H6124 - SPECIFIC ENERGY AND SPECIFIC FORCE IN EITHER A TRAPEZOID-ETC(U)
ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE
H6124 - Specific Energy and Specific Force in Either Trapezoidal, Triangular, or Rectangular Open Channel

PREPARING AGENCY
Hydraulic Analysis Division, Hydraulics Laboratory, U.S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, MS 39180

AUTHOR(S)
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DATE PROGRAM COMPLETED
Nov 73

STATUS OF PROGRAM
Documented Nov 1977 Origin Operational

A. PURPOSE OF PROGRAM
To compute the specific energy and specific force in either a trapezoidal, triangular, or rectangular open channel.

B. PROGRAM SPECIFICATIONS
SEE FOLLOWING PAGE.

C. METHODS
The program is written in G635 time-sharing series, FORTRAN IV and is part of a Conversationally Oriented Real-Time Program-Generating System (CORPS). All I/O requirements are handled in the main program with the subroutine handling the computation.

D. EQUIPMENT DETAILS
The program was developed and is operational on WES 66/80, Vicksburg, MS. It is also operational on the HIS 66/80, Macon, GA, and Boeing CDC, Seattle, WA.

E. INPUT-OUTPUT
The required inputs which are entered at execute time are: discharge-cfs, channel bottom width (zero if triangular section)-ft, channel side slope (cotangent, zero if rectangular section), and number of flow depths and flow depths-ft. The output includes the given data, plus the specific energy, ft, and specific force, ft3.

F. ADDITIONAL REMARKS
Complete documentation of this program is available from the Engineer Computer Program Library, Technical Information Center, WES.
B. PROGRAM SPECIFICATIONS:

Language: ANSI FORTRAN (FORTRAN IV)

Solution Requirements: The run command

```
RUN WESLIB/CORPS/H6124, R
```

plus the input variables defined in (E)

Method of Analysis: Solves algebraic equations for the specific energy and specific force.

Core Requirements G635: 10 K words

External Storage: None

Restrictions: Velocity distribution is uniform across the flow section and the invert slope is small (i.e., <10 degrees).

General Equations:

Specific Energy \( E \) (ft of water) \[
E = y + \frac{Q^2}{2gA^2}
\]

Specific Force \( F \) (ft\(^3\) of water) \[
F = A\bar{y} + \frac{Q^2}{6A}
\]

where: \( Q \) is the discharge (cfs), \( g \) is acceleration of gravity (32.2 ft/sec\(^2\)), \( y \) is flow depth (ft), \( A \) is cross-section area (ft\(^2\)), and \( \bar{y} \) is the distance (ft) of the centroid of the area \( A \) below the water surface.

Range of Quantities: Unlimited for practical application.

Accuracy: Governed by accuracy of input data; the specific energy and specific force are printed to ±0.01 ft and ft\(^3\).
1. **PROGRAM NUMBER:** 722-F3-RO-6AJ

2. **TITLE:** H6124 - Specific Energy and Specific Force in Either a Trapezoidal, Triangular, or Rectangular Open Channel.

3. **REVISION LOG:** N/A

4. **PURPOSE OF PROGRAM:** To compute the specific energy and specific force in either a trapezoidal, triangular, or rectangular open channel.

Reference:


5. **STEP SOLUTION:**

a. Enter inputs:

   (1) Discharge \( Q \), cfs
   (2) Channel bottom width \( b \), ft (zero if triangular section)
   (3) Channel side slope \( Z \) expressed as the cotangent (zero if rectangular section)
   (4) Flow depth \( y \), ft

b. The computational steps are:

   (1) Area \( A \), ft\(^2\)

   \[
   A = (b + yZ)y
   \]

   (2) Specific Energy \( E \), ft of water

   \[
   E = y + \frac{Q^2}{2gA^2}
   \]

   where \( g \) is acceleration of gravity (32.2 ft/sec\(^2\)).
(3) Moment \( (A\vec{y}) \), \( \text{ft}^3 \), of area with respect to the surface
\[
A\vec{y} = \frac{y^2b}{2} + \frac{y^3z}{3}
\]

(4) Specific force \( (F) \), \( \text{ft}^3 \) of water
\[
F = A\vec{y} + \frac{q^2}{gA}
\]

c. The given data and specific energy and specific force are printed.

