APPENDIX B

INVENTORY OF WATERWAYS EXPERIMENT STATION MODEL TESTS

B-1. General. Numerous breakwater and jetty model investigations have been conducted at the US Army Engineer Waterways Experiment Station (WES). These investigations, which are summarized in the following paragraphs, should provide excellent guidance as to the type of design information obtainable from these studies. Table B-1 lists pertinent information from each model study and shows the variance of the stability coefficient for different types of armor and environmental conditions used on similar types of structures.

B-2. Stability Tests Conducted on Breakwater or Jetty Trunk Sections (New Construction).

a. Purposes of Studies. The purposes of these studies are typically to experimentally investigate through two-dimensional model tests the armor stability, wave transmission properties, and wave overtopping characteristics of a proposed breakwater trunk section.

b. Tests and Results. Tests are conducted using the range of water levels, wave periods, and wave heights that are expected during the design life of the structure. Alternate plans that may reduce the structure's cost without significantly affecting its performance are investigated if the original section proves to be acceptable. If the original section proves to be inadequate, modifications are made as needed to achieve an acceptable level of stability and wave protection. Thus the model serves as a tool to aid in optimization of the structure.

c. Studies Conducted.

(1) Waianae Small-Boat Harbor, Oahu, Hawaii, Design for Wave Protection (item 8).

(2) Stability of Rubble-Mound Breakwater, Lahaina Harbor, Hawaii (item 22).

(3) Rubble-Mound Breakwater Stability and Wave-Attenuation Tests, Port Ontario Harbor, New York (item 34).

(4) Stability of Rubble-Mound Breakwater, Maalaea Harbor, Maui, Hawaii (item 33).

(5) South Jetty Stability Study, Masonboro Inlet, North Carolina (item 32).

(6) Designs for Rubble-Mound Breakwaters, Dana Point Harbor, California (item 42).

(7) Stability and Transmission Tests of Tribar Breakwater Section Proposed for Monterey Harbor, California (item 44).

(8) Stability Tests on Proposed Rubble-Mound Breakwaters, Nassau Harbor, Bahamas (item 67).

(9) Design of Tetrapod Cover Layer for a Rubble-Mound Breakwater, Crescent City Harbor, Crescent City, California (item 64).

(10) Stability of Crescent City Harbor Breakwater, Crescent City, California (item 54).

(11) Stability of Proposed Breakwater, Burns Waterway Harbor, Indiana (item 75).

(12) Designs for Rubble-Mound Breakwater, Noyo Harbor, California (item 74).

(13) Placed-Stone Stability Tests, Tillamook, Oregon (item 91).

B-3. Stability Tests Conducted on Breakwater or Jetty Head and Trunk Sections (New Construction).

a. Purposes of Studies. The purposes of these types of studies are to experimentally investigate through three-dimensional model tests the armor stability, wave transmission properties, and wave overtopping characteristics of a proposed breakwater trunk and head section.

b. Tests and Results. Tests are typically the same as those described in paragraph B-2b except that they are conducted for at least two angles of wave attack. Again, test results are used to aid in optimization of the structure.

c. Studies Conducted.

(1) Jetty Stability Study, Oregon Inlet, North Carolina (item 31).

(2) Stability of Rubble-Mound Breakwaters, Jubail Harbor, Saudi Arabia (item 29).

(3) Designs for Rubble-Mound Breakwater Construction, Tsoying Harbor, Taiwan (item 71).

(4) Breakwater Stability Study, Mission Bay, California (item 89).

(5) Breakwater and Revetment Stability Study, San Juan National Historic Site, San Juan, Puerto Rico (item 86).

(6) Breakwater Stability Study, Imperial Beach, California (item 90).

B-4. Stability Tests Conducted on Breakwater or Jetty Sections for Rehabilitation and/or Repair of Existing Structures.

a. Purposes of Studies. Studies of this type typically investigate the adequacy of proposed repair plans and, if necessary, develop alternate designs from which the optimum plan for stability, constructability, and economy can be determined.

b. Tests and Results. Structures in need of repair or rehabilitation have normally been subjected to wave conditions in excess of the originally estimated design conditions. Thus, model tests typically simulate those storm conditions that have produced damage to the prototype structure.

c. Studies Conducted.

(1) Stability Tests of Modified Repair Options for the San Pedro Breakwater, Los Angeles, California (item 7).

