Designation: ~~D6092 – 14$^{\varepsilon 1}$~~ D6092 – 21

Standard Practice for Specifying Standard Sizes of Stone for Erosion Control[1]

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.

~~ε[1] NOTE—Figure 4 was editorially corrected in June 2018.~~

1. ~~Scope*~~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~~rationalized 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, health, and environmental 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.*

1.5 *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]

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

[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.
Current edition approved ~~Feb. 1, 2014~~Nov. 1, 2021. Published ~~March 2014~~November 2021. Originally approved in 1997. Last previous edition approved in ~~2008~~2014 as ~~D6092 – 97 (2008).~~D6092 – 14$^{\varepsilon 1}$. DOI: ~~10.1520/D6092-14E01.~~10.1520/D6092-21.

[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.

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

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/spalls, n—*stone, filter stone consisting of crushed stone ranging in size from minus 2.0 in. (50 mm) to No. 100 (150 µm) 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.~~

3.2.1.1 *Discussion—*
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.~~

3.2.2 *~~gradation—~~gradation, n—*the proportions by mass of stones distributed within specified ranges between maximum and minimum limits.

3.2.3 *prolate ~~sphere—~~sphere, n—*a spheroid in which the polar axis is greater than the equatorial diameter.

3.2.4 *~~riprap—~~riprap, n—*stone materials generally less than 3000 lb in mass (1400 kg), specially selected and graded, and when properly placed prevents erosion through minor wave action, or strong currents and thereby preserves the shape of a surface, slope, or the underlying structure.

3.2.5 *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

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~~	~~. . .~~	~~. . .~~	~~. . .~~	~~. . .~~	~~. . .~~
3000	(1364)	100	. . .	. . .	. . .	. . .	. . .
~~1500~~	~~(680)~~	~~50 to 100~~	~~100~~	~~. . .~~	~~. . .~~	~~. . .~~	~~. . .~~
1500	(682)	50 to 100	100	. . .	. . .	. . .	. . .
~~1000~~	~~(450)~~	~~. . .~~	~~. . .~~	~~. . .~~	~~. . .~~	~~. . .~~	~~. . .~~
1000	(454)	. . .	. . .	. . .	. . .	. . .	. . .
~~700~~	~~(320)~~	~~15 to 50~~	~~50 to 100~~	~~100~~	~~. . .~~	~~. . .~~	~~. . .~~
700	(318)	15 to 50	50 to 100	100	. . .	. . .	. . .
~~500~~	~~(230)~~	~~. . .~~	~~. . .~~	~~. . .~~	~~. . .~~	~~. . .~~	~~. . .~~
500	(227)	. . .	. . .	. . .	. . .	. . .	. . .
~~300~~	~~(140)~~	~~. . .~~	~~15 to 50~~	~~50 to 100~~	~~100~~	~~. . .~~	~~. . .~~
300	(136)	. . .	15 to 50	50 to 100	100	. . .	. . .
~~250~~	~~(110)~~	~~0 to 15~~	~~. . .~~	~~. . .~~	~~. . .~~	~~. . .~~	~~. . .~~
250	(114)	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~~
2	(1.0)	. . .	. . .	. . .	. . .	. . .	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.

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~~Mass		
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	. . .
⅜ 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.

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. Standard gradings typically vary between states, provinces, and within other geographic districts based on influence of a local department of transportation or other dominant entity, which is historically the primary purchaser or specifier of erosion control stone products.

