



# Coastal Engineering Technical Note



CETN-I-1  
12/88

## COMPUTER PROGRAM PCDFRAC: COMBINED REFLECTION AND DIFFRACTION BY A VERTICAL WEDGE-SHAPED STRUCTURE

**PROGRAM PURPOSE:** To calculate wave amplification factors for the modification of incident wave heights due to reflection and diffraction by a vertical wedge-shaped structure.

**BACKGROUND:** In coastal engineering design, it is often necessary to determine the wave field near a structure. Waves impinging on these structures are modified considerably. Wave diffraction transmits energy into the sheltered areas behind the structure; wave heights there tend to be lower than the incident height. On the other hand, wave reflection seaward of the structure amplifies the wave height. In the past, designers have relied on graphical solutions (Wiegel, 1962; Shore Protection Manual, 1984) for dimensionless wave amplification factors in the area near a semi-infinite breakwater. These graphs have two limitations:

- 1) They only describe the wave field behind the structure.
- 2) Only thin semi-infinite breakwaters were analyzed.

Chen (1987) developed an analytical solution for the diffraction and reflection of an incident monochromatic wave train by a vertical wedge-shaped structure of arbitrary wedge angle (a semi-infinite breakwater being a wedge of zero angle). The computer program PCDFRAC was developed from the analytical solution. PCDFRAC is explained in detail by Kaihatu and Chen (1988).

### ASSUMPTIONS:

- 1) Rigid and impermeable bottom.
- 2) Constant depth.
- 3) Linear, monochromatic incident waves.

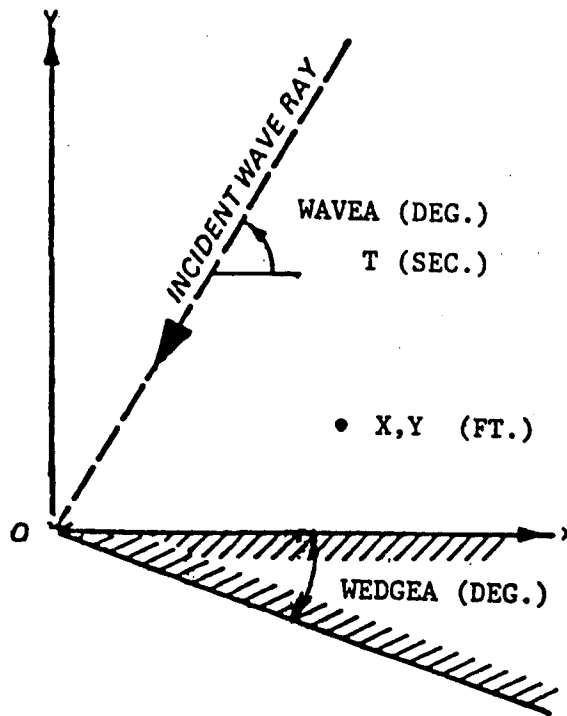


Figure 1. Input conventions for PCDFRAC.

**PROGRAM INPUT:** The program is a DOS-executable file for use on any IBM-compatible personal computer (PC). It may be run interactively, or in a file-processing batch mode. Input conventions are shown in Figure 1. The execution sequence is:

- 1) The program will ask if the user wishes to write the output to a file. If so, the user will supply an eight-character string to serve as the file name. If the file name matches that of an existing file on the hard disk, the program will ask the user to either enter a new file name or allow it to overwrite the contents of the old file.
- 2) The program will then ask if the input data is located in a file. If so, it will inquire the file name; batch job operation will then start. If not, the program will require further information from the user (interactive mode).
- 3) In interactive mode, the user will need to supply the following information at the appropriate prompt:
  - a) Whether or not a wedge angle is to be set. Zero degrees is the default.
  - b) The wedge angle in degrees, if other than zero.
  - c) The water depth, in feet.

- d) The incident wave period, in seconds.
- e) The incident wave direction, in degrees counter-clockwise from the positive x-axis.
- f) The number of points where output is required.
- g) The (x,y) coordinates of the points, in feet.