6. **ACCURACY**: Governed by accuracy of input data. The specific energy and the specific force are printed to \( \pm 0.01 \) ft and \( \text{ft}^3 \).

7. **REMARKS**: Velocity distribution is uniform across flow section and the invert slope is small (i.e., <10 degrees).
PART II: COMPUTER FUNCTIONAL DESCRIPTION

1. REVISION LOG: N/A

2. FUNCTIONAL FLOW CHART:

START

READ inputs: bottom width, side slope, discharge, number of flow depths, and flow depths

PRINT: type of cross-section, bottom width, side slope, and discharge

PRINT: flow depth, specific energy and specific force

F

all flow depths used

T

rerun

STOP

READ: desired inputs

H6124

Calculate area, moment of area with respect to surface, specific energy and specific force

RETURN
3. **EQUIPMENT AND OPERATING SYSTEM:** The program was developed on a G635 time-share system in which input/output equipment consisted of a Model 33 remote teletype. It is now operational on the WES G635, Vicksburg, MS; HIS 66/80, Macon, GA; and Boeing CDC, Seattle, WA.

4. **INPUT REQUIREMENTS:** The required inputs are entered via the user's time-share terminal device in free format. All input cues and reads are performed in the main program. The subroutine handles the computations. Since computations are done in the subroutine, the necessary inputs to subroutine H6124 are passed via the CALL statement. The calling sequence is:

   CALL H6124(arg1,...,arg6)

where:

- arg1 - discharge, cfs
- arg2 - bottom width, ft
- arg3 - side slope, cotangent
- arg4 - flow depth, ft
- arg5 - specific energy, ft of water
- arg6 - specific force, ft$^3$ of water

All values are floating point. Arguments 1-4 are inputs and arguments 5 and 6 are output.

5. **SECONDARY STORAGE INPUT:** None

6. **INPUT DATA DESCRIPTION:** The following names are used for the input variables in program H6124.
DISCH - discharge, cfs
BWID - channel bottom width, ft
SLOPE - channel side slope, cotangent
NDEPTHS - number of flow depths, integer
Y - flow depth, ft

7. OUTPUT DATA DESCRIPTION: The following names are used for the output variables in program H6124:

ENERGY - specific energy, ft of water
FORCE - specific force, ft$^3$ of water

8. PROGRAM ERROR MESSAGES: None

9. VARIABLE DEFINITIONS:

AREA - flow depth area, ft$^2$
AY - moment of area with respect to surface, ft$^3$
BWID - channel bottom width, ft
NDEPTHS - number of flow depths, 0 < NDEPTHS < 25
Y - flow depth, ft; dimensioned max 25
DEPT - flow depth, ft; equal to Y(I) for I = 1, ..., NDEPTHS
DISCH - discharge, cfs
ENERGY - specific energy, ft of water
FORCE - specific force, ft$^3$ of water
G - acceleration of gravity, 32.2 ft/sec$^2$
HPFILE - five character name of program; passed to WESLIB count routine HACCT
JKL - direct return from RERUN to desired input read
KKK - total number of inputs, passed to RERUN

LQX - equal 1, print instructions from RERUN; equal 3, no print

LQZ - equal 1, execute all input cues and reads; equal 2, call WESLIB routine RERUN and enter only desired inputs

SSLOPE - channel side slope, cotangent

TYPE - character; type of cross section, either trap, rect, or tria.

ZZZZZ - character; equal RE, rerun; equal ST, stop

10. **EXAMPLE CASE:** Compute the specific energy and specific force for 6 given flow depths of a rectangular channel cross section.

   a. **Input data:**
   
   Bottom width (0 if tria sect) (BWID) = 3.51 ft
   
   Side slope (0 if rect sect) (SSLOPE) = 0
   
   