Coastal Engineering Technical Note

COMPUTER PROGRAM MADSEN FOR WAVE TRANSMISSION BY PERMEABLE RUBBLE-MOUND BREAKWATERS

PURPOSE: This Technical Note is intended to inform Corps coastal engineers and planners of the availability of a computer program (MADSEN) which estimates wave transmission and reflection coefficients for permeable rubble-mound breakwaters. This program has proven an invaluable tool for preliminary evaluation of the effectiveness of alternative breakwater or jetty cross sections and results in substantial time savings over available manual techniques. The program has been and will be updated to represent recent research findings for wave runup, reflection, overtopping, and transmission through multilayer permeable rubble-mound structures.

BACKGROUND: The importance of permeability to the stability and effectiveness of rubble-mound breakwaters and jetties has received much attention from researchers and designers in recent years. Higher permeability is generally desirable for structural stability, but does result in some transmission of wave energy through the structure; the wave energy which has not been transmitted through the structure or by overtopping is either dissipated or reflected by the structure. Madsen and White (1976) addressed the problem of predicting the combined effect of all these processes using both theoretical and empirical methods. Their work formed the basis of further theoretical considerations and experiments by Seelig (1980) and by Seelig and Ahrens (1981). The subject program was originally developed by Seelig in 1979 to test wave transmission and reflection predicted by theory against that measured in laboratory experiments. It has since been modified to incorporate the empirical findings of those experiments. It remains, however, only a tool to estimate wave transmission characteristics in a simplified manner and should not be substituted

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for physical model testing in a final design. Its use should be limited to permeable rubble-mound structures.

INPUT REQUIREMENTS: A single run of the program can model a large number of wave conditions represented by a corresponding significant wave height and peak period. The number, porosities, and mean diameters of layered materials must be specified along with the number, horizontal lengths, and thicknesses of layers. Caution in providing porosities and mean diameters should be used with cross sections, including concrete shapes such as dolosse or tribars. Other input data required include the structure height, water depth at the toe of the structure, top width of the breakwater, and tangent of the front slope of the breakwater. These input requirements and comparisons of program predictions to laboratory test results are described by Seelig (1980). The computer program allows the use of either metric or English units.

OUTPUT: An example of the program output is shown below:

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TEST OF IMADSEN

COMPUTATIONS OF WAVE TRANSMISSIONS THROUGH A POROUS BREAKWATER

NUM OF WAVE CONDITIONS=                          4
NUM OF MATERIALS=                                2
NUM OF HORIZONTAL LAYERS=                        2
STRUCTURE HEIGHT (M)=                            6.000
WATER DEPTH AT TOE OF STRUCTURE (M)=             4.800
KINEMATIC VISCOSITY (M2/SEC)=                    0.00000120
BW TOP WIDTH (M)=                                2.520
COTAN OF  FRONT SLOPE=                           1.5000
RUNUP COEFFICIENTS                 A= 0.692 B= 0.504

MATERIAL CHARACTERISTICS (ARMOR MATERIAL IS NUMBER 1)
MATERIAL=  1 DIAMETER (M)= 0.875 POROSITY= 0.470
MATERIAL=  2 DIAMETER (M)= 0.335 POROSITY= 0.470

HORIZONTAL LAYER CHARACTERISTICS

(LAYER NEXT TO SEABED LAYER IS NUMBER 1)
                                                MATERIAL=    1      2
HORIZONTAL LAYER=  1 THICKNESS (M)= 0.500 LENGTHS (M)=   2.8    4.8
HORIZONTAL LAYER=  2 THICKNESS (M)= 2.500 LENGTHS (M)=   3.0    4.0

 * * * IRREGULAR WAVES * * *

  H(M)  T(SEC) H/(G*T*T))  H/L   D/(G*T*T) KTT   KTO   KT   KR   HT(M)
  0.20  7.00  0.00042   0.0045   0.0100 0.367 0.000 0.367  0.35 0.073
  0.80  7.00  0.00167   0.0178   0.0100 0.207 0.009 0.207  0.36 0.166
  0.50  7.00  0.00104   0.0111   0.0100 0.257 0.000 0.257  0.37 0.129
  2.00 10.00  0.00204   0.0301   0.0049 0.139 0.125 0.187  0.37 0.375

H   - INCIDENT SIGNIFICANT WAVE HEIGHT
T   - PEAK WAVE PERIOD
L   - WAVELENGTH  AT SITE
D   - DEPTH AT SITE
G   - ACCELERATION OF GRAVITY
KTT - WAVE TRANSMISSION THROUGH THE STRUCTURE
KTO - WAVE TRANSMISSION BY OVERTOPPING COEFFICIENT
KT  - TOTAL WAVE TRANSMISSION COEFFICIENT
KR  - WAVE REFLECTION COEFFICIENT
HT  - TRANSMITTED SIGNIFICANT WAVE HEIGHT
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PROGRAM AVAILABILITY: A FORTRAN listing of the most recent version of the program MADSEN is available from the CERC Coastal Design Branch. The program is available for interactive use on the WES Honeywell DPS-1 System and the CYBERNET Services System. For further information, contact Orson Smith at (601) 634-2013 (FTS 542-2013).

REFERENCES:

MADSEN, O. S., and WHITE, S. M., "Reflection and Transmission Characteristics of Porous Rubble-Mound Breakwaters," Miscellaneous Report 76-5, Coastal Engineering Research Center, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss., 1976.

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