(2) Breakwater Rehabilitation Study, Crescent City Harbor, California (item 6).

(3) San Pedro Breakwater Repair Study, Los Angeles, California (item 28).

(4) Stability Tests of Nawiliwili Breakwater Repair (item 47).

(5) Proposed Jetty-Head Repair Sections, Humboldt Bay, California (item 46).

(6) Designs for Rubble-Mound Breakwater Repair, Kahului Harbor, Maui, Hawaii (item 72).

(7) Designs for Rubble-Mound Breakwater Repair, Morro Bay Harbor, California (item 70).

(8) Design for Rubble-Mound Breakwater Repairs, Nawiliwili Harbor, Nawiliwili, Hawaii (item 77).

(9) Kahului Breakwater Stability Study, Kahului, Maui, Hawaii (item 87).

(10) Nawiliwili Breakwater Stability Study, Nawiliwili Harbor, Kauai, Hawaii (item 92).

Table B-1. Breakwater Stability Two- and Three-Dimensional Site-Specific Model Studies Conducted at US Army Engineer Waterways Experiment Station

Project Location	Type of Structure	Type of Armor	Type of Placement	Armor weight tons	Armor Specific Weight lb/ft^3	Sea-bottom Slope	Sea-side Structure Slope	Total Water Depth ft	Structure Height ft	Degree of Overtop	Wave Period sec	Wave Height ft	Model K_D	Wave Form	Angle of Wave Attack deg	Reference[a]
							Nonbreaking Waves on Breakwater Trunks									
Rough Angular Stone																
Burns Harbor, Indiana[b]	Breakwater	Stone	Random 2 Layers	13.5	165	1:100	1:1.5	47.0	57.0	Mod	11	15.0	3.1	Non-breaking	90.0	TR 2-766 Mar 1967 (item 75)
Long Beach (Sohio), California[b]	Breakwater	Stone	Random 2 Layers	7.5	165	Flat	1:2	55.4	64.0	Min	13	14.0	3.8	Non-breaking	90.0	Unpublished[c]
Mission Bay, California[b]	Breakwater	Stone	Random 2 Layers	14.5	165	Flat	1:1.5	34.6	47.5	Mod	9-15	16.7	4.3	Non-breaking	90.0	TR HL-83-18 Sep 1983 (item 89)
Morro Bay, California[d]	Breakwater	Stone	Random 2 Layers	25.0	175	1:50	1:2.25	38.0	48.0	Maj	15	27.0	5.6	Non-breaking	90.0	TR 2-567 May 1961 (item 70)
												28.0	6.4	Non-breaking		
Rough Dimensional Stone (Special Placed)																
Dana Point, California[b]	Breakwater	Stone	Special 2 Layers	12.0	165	1:30	1:2	37.0	44.0	Maj	18	22.0	9.3	Non-breaking	90.0	TR 2-725 Jun 1966 (item 42)
Siuslaw, Oregon[d]	Breakwater	Stone	Special 2 Layers	10.0	170	Flat	1:2	30.0	42.0	Mod	12	17.0	4.6	Non-breaking	90.0	TR 2-631 July 1963 (item 135)
	Breakwater	Stone	Special 1 Layer	10.0	170	Flat	1:1.5	30.0	40.0	Mod	12	15.0	4.2	Non-breaking	90.0	
	Breakwater	Stone	Special 2 Layers	10.0	170	Flat	1:2	30.0	42.0	Mod	12	19.0	6.4	Non-breaking	90.0	
	Breakwater	Stone	Special 2 Layers	10.0	170	Flat	1:2	30.0	49.5	Minor	12	16.0	4.4	Non-breaking	90.0	
	Breakwater	Stone	Special 1 Layer	10.0	170	Flat	1:1.5	30.0	47.5	Minor	12	15.0	4.2	Non-breaking	90.0	
	Breakwater	Stone	Special 2 Layers	10.0	170	Flat	1:2	30.0	49.5	Minor	12	17.0	5.2	Non-breaking	90.0	

(Continued)

[a] All references refer to WES publications.

[b] New projects.

[c] "Long Beach-Sohio Breakwater Stability Study: Long Beach, California," by R. D. Carver, 1979 (can be obtained from Port of Long Beach, Long Beach, California 90801).

[d] Rehabilitated projects.

