Coastal Engineering Technical Note

VOLUMETRIC RATE OF OVERTOPPING COMPUTER PROGRAM: QOVERTOP (MACE-22)

PROGRAM PURPOSE: To estimate volumetric rate of overtopping of a breakwater, revetment or seawall in cubic feet per minute per linear foot of structure or in cubic meters per minute per linear meter.

PROGRAM CAPABILITY: QOVERTOP is written in Microsoft BASIC for PC-DOS. The user has the option of directing output to the screen, a dot matrix printer, or a data file. The input data needed is (1) mean water depth at toe of structure, height of structure, crest above seabed, cotangent of seaward slope, onshore wind velocity, overtopping parameters, equivalent deepwater wave height and slope characteristics. This data is used to predict potential runup, volumetric overtopping and probability that they will be exceeded. In addition the mean overtopping rate is estimated. All values are displayed in tabular form suitable for publication.

PROGRAM APPLICATION: QOVERTOP may be used to estimate volumetric rate of overtopping of a breakwater, revetment or seawall. The structure surface may concrete, riprap, uniform rock, dolosse, modified cubes, tetrapods, quadripods, hexipods, tribars, or plain cubes. Overtopping is predicted using equations 7-10 and 7-12 presented in the Shore Protection Manual (1984). Equation 7-10 estimates an overtopping rate, given equivalent deepwater waveheight, height of structure above seabed, mean water depth at structure toe (including wave setup) and potential runup on structure's seaward slope. Equation 7-12 adjusts rate to account for increased overtopping due to onshore winds. Equation 7-12 is unverified and may overpredict in some cases. The fore slope of the structure is assumed to be nearly horizontal. The equivalent deepwater wave height is usually taken in practice to be the linear equivalent deepwater wave height of the breaking or depth-limited wave height at structure toe, such as might be estimated by Goda's method (Goda, 1975; Seelig and Ahrens, 1980; and CETN-I-2, 1979).

Two empirical overtopping coefficients must be estimated; Q^* and α, are related to structure geometry, water depth and wave conditions. For smooth slope structures, QOVERTOP can automatically calculate Q^* and α, or user may input values they have chosen. The user must use their own best judgment in selecting these coefficients for rough slope structures. Specific guidance for selection of Q^* and α for dolosse, tribars, modified cubes, tetrapods, quadripods, hexapods and plain cubes based on either prototype or model results has not been developed and user should exercise caution in this portion of QOVERTOP. Some empirical suggested guidance for estimating these coefficients for rubblemound structures is presented in Figures 7-24 through 7-33 of the SPM. The program prompts user for each item of input and provides parameters with which user may select Q* and a. The wave spectrum is assumed to be Rayleigh distributed. The wave height at toe of structure is Hs, the significant wave height having a probability of exceedance of 13.5 %. The probability of exceedance and rule of equivalence are used to correlate various wave heights. The program them computes the equivalent deepwater wave height. Potential runup is evaluated directly for each waveheight using empirically derived equations. For rough slopes the method is outlined in Burke and Ahrens(1987). For smooth slopes the procedure comes from Ahrens and Titus(1985) equation #10 for breaking waves and equation #11 for transitional waves. The equation used for nonbreaking waves comes from research presently being conducted at WES (Burke and Ahrens, 1987).

Calculations of overtopping follows directly from potential runup rates. The program displays a table of input values and a table of probability of exceedance from 1 % to 99 % and associated wave heights, potential runups and metric units. In additions the mean overtopping rate which is the mean value of the overtopping rates for the probability 1 % to 99 % is displayed.

The program then asks user if a overtopping rate for a particular probability is needed and probability of interest. Values are displayed in same tabular form and question is repeated. The user then has the opportunity to find probability of exceedance of a given overtopping rate. The program uses an iterative process on equation 7-10(SPM, 1984) to determine runup and in turn, wave height and its probability. All values are displayed continuously on the same table until user terminates the process.

PROGRAM AVAILABILITY: The program is available for the IBM PC, XT, or AT on a 5 1/4-in. diskette or as a printed program listing and may be obtained from the Engineering Computer Programs Library Section, Ms. Gloria J. Naylor (601) 634-2581 (FTS 542-2581) US Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, Mississippi 39180-0631. Questions concerning application of QOVERTOP can be directed to Ms. Cheryl E. Burke at (601) 634-4029 (FTS 542-4029).

