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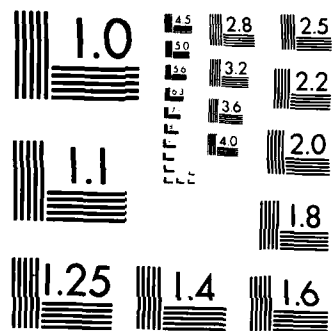
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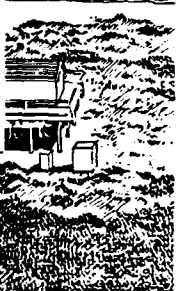
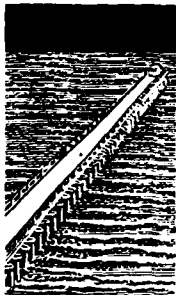
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MISCELLANEOUS PAPER CERC-83-9

HANDHELD CALCULATOR ALGORITHMS FOR COASTAL ENGINEERING

REPORT 4

by

Julie L. Dean and Todd L. Walton, Jr.

Coastal Engineering Research Center

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This is the fourth in a series of reports providing handheld calculator algorithms for use in coastal engineering. The first and second reports in this series were published as Coastal Engineering Technical Aids (CETA's), and are available from the US Army Engineer Waterways Experiment Station Tech- nical Report Distribution Center, Vicksburg, Miss. Of these, CETA 82-1 pre- sents a set of six algorithms for programs useful in performing certain wave transformation and wave generation calculations with both the Texas Instruments (Continued)		

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20. ABSTRACT (Concluded).

TI-59 (Algebraic Operating System (AOS) notation) and the Hewlett-Packard HP-67 (Reverse Polish Notation (RPN)); CETA 82-4 presents the same six algorithms for use on the HP-41CV (RPN). The third report, Miscellaneous Paper CERC-83-9, Report 3, provides calculator algorithms for use with the HP-41CV that forecast gravity water waves in deep and shallow water.

The present report provides algorithms for three calculator programs intended for use with the HP-41CV. The first program computes the breaking wave forces on and moments about the base of vertical face structures using the Minikin method. The second program computes the non-breaking wave force and overturning moment at the base of vertical face structures using both the Miche-Rundgren and Sainflou equations. The last program computes the pressure distribution corresponding to the Miche-Rundgren and/or Sainflou solutions. The reference to these programs is the Shore Protection Manual (US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, 1984).

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PREFACE

This report was prepared and published with funds provided by the Office, Chief of Engineers (OCE), through the Littoral Data Collection Methods and Engineering Application Research Work Unit of the Shore Protection and Restoration research program. Ms. Julie L. Dean, Civil Engineer, and Dr. Todd L. Walton, Research Hydraulic Engineer, Coastal Structures and Evaluation Branch, Coastal Engineering Research Center (CERC), prepared the report. The authors gratefully acknowledge the assistance of Messrs. Orson P. Smith and Robert B. Lund of the Coastal Design Branch, CERC, for their review of the report.

This report was prepared under general supervision of Dr. Robert W. Whalin, Chief, CERC, Dr. Fred E. Camfield, Acting Chief, Engineering Development Division, and Mr. Thomas Richardson, Chief, Coastal Structures and Evaluation Branch. During report review and publication, Dr. William L. Wood was Chief, Engineering Development Division.

Commanders and Directors of the US Army Engineer Waterways Experiment Station during the preparation and publication of this report were COL Tilford C. Creel, CE, and COL Robert C. Lee, CE. Mr. F. R. Brown was Technical Director.

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HANDHELD CALCULATOR ALGORITHMS FOR COASTAL ENGINEERING

PART I: INTRODUCTION

1. The advent of the handheld programmable calculator has led to the development of numerous programs in various fields of engineering and science. Coastal engineering is no exception. This report contains three programs, two of which compute breaking and non-breaking forces and moments on vertical face structures. The third program computes a non-breaking pressure distribution on vertical face structures. The reference to the programs is the Shore Protection Manual (SPM 1984).

2. The three programs presented herein are versions of Reverse Polish Notation (RPN) logic suitable for use on HP-41CV programmable calculators with or without accessory printer. Each program is documented, assumptions are briefly described, and references to more detailed presentations of the theory are given.

3. Each of the RPN programs incorporates HP-41 compatible print routines which print and label all input and output parameters. The user has only to enter the input parameters, and the results are automatically computed and printed. Since the printing routines increase program length by as much as 25 percent, use of a magnetic card for permanent program storage is recommended. The print steps do not need to be deleted if a printer is unavailable.

PART II: DEFINITION SKETCH AND PROGRAMS

4. Three programs (108, 109, 110) are presented in this report. Program 108 calculates the breaking wave force on and moment about the base of vertical face structures using Minikin's method. Program 109 computes the non-breaking wave force on and the overturning moment at the base of a vertical face structure using both the Miche-Rundgren and Sainflou equations. Program 110 calculates the non-breaking pressure distribution when either the wave crest or the wave trough is at the structure using the Miche-Rundgren and/or Sainflou equations.

5. Each program allows either US customary or metric input and output. Program listings are annotated, making it possible to follow the logic of the algorithm and to make modifications if desired.

6. There are undoubtedly many other calculator programs that have been developed on coastal engineering subjects. Practicing engineers are encouraged to submit them to the Coastal Engineering Research Center (CERC). If the response is great enough, additional reports presenting the programs will be prepared. Program authors will be given appropriate credit in these reports and will be included in the report review process. Comments, programs, or suggestions for programs should be sent to:

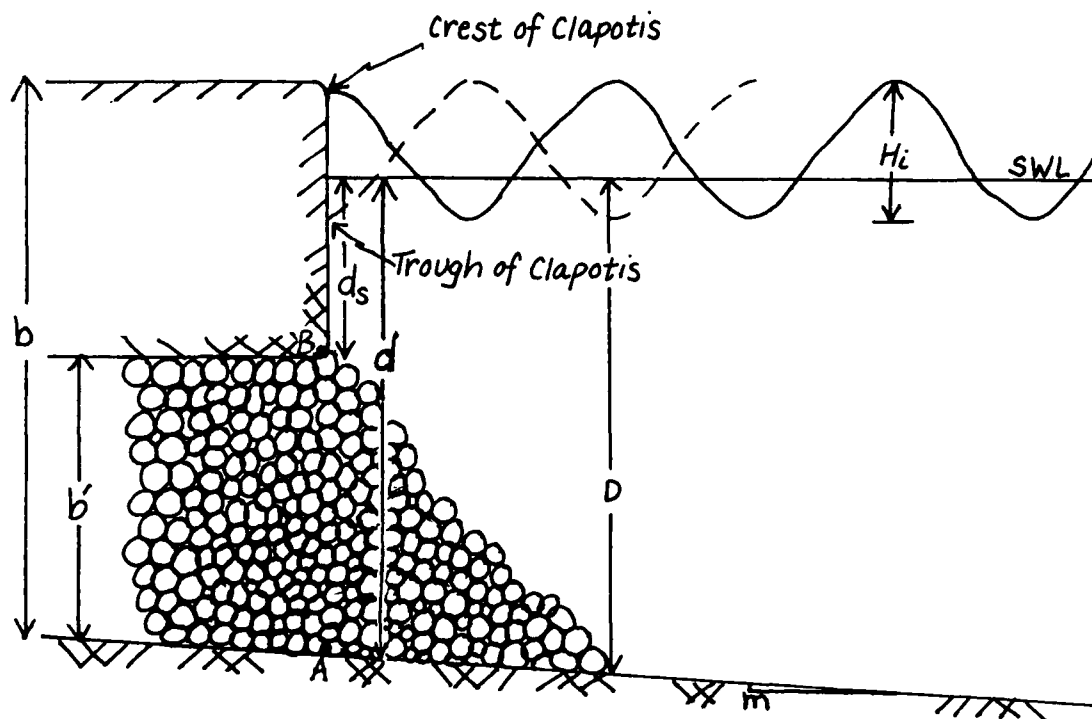
Commander and Director
US Army Engineer Waterways Experiment Station
Coastal Engineering Research Center
ATTN: Coastal Structures and Evaluation Branch
PO Box 631
Vicksburg, Mississippi 39180-0631

7. These and future programs will generally correspond to the following numbering scheme:

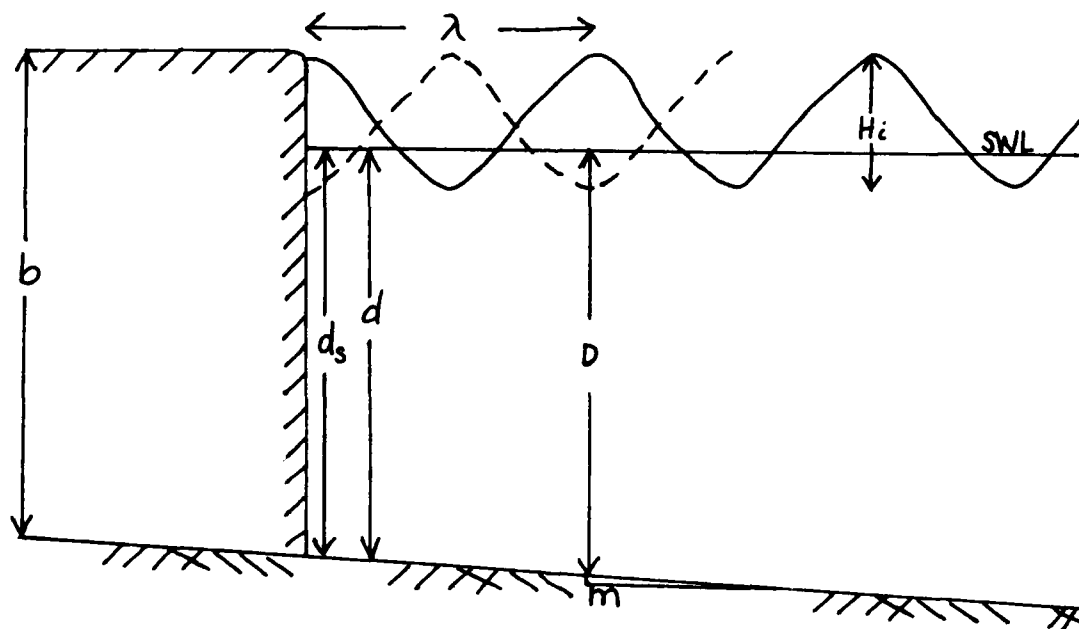
Miscellaneous	0-99
Waves and Currents	100-299
Inlets	300-499
Beaches	500-699
Geology	700-899
Structures	900-1099

8. In general, the documentation of programs submitted should be in a format paralleling that of the programs presented in this report. A blank set of forms which can be reproduced is included in Appendix A.