(Sheet 1 of 8)

Table B-1 (Continued)

Project Location	Type of Structure	Type of Armor	Type of Placement	Armor weight tons	Armor Specific Weight lb/ft^3	Sea-bottom Slope	Sea-side Structure Slope	Total Water Depth ft	Structure Height ft	Degree of Overtop	Wave Period sec	Wave Height ft	Model K_D	Wave Form	Angle of Wave Attack deg	Reference
					Nonbreaking Waves on Breakwater Trunks (Continued)											
Tetrapods/Quadripods																
Crescent City, California[a]	Breakwater	Tetrapod	Random	17.6	140	Flat	1:2	69.0	84.0	Mod	14	23.0	14.4	Non-breaking	90.0	TM 2-413 Jun 1955 (item 64)
	Breakwater	Tetrapod	Random	17.6	140	Flat	1:3	69.0	84.0	Mod	14	25.0	12.4	Non-breaking	90.0	
	Breakwater	Tetrapod	Random	17.6	140	Flat	1:4	69.0	84.0	Mod	14	26.0	10.4	Non-breaking	90.0	
Crescent City, California[a]	Breakwater	Tetrapod	Random	25.0	150	Flat	1:1.333	55.0	70.0	Mod	14	20.0	7.4	Non-breaking	90.0	MP 2-171 Apr 1956 (item 65)
Tribars																
Monterey Harbor, California[a]	Breakwater	Tribars	Random 2 Layers	12.0	150	Flat	1:1.5	45.2	54.0	Maj	17	18.0	10.0	Non-breaking	90.0	MP H-69-11 Sep 1969 (item 44)
Morro Bay, California[b]	Breakwater	Tribars	Random 1 Layer	20.0	150	1:50	1:1.5	38.0	48.0	Maj	13	24.0	14.4	Non-breaking	90.0	TR 2-567 May 1961 (item 70)
						Breaking Waves on Breakwater Trunks										
Rough Angular Stone																
Lahaina Harbor, Hawaii[a]	Breakwater	Stone	Random 2 Layers	2.75	170	1:20	1:2	7.5	17.0	None	16	8.0	1.8	Breaking	90.0	TR H-76-8 Apr 1976 (item 22)
Jubail Harbor, Saudi Arabia[a]	Breakwater	Stone	Random 2 Layers	7.15	165	1:10	1:2	19.7	36.1	None	9	13.4	3.5	Breaking	90.0	TR H-76-20 Dec 1976 (item 29)
Port Ontario Harbor, New York[c]	Breakwater	Stone	Random 2 Layers	5.3	155	1:50	1:2	12.3	17.7	Mod	11	9.8	2.1	Breaking	90.0	TR HL-81-5 Apr 1981 (item 34)
San Juan, Puerto Rico[c]	Breakwater	Stone	Random 2 Layers	33.9	165	1:20	1:2	22.9	23.0	Sev	17	23.3	3.9	Breaking	90.0	TR HL-81-11 Sep 1981 (item 86)

(Continued)

[a] New projects.

[b] Rehabilitated projects.

(Sheet 2 of 8)

Table B-1 (Continued)