INPUT:

1. Height of structure above sea bottom (feet or meters)
2. Water depth at toe of structure (feet or meters)
3. Cotangent of structure slope
4. Onshore wind velocity (miles/hour, km/hr, m/sec) (optional)
5. Overtopping parameters, Q* and α
6. Significant wave height at the toe of the structure (feet or meters)
7. Peak period (seconds)

OUTPUT: The estimated significant and mean overtopping rates in cubic feet per minute per linear foot and cubic meters per minute per linear meter.

SAMPLE PROBLEM: An impermeable structure with a smooth slope of of 1 on 3 is subjected to waves having a deepwater height of 4.9 feet and a period of 8 seconds. The depth at the structure toe is 9.8 feet and the crest elevation is 4.8 feet above the still water level. The onshore winds are 35 knots. A) Estimate the overtopping rate for the given wave; b) estimate the overtopping rate for 7% exceedance; and c) estimate the probability of exceedance for an overtopping rate of 100 cubic feet per minute per foot.

<u>SAMPLE RUN</u>:

```
OVERTOPPING RATES ESTIMATION
QOVERTOP
VERSION 3-87
USE UPPER CASE FOR ALL RESPONSES

PRESS ANY KEY TO CONTINUE
DISTANCE AND HEIGHT IN FEET OR METERS (F OR M)   ? F

ADJUSTING RATE TO ACCOUNT FOR INCREASED OVERTOPPING DUE TO ONSHORE WINDS
USES EQUATION 7-12 FROM THE 1984 EDITION OF THE SPM.

THIS EQUATION IS UNVERIFIED AND MAY OVER PREDICT IN SOME CASES.

ADJUST RATE TO ACCOUNT FOR INCREASED OVERTOPPING DUE TO
ONSHORE WINDS (Y OR N) ? Y

ONSHORE WIND VELOCITY UNITS
   A-MILES/HOUR
   B-KNOTS
   C-METERS/SEC
   D-KILOMETERS/HOUR

SELECT UNIT BY ENTERING A, B, C, OR D   ? B

ONSHORE WIND VELOCITY     ? 35

HEIGHT OF STRUCTURE CREST ABOVE SEA BED     ? 14.6

MEAN WATER DEPTH AT TOE OF STRUCTURE     ? 9.8

COTANGENT OF STRUCTURE SEAWARD SLOPE
(E. G., 1.5 FOR 1.Ø VERTICAL TO 1.5 HORIZONTAL) ? 3


SIGNIFICANT WAVE HEIGHT AT TOE OF STRUCTURE     ? 4.9

PEAK          PERIOD (IN SECONDS)     ? 8


ROUGH SLOPE OR SMOOTH SLOPE (R OR S)? S
```

```
THE AXIS VALUES FOR THE FIGURES ARE:      ds/Ho'      =  2.252
                                          Ho'/(gT^2) =  0.0021

OVERTOPPING PARAMETER Q*? .09

SINCE YOU HAVE A SMOOTH SLOPE, WOULD YOU LIKE TO USE THE MEAN VALUE
OF ALPHA (Y OR N) ? Y

                         INPUT DATA

HEIGHT OF STRUCTURE CREST ABOVE SEA BED         = 14.6 FT    =  4.5 M
MEAN WATER DEPTH AT TOE OF STRUCTURE            =  9.8 FT    =  3.0 M
COTANGENT OF STRUCTURE SEAWARD SLOPE            =  3.00
ONSHORE WIND VELOCITY                           = 40.3 MPH   =   35.0 KN
                                                = 18.0 M/SEC =  64.9 KM/HR

OVERTOPPING PARAMETER Q*                        = .0900
OVERTOPPING PARAMETER ALPHA                     = .0765
EQUIVALENT DEEPWATER SIGNIFICANT WAVE HEIGHT    =  4.4 FT    =  1.3 M
PEAK SPECTRAL PERIOD                            =  8.0 SECONDS
SIGNIFICANT WAVE HEIGHT AT TOE                  =  4.9 FT    =  1.5 M
SMOOTH SLOPE
```