**PROGRAM OUTPUT:** The program will give the wave amplification factors and phase angles in a tabular form. This output is written to the screen and to any user-specified file. The output consists of:

- 1) The user input.
- 2) The incident wave length, in feet.
- 3) The wave amplification factor at each desired location. This can be multiplied by the incident wave height to yield the actual wave height at that location.
- 4) The phase of the amplified wave at each location.

**EXAMPLE:** Figure 2 shows an example problem. The wave amplification factors are required at the locations shown. Figure 3 shows the interactive input needed (with the user input underlined), and Figure 4 shows the resulting table.

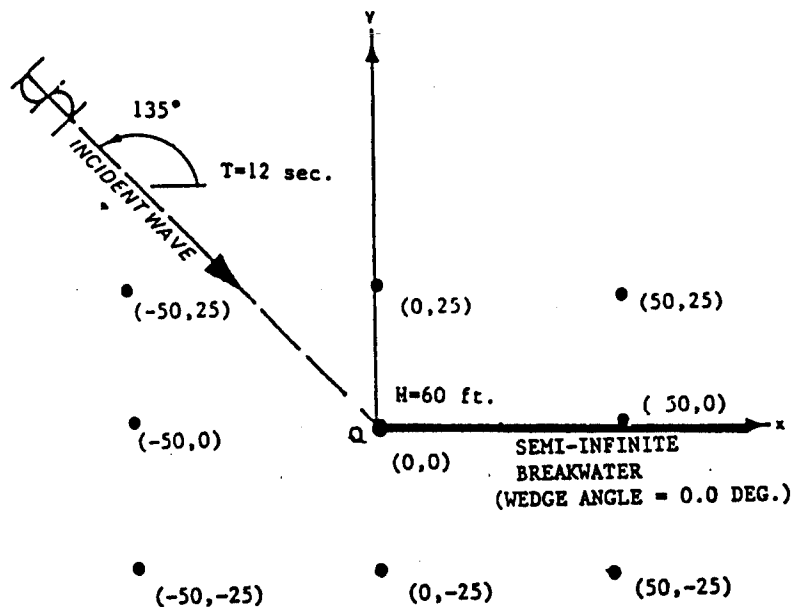


Figure 2. Sample problem - semi-infinite breakwater.

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* "PCDFRAC" - A PROGRAM WHICH CALCULATES WAVE AMPLIFICATION FACTORS *
* BASED ON THE COMBINED DIFFRACTION AND REFLECTION OF WAVES BY A *
* VERTICAL WEDGE OF ARBITRARY WEDGE ANGLE. THE PROGRAM ALSO CALCU- *
* LATES THE PHASE OF THE AMPLIFIED WAVE. THE PROGRAM WILL DEFAULT TO *
* ZERO WEDGE ANGLE (SEMI-INFINITE BREAKWATER CASE) IF NO WEDGE ANGLE *
* IS SPECIFIED. *
*
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-----  
DO YOU WANT OUTPUT IN A FILE ? (0="NO", 1="YES") = 1

-----  
ENTER NAME OF OUTPUT FILE = TEST1.OP

-----  
IS INPUT DATA LOCATED IN A FILE ? (0="NO",1="YES") = 0

-----  
OPTION TO SET WEDGE ANGLE (DEFAULT VALUE = 0.00 DEG.)

SET WEDGE ANGLE ? (0="NO",1="YES") = 0

-----  
SET INITIAL VALUES

INPUT WATER DEPTH (FT.) = 20

INPUT INCIDENT WAVE PERIOD (SEC.) = 8

INPUT INCIDENT WAVE ANGLE  
(DEG. CCW FROM POSITIVE X - AXIS) = 135

-----  
HOW MANY POINTS DO YOU WISH TO ENTER (UP TO 99)? = 9

AT EACH PROMPT, DO THE FOLLOWING :

- 1) TYPE IN X - COORDINATE
- 2) TYPE A COMMA
- 3) TYPE IN Y - COORDINATE
- 4) PRESS "ENTER"