Project Location	Type of Structure	Type of Armor	Type of Placement	Armor weight tons	Armor Specific Weight lb/ft^3	Sea-bottom Slope	Sea-side Structure Slope	Total Water Depth ft	Structure Height ft	Degree of Overtop	Wave Period sec	Wave Height ft	Model K_D	Wave Form	Angle of Wave Attack deg	Reference
							Breaking Waves on Breakwater Trunks (Continued)									
Rough Angular Stone (Cont)																
Masonboro Inlet, North Carolina[a]	Jetty	Stone	Random 2 Layers	18.0	165	1:20	1:2	14.5	13.0	Sev	15	13.5	1.4	Breaking	90.0	MP H-78-12 Oct 1978 (item 32)
Oregon Inlet, North Carolina[a]	Jetty	Stone	Random 2 Layers	22.0	165	1:20	1:1.5	16.5	22.5	Sev	15	15.5	2.4	Breaking	90.0	TR CERC-83-3 Sep 1983 (item 31)
Fort Fisher, North Carolina[a]	Revetment	Stone	Random 2 Layers	4.3	165	1:55	1:2	14.7	17.0	Mod-Maj	10	11.8	4.0	Breaking	90.0	TR HL-82-26 Nov 1982 (item 88)
Rough Dimensioned Stone (Special Placed)																
Tillamook, Oregon[b]	Breakwater	Stone	Special 2 Layers	9.5	170	1:20	1:2	30.0	40.0	Mod	13	26.0	17.2	Breaking	90.0	TR HL-79-16 Sep 1979 (item 91)
	Toe	Stone	Special 2 Layers	6.4	170	1:20	1:1.5	20.0	40.0	Min	13	16.0	7.9	Breaking	90.0	
	Breakwater	Stone	Special 2 Layers	22.6	170	1:20	1:2	40.0	50.0	Mod	13	33.0	14.9	Breaking	90.0	
	Toe	Stone	Special 2 Layers	15.2	170	1:20	1:1.5	30.0	50.0	Min	13	26.0	14.5	Breaking	90.0	
	Breakwater	Stone	Random 2 Layers	22.6	170	1:20	1:2	40.0	50.0	Mod	13	33.0	22.2	Breaking	90.0	
	Toe	Stone	Random	15.2	170	1:20	1:2	30.0	50.0	Min	13	26.0	7.3	Breaking	90.0	
Fort Fisher, North Carolina[a]	Revetment	Stone	Special 2 Layers	3.0	165	1:55	1:2	14.7	17.0	Mon-Maj	10	11.8	5.8	Breaking Nov 82	90.0	TR HL-82-26 Nov 82 (item 88)
Tetrapods/Quadripods																
Noyo Harbor, California[a]	Breakwater	Tetrapod	Random	36.0	150		1:3	48.0	60.0	Mod	14	29.0	7.0	Breaking	90.0	MP 2-841 Aug 1966 (item 74)

(Continued)

[a] New projects.

[b] Rehabilitated projects.

(Sheet 3 of 8)

Table B-1 (Continued)

Project Location	Type of Structure	Type of Armor	Type of Placement	Armor weight tons	Armor Specific Weight lb/ft^3	Sea-bottom Slope	Sea-side Structure Slope	Total Water Depth ft	Structure Height ft	Degree of Overtop	Wave Period sec	Wave Height ft	Model K_D	Wave Form	Angle of Wave Attack deg	Reference
						Breaking Waves on Breakwater Trunks (Continued)										
Tribars																
Nassau Harbor, Bahamas[a]	Breakwater	Tribars	Random 2 Layers	10.0	150	Flat	1:1.5	25.0	35.0	Mod/Maj	11	19.0	14.1	Breaking	90.0	MP 2-799 Mar 1966 (item 67)
				19.0	150	Flat	1:1.5	30.0	40.0	Maj	11	23.0	13.2	Breaking	90.0	
	Breakwater	Tribars	Random 2 Layers	31.0	150	Flat	1:1.5	38.0	48.0	Maj	11	25.0	10.4	Breaking	90.0	
Kahului Harbor, Maui, Hawaii[b]	Breakwater	Tribars	Random 2 Layers	35.0	156	1:125	1:2	58.0	68.0	Sev	18	37.0	19.0	Breaking	90.0	TR 2-644 Feb 1964 (item 72)
Kahului, Maui, Hawaii[b]	Breakwater	Tribars	Random 2 Layers	35.0	146	1:27	1:3.6	42.0	55.8	Maj	18	34.0	10.6	Breaking	90.0	TR HL-82-14 Jul 1982 (item 87)
Kahului, Maui, Hawaii[b]	Breakwater	Tribars	Random 2 Layers	19.0	146	1:27	1:2.6	29.0	41.3	Maj	18	25.6	11.8	Breaking	90.0	
Kahului, Maui, Hawaii[b]	Breakwater	Tribars	Special 1 Layer	10.0	146	1:27	1:2	24.0	32.1	Maj	18	21.5	15.7	Breaking	90.0	
Nawiliwili Harbor, Hawaii[b]	Breakwater	Tribars	Special 1 Layer	17.8	158	1:55	1:1.5	32.0	45.0	Maj	16	24.0	12.9	Breaking	90.0	MP 2-377 Feb 1960 (item 77)
Dolos																
Lahaina Harbor, Hawaii[a]	Breakwater	Dolos	Random 2 Layers	0.75	150	1:20	1:2	7.5	14.5	None	16	8.0	10.5	Breaking	90.0	TR H-76-8 Apr 1976 (item 22)
Maalaea Harbor, Maui, Hawaii[a]	Breakwater	Dolos	Random 2 Layers	6.0	147	1:50	1:1.5	19.0	28.0	Maj	16	16.7	17.5	Breaking	90.0	MP HL-81-1 Jan 1981 (item 33)
Waianae Harbor, Oahu, Hawaii[a]	Breakwater	Dolos	Random 2 Layers	1.5	150	1:20/ 1:53	1:2	16.0	28.0	Mod	16	11.8	16.9	Breaking	90.0	TR H-76-8 May 1976 (item 8)

(Continued)

[a]New projects.
[b]Rehabilitated projects.