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~~should 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, 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~~Manufacturing

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 generally 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 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

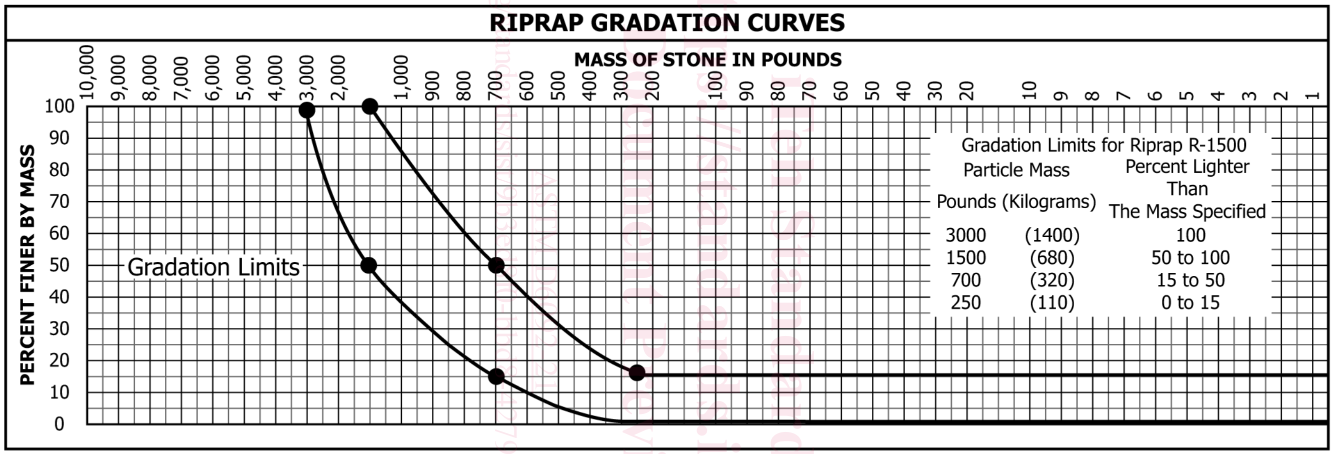
8.1 erosion control; filter/bedding stone; gradation; quarried stone; riprap; standard size designation

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

Maximum Dimension		Cube								Sphere							
		Specific Gravity^B								Specific Gravity^B							
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)								Approximate Mass of Stone, lb (kg)							
~~42~~	~~(105)~~	~~6950~~	~~(3160)~~	~~7090~~	~~(3223)~~	~~7225~~	~~(3284)~~	~~7350~~	~~(3341)~~	~~3640~~	~~(1655)~~	~~3712~~	~~(1687)~~	~~3780~~	~~(1718)~~	~~3850~~	~~(1750)~~
42	(107)	6950	(3159)	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)~~
30	(76)	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)~~
20	(51)	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)~~
6	(15)	20	(9)	20	(9)	21	(9)	21	(9)	10	(4)	11	(5)	11	(5)	11	(5)

Maximum Dimension		Prolate Sphere								Average of Cube and Sphere							
		Specific Gravity^B								Specific Gravity^B							
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)								Approximate Mass of Stone, lb (kg)							
~~42~~	~~(105)~~	~~3238~~	~~(1472)~~	~~3300~~	~~(1500)~~	~~3362~~	~~(1528)~~	~~3424~~	~~(1556)~~	~~5300~~	~~(2409)~~	~~5401~~	~~(2455)~~	~~5500~~	~~(2500)~~	~~5600~~	~~(2545)~~
42	(107)	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)~~
30	(76)	1180	(536)	1202	(546)	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)~~
20	(51)	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)~~
6	(15)	9	(4)	10	(4)	10	(4)	10	(4)	15	(7)	16	(7)	16	(7)	16	(7)

^{A} Rounded to two figures from conversion of inch-pound (U.S. Customary) units.
^{B}For stone of specific gravity greater than 2.75, refer to the nomograph in Fig. 2 or Test Method D5519.



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 or gap graded and are unacceptable.

