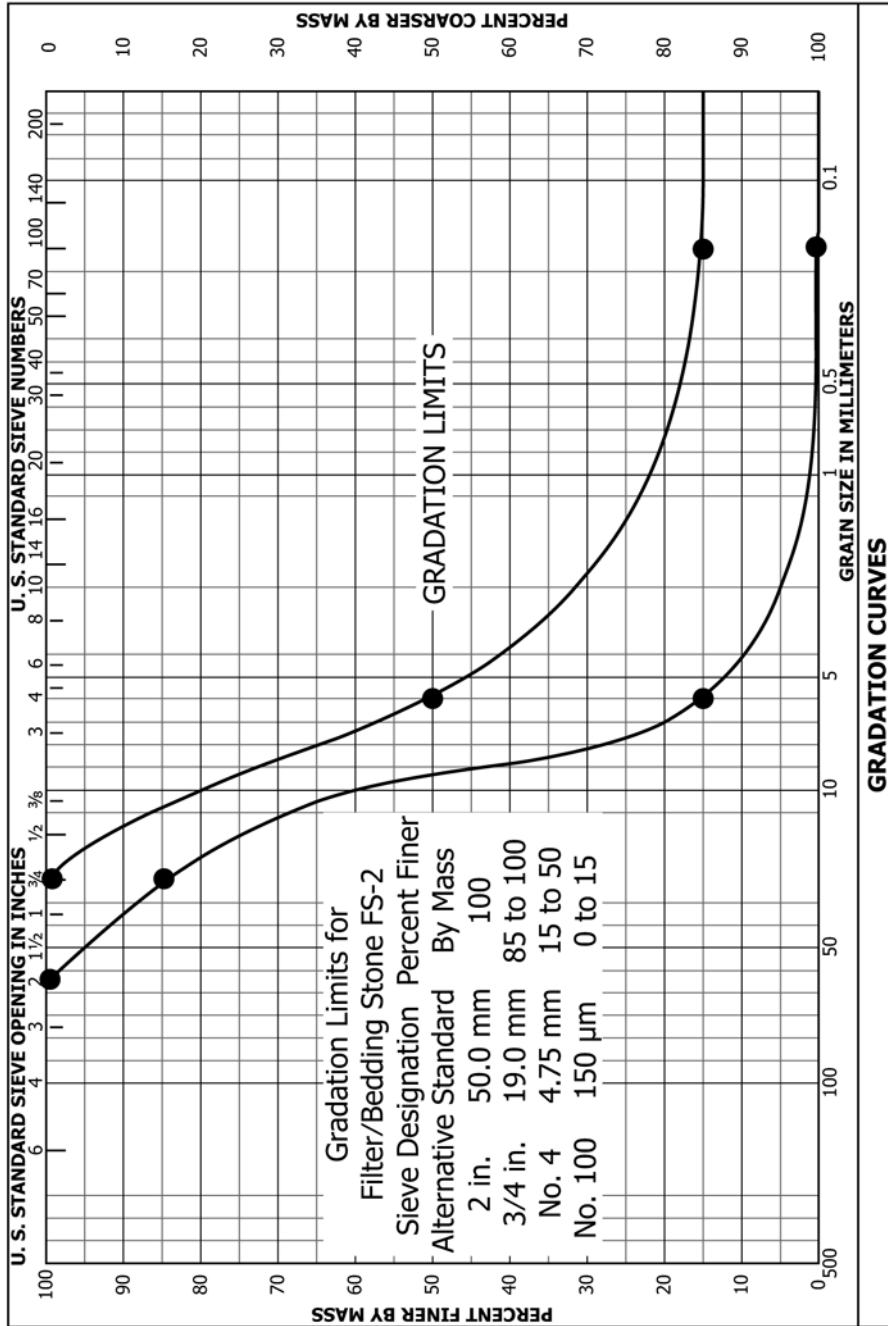


FIG. 8 Gradation Limits for Bedding FS-2

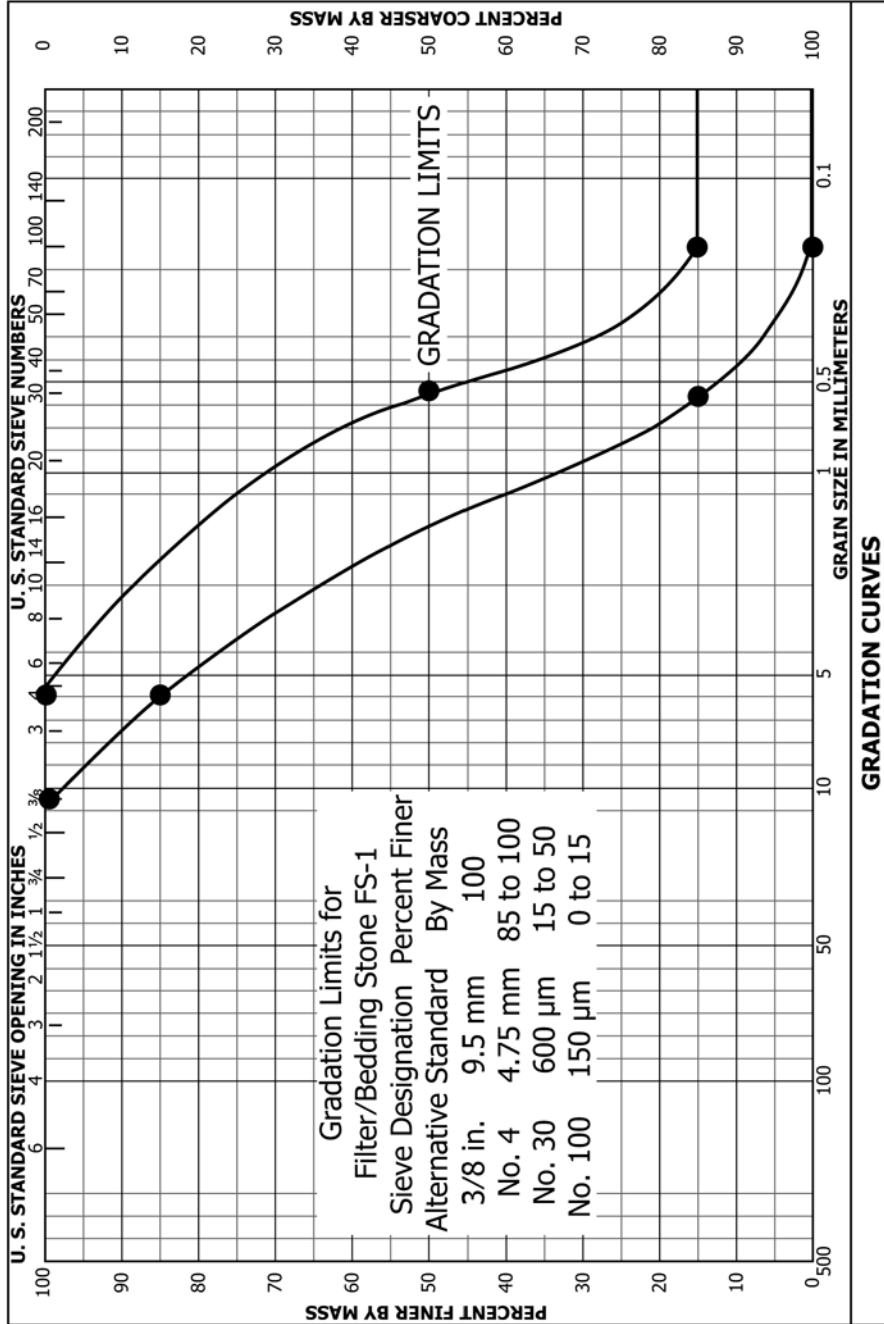


FIG. 9 Gradation Limits for Bedding FS-1

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D6092 – 97 (2008)) that may impact the use of this standard. (Approved Feb. 1, 2014.)

- (1) Revised **Table 1** formatting for better graphic definition and data alignment to improve ease of use.
- (2) Inserted a new **Table 2** for clarification and ease of use for the standard sizes of spalls and filter/bedding stone. Previously the standard sizes were only listed in **Figs. 7-9**.
- (3) Retitled former Table 2 to **Table 3**. SI units were introduced for clarification and ease of use. The formatting was revised for better graphic definition to improve ease of use.
- (4) Revised **2.1** by adding the reference to Specification **E11**.
- (5) Revised **3.2.1** for clarity and ease of understanding.
- (6) Added **3.2.4** to define the term “prolate sphere.”
- (7) Revised Section **7** for clarity and ease of use.
- (8) Replaced **Figs. 1-9** for clarity and ease of use.

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