Definition Sketch of Input Values*



I. With Rubble Foundation



II. No Rubble Foundation

*Adapted from SPM Figures 7-100, 7-101.

Program Description

108R-41CV Breaking Wave Forces and Moments on Vertical Face Structures - Minikin's Method (RPN Logic)	
Program Title	
Name	Julie Dean
Address	U. S. Army Engineer Waterways Experiment Station Coastal Engineering Research Center
City	P. O. Box 631 Vicksburg
State	Mississippi
Zip Code	39180-0631
Date	8/83

Program Description, Equations, Variables, etc.

This program calculates the breaking wave force on and moment about the base of vertical face structures using Minikin's Method (Shore Protection Manual, 1984). Input values are the water depth at the structure, d_s , the height of the structure, b , the unit weight of water, γ_w , the wave period, T , and the nearshore bottom slope, m . If the structure is founded on a rubble base, the program will ask for the water depth D at the toe of the foundation; if no substructure is present, a water depth D will be calculated at a distance one wavelength seaward of the structure. If the top of the structure is lower than the crest of the design breaker, reduced forces and moments will be calculated.

The wavelength used in the program is calculated using an explicit formula (Nielsen, 1982). The breaker height H_b is calculated using equations (2-92), (2-93), (2-94), (7-3), and (7-4) of the Shore Protection Manual (see program 104R-41CV, CETA 82-4). For a nearshore bottom slope of zero, breaker height is given by $H_b = 0.78d_s$.

The algorithms use either the U. S. Customary or Metric system of units.

REFERENCES

Nielsen, P., "Explicit Formulae for Practical Wave Calculations," Coastal Engineering, p. 389-398, 1982.

U. S. Army, Corps of Engineers, Coastal Engineering Research Center, Shore Protection Manual, Chapters 2 and 7 (1984).

Walton, T. L., "Hand-Held Calculator Algorithms for Coastal Engineering (Second Series)," Coastal Engineering Technical Aid No. 82-4, U. S. Army Corps of Engineers, November 1982.

Operating Limits and Warnings

108R-41CV-1

User Instructions

108R-41CV BREAKING WAVE FORCES AND MOMENTS ON VERTICAL FACE STRUCTURES
MINIKIN METHOD

SIZE: 019

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	LOAD PROGRAM (BWF)		[XEQ] "BWF"	E OR M?
2	CHOOSE U.S. CUSTOMARY OR METRIC UNITS		US or M, [R/S]	d_s ?
3	ENTER DEPTH AT TOE OF WALL, d_s (feet or meters)	d_s	[R/S]	b ?
4	ENTER WALL HEIGHT, b (feet or meters)	b	[R/S]	UNIT WT.?
5	ENTER UNIT WEIGHT OF WATER (lb/ft^3 or kg/m^3)	γ_{water}	[R/S]	T ?
6	ENTER WAVE PERIOD (SEC.)	T	[R/S]	SLOPE?
7	ENTER NEARSHORE SLOPE	m	[R/S]	RUBBLE FDN?
8	ANSWER YES OR NO TO RUBBLE FOUNDATION OPTION		Y or N, [R/S]	
	- IF YES, INPUT DEPTH AT TOE OF SUBSTRUCTURE (feet or meters)	D	[R/S]	
	- IF NO, DEPTH D IS CALCU- LATED IN PROGRAM			
9	READ FORCE (lb/ft or kg/m)			"FORCE = "
	READ MOMENT (ft-lb/ft or kg-m/m)			"MOMENT = "

108R-41CV-2

User Instructions

				SIZE:
STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
	EXAMPLE PROBLEM:			
	$d_s = 7.5 \text{ ft.} = 2.286 \text{ m}$			
	$b = 10 \text{ ft.} = 3.048 \text{ m}$			
	$\gamma_w = 64 \text{ lb/ft}^3 = 1025.18 \text{ kg/m}^3$			
	$T = 6 \text{ sec}$			
	$m = 0.05$			
	BREAKING WAVE FORCES US CUST. UNITS $d_s = 7.5000 \text{ ***}$ $b = 10.0000 \text{ ***}$ UNIT WT. WATER = 64.0000 *** $T = 6.0000 \text{ ***}$ $m = 0.0500 \text{ ***}$ FORCE = 10,776,115 MOMENT = 173,363,511.5 BREAKING WAVE FORCES METRIC UNITS $d_s = 2.2860 \text{ ***}$ $b = 3.0480 \text{ ***}$ UNIT WT. WATER = 1025.1843 *** $T = 6.0000 \text{ ***}$ $m = 0.0500 \text{ ***}$ FORCE = 30,923,794.1 MOMENT = 52,769,622.5			
	Note that the moment calculated when a rubble foundation exists is the moment at the base of the foundation (Point A), not the base of the structure (Point B). The moment at point B can be calculated:			
	$M = M_A - b'F''$			
	where $b' = \text{height of rubble foundation}$			
	$F'' = \text{reduced force on wall}$			
	See Definition Sketch			

108R-41CV-3

User Instructions

				SIZE:
STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
	EXAMPLE PROBLEM:	NON-SPEAKING WAVE FORCE.		NON-SPEAKING WAVE FORCE:
	depth = 10' = 3.048 m	NO CONST. UNITS		METRIC UNITS
	T = 6 sec	DEPTH=		DEPTH=
	$\chi = 1.0$	10.0000 ***		3.0480 ***
	$\gamma_w = 64 \text{ lb/ft}^3 = 1025.184 \text{ kg/m}^3$	PERIOD=		PERIOD=
		6.0000 ***		6.0000 ***
		WAVE HT.=		WAVE HT.=
		5.0000 ***		1.5240 ***
		REFLECTION COEFF.=		REFLECTION COEFF.=
		1.0000 ***		1.0000 ***
		UNIT WT. WATER=		UNIT WT. WATER=
		64.0000 ***		1.025.1840 ***
	Choose:			
	low wall height option	YC-MR=10.5909		YC-MR=5.6667
	wall ht. = 10' = 3.048 m	YT-MR=0.5909		YT-MR=0.6187
	rubble foundation option	YC-SF=16.4853		YC-SF=5.0000
	rubble ht. = 5' = 1.524 m	YT-SF=6.4853		YT-SF=1.9524
		WALL HT=		WALL HT=
		10.0000 ***		3.0480 ***
		RUBBLE HT=		RUBBLE HT=
		5.0000 ***		1.5240 ***
	Read:			
	Force in lb/ft or kg/m	MOUSE-P		MOUSE-P
	Moment in lb-ft/ft or kgm/m	PC=0.870.4132		PC=4.024.0724
		PT=70.5920		PT=494.0106
		MC=0.544.0056		MC=0.995.6281
		MT=1.232.4417		MT=957.7513
	Sainflou theory gives the	SOINFLOU		SOINFLOU
	values predicted by	PC=2.440.2858		PC=3.631.4595
		PT=52.7174		PT=87.3962
		MC=17.202.5087		MC=7.893.0811
		MT=723.7641		MT=146.8834
	SPM Figures 7-90, 7-91, 7-92.			
	Note that the moment calculated			
	when a rubble foundation exists			
	is the moment at the base of			
	the foundation, not at the base			
	of the structure.			
	The moment at the toe of the structure can be found from			
	$M_{\text{toe of structure}} = M_{\text{base of fdn.}} - b'F''$			
	where b' = height of rubble foundation			
	and F'' = reduced force on wall. See Fig. 7-98 (SPM) or Definition Sketch.			

109R-41CV-9

User Instructions

				SIZE:
STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
12	READ MICHE-RUNDGREN*			MICHE-R
	FORCE WITH CREST AT WALL (lb/ft or kg/m)			$P_c =$
	FORCE WITH TROUGH AT WALL (lb/ft or kg/m)	R/S		$P_t =$
	MOMENT WITH CREST AT WALL ($lb-ft/ft$ or $kg-m/m$)	R/S		$M_c =$
	MOMENT WITH TROUGH AT WALL ($lb-ft/ft$ or $kg-m/m$)	R/S		$M_t =$
13	READ SAINFLOU*		R/S	SAINFLOU
	FORCE WITH CREST AT WALL (lb/ft or kg/m)			$P_c =$
	FORCE WITH TROUGH AT WALL (lb/ft or kg/m)	R/S		$P_t =$
	MOMENT WITH CREST AT WALL ($lb-ft/ft$ or $kg-m/m$)	R/S		$M_c =$
	MOMENT WITH TROUGH AT WALL ($lb-ft/ft$ or $kg-m/m$)	R/S		$M_t =$
	*The solution giving lower values of force and moment is the solution that corresponds to SPM Figures 7-91, 7-92, 7-93, 7-94, and 7-95.			
	Note:			
	SPM Figure 7-90 plots the Miche-Rundgren theory for large values of H_i/gT^2 ; but as H_i/gT^2 approaches zero, the curves are constrained to pass through $h_o/H_i=1.0$			
	For small values of H_i/gT^2 , the program's y_c and y_t may not correspond to the Shore Protection Manual's.			