(X,Y) COORDINATES FOR POINT NO. 1 (FT.) = -50,25

(X,Y) COORDINATES FOR POINT NO. 2 (FT.) = 0,25

(X,Y) COORDINATES FOR POINT NO. 3 (FT.) = 50,25

(X,Y) COORDINATES FOR POINT NO. 4 (FT.) = -50,0

(X,Y) COORDINATES FOR POINT NO. 5 (FT.) = 0,0

(X,Y) COORDINATES FOR POINT NO. 6 (FT.) = 50,0

(X,Y) COORDINATES FOR POINT NO. 7 (FT.) = -50,-25

(X,Y) COORDINATES FOR POINT NO. 8 (FT.) = 0,-25

(X,Y) COORDINATES FOR POINT NO. 9 (FT.) = 50,-25

Figure 3. User input for sample problem.

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SEMI-INFINITE BREAKWATER (WEDGE ANGLE = 0.00 DEGREES)
-----
DEPTH   PERIOD   WAV.ANGLE  WAVLNG.  WDG.ANG.   X       Y       AMP     PHA
(FT)    (SEC)    (DEG)     (FT)     (DEG)     (FT)    (FT)    (FT)    (RAD)
-----
20.00   8.00    135.00    190.00    0.00
          -50.00   25.00    0.98     1.77
          0.00   25.00    1.04     0.45
          50.00   25.00    1.44    -0.81
          -50.00   0.00    1.00     1.17
          0.00   0.00    1.00     0.00
          50.00   0.00    1.69    -0.90
          -50.00  -25.00   1.03     0.59
          0.00  -25.00   0.86    -0.55
          50.00  -25.00   0.60    -2.18
-----

```

YOUR OUTPUT IS IN TEST1.OP  
Execution terminated : 0

Figure 4. Solution to sample problem.

INPUT FILE FORMAT: A sample input file (for batch mode) is shown in Figure 5. The file contains the data from the previous example. It uses the formats shown:

- 1) Line 1: (FORMAT(4F10.2)) D,T,WAVEA,WEDGEA  
This input is the water depth, incident wave period, incident wave approach angle and the wedge angle if any. If a semi-infinite breakwater case is to be run, the last field may be left blank.
- 2) Line 2 (and succeeding lines): (FORMAT(2F10.2,29X,I1)) X,Y,END  
One (X,Y) output location is given on each line. END is an end-of-data-set marker, denoting the end of X,Y data for a set of D, T, WAVEA and WEDGEA values. Additional sets of D, T, WAVEA, WEDGEA, X and Y data may be given in the same file, with each set terminating with END. The value of END to terminate a data set is 1; the END field may be left blank otherwise.

```

20.00      8.00      135.00      0.00
50.00     -25.00
 0.00     -25.00
-50.00     -25.00
50.00      0.00
 0.00      0.00
-50.00      0.00
50.00      25.00
 0.00      25.00
-50.00      25.00

```

1

Figure 5. Input file for sample problem.

AVAILABILITY: A DOS-executable version of PCDFRAC is available on 5 1/4" floppy diskette from the CERC Coastal Oceanography Branch. The diskette also contains the FORTRAN source code and sample input and output files. For further information, contact James M. Kaihatu at (601) 634-2834.

REFERENCES:

Chen, H.S. 1987. "Combined Reflection and Diffraction by a Vertical Wedge," Technical Report CERC-87-16, Coastal Engineering Research Center, US Army Engineer Waterways Experiment Station, Vicksburg, MS., pp. 4-12.

Kaihatu, J.M. and H.S. Chen. 1988 (in preparation). "Combined Reflection and Diffraction by a Vertical Wedge: PCDFRAC Users' Manual," Coastal Engineering Research Center, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

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, DC.

Wiegel, R.L. 1962 (Jan.). "Diffraction of Waves by a Semi-Infinite Breakwater," Journal of the Hydraulics Division, ASCE, Vol. 88, No. HY1, New York, NY, pp 27-44.