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An HP-25 Program for Solving the Strong Shock Algorithm for Yield and Origin-Shift

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AN HP-25 PROGRAM FOR SOLVING THE STRONG SHOCK ALGORITHM

FOR YIELD AND ORIGIN-SHIFT

by

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ABSTRACT

We present a program for the HP-25 hand calculator which solves the strong shock algorithm for yield and origin-shift. The program is intended for quick-look analysis of field data and could easily be modified and improved upon for use with other calculators having larger program and data memories.

I. INTRODUCTION

The strong shock yield algorithm provides a means of analyzing hydrodynamic shock propagation data to obtain the yield of an underground explosion. Where a and b are known constants and $R(t)$ is the experimentally measured shock front position at time t, the strong shock algorithm can be written in terms of the explosion yield W as

$$R(t) + R_o = a\, W^{\frac{1-b}{3}} (t + t_o)^b \ . \tag{1}$$

Here, the units of radius, time, and yield are meters, milliseconds, and kilotons, respectively. R and t are determined relative to a presumed spatial and temporal origin of the explosion. R_o and t_o are additive corrections which correct the data to the actual explosion time and location. The least squares solution of Eq. (1) for W and R_o given in Ref. 1 is herein implemented in its barest essentials for the HP-25 hand calculator [e.g., data times are presumed to have already been corrected such that we can ignore t_o in Eq. (1)]. The program may easily be converted to other calculators having larger program and data memories and thereby made more elaborate and/or easier to use.

II. THE HP-25 PROGRAM

Our HP-25 program is presented in TABLE I with user instructions in TABLE II. Using data taken from Case 2 of Ref. 1, program results are demonstrated in the following example:

i	t_i	R_i	Fitted Values (Using points 1 to i)	
			W	R_o
1	1.0	20.1318	--	--
2	1.1	20.8166	132.19	-5.35
3	1.2	21.5138	159.05	-4.85
4	1.3	22.1247	148.71	-5.04
5	1.4	22.7172	141.62	-5.17
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
26	3.5	32.3807	149.5404	-5.0120

Note that, as presented in TABLE I, the program computes W and R_o after each radius-time pair is entered. This takes $\sim$ 4-1/2 s. If step 06 in the program is changed from NOP to GTO 00, this calculation is skipped and the calculator stops after $\sim$ 1 s and displays instead the number of points entered so far. To calculate W and R_o, press

GTO 07 followed by R/S once the calculator has stopped. W and R_o will be computed and displayed as before. The user can then continue to add or delete points as desired.

TABLE I

THE HP-25 PROGRAM

Step	Instruction	Notes	Step	Instruction	Notes	Register Usage	
00	STOP		25	x	R_o	0	Λ^{-1}
	x < 0	Remove data point?		RCL 3		1	a
	GTO 45			RCL 5		2	b
	RCL 2			x		3	N
	y^x	t_i^b		RCL 7		4	$\Sigma\, R_i$
05	$\Sigma\,+$		30	RCL 4		5	$\Sigma\, R_i\, t_i^b$
06	NOP	(or GTO 00 – see text)		x		6	$\Sigma\, (t_i^b)^2$
07	2			–		7	$\Sigma\, t_i^b$
	RCL 3			RCL 0			
	x < y	N $\geq$ 2 ?		x			
10	GTO 00		35	RCL 1			
	RCL 6			$\div$			
	x			1			
	RCL 7			RCL 2			
	x^2			–			
15	–		40	3			
	1/x	Δ^{-1}		x $\rightleftarrows$ y			
	STO 0			$\div$			
	RCL 7			y^x	(y)=R_o,(x)=W		
	RCL 5			GTO 00			
20	x		45	CHS	Take out data point.		
	RCL 4			RCL 2			
	RCL 6			y^x			
	x			$\Sigma\,-$			
	–		49	GTO 06			

TABLE II

USER INSTRUCTIONS

Step	Instructions
1	Enter program
2	Clear registers [press f STK]
3	Load register 1 with a-value [key in a value followed by STO 1]
4	Load register 2 with b-value [key in b value followed by STO 2]
5	Initiate program [press f PRGM in run mode]
6	Key in first radius point (m) and press ENTER
7	Key in first time point (ms)
8	Restart program [press R/S]. Program stops and displays 1.00.
9-11	Key in next radius and time points and press R/S

When program stops, W is displayed in x-register

R_o is available for display

in y-register [press x ⇄ y]

If program step 06 is changed to GTO 00, program skips over calculation of W and R_o after each point is entered and stops with the display showing the number of points so far entered. To do the W, R_o calculation, press GTO 07 and R/S. Results are given as in above case.

Options:

1. To enter additional points, repeat steps 9 - 11.

2. To remove a point, execute steps 9 - 11, but set time value negative.

3. To reinitiate for another problem, start over from step 2.

REFERENCES

1. H. C. Goldwire, Jr., "Solving the Strong Shock Algorithm for Yield and Origin-Shift," Los Alamos Scientific Laboratory report LA-6786 (In preparation).