109R-41CV-8

User Instructions

109R-41CV - Non-Breaking Wave Forces and Moments on Vertical-Face Structures - Miche-Rundgren and Sainflou Equations

SIZE: 058

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	BEGIN PROGRAM		[XEQ] "NBWF"	E OR M?
2	CHOOSE U.S. CUSTOMARY OR METRIC UNITS		US or M [RS]	DEPTH?
3	ENTER DEPTH (feet or meters)	d	[R/S]	PERIOD?
4	ENTER WAVE PERIOD (seconds)	T	[R/S]	WAVE HT.?
5	ENTER WAVE HEIGHT (feet or meters)	H _i	[R/S]	REFLEC. COEFF.?
6	ENTER REFLECTION COEFFICIENT	X	[R/S]	UNIT WT.?
7	ENTER UNIT WT. OF WATER (lb/ft ³ or kg/m ³)	γ_w	[R/S]	
8	READ MICHE-RUNDGREN Height of crest above bottom Height of trough above bottom READ SAINFLOU Height of crest above bottom Height of trough above bottom			YC-MR= YT-MR= YC-SF= YT-SF= LOW WALL HT.?
9	CHOOSE LOW WALL HT. OPTION? IF YES ENTER WALL HEIGHT (ft or m)	b	[R/S]	WALL HT.? RUBBLE FDN?
10	CHOOSE RUBBLE FOUNDATION OPTION? IF YES ENTER HEIGHT OF RUBBLE FOUNDATION (feet or meters)	b'	[R/S]	RUBBLE HT.?
	(continued on next page)			

109R-41CV-7

REDUCTION FACTORS

$$F_{\text{low wall}} = r_f \cdot F_T$$

$$F_{\text{rubble}} = F_T - r_f' \cdot F_T$$

$$F_{\text{low wall \& rubble}} = r_f \cdot F_T - r_f' \cdot F_T$$

$$\text{Where } r_f = \frac{b}{y} \left(2 - \frac{b}{y} \right)$$

$$r_f' = \frac{b'}{y} \left(2 - \frac{b'}{y} \right)$$

$$M_{\text{low wall}} = r_m \cdot M_T$$

$$M_{\text{rubble}} = M_T - r_m' \cdot M_T$$

$$M_{\text{low wall \& rubble}} = r_m \cdot M_T - r_m' \cdot M_T$$

$$\text{Where } r_m = \left(\frac{b}{y} \right)^2 \left(3 - 2\frac{b}{y} \right)$$

$$r_m' = \left(\frac{b'}{y} \right)^2 \left(3 - 2\frac{b'}{y} \right)$$

Miche-Rundgren:

$$Y_c(K) = Y_o + H_i(1+\chi) \cdot F1/2 + (\pi \cdot H_i^2 \cdot F1 \cdot F2/4 \cdot L) \left((1+\chi)^2 \cdot F5 + (1-\chi)^2 \cdot F6 \right)$$

$$Y_t(K) = Y_c(K) - (1+\chi)H_i \cdot F1$$

$$P1 = -Y_o - H_i(1+\chi) \cdot F4/2 - (\pi \cdot H_i^2 \cdot F3/4 \cdot L) \left((1+\chi)^2 \cdot F7 + (1-\chi)^2 \cdot F8 \right)$$

$$P_c(K) = \gamma \cdot P1 \dots \dots \dots \text{crest interval pressure}$$

$$P_t(K) = P_c(K) + \gamma \cdot H_i(1+\chi) \cdot F4 \dots \dots \dots \text{trough interval pressure}$$

$$M_c(K) = P_c(K) \cdot (Y_c(K) + d) \dots \dots \dots \text{crest interval moment}$$

$$M_t(K) = P_t(K) \cdot (Y_t(K) + d) \dots \dots \dots \text{trough interval moment}$$

Sainflou:

$$Y_c(K) = Y_o + H_i \cdot F1 + \pi \cdot H_i^2 \cdot F1 \cdot F2/L$$

$$Y_t(K) = Y_c(K) - 2 \cdot H_i \cdot F1$$

$$P1 = -Y_o - H \cdot F4$$

$$P_c(K) = \gamma P1 \dots \dots \dots \text{crest interval pressure}$$

$$P_t(K) = (H \cdot F4 - Y_o) \cdot \gamma \dots \dots \dots \text{trough interval pressure}$$

$$M_c(K) = P_c(K) (Y_c(K) + d) \dots \dots \dots \text{crest interval moment}$$

$$M_t(K) = P_t(K) (Y_t(K) + d) \dots \dots \dots \text{trough interval moment}$$

109R-41CV-5

EQUATIONS USED

$$Gt = \left(\frac{2\pi}{T}\right)^2 \frac{d}{g}$$

$$Fterm = Gt + (1 + 0.6522Gt + 0.4622Gt^2 + 0.0864Gt^3 + 0.0675Gt^4)^{-1}$$

$$L = T(G \cdot d / Fterm)^{1/2}$$

$$\Delta = d/L$$

$$C1 = \cosh (2\pi\Delta)$$

$$S1 = \sinh (2\pi\Delta)$$

$$T1 = \tanh (2\pi\Delta)$$

$$F5 = 1 + 3/4(S1)^2 - 1/4(C1)^2$$

$$F6 = 3/4(S1)^2 + 1/4(C1)^2$$

$$N = \text{number of intervals}$$

$$Dd = d/N$$

$$E = Yo/L$$

$$C2 = \cosh (2\pi(\Delta+E))$$

$$S2 = \sinh (2\pi(\Delta+E))$$

$$C3 = \cosh (2\pi(2\Delta+E))$$

$$S3 = \sinh (2\pi(2\Delta+E))$$

$$C4 = \cosh (2\pi E)$$

$$S4 = \sinh (2\pi E)$$

$$F1 = S2/S1$$

$$F2 = C2/S1$$

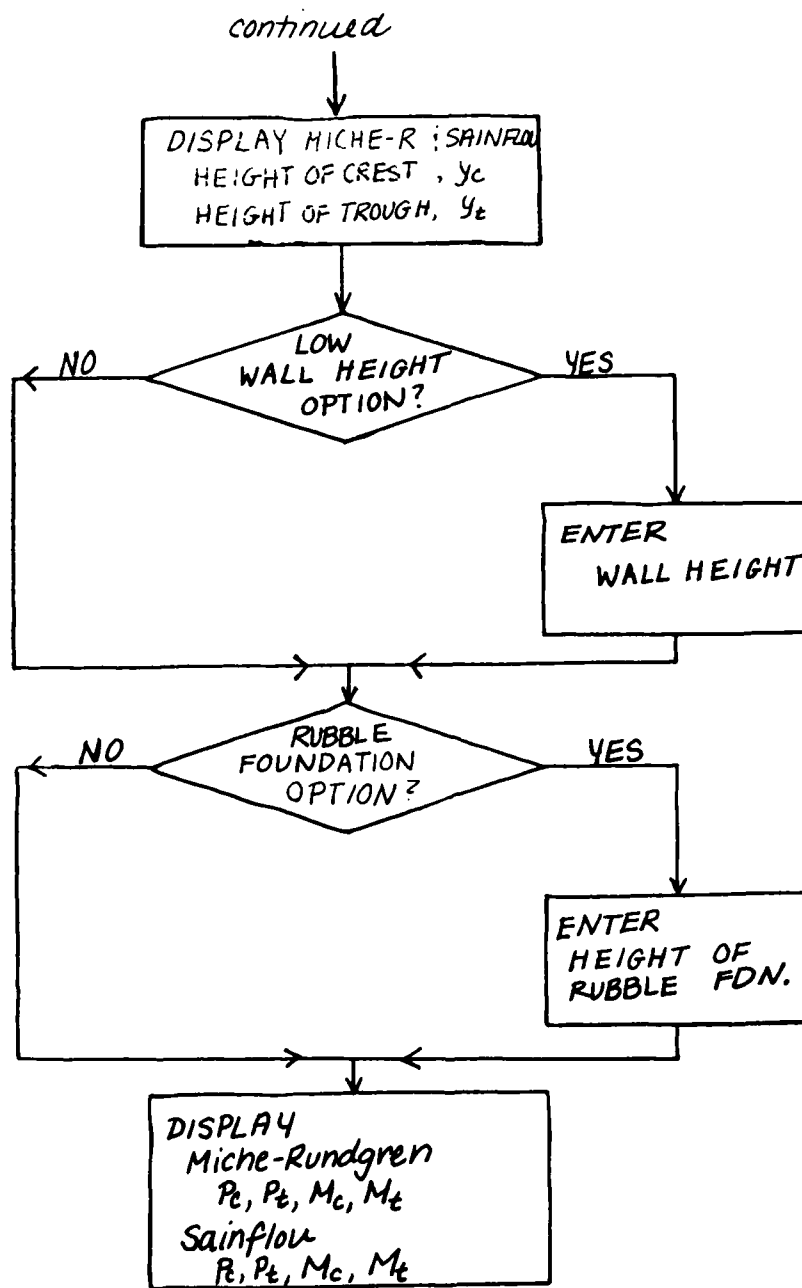
$$F3 = S4/(S1)^2$$

$$F4 = S4/(S1)(C1)$$

$$F7 = \left(1 - 1/4(C1)^2\right) C3 - 2 \cdot T1 \cdot S3 + 0.75 \left(C4/(S1)^2 - 2 \cdot C2/C1\right)$$

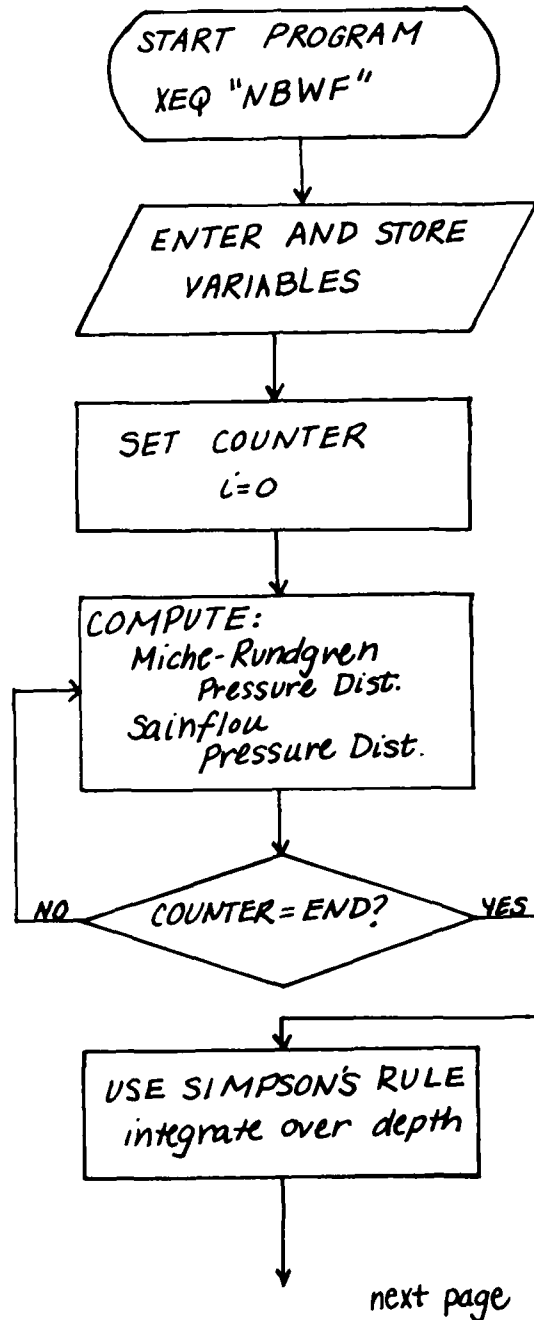
$$F8 = C3/4 (C1)^2 - 2 \cdot T1 \cdot S3 + 0.75 \left(C4/(S1)^2 - 2 \cdot C2/C1\right)$$