(Sheet 4 of 8)

Table B-1 (Continued)

Project Location	Type of Structure	Type of Armor	Type of Placement	Armor weight tons	Armor Specific Weight lb/ft^3	Sea-bottom Slope	Sea-side Structure Slope	Total Water Depth ft	Structure Height ft	Degree of Overtop	Wave Period sec	Wave Height ft	Model K_D	Wave Form	Angle of Wave Attack deg	Reference
Breaking Waves on Breakwater Trunks (Continued)																
Dolos (Continued)																
Kahului, Maui, Hawaii[a]	Breakwater	Dolos	Random 2 Layers	30.0	146	1:100	1:1.7	49.0	56.5	Maj	18	29.8	18.3	Breaking	90.0	TR HL-82-14 Jul 1982 (item 87)
Nawiliwili Harbor, Hawaii[a]	Breakwater	Dolos	Random 2 Layers on toe	2.0	146	1:10	1:1.5	10.0	16.5	Min	16	8.9	8.2	Breaking	90.0	MP H-78-4 Jan 1978 (item 47)
Oregon Inlet, North Carolina[b]	Jetty	Dolos	Random 2 Layers	9.5	150	1:20	1:1.5	16.5	22.5	Sev	15	15.5	8.3	Breaking	90.0	TR CERC-83-3 Sep 1983 (item 31)
Atlantic Station, New Jersey[b]	Breakwater	Dolos	Random 2 Layers	43.0	150	1:10	1:2	56.3	104.0	Min-Mod	16	40.0	23.0	Breaking	90.0	Unpublished[c]
Nonbreaking Waves on Breakwater Heads																
Rough Angular Stone																
Mission Bay, California[b]	Breakwater	Stone	Random 2 Layers	14.5	165	Flat	1:2	34.6	47.5	Mod	9-15	16.7	3.4	Non-breaking	33.0	TR HL-83-18 Sep 1983 (item 89)
Oregon Inlet, North Carolina[b]	Jetty	Stone	Random 2 Layers	30.0	165	1:20	1:3	28.0	38.0	Mod	15	17.6	1.3	Non-breaking	90.0	TR CERC-83-3 Sep 1983 (item 31)
								28.0	38.0	Maj	15	22.0	2.5	Non-breaking	45.0	
Rough Dimensioned Stone (Special Placed)																
Siuslaw, Oregon[a]	Breakwater	Stone	Special 3 Layers	18.0	170	Flat	1:2	40.0	51.5	Mod	14	21.0	4.8	Non-breaking	90.0	TR 2-631 Jul 1963 (item 135)
				18.0	170	Flat	1:2	40.0	51.5	Mod	14	21.0	7.2		90.0	
				18.0	170	Flat	1:2	40.0	51.5	Mod	14	24.0	7.2		90.0	
				18.0	170	Flat	1:1.5	40.0	59.0	Minor	14	24.0	8.2		90.0	
				18.0	170	Flat	1:1.5	40.0	59.0	Minor	14	22.0	6.3		90.0	
				18.0	170	Flat	1:1.5	40.0	59.0	Minor	14	24.0	8.2		90.0	

(Continued)

[a] Rehabilitated projects.
[b] New projects.
[c] "Atlantic Generating Station Breakwater Stability Study" by D. D. Davidson and D. G. Markle, 1978 (can be obtained from Public Service Electric and Gas Co. of New Jersey, Newark, New Jersey 07101).

