



# Coastal Engineering Technical Note



COMPUTER PROGRAM: HUDSON (MACE-4)  
BREAKWATER DESIGN BY THE HUDSON FORMULA

PROGRAM PURPOSE: To estimate the armor weight, minimum crest width, armor thickness, and the number of armor units per unit of area of a breakwater using varying values for the seaward slope and wave height by application of the Hudson formula.

PROGRAM CAPABILITY: This program is written in Microsoft BASIC for PC-DOS and produces a tabular printout of seaward slope, armor weight, minimum crest width, armor thickness, and number of armor units per unit area. The calculations are based on slope values ranging from 1.5 to 3.0. Calculations may be repeated using differing armor units, wave heights, type waves (breaking or non-breaking), and breakwater segments (head or trunk).

PROGRAM APPLICATION: HUDSON may be used to define the key dimensions of a rubblemound breakwater's primary armor layer in lieu of hand computations using equations 7-116, 7-117, 7-120, 7-121, and 7-122 presented in Chapter 7 of the Shore Protection Manual (SPM) (1984). The same cautions and limitations discussed in the SPM for these equations apply to the use of the program HUDSON.

PROGRAM AVAILABILITY: The program is available for the IBM PC on a 5-1/4-in. diskette or as a printed program listing and may be obtained from Ms. Gloria J. Naylor (601) 634-2581 of the Engineering Computer Programs Library, Technical Information Center, U.S. Army Engineer Waterways Experiment Station, P.O. Box 631, Vicksburg, Mississippi 39180-0631. Questions concerning the application of HUDSON can be directed to Mr. Doyle L. Jones at (601) 634-2069 of the Coastal Design Branch, CERC.

INPUT:

1. Armor unit weight
2. Wave height
3. Salt or fresh water
4. Stability coefficient (ref. Table 7-8 SPM (1984)) (Optional)
5. Number of units comprising the thickness of the armor layer
6. Layer coefficient (ref. Table 7-13 SPM (1984)) (Optional)

OUTPUT: A table of seaward slope, armor weight, minimum crest width (Assume 3 units), armor thickness, and the number of armor units per unit of area. Values are given both in the English and metric systems as shown in Table 1.

SAMPLE PROBLEM: The trunk of a breakwater in saltwater is constructed of dolos armor units with a unit weight of 140 lb/ft<sup>3</sup>. The incoming waves are breaking and are 10 ft high. Determine (1) armor weight, (2) minimum crest width, (3) armor thickness and (4) the number of armor units per unit area for structure slopes 1.5, 2.0, and 3.0.

REFERENCE:

Shore Protection Manual. 1984. 4th ed., 2 Vols, U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, U.S. Government Printing Office, Washington, D.C.

RUN  
BREAKWATER ARMOR LAYER DESIGN  
BY USE OF HUDSON FORMULA  
HUDSON  
VERSION 3-87

OUTPUT TO:  
1 - PRINTER  
2 - SCREEN  
3 - DATA FILE

SELECT 1, 2, OR 3 ? 2  
ARMOR UNITS

-----  
1 - QUARRYSTONE - SMOOTH ROUNDED  
2 - QUARRYSTONE - ROUGH ANGULAR  
3 - QUARRYSTONE - PARALLELPIPED  
4 - TETRAPOD  
5 - QUADRIPOD  
6 - TRIBAR  
7 - DOLOS  
8 - MODIFIED CUBE  
9 - HEXAPOD  
10 - TOSKANE  
11 - QUARRYSTONE - GRADED ANGULAR

WHAT IS THE NUMBER OF THE ARMOR UNIT ? 7  
UNIT WEIGHT OR MASS OF ARMOR UNITS  
E - POUNDS/CUBIC FOOT  
M - KILOGRAMS/CUBIC METER

WHICH UNITS (E OR M) ? E  
ARMOR UNIT WEIGHT OR MASS ? 140  
WAVE HEIGHT UNITS  
F - FEET  
M - METERS

WHICH UNITS (F OR M) ? F  
WAVE HEIGHT ? 10  
SALT WATER OR FRESH WATER (S OR F) ? S  
T - STRUCTURE TRUNK  
H - STRUCTURE HEAD

WHICH PART OF STRUCTURE (T OR H) ? T  
B - BREAKING WAVE  
N - NONBREAKING WAVE

WHICH TYPE OF WAVE (B OR N) ? B  
WHAT IS THE NUMBER OF UNITS COMPRISING THE THICKNESS  
OF THE ARMOR LAYER ? 3  
PLACEMENT  
R - RANDOM  
S - SPECIAL  
U - UNIFORM

SELECT R, S, OR U? R

- 1 - ARMOR UNIT = DOLOS
- 2 - UNIT WEIGHT OR MASS OR ARMOR UNIT = LBS/CU FT
- 3 - ARMOR UNIT WEIGHT OR MASS = 140
- 4 - WAVE HEIGHT UNIT = FT
- 5 - WAVE HEIGHT = 10
- 6 - SALT WATER
- 7 - NUMBER OF UNITS COMPRISING THICKNESS = 3
- 8 - STRUCTURE TRUNK
- 9 - BREAKING WAVE
- 10 - ARMOR PLACEMENT = RANDOM

IF ALL INPUT DATA IS CORRECT ENTER 0, OTHERWISE ENTER AN INTEGER BETWEEN 1 AND 10 TO INDICATE THE INCORRECT DATA ENTER A NUMBER ? 0

DOLOS

ARMOR UNIT WEIGHT = 140.0 LBS/CU FT = 2243 KG/CU M  
 WAVE HEIGHT = 10.0 FEET = 3.0 METERS  
 LAYER COEFFICIENT = 0.94  
 ARMOR POROSITY = 56 %

STRUCTURE SLOPE (COT)	ARMOR WEIGHT		MIN CREST WIDTH		ARMOR THICKNESS		NO. PER UNIT AREA	
	(TN)	(M TN)	(FT)	(M)	(FT)	(M)	(SQYD)	(SQM)
1.5	12.67	11.49	15.9	4.9	15.9	4.9	0.79	0.95
2.0	1.32	1.20	7.5	2.3	7.5	2.3	3.58	4.29
3.0	0.88	0.80	6.6	2.0	6.6	2.0	4.69	5.63

STABILITY OF DOLOSSE ON SLOPES STEEPER THAN 1 ON 2 SHOULD BE SUBSTANTIATED BY SITE-SPECIFIC MODEL TESTS.

REFERS TO NO-DAMAGE CRITERIA (<5 PERCENT DISPLACEMENT, ROCKING, ETC.); IF NO ROCKING (<2 PERCENT) IS DESIRED, REDUCE KD 50 PERCENT (ZWAMBORN AND VAN NIEKERK, 1982).

MORE COMPUTATIONS (Y OR N) ? N  
 OK