109R-41CV-4



109R-41CV-3

Program "NBWF" Flowchart



Program Description

109R-41CV Non-Breaking Wave Forces and Moments on Vertical-Face Structures - Miche-Rundgren and Sainflou Equations (RPN Logic)			
Program Title			
Name	Julie Dean	Date	6/83
Address	U. S. Army Engineer Waterways Experiment Station Coastal Engineering Research Center		
City	P. O. Box 631 Vicksburg	State	Mississippi
		Zip Code	39180-0631
Program Description, Equations, Variables, etc.			
This program computes the non-breaking wave force and overturning moment at the base of vertical face structures (including the hydrostatic components) given the reflection coefficient, X, depth of water, d, wave period, T, incident wave height, H_i, and unit weight of water, γ_w. The force and moment are calculated using both the Miche-Rundgren and Sainflou equations; the Miche-Rundgren theory is more accurate for steeper waves, while the theory of Sainflou gives better results for long, low-steepness waves. The program can be used in lieu of figures 7-90, 7-91, 7-92, 7-93, 7-94, and 7-95 in the Shore Protection Manual (SPM); see also CETN I-21, 12/82. The program outputs the wave forces and moments at the wall for crest and trough for both the Miche-Rundgren and Sainflou cases with the option of calculating the reduced force and moment due to a low height wall and/or a rubble foundation. The solution with the lower values of force and moment is the solution as given by SPM figures 7-90, 7-91, 7-92, 7-93, 7-94, and 7-95. If a rubble foundation exists, the moment calculated is the moment at the base of the foundation, i.e. sea bottom, not at the base of the structure. The algorithm uses either U. S. Customary or Metric system of units.			
REFERENCES			
Hughes, S. A., August 1982, Basic Program: "WAVEFOR", available from Coastal Engineering Research Center, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss. 39180-0631. U. S. Army Corps of Engineers, Coastal Engineering Research Center, CETN-I-21, 12/82. U. S. Army Corps of Engineers, Coastal Engineering Research Center, Shore Protection Manual, Chapter 7, (1984).			
Operating Limits and Warnings			

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108R-41CV-8

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
232	/			288	-		
233	STO 15		$a \rightarrow R_{15}$	289	RCL 13		
234	GTO 08			290	3.0		
235	*LBL 06			291	Y+X		
236	RCL 13			292	4.0		
237	0.5			293	*		
238	X<Y			294	CHS		
239	X<Y?		$x < 0.5?$	295	1		
240	GTO 07			296	+		
241	RCL 13			297	1/X		
242	3.0			298	*		
243	Y+X			299	STO 15		$a \rightarrow R_{15}$
244	4			300	*LBL 08		
245	*			301	RCL 12		
246	RCL 13			302	2		
247	X+2			303	/		
248	12			304	RCL 01		
249	*			305	+		
250	-			306	X+2		
251	RCL 13			307	RCL 03		
252	12			308	2.		
253	*			309	/		
254	+			310	*		
255	3			311	STO 16		$R_5 \rightarrow R_{16}$
256	-			312	RCL 01		
257	STO 14		$r_m \rightarrow R_{14}$	313	RCL 05		
258	RCL 13			314	+		
259	0.75			315	RCL 01		
260	*			316	*		
261	0.25			317	RCL 05		
262	-			318	/		
263	RCL 12			319	RCL 12		
264	*			320	*		
265	STO 15		$a \rightarrow R_{15}$	321	RCL 06		
266	GTO 08			322	/		
267	*LBL 07			323	RCL 03		
268	RCL 13			324	*		
269	3.0			325	101		
270	Y+X			326	*		
271	4			327	RCL 12		
272	*			328	*		
273	STO 14		$r_m \rightarrow R_{14}$	329	3		
274	RCL 13			330	/		
275	3.0			331	STO 17		$R_m \rightarrow R_{17}$
276	Y+X			332	RCL 14		
277	2			333	*		
278	*			334	RCL 16		
279	RCL 12			335	+		
280	*			336	"FORCE="		"Force = "
281	RCL 13			337	ARCL X		
282	4.0			338	TONE 8		
283	Y+X			339	AVIEW		
284	RCL 12			340	RCL 01		
285	*			341	RCL 14		
286	3.0			342	*		
287	*			343	RCL 15		
				344	-		

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STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
118	/			175	-		
119	RCL 05			176	CHS		
120	-			177	RCL 13		
121	RCL 05			178	*		
122	RCL 00			179	STO 10		$m\tau_p = m(4.9.25m)$
123	/			180	RCL 09		$\rightarrow R_{10}$
124	SORT			181	*		
125	*			182	1		
126	2			183	-		
127	*			184	RCL 07		
128	P!			185	RCL 08		
129	*			186	*		
130	RCL 04			187	-		
131	/		$L_D \rightarrow R_{06}$	188	STO 11		$m\tau_{pb} - ad_s - 1 \rightarrow R_{11}$
132	STO 06			189	X12		
133	RCL 18			190	4		
134	X*0?			191	RCL 08		
135	GTO 10		if $m=0$	192	*		
136	RCL 01		$H_b = 0.78d_s$	193	RCL 09		
137	0.78			194	*		
138	*			195	RCL 10		
139	GTO 11			196	*		
140	LBL 10			197	RCL 07		
141	RCL 04			198	*		
142	X12			199	+		
143	RCL 00			200	SORT		
144	*			201	RCL 11		
145	1/X			202	+		
146	RCL 01			203	2		
147	*			204	/		
148	STO 07		$\frac{d_s}{gT^2} \rightarrow R_{07}$	205	RCL 08		
149	RCL 18			206	/		
150	19			207	RCL 10		
151	*			208	/		
152	CHS			209	RCL 07		
153	E*H			210	/		
154	CHS			211	RCL 01		
155	1			212	*		
156	+			213	LBL 11		$H_b \rightarrow R_{12}$
157	43.75			214	STO 12		
158	*		$43.75(1 - e^{-19m}) \rightarrow R_{08}$	215	2		
159	STO 08			216	/		
160	RCL 18			217	RCL 01		
161	19.5			218	-		
162	*			219	RCL 02		
163	CHS			220	+		
164	E*H			221	RCL 12		
165	1			222	/		$X = \frac{b'}{H_b} \rightarrow R_{13}$
166	+			223	STO 13		$X \geq 1.0?$
167	1.56			224	1.0		
168	/			225	X12		
169	1.4			226	X12		
170	STO 09		$\frac{1.56}{(1 + e^{-19.5m})} \rightarrow R_{09}$	227	GTO 06		
171	RCL 18			228	1.0		
172	9.25			229	STO 14		$\gamma_m \rightarrow R_{14}$
173	*			230	RCL 12		
174	4			231	2		