(Sheet 5 of 8)

Table B-1 (Continued)

Project Location	Type of Structure	Type of Armor	Type of Placement	Armor weight tons	Armor Specific Weight lb/ft^3	Sea-bottom Slope	Sea-side Structure Slope	Total Water Depth ft	Structure Height ft	Degree of Overtop	Wave Period sec	Wave Height ft	Model K_D	Wave Form	Angle of Wave Attack deg	Reference
					Nonbreaking Waves on Breakwater Heads (Continued)											
Rough Dimensioned Stone (Special Placed) (Continued)																
Tetrapods/Quadripods																
Nassau Harbor, Bahamas[a]	Breakwater	Quadrapod	Random	7.0	150	Flat	1:1.5	25.0	35.0	Min	11	12.0	5.1	Non-breaking	90.0	TR 2-697 Oct 1965 (item 73)
	Breakwater	Tetrapod	Random	14.0	150	Flat	1:1.5	25.0	35.0	Mod	11	15.0	5.0	Non-breaking	90.0	
	Breakwater	Tetrapod	Random	17.0	150	Flat	1:1.5	25.0	35.0	Mod	11	16.0	5.0	Non-breaking	90.0	
Humboldt Bay, California[b]	Jetty	Tetrapod	Random	28.0	150	1:10	1:5	43.0	60.0	Min	16	23.0	2.7	Non-breaking	90.0	
Tribars																
Humboldt Bay, California[b]	Jetty	Tribars	Random 2 Layers	23.0	150	1:10	1:5	43.0	60.0	Mod	16	29.0	6.6	Non-breaking	45.0	TR HL-71-8 Nov 1971 (item 46)
	Jetty	Tribars	Random 2 Layers	33.0	150	1:10	1:5	43.0	60.0	Mod	16	36.0	6.6	Non-breaking	45.0	
	Jetty	Tribars	Random 2 Layers	44.0	150	1:10	1:5	43.0	60.0	Maj	16	36.0	6.6	Non-breaking	45.0	
Kahului Harbor, Maui, Hawaii[b]	Breakwater	Tribars	Random 2 Layers	35.0	156	1:125	1:3	58.0	68.5	Maj	14	30.0	6.8	Non-breaking	90.0	TR 2-644 Feb 1964 (item 72)
	Breakwater	Tribars	Random 2 Layers	50.0	156	1:125	1:4	58.0	85.5	Min	18	35.0	5.6	Non-breaking	90.0	
	Breakwater	Tribars	Random 2 Layers	35.0	156	1:125	1:3	58.0	68.5	Maj	18	36.0	8.2	Non-breaking	50.0	
	Breakwater	Tribars	Random 2 Layers	50.0	156	1:125	1:3	58.0	68.5	Maj	18	36.0	8.2	Non-breaking	50.0	
Morro Bay, Harbor California[b]	Breakwater	Tribars	Random 1 Layer Above swl 2 Layers Below swl	20.0	150	1:50	1:2.25	38.0	48.0	Maj	15	25.0	10.7	Non-breaking	90.0	TR 2-567 May 1961 (item 70)

(Continued)

[a] New projects.
[b] Rehabilitated projects.

(Sheet 6 of 8)

Table B-1 (Continued)

Project Location	Type of Structure	Type of Armor	Type of Placement	Armor weight tons	Armor Specific Weight lb/ft^3	Sea-bottom Slope	Sea-side Structure Slope	Total Water Depth ft	Structure Height ft	Degree of Overtop	Wave Period sec	Wave Height ft	Model K_D	Wave Form	Angle of Wave Attack deg	Reference
					Nonbreaking Waves on Breakwater Heads (Continued)											
Dolos																
Jubail Harbor, Saudi Arabia[a]	Breakwater	Dolos	Random 2 Layers	5.5	150	Flat	1:2	29.5	46.0	None	9	15.4	10.3	Non-breaking	54.0	TR H-76-20 Dec 1976 (item 29)
	Breakwater	Dolos	Random 2 Layers	5.5	150	Flat	1:2	29.5	46.0	None	9	15.4	10.3	Non-breaking	68.0	
Oregon Inlet, North Carolina[a]	Jetty	Dolos	Random 2 Layers	14.0	150	1:20	1:3	28.0	38.0	Mod	15	17.6	4.0	Non-breaking	0.0	TR CERC-83-3 Sep 1983 (item 31)
	Jetty	Dolos	Random 2 Layers	14.0	150	1:20	1:3	28.0	38.0	Mod	15	17.6	4.0	Non-breaking	22.5	
	Jetty	Dolos	Random 2 Layers	14.0	150	1:20	1:3	28.0	38.0	Mod	15	17.6	4.0	Non-breaking	45.0	
	Jetty	Dolos	Random 2 Layers	14.0	150	1:20	1:3	28.0	38.0	Mod	15	17.6	4.0	Non-breaking	67.5	
	Jetty	Dolos	Random 2 Layers	14.0	150	1:20	1:3	28.0	38.0	Mod	15	17.6	4.0	Non-breaking	90.0	
	Jetty	Dolos	Random 2 Layers	14.0	150	1:20	1:3	28.0	38.0	Sig	15	22.0	7.8	Non-breaking	45.0	
Cubes																
Humboldt Bay, California[b]	Jetty	Cube	Random 1-2 Layers	100.0	150	1:10	1:5	43.0	60.0	Min	16	22.0	0.7	Non-breaking	45.0	TR H-71-8 Nov 1971 (item 46)
Tri-Long																
Humboldt Bay, California[b]	Jetty	Tri-Long	Random 1-2 Layers	28.0	150	1:10	1:5	43.0	60.0	Min	16	21.0	2.1	Non-breaking	45.0	TR H-71-8 Nov 1971 (item 46)
						Breaking Waves on Breakwater Heads										
Rough Angular Stone																
Oregon Inlet, North Carolina[b]	Jetty	Stone	Random 2 Layers	30.0	165	1:20	1:3	21.0	38.0	Min	15	17.6	1.3	Breaking	90.0	TR CERC-83-3 Sep 1983 (item 31)