FIG. 1 Gradation Limits for Riprap R-1500

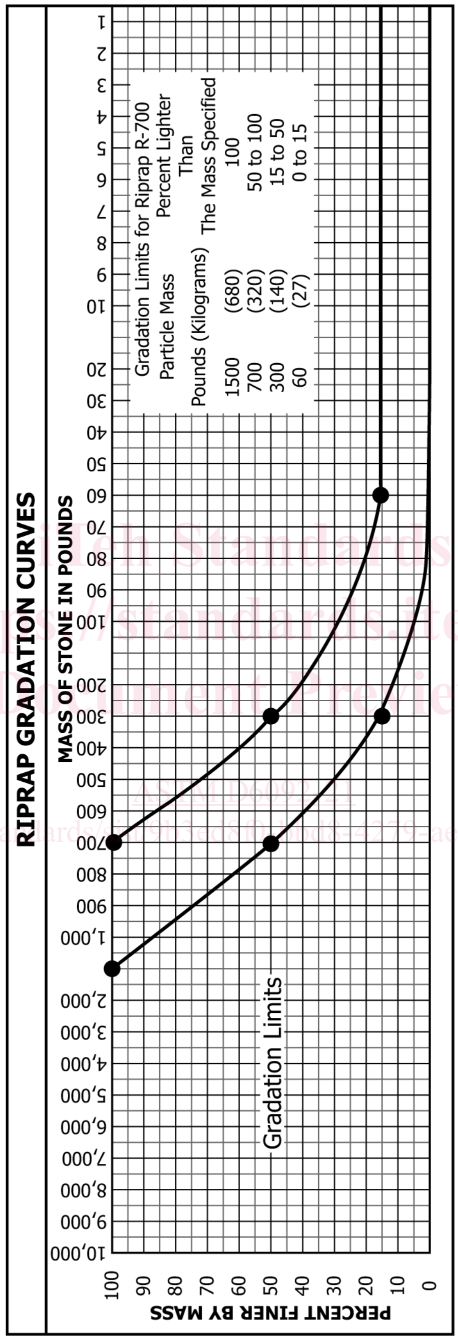


FIG. 2 Gradation Limits for Riprap R-700

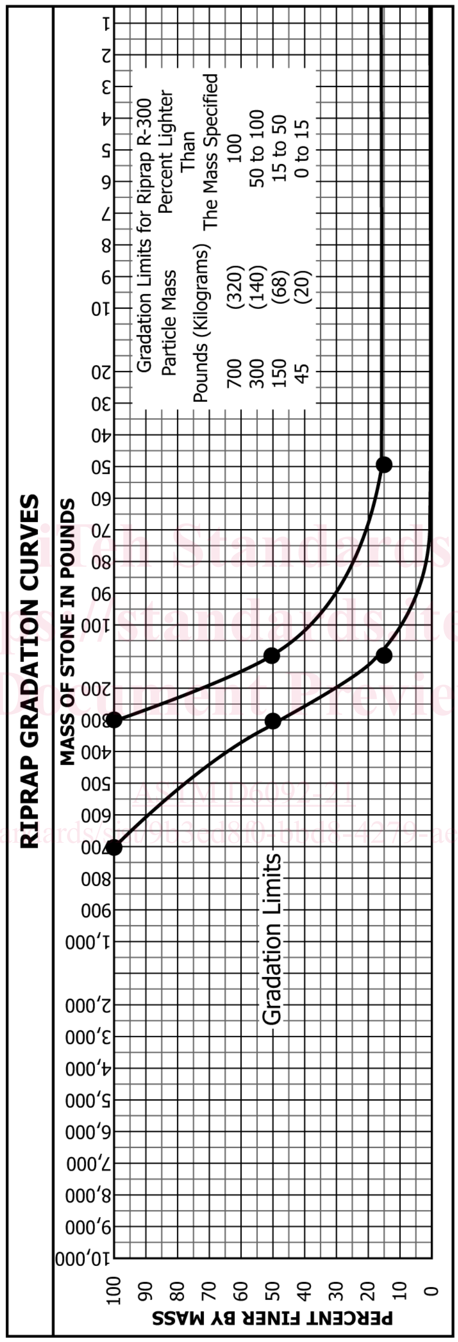


FIG. 3 Gradation Curve for Riprap R-300