OUTPUT DATA

% EXCEEDANCE	POTENTIAL RUNUP FT	POTENTIAL RUNUP M	OVERTOPPING RATE FT^3-MIN/FT	OVERTOPPING RATE M^3-MIN/M	WAVE HEIGHT FT	WAVE HEIGHT M
1.0	17.3	5.3	457.0	42.4	7.4	2.3
5.0	15.5	4.7	418.0	38.8	6.0	1.8
10.0	14.2	4.3	384.9	35.7	5.3	1.6
13.5	13.5	4.1	364.5	33.8	4.9	1.5
15.0	13.2	4.0	355.9	33.0	4.8	1.5
20.0	12.3	3.7	328.0	30.4	4.4	1.3
25.0	11.5	3.5	299.8	27.8	4.1	1.2
30.0	10.7	3.2	270.4	25.1	3.8	1.2
35.0	9.9	3.0	239.3	22.2	3.6	1.1
40.0	9.1	2.8	205.8	19.1	3.3	1.0
45.0	8.3	2.5	169.2	15.7	3.1	0.9
50.0	7.6	2.3	133.7	12.4	2.9	0.9
55.0	7.0	2.1	103.6	9.6	2.7	0.8
60.0	6.4	2.0	73.6	6.8	2.5	0.8
65.0	5.9	1.8	44.0	4.1	2.3	0.7
70.0	5.3	1.6	16.6	1.5	2.1	0.6
75.0	4.7	1.4	0.0	0.0	1.9	0.6
80.0	4.1	1.3	0.0	0.0	1.6	0.5
85.0	3.5	1.1	0.0	0.0	1.4	0.4
90.0	2.8	0.9	0.0	0.0	1.1	0.3
95.0	1.9	0.6	0.0	0.0	0.8	0.2
99.0	0.8	0.3	0.0	0.0	0.3	0.1

MEAN OVERTOPPING RATE = 164.9 FT^3-MIN/FT = 15.3 M^3-MIN/M

DO YOU WISH TO ESTIMATE OVERTOPPING FOR
ANOTHER EXCEEDANCE PROBABILITY (Y OR N) ? Y

WHAT IS THE EXCEEDANCE PROBABILITY (PERCENT) ? 7

	POTENTIAL RUNUP		OVERTOPPING RATE		WAVE HEIGHT	
% EXCEEDANCE	FT	M	FT^3-MIN/FT	M^3-MIN/M	FT	M
7.Ø	15.Ø	4.6	4Ø3.9	37.5	5.7	1.7

DO YOU WISH TO ESTIMATE OVERTOPPING FOR
ANOTHER EXCEEDANCE PROBABILITY (Y OR N) ? N

DO YOU WISH TO ESTIMATE THE PROBABILITY OF EXCEEDANCE
FOR A GIVEN OVERTOPPING RATE (Y OR N) ? Y

<<< CAUTION >>>
THE PROBABILITY CALCULATED WILL ONLY BE APPROXIMATE

OVERTOPPING RATE ? 1ØØ

	POTENTIAL RUNUP		OVERTOPPING RATE		WAVE HEIGHT	
% EXCEEDANCE	FT	M	FT^3-MIN/FT	M^3-MIN/M	FT	M
56.Ø	6.9	2.1	97.6	9.1	5.7	1.7

ANOTHER OVERTOPPING RATE (Y OR N)? N

DO YOU WISH TO CHANGE THE WAVE PARAMETERS
OR THE STRUCTURE CHARACTERISTICS AND THEN DO MORE CALCULATIONS (Y OR N) ? N

<u>REFERENCES</u>:

Ahrens, J. P. and Titus, M. F., 1985. "Wave Runup Formulas for Smooth Slopes", Journal of Waterway, Port, Coastal and Ocean Engineering, Vol. 111, No. 1, New York, NY.

Burke, C. E., and Ahrens, J. P., 1987(in preparation). "Estimating Irregular Wave Runup on Smooth Slopes", Miscellaneous Paper, US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi

Computer Program: GODAS - Waves and Wave Setup, September, 1979. Coastal Engineering Technical Note CETN-I-2, US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Goda, Y., "Irregular Wave Deformation in the Surf Zone," Coastal Engineering in Japan, Vol. 18, pp. 13-26, 1975.

Seelig, W. H. and Ahrens, J. P., "Estimating Nearshore Conditions for Irregular Waves," June 1980, Technical Paper 80-3, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Shore Protection Manual, 1984, U. S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, U. S. Government Printing Office, Washington, DC.