(Continued)

[a] New projects.
[b] Rehabilitated projects.

(Sheet 7 of 8)

Table B-1 (Concluded)

Project Location	Type of Structure	Type of Armor	Type of Placement	Armor weight tons	Armor Specific Weight lb/ft^3	Sea-bottom Slope	Sea-side Structure Slope	Total Water Depth ft	Structure Height ft	Degree of Overtop	Wave Period sec	Wave Height ft	Model K_D	Wave Form	Angle of Wave Attack deg	Reference
						Breaking Waves on Breakwater Heads (Continued)										
Rough Angular Stone (Continued)																
Oregon Inlet, North Carolina[a]	Jetty			30.0	165	1:20	1:3	23.0	38.0	Mod	15	19.2	1.7	Breaking	45.0	
San Juan, Puerto Rico[a]	Breakwater	Stone	Random 2 Layers	27.7	165	1:20	1:2	26.9	27.0	Sev	17	28.0	8.3	Breaking	72.0	TR HL-81-11 Sep 1981 (item 86)
	Breakwater	Stone	Random 2 Layers	27.7	165	1:20	1:2	26.9	27.0	Sev	17	28.0	8.3	Breaking	42.0	
Dolos																
Oregon Inlet, North Carolina[a]	Jetty	Dolos	Random 2 Layers	14.0	150	1:20	1:3	21.0	38.0	None	15	17.6	4.0	Breaking	0.0	TR CERC-83-3 Sep 1983 (item 31)
	Jetty	Dolos	Random 2 Layers	14.0	150	1:20	1:3	21.0	38.0	None	15	17.6	4.0	Breaking	22.5	
	Jetty	Dolos	Random 2 Layers	14.0	150	1:20	1:3	21.0	38.0	None	15	17.6	4.0	Breaking	45.0	
	Jetty	Dolos	Random 2 Layers	14.0	150	1:20	1:3	21.0	38.0	None	15	17.6	4.0	Breaking	67.5	
	Jetty	Dolos	Random 2 Layers	14.0	150	1:20	1:3	21.0	38.0	None	15	17.6	4.0	Breaking	90.0	
Oregon Inlet, North Carolina[a]	Jetty	Dolos	Random 2 Layers	14.0	150	1:20	1:3	23.0	38.0	Min	15	19.2	5.2	Breaking	45.0	
Humboldt Bay, California[b]	Jetty	Dolos	Random 2 Layers	45.0	155	1:10	1:5	43.0	60.0	Maj	16	40.0	7.7	Breaking	45.0	
Atlantic Station, New Jersey[a]	Breakwater	Dolos	Random 2 Layers	62.0	150	1:10	1:3	56.3	104.0	Min-Mod	16	40.0	10.6	Breaking	Var	Unpublished[c]

[a] New projects.
[b] Rehabilitated projects.
[c] "Atlantic Generating Station Breakwater Stability Study" by D. D. Davidson and D. G. Markle, 1978 (can be obtained from Public Service Electric and Gas Co. of New Jersey, Newark, New Jersey 07101).

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