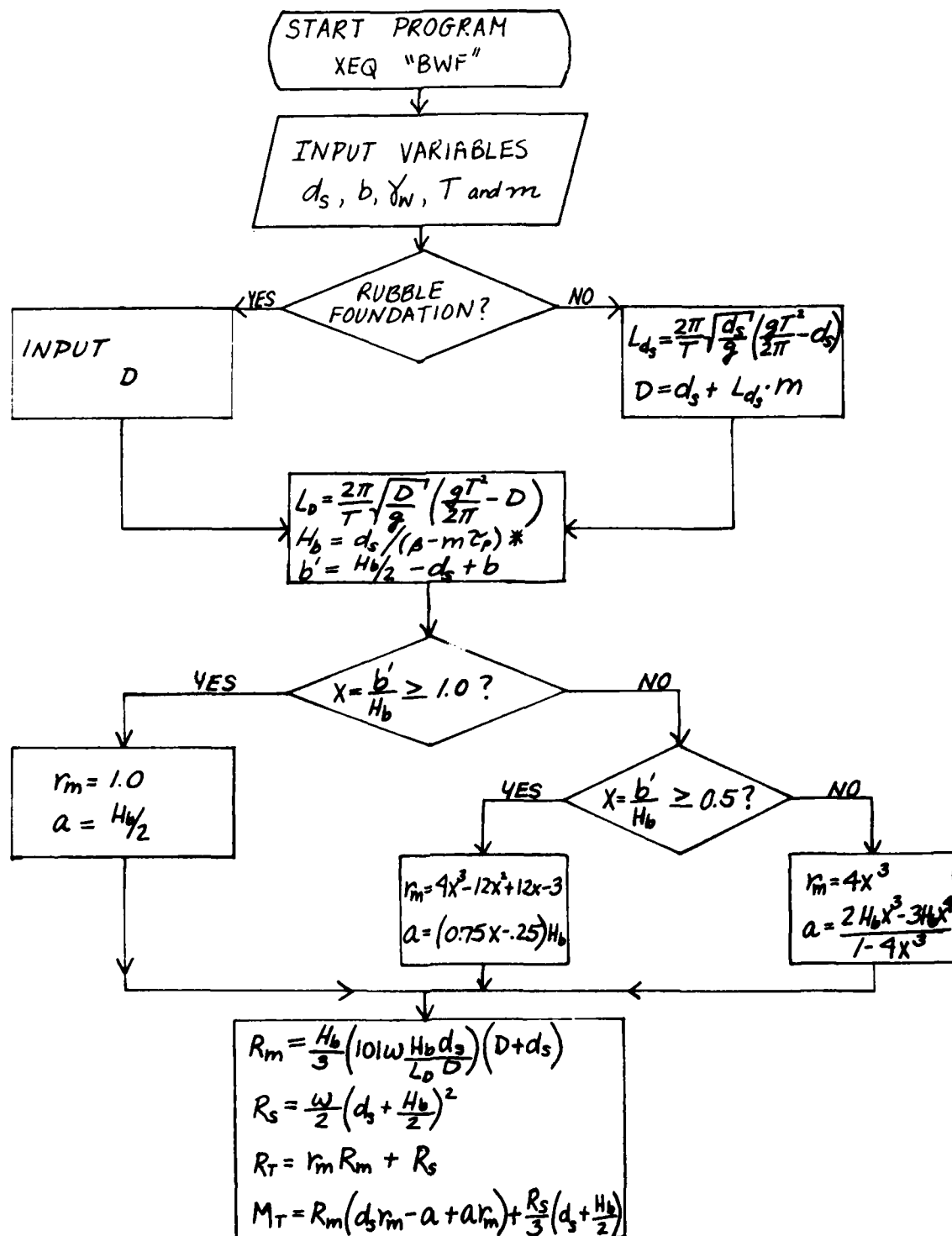
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Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
01	LBL 01			60	FS? 55		
02	"PRESS" W-VE "			61	XEQ 03		
03	"ACROSS"			62	STO 18		$m \rightarrow R_{18}$
04	AVIEW			63	"RUBBLE FDN?"		
05	LBL 05			64	ADD		
06	"US OR #?"			65	TONE 6		
07	ADD			66	PROMPT		
08	TONE 0			67	AOFF		
09	PROMPT			68	ASTO Y		
10	AOFF			69	CLA		
11	ASTO Y			70	"Y"		
12	CLA			71	ASTO X		
13	"US"			72	CLA		
14	ASTO X			73	X*Y?		
15	CLA			74	GTO 04		
16	X=Y?			75	"D?"		
17	GTO 01			76	TONE 7		
18	"METRIC UNITS"			77	PROMPT		
19	AVIEW			78	"D="		
20	LBL 01			79	FS? 55		
21	GTO 02			80	XEQ 03		
22	LBL 01			81	STO 05		$D \rightarrow R_{05}$
23	"US CUST. UNITS"			82	GTO 05		
24	AVIEW			83	LBL 04		
25	TO 2			84	RCL 04		
26	LBL 02		$g \rightarrow R_{00}$	85	X+2		
27	STO 00			86	RCL 00		
28	"D?"			87	*		
29	TONE 1			88	2		
30	PROMPT			89	/		
31	"S="			90	PI		
32	FS? 55			91	/		
33	XEQ 03		$d_s \rightarrow R_{01}$	92	RCL 01		
34	STO 01			93	-		
35	"B"			94	RCL 01		
36	TONE 2			95	RCL 00		
37	PROMPT			96	/		
38	"S="			97	SEPT		
39	FS? 55			98	*		
40	XEQ 03			99	2		
41	STO 02		$b \rightarrow R_{02}$	100	*		
42	"UNIT WT?"			101	PI		
43	TONE 3			102	*		
44	PROMPT			103	RCL 04		
45	"UNIT WT WATER="			104	/		
46	FS? 55			105	RCL 18		
47	XEQ 03			106	*		
48	STO 03		$\gamma_{water} \rightarrow R_{03}$	107	RCL 01		
49	"T"			108	+		
50	TONE 4			109	STO 05		$D \rightarrow R_{05}$
51	PROMPT			110	LBL 05		
52	"T"			111	RCL 04		
53	FS? 55			112	X+2		
54	XEQ 03			113	RCL 00		
55	STO 04		$T \rightarrow R_{04}$	114	+		
56	"CUST. UNITS"			115	2		
57	TONE 5			116	/		
58	PROMPT			117	PI		
59	"N="						

108R-41CV-5

Flowchart for "BWF"



*See program 104R-41CV (CETA 82-4) for equations used in calculating H_b .

108R-41CV-4

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
01	*PROMPT			60	PROMPT		
02	*UNIT WT. WATER*			61	*UNIT WT. WATER*		
03	*WAVE SQUARE*			62	FSI 55		
04	DATE			63	NEG R1		
05	FSI 55			64	STO R5		$\gamma_w \rightarrow R_{05}$
06	R01			65	*		
07	CEL 11			66	R1		
08	CLR			67	*		
09	CF R1			68	RCL R2		
10	CF R2			69	*		
11	*UP GR *9*			70	X12		
12	GR			71	RCL R1		
13	PERMOT			72	*		
14	ROFF			73	RCL R2		
15	RTD Y			74	*		
16	CLR			75	STO R5		$Gt = \left(\frac{2\pi}{T}\right)^2 \frac{d}{g} \rightarrow R_{06}$
17	*H2*			76	4.8		
18	STO R1			77	Y12		
19	CLR			78	R.0675		
20	WV			79	*		
21	STO R2			80	RCL R3		
22	*METRIC UNIT*			81	3.0		
23	WV			82	Y12		
24	WV			83	R.0864		
25	STO R3			84	*		
26	SCALE R2			85	+		
27	*US CUST. UNIT*			86	RCL R6		
28	WV			87	X12		
29	CEL 2			88	R.4622		
30	SCALE R3			89	*		
31	STO R4		$g \rightarrow R_{00}$	90	+		
32	FSI 55			91	RCL R6		
33	GR			92	R.6522		
34	*PERIOD*			93	*		
35	PERMOT			94	+		
36	*PERTH*			95	1		
37	FSI 55			96	+		
38	NEG R1			97	1/X		
39	STO R1		$d \rightarrow R_{01}$	98	RCL R5		
40	*REFLECT*			99	+		
41	PROMPT			100	1/X		
42	*PERIOD*			101	RCL R2		
43	FSI 55			102	*		
44	NEG R2			103	RCL R1		
45	STO R2		$T \rightarrow R_{02}$	104	*		
46	*WAVE HT.?			105	SOFT		
47	PERMOT			106	RCL R2		
48	*WAVE HT.?			107	*		
49	FSI 55			108	STO R3		$L \rightarrow R_{08}$
50	NEG R1			109	RCL R1		
51	STO R3		$H_i \rightarrow R_{03}$	110	RCL R3		
52	*PERIOD CONVE*			111	*		
53	FSI 55			112	STO 11		
54	*REFLECTION COEF			113	*		
55	*F.L.*			114	*		
56	FSI 55			115	R1		
57	NEG R2			116	*		
58	STO R4		$\chi \rightarrow R_{04}$	117	STO 11		$2\pi\Delta \rightarrow R_{11}$
59	*UNIT WT*						

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STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
118	XEQ "COSH"			175	P1		
119	STO 12		$C1 \rightarrow R_{12}$	176	*		
120	RCL 11			177	STO 11		
121	XEQ "SINH"			178	XEQ "COSH"		
122	STO 13		$S1 \rightarrow R_{13}$	179	STO 21		$C2 \rightarrow R_{21}$
123	RCL 12			180	RCL 11		
124	/			181	XEQ "SINH"		
125	STO 14		$T1 \rightarrow R_{14}$	182	STO 22		$S2 \rightarrow R_{22}$
126	RCL 12			183	RCL 10		
127	X*2			184	2		
128	4			185	*		
129	*			186	RCL 20		
130	1/Y			187	*		
131	CHS			188	2		
132	RCL 13			189	*		
133	X*2			190	P1		
134	4			191	*		
135	*			192	STO 11		
136	1/Y			193	XEQ "COSH"		
137	3			194	STO 23		$C3 \rightarrow R_{23}$
138	*			195	RCL 11		
139	+			196	XEQ "SINH"		
140	1			197	STO 24		$S3 \rightarrow R_{24}$
141	+			198	RCL 20		
142	STO 15			199	2		
143	RCL 12		$F5 \rightarrow R_{15}$	200	*		
144	X*2			201	P1		
145	4			202	*		
146	*			203	STO 11		
147	1/Y			204	XEQ "COSH"		
148	RCL 13			205	STO 25		$C4 \rightarrow R_{25}$
149	X*2			206	RCL 11		
150	4			207	XEQ "SINH"		
151	*			208	STO 26		$S4 \rightarrow R_{26}$
152	1/Y			209	RCL 22		
153	3			210	RCL 17		
154	*			211	/		
155	+			212	STO 27		$F1 \rightarrow R_{27}$
156	STO 16		$F6 \rightarrow R_{16}$	213	RCL 21		
157	RCL P1			214	RCL 17		
158	10.0			215	/		
159	/			216	STO 28		$F2 \rightarrow R_{28}$
160	STO 17		$Dd = \frac{d}{N} \rightarrow R_{17}$	217	RCL 26		
161	P.0			218	RCL 13		
162	STO 18		$y_0 = 0 \rightarrow R_{18}$	219	X*2		
163	STO 19		$counter \rightarrow R_{19}$	220			
164	XCL 04			221	STO 29		$F3 \rightarrow R_{29}$
165	1/Y			222	RCL 26		
166	STO 19			223	RCL 13		
167	RCL 19			224			
168	RCL 05			225	RCL 12		
169	1/Y			226			
170	STO 20		$E = y_0/L \rightarrow R_{20}$	227	STO 30		$F4 \rightarrow R_{30}$
171	RCL 19			228	RCL 21		
172	*			229	RCL 12		
173	2			230	/		
174	*			231	2		

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
233 *				299 *			
234 CHS				299 RCL 28			
235 RCL 25				291 *			
236 RCL 13				292 4			
236 X12				297 /			
237 /				294 RCL 08			
238 +				295 /			
239 0.75				296 RCL 04			
242 *				297 1			
241 RCL 14				299 +			
242 RCL 24				299 RCL 03			
243 *				300 *			
244 2				301 RCL 27			
245 *				302 *			
245 CHS				303 2			
247 +				304 /			
248 STO 11			(quantity) $\rightarrow R_{11}$	305 +			Miche-Rundgren
249 RCL 12				306 RCL 18			
250 X12				307 +			
251 4				308 STO 34			$y_c(k) \rightarrow R_{34}$
252 *				309 RCL 04			
253 1/5				310 1			
254 CHS				311 +			
255 1				312 RCL 03			
256 +				313 *			
257 RCL 23				314 RCL 27			
258 *				315 *			
259 +				316 CHS			
260 STO 32			$F7 \rightarrow R_{32}$	317 RCL 34			
261 RCL 23				318 +			
262 4				319 STO 35			$y_t(k) \rightarrow R_{35}$
263 /				320 1			
264 RCL 13				321 RCL 04			
265 X12				322 -			
266 /				323 X12			
267 RCL 11				324 RCL 33			
268 +				325 *			
268 STO 32			$F8 \rightarrow R_{33}$	326 1			
270 1.0				327 RCL 04			
271 RCL 04				328 +			
272 -				329 X12			
273 X12				330 RCL 32			
274 RCL 16				331 *			
275 *				332 +			
276 RCL 04				333 PI			
277 1				334 *			
278 +				335 RCL 07			
279 X12				336 X12			
280 RCL 15				337 *			
281 *				338 RCL 24			
282 *				339 *			
283 PI				340 4			
284 *				341 /			
285 RCL 03				342 RCL 08			
286 X12				343 /			
287 *				344 1			
288 RCL 27							

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
345	RCL 04			402	*		Sainflou
346	+			403	+		
347	RCL 03			404	RCL 18		
348	*			405	+		
349	RCL 30			406	STO 41		$y_c(k) \rightarrow R_{41}$
350	*			407	RCL 03		
351	2			408	2		
352	/			409	*		
353	+			410	RCL 27		
354	RCL 10			411	*		
355	+			412	-		
356	CHS			413	STO 42		$y_t(k) \rightarrow R_{42}$
357	RCL 05			414	RCL 30		
358	*			415	RCL 03		
359	STO 49			416	*		
360	XEQ 05			417	RCL 18		
361	ST+ 37			418	+		
362	RCL 04		$\Sigma P_c(k) \rightarrow R_{37}$	419	CHS		
363	1			420	RCL 05		
364	+			421	*		
365	RCL 03			422	STO 51		
366	*			423	XEQ 06		
367	RCL 05			424	ST+ 44		$\Sigma P_c(k) \rightarrow R_{44}$
368	*			425	RCL 30		
369	RCL 30			426	RCL 03		
370	*			427	*		
371	RCL 49			428	RCL 18		
372	+			429	-		
373	STO 50			430	RCL 05		
374	XEQ 06			431	*		
375	ST+ 33		$\Sigma P_t(k) \rightarrow R_{38}$	432	STO 52		
376	RCL 34			433	XEQ 06		
377	RCL 01			434	ST+ 45		$\Sigma P_t(k) \rightarrow R_{45}$
378	+			435	RCL 41		
379	RCL 49			436	RCL 01		
380	*			437	+		
381	XEQ 06			438	RCL 51		
382	ST+ 39			439	*		
383	RCL 35		$\Sigma M(k) \rightarrow R_{39}$	440	XEQ 06		
384	RCL 01			441	ST+ 46		$\Sigma M_c(k) \rightarrow R_{46}$
385	+			442	RCL 42		
386	RCL 59			443	RCL 01		
387	*			444	+		
388	XEQ 06			445	RCL 52		
389	ST+ 43			446	*		
390	RCL 17		$\Sigma M_t(k) \rightarrow R_{40}$	447	XEQ 06		
391	RCL 20			448	ST+ 47		$\Sigma M_t(k) \rightarrow R_{47}$
392	*			449	RCL 17		
393	RCL 03			450	ST- 16		
394	112			451	RCL 16		
395	*			452	11.0		
396	PI			453	X=Y?		
397	*			454	GTO 05		
398	RCL 02			455	GTO 04		
399	/			456	LBL 05		
400	RCL 27			457	FS? 55		
401	RCL 03						

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
458	ADV			514	STO 02		$b \rightarrow R_0$
459	RCL 34			515	*LBL 13		Rubble Foundation
460	ABS			516	*RUBBLE FDN?		Option
461	ST+ 54			517	ADV		
462	RCL 54			518	PROMPT		
463	*YC-MR="		$"y_c - MR = "$	519	POFF		
464	APCL X			520	ASTO Y		
465	AVIEW			521	CLA		
466	TONE 3			522	*Y"		
467	RCL 35			523	ASTO X		
468	ABS			524	CLA		
469	ST+ 55			525	X=Y?		
470	RCL 55			526	GTO 14		
471	*YT-MR="		$"y_t - MR = "$	527	GTO 15		
472	APCL X			528	*LBL 14		
473	AVIEW			529	SF 02		
474	TONE 2			530	*RUBBLE HT?"		
475	RCL 41			531	PROMPT		
476	ABS			532	*RUBBLE HT="		
477	ST+ 56			533	FS? 55		
478	RCL 56			534	XEQ 02		
479	*YC-SF="		$"y_c - SF = "$	535	STO 07		$b' \rightarrow R_0$
480	ARCL X			536	*LBL 15		
481	AVIEW			537	FS? 55		
482	TONE 8			538	ADV		
483	RCL 42			539	*MICHE-R"		Miche-Rundgren
484	ABS			540	AVIEW		
485	ST+ 57			541	RCL 37		
486	RCL 57			542	30		
487	*YT-SF="		$"y_t - SF = "$	543	/		
488	ARCL X			544	RCL 54		
489	AVIEW			545	*		
490	TONE 9			546	XEQ 16		
491	*LOW WALL HT?"		Low Wall Height	547	*PC="		$"P_c = "$
492	ADV		Option	548	APCL X		
493	PROMPT			549	AVIEW		
494	POFF			550	TONE 2		
495	ASTO Y			551	STOP		
496	CLA			552	RCL 38		
497	*Y"			553	30		
498	ASTO X			554	/		
499	CLA			555	RCL 55		
500	X=Y?			556	*		
501	GTO 11			557	XEQ 16		
502	GTO 13			558	*ST="		$"P_t = "$
503	*LBL 12			559	APCL X		
504	FS? 55			560	AVIEW		
505	ADV			561	TONE 3		
506	SF 01			562	STOP		
507	*WALL HT?"			563	RCL 39		
508	PROMPT			564	30		
509	FS? 55			565	/		
510	ADV			566	RCL 54		
511	*WALL HT="			567	*		
512	FS? 55			568	XEQ 17		
513	XEQ 02			569	*PC="		$"M_c = "$
				570	APCL X		

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
571	AVIEW			628	*PI=		"M _t = "
572	TONE 4			629	ARCL X		
573	STOP			630	AVIEW		
574	RCL 40			631	TONE 9		
575	30			632	STOP		
576	/			633	CF 01		
577	RCL 55			634	CF 02		
578	*			635	GTO 11		
579	XEQ 17		"M _t = "	636	LBL 02		
580	*MT=			637	PRG		
581	ARCL X			638	PRX		
582	AVIEW			639	RTN		
583	TONE 5			640	LBL "COSH"		cosh() subroutine
584	STOP			641	STO 11		
585	FS? 55			642	ETX		
586	ADV			643	RCL 11		
587	*SAINFLOU		Sainflou	644	CHS		
588	AVIEW			645	ETX		
589	RCL 44			646	+		
590	30			647	2		
591	/			648	/		
592	RCL 56			649	RTN		
593	*			650	LBL "SINH"		sinh() subroutine
594	XEQ 16			651	STO 11		
595	*PC=		"P _c = "	652	E*X		
596	ARCL X			653	RCL 11		
597	AVIEW			654	CHS		
598	TONE 6			655	E*X		
599	STOP			656	-		
600	RCL 45			657	2		
601	30			658	/		
602	/			659	RTN		
603	RCL 57			660	LBL 06		Simpson's Rule subroutine
604	*			661	STO 11		
605	XEQ 15			662	RCL 10		
606	*PT=		"P _t = "	663	1.0		
607	ARCL X			664	X<Y?		
608	AVIEW			665	X=Y?		
609	TONE 7			666	GTO 07		
610	STOP			667	11.0		
611	RCL 46			668	X<Y?		
612	30			669	X=Y?		
613	/			670	GTO 10		
614	RCL 55			671	RCL 10		
615	*			672	ENTER		
616	XEQ 17			673	2		
617	*PC=		"P _c = "	674	MOD		
618	ARCL X			675	X=0?		
619	AVIEW			676	GTO 09		
620	TONE 8			677	RCL 11		
621	STOP			678	2		
622	RCL 47			679	*		
623	30			680	GTO 09		
624	/			681	LBL 08		
625	RCL 57			682	RCL 11		
626	*			683	4		
627	XEQ 17						

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
694 *				741 STO 31			
695 STO 09				742 GTD 29			
696*LBL 07				743*LBL 18			
697 RCL 34				744 RCL 31			
698 STO 54				745 RCL 11			
699 RCL 35				746 -			
699 STO 55				747 STO 31			
691 RCL 41				748*LBL 29			
692 STO 56				749 RCL 31			
693 RCL 42				750 RTN			
694 STO 57				751*LBL 17			
695*LBL 10				752 STO 31			
696 RCL 11				753 STO 11			
697*LBL 03				754 LASTX			
698 RTN				755 STO 36			
699*LBL 16				756 F02 01			
700 STO 31				757 GTD 22			
701 STO 11				758 RCL 09			
702 LASTX				759 RCL 36			
703 STO 36				760 /			
704 F02 01				761 STO 48			
705 GTD 19				762 1.0			
706 RCL 09				763 X<=Y?			
707 RCL 36				764 GTD 22			
708 /				765 3			
709 STO 48				766 RCL 48			
710 1.0				767 2			
711 X<=Y?				768 *			
712 GTD 19				769 -			
713 2				770 RCL 48			
714 RCL 48				771 X*2			
715 -				772 *			
716 RCL 48				773 RCL 31			
717 *				774 *			
718 RCL 31				775 STO 31			
719 *				776*LBL 22			
720 STO 31				777 F02 02			
721*LBL 19				778 GTD 22			
722 F02 02				779 RCL 07			
723 GTD 29				780 RCL 36			
724 RCL 07				781 /			
725 RCL 36				782 STO 48			
726 /				783 1.0			
727 STO 48				784 X<=Y?			
728 1.0				785 GTD 21			
729 X<=Y?				786 3			
730 GTD 19				787 RCL 48			
731 2				788 2			
732 RCL 48				789 *			
733 -				790 -			
734 RCL 48				791 RCL 48			
735 *				792 X*2			
736 CHS				793 *			
737 RCL 11				794 CHS			
738 *				795 RCL 11			
739 RCL 31				796 *			
740 +							

Force Reduction
Subroutine

low wall reduction

Rubble Reduction

Moment Reduction
Subroutine

low wall reduction

Rubble Reduction

[illegible]

109R-41CV-17

Program Description

110R-41CV Non-breaking Wave Pressure Distribution on Vertical Face			
Program Title		Structures - Miche-Rundgren and Sainflou Solutions (RPN Logic)	
Name	Julie Dean	Date	8/83
Address	U. S. Army Engineer Waterways Experiment Station Coastal Engineering Research Center		
City	P. O. Box 631 Vicksburg	State	Mississippi
		Zip Code	39180-0631
Program Description, Equations, Variables, etc.			
This program calculates non-breaking pressure distributions when the wave crest is at the structure and when the wave trough is at the structure using both the Miche-Rundgren and Sainflou equations. The solution corresponding to Figure 7-91 or 7-94 of the Shore Protection Manual is the solution with an overall lower pressure value. Input values are the water depth at the structure d, wave period T, incident wave height H_i, reflection coefficient χ, and unit weight of water γ_w. The user is given the option of calculating the pressure distribution values using either or both the Miche-Rundgren and Sainflou solutions. This program is identical to 109R except that the pressure distribution is printed out without integrating to obtain force. The algorithm uses U. S. Customary or Metric system of units.			
<u>REFERENCES</u>			
Hughes, S. A., August 1982, Basic Program: "WAVEFOR", available from Coastal Engineering Research Center, U. S. Army Engineer Waterways Experiment Station, Vicksburg, MS 39180-0631. U. S. Army Corps of Engineers, Coastal Engineering Research Center, CETN-1-21, 12/82. U. S. Army Corps of Engineers, Coastal Engineering Research Center, Shore Protection Manual, Chapter 7 (1984).			
Operating Limits and Warnings			
Because of the large number of output values, this program has been written for use with printer only. It can easily be modified to run without the printer by deleting the printer instructions and inserting R/S statements where output values are desired.			

110R-41CV-1

User Instructions

110R-41CV Non-Breaking Wave Pressure Distribution on Vertical Face
Structures - Miche-Rundgren and Sainflou Solutions (RPN Logic)

SIZE: 063

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	LOAD PROGRAM (NBPD)		[XEQ] "NBPD"	E OR M?
2	CHOOSE U.S. CUSTOMARY OR METRIC UNITS		US or M, [R/S]	DEPTH?
3	ENTER DEPTH (feet or meters)	d	[R/S]	PERIOD?
4	ENTER WAVE PERIOD (seconds)	T	[R/S]	WAVE HT.?
5	ENTER INCIDENT WAVE HEIGHT (feet or meters)	H _i	[R/S]	REFLEC COEFF?
6	ENTER REFLECTION COEFFICIENT	X	[R/S]	UNIT WT?
7	ENTER UNIT WEIGHT OF WATER (lb/ft ³ or kg/m ³)	γ _w	[R/S]	MR?
8	ANSWER YES OR NO TO MICHE-RUNDGREN PRESSURE DISTRIBUTION		Y or N, [R/S]	SF?
9	ANSWER YES OR NO TO SAINFLOU PRESSURE DISTRIBUTION		Y or N, [R/S]	
10	READ ELEVATIONS (ft. or m) READ PRESSURES (lb/ft ² or kg/m ²) The solution corresponding to Figure 7-91 or 7-94 of the Shore Protection Manual is the solution with an overall lower pressure value.			

110R-41CV-2

User Instructions

STEP	INSTRUCTIONS	INPUT	FUNCTION	SIZE:	
				DISPLAY	
	Example Problem:	NON-BPKG PRESSURE DIST.	SAINFLOU...CREST AT WALL		
	- U.S. Customary Units	US CUST. UNITS	ELEVATION PRESSURE		
	depth = 10 ft.	DEPTH = 10.0000 ***	6.4053 0.0000		
	period = 6 sec.	PERIOD = 6.0000 ***	4.6568 89.1164		
	H _i = 5 ft.	WAVE HT. = 5.0000 ***	2.9439 178.3298		
	$\chi = 1.0$	REFLECTION COEFF. = 1.0000 ***	1.2618 267.7335		
	$\gamma_w = 64 \text{ lb/ft}^3$	UNIT WT. WATER = 64.0000 ***	-0.3941 357.4277		
			-2.0279 447.5094		
			-3.6436 538.0785		
			-5.2450 629.2364		
			-6.8358 721.0869		
			-8.4197 813.7365		
			-10.0000 907.2946		
	Read Miche-Rundgren:	MICHE-R...CREST AT WALL	SAINFLOU...TROUGH AT WALL		
	elevation (ft.)	ELEVATION PRESSURE	ELEVATION PRESSURE		
	pressure (lb/ft ²)	8.5929 0.0000	-3.5947 0.0000		
		6.5401 40.0000	-4.2377 38.8836		
		4.5516 181.6486	-4.8784 77.6712		
		2.6185 274.8357	-5.5186 116.2665		
		0.7325 369.7969	-6.1585 154.5723		
		-1.1147 466.7117	-6.7983 192.4906		
		-2.9289 565.7828	-7.4382 229.9215		
		-4.7184 667.2433	-8.0794 266.7636		
		-6.4992 771.3541	-8.7187 302.9131		
		-8.2476 878.4892	-9.3597 338.2635		
		-10.0000 988.7386	-10.0000 372.7854		
	Read Sainflou:	MICHE-R...TROUGH AT WALL	END		
	elevation (ft.)	ELEVATION PRESSURE			
	pressure (lb/ft ²)	-1.4071 0.0000			
		-2.7541 39.8481			
		-3.2707 80.9918			
		-4.1619 123.3686			
		-5.0319 166.9416			
		-5.8846 211.6934			
		-6.7235 257.6259			
		-7.5517 304.7705			
		-8.3720 353.1803			
		-9.1873 402.9363			
		-10.0000 454.1494			
	Since the Sainflou				
	pressure distribu-				
	tion provides lower				
	pressures than the				
	Miche-Rundgren				
	theory, the Sainflou				
	solution corresponds to				
	SPM Figure 7-91.				

110R-41CV-3

User Instructions

				SIZE:
STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
	Example Problem:	NON-BRKG PRESSURE DIST.		SAINFLOU...CREST AT WALL
	- Metric Units	METRIC UNITS		ELEVATION PRESSURE
	depth = 3.05m	DEPTH =		1.9459 0.0000
	period = 6sec.	PERIOD = 3.0500 ***		1.4135 434.9514
	$H_i = 1.52m$	WAVE HT. = 6.0000 ***		0.8919 370.3707
	$\chi = 1.0$	REFLECTION COEFF. = 1.5200 ***		9.3797 1.306.7274
	$\gamma_w = 1025.18 \text{ kg/m}^3$	UNIT WT. WATER = 1.0000 ***		-0.1246 1.744.4952
		1.025.1800 ***		-0.6231 2.184.1519
				-1.1142 2.626.1841
				-1.6219 3.071.0866
				-2.0867 3.519.3651
				-2.5627 3.971.5383
				-3.0500 4.428.1412
	Read Miche-Rundgren:	MICHE-R...CREST AT WALL		SAINFLOU...TROUGH AT WALL
	elevation (m)	ELEVATION PRESSURE		ELEVATION PRESSURE
	pressure (kg/m ²)	2.6078 0.0000		-1.0941 0.0000
		1.9823 439.5290		-1.2983 190.4964
		1.3783 886.2443		-1.4969 380.7413
		0.7901 1.340.9499		-1.6915 569.3520
		0.2162 1.804.0756		-1.8769 756.9442
		-0.3457 2.276.7932		-2.0722 942.6471
		-0.8980 2.759.9939		-2.2676 1.125.9747
		-1.4425 3.254.9025		-2.4631 1.306.4320
		-1.9815 3.762.4924		-2.6587 1.483.5133
		-2.5167 4.284.4995		-2.8543 1.656.6994
		-3.0500 4.822.7992		-3.0500 1.825.4568
				END
	Read Sainflou:	MICHE-R...TROUGH AT WALL		
	elevation (m)	ELEVATION PRESSURE		
	pressure (kg/m ²)	-0.4322 0.0000		
		-0.7205 194.9660		
		-0.9996 396.2226		
		-1.2710 603.4734		
		-1.5360 816.5249		
		-1.7959 1.025.2984		
		-2.0514 1.255.7845		
		-2.3079 1.490.1450		
		-2.5579 1.725.6505		
		-2.8023 1.969.6595		
		-3.0500 2.219.7145		
	Since the Sainflou			
	Pressure distribution			
	provides lower pres-			
	sures than the			
	Miche-Rundgren theory,			
	the Sainflou solution			
	Corresponds to SPM Figure 7-91.			

110R-41CV-4

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
01	LCL "NPP"			60	PPX		
02	"NON-ERRG PRESSU"			61	STO 05		$\delta W \rightarrow R_{05}$
03	"LDE DIST."			62	2		
04	AVIEW			63	PI		
05	PPV			64	*		
06	CLAS			65	RCL 02		
07	CF 00			66	/		
08	CF 01			67	X12		
09	"US OR M?"			68	RCL 01		
10	GEN			69	*		
11	PROMPT			70	RCL 06		
12	ADFF			71	/		$Gt \rightarrow R_{06}$
13	ASTO Y			72	STO 06		
14	CLR			73	4.0		
15	"US"			74	Y1X		
16	ASTO X			75	0.0675		
17	CLR			76	*		
18	X=12			77	RCL 06		
19	GTO 02			78	3.0		
20	"METRIC UNITS"			79	Y1X		
21	AVIEW			80	0.0864		
22	9.81			81	*		
23	GTO 03			82	+		
24	LCL 02			83	RCL 06		
25	"US CUST. UNITS"			84	X12		
26	AVIEW			85	0.4622		
27	32.2			86	*		
28	LCL 03			87	+		
29	STO 00		$g \rightarrow R_{00}$	88	RCL 05		
30	ADP			89	0.6522		
31	"DEPTH?"			90	*		
32	PROMPT			91	+		
33	"DEPTH?"			92	1		
34	PPR			93	+		
35	PPY			94	1/X		
36	STO 01		$d \rightarrow R_{01}$	95	RCL 05		
37	"PERIOD?"			96	+		
38	PROMPT			97	1/X		
39	"PERIOD?"			98	RCL 00		
40	PPR			99	*		
41	PPY			100	RCL 01		
42	STO 02		$T \rightarrow R_{02}$	101	*		
43	"WAVE HT.?"			102	SQRT		
44	PROMPT			103	RCL 02		
45	"WAVE HT.?"			104	*		
46	PPR			105	STO 03		$L \rightarrow R_{08}$
47	PPY			106	RCL 01		
48	STO 03		$H_i \rightarrow R_{03}$	107	RCL 02		
49	"REFLECT. COEFF?"			108	*		
50	PROMPT			109	STO 10		$\Delta \rightarrow R_{10}$
51	"REFLECTION COEFF?"			110	1		
52	"REF.?"			111	*		
53	PPR			112	01		
54	PPY			113	*		
55	STO 04		$X \rightarrow R_{04}$	114	STO 11		$() \rightarrow R_{11}$
56	"UNIT WT.?"			115	XEQ "COSH"		
57	PROMPT			116	STO 12		$CI \rightarrow R_{12}$
58	"UNIT WT. WATER?"			117	RCL 11		
59	PPR			118	XEQ "SINH"		$SI \rightarrow R_{13}$
				119	STO 13		

110R-41CV-5

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
120	RCL 12			178	XEQ "SINH"		
121	/			179	STO 22		S2 → R ₂₂
122	STO 14		T1 → R ₁₄	180	RCL 18		
123	RCL 12			181	2		
124	X*2			182	*		
125	4			183	RCL 28		
126	*			184	+		
127	1/X			185	2		
128	CHS			186	*		
129	RCL 12			187	PI		
130	X*2			188	*		
131	4			189	STO 11		
132	*			190	XEQ "COSH"		
133	1/X			191	STO 23		C3 → R ₂₃
134	2			192	RCL 11		
135	*			193	XEQ "SINH"		
136	+			194	STO 24		S3 → R ₂₄
137	1			195	RCL 28		
138	+			196	2		
139	STO 15		F5 → R ₁₅	197	*		
140	RCL 12			198	PI		
141	X*2			199	*		
142	4			200	STO 11		
143	*			201	XEQ "COSH"		
144	1/X			202	STO 25		C4 → R ₂₅
145	RCL 13			203	RCL 11		
146	X*2			204	XEQ "SINH"		
147	4			205	STO 26		S4 → R ₂₆
148	*			206	RCL 22		
149	1/X			207	RCL 13		
150	2			208	/		
151	*			209	STO 27		F1 → R ₂₇
152	+			210	RCL 21		
153	STO 16		F6 → R ₁₆	211	RCL 13		
154	RCL 21			212	/		
155	12.8			213	STO 28		F2 → R ₂₈
156				214	RCL 26		
157	STO 17		Dd → R ₁₇	215	RCL 13		
158	0.2			216	X*2		
159	STO 18		y ₀ = 0 → R ₁₈	217	/		
160	STO 19		0 → R ₁₉ (counter)	218	STO 29		F3 → R ₂₉
161	LRL 04			219	RCL 26		
162	1.8			220	RCL 13		
163	STO 19			221			
164	RCL 11			222	RCL 12		
165	RCL 11			223	/		
166				224	STO 30		F4 → R ₃₀
167	STO 20		E → R ₂₀	225	RCL 21		
168	RCL 19			226	RCL 12		
169	+			227			
170	2			228	2		
171	*			229	*		
172	PI			230	CHS		
173	*			231	RCL 25		
174	STO 11			232	RCL 13		
175	XEQ "COSH"			233	X*2		
176	STO 21		C2 → R ₂₁	234	/		
177	RCL 11			235	+		

110R-41CV-6

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
236	9.75			293	GTO 14		
237	*			294	11.9		
238	RCL 14			295	RCL 04		
239	RCL 24			296	-		
240	*			297	X+2		
241	2			298	RCL 16		
242	*			299	*		
243	CHS			300	RCL 04		
244	+			301	1		
245	GTO 11		(quantity) → R ₁₁	302	+		
246	RCL 12			303	X+2		
247	X+2			304	RCL 15		
248	4			305	*		
249	*			306	+		
250	1/X			307	P!		
251	CHS			308	*		
252	1			309	RCL 03		
253	+			310	X+2		
254	RCL 23			311	*		
255	*			312	RCL 27		
256	+			313	*		
257	GTO 32		F7 → R ₃₂	314	RCL 26		
258	RCL 23			315	*		
259	+			316	4		
260	/			317	/		
261	RCL 12			318	RCL 09		
262	X+2			319	/		
263	/			320	RCL 04		
264	RCL 11			321	1		
265	+			322	+		
266	GTO 33		F8 → R ₃₃	323	RCL 23		
267	FS? 00			324	*		
268	GTO 12			325	RCL 27		
269	FS? 01			326	*		
270	GTO 14			327	2		
271	"MP?"			328	/		
272	ADN			329	+		
273	PROMPT			330	RCL 18		
274	AOFF			331	+		
275	ASTO Y			332	GTO 34		Y _c
276	CLA			333	ACX		
277	"N"			334	6		
278	ASTO X			335	SPFCHR		
279	CLA			336	RCL 04		
280	X=Y?			337	1		
281	GTO 11			338	+		
282	SP 00			339	RCL 03		
283	ADN			340	*		
284	"NICHIE-ALL CREST"			341	RCL 27		
285	"N AT WALL"			342	*		
286	ADN			343	CHS		
287	ADN			344	RCL 34		
288	"ELEVATION PRES"			345	+		
289	"FSURE"			346	GTO 35		Y _t
290	PRR			347	RCL 19		
291	*LBL 12			348	40		
292	FS? 01			349	+		

110R-41CV-7

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
350	STO 40			407	RCL 19		
351	RCL 35			408	51		
352	STO IND 40			409	+		
353	1.0			410	STO 40		
354	RCL 04			411	RCL 35		
355	-			412	STO IND 40		
356	X*2			413	RCL 17		
357	RCL 33			414	ST- 18		
358	*			415	RCL 19		
359	1			416	11.0		
360	RCL 04			417	X*Y?		
361	+			418	GTO 04		
362	X*2			419	0.0		
363	RCL 32			420	STO 19		
364	*			421	ADV		
365	+			422	"NICHE-R...TROUS"		
366	PI			423	"FM AT WALL"		
367	*			424	PRA		
368	RCL 03			425	ADV		
369	X*2			426	"ELEVATION PRES"		
370	*			427	"FSURE"		
371	RCL 29			428	PRA		
372	*			429	LBL 10		
373	4			430	RCL 19		
374	/			431	1		
375	RCL 08			432	+		
376	/			433	STO 19		
377	1			434	40		
378	RCL 04			435	+		
379	+			436	STO 40		
380	RCL 03			437	RCL IND 40		
381	*			438	ACX		
382	RCL 30			439	6		
383	*			440	SKPCHR		
384	2			441	RCL 19		
385	/			442	51		
386	+			443	+		
387	RCL 19			444	STO 40		
388	+			445	RCL IND 40		
389	CHS			446	ACX		
390	RCL 05			447	PRBUF		
391	*			448	RCL 19		
392	STO 36			449	11.0		
393	ACX			450	X=Y?		
394	PRBUF			451	GTO 11		
395	RCL 04			452	GTO 10		
396	1			453	FS? 01		
397	+			454	GTO 14		
398	RCL 03			455	LBL 11		
399	*			456	"SF?"		
400	RCL 05			457	ACN		
401	+			458	PROMPT		
402	RCL 30			459	AOFF		
403	*			460	ASTO Y		
404	RCL 36			461	CLP		
405	+			462	"N"		
406	STO 35						

110R-41CV-8

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
463	ASTO X			519	+		
464	CLP			520	CHS		
465	X=Y?			521	PCL 05		
466	GTO 13			522	*		
467	SF 01			523	STO 39		Pc
468	ADV			524	ACX		
469	"SAINFLOU...CRES"			525	PRBUF		
470	"HT AT WALL"			526	RCL 30		
471	PPR			527	RCL 03		
472	ADV			528	*		
473	"ELEVATION PRES"			529	RCL 18		
474	"FSURE"			530	-		
475	PPR			531	PCL 05		
476	0.0			532	*		
477	STO 18			533	STO 30		Pe
478	STO 19			534	RCL 19		
479	GTO 04			535	51		
480	LRL 14			536	+		
481	RCL 27			537	STO 40		
482	RCL 28			538	RCL 38		
483	*			539	STO IND 40		
484	RCL 03			540	PCL 17		
485	X*2			541	ST- 18		
486	*			542	RCL 19		
487	PI			543	11.0		
488	*			544	X*Y?		
489	RCL 03			545	GTO 04		
490	/			546	ADV		
491	RCL 27			547	"SAINFLOU...TROUG"		
492	RCL 03			548	"H AT WALL"		
493	*			549	PPR		
494	+			550	ADV		
495	RCL 18			551	"ELEVATION PRES"		
496	+			552	"FSURE"		
497	STO 37		Yc	553	PPR		
498	ACX			554	0.0		
499	6			555	STO 19		
500	SKPCHR			556	LRL 15		
501	RCL 37			557	RCL 19		
502	RCL 03			558	1		
503	2			559	+		
504	*			560	STO 19		
505	RCL 27			561	40		
506	*			562	+		
507	-			563	STO 40		
508	STO 30		Yt	564	RCL IND 40		
509	RCL 19			565	ACX		
510	40			566	6		
511	+			567	SKPCHR		
512	STO 40			568	RCL 19		
513	RCL 30			569	51		
514	STO IND 40			570	+		
515	RCL 30			571	STO 40		
516	PCL 03			572	RCL IND 40		
517	*			573	ACX		
518	PCL 18			574	PRBUF		

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APPENDIX A: BLANK PROGRAM FORMS

Program Description

Program Title		
Name	Date	
Address		
City	State	Zip Code
Program Description, Equations, Variables, etc.		
Operating Limits and Warnings		

User Instructions

[illegible]

Program Listing

[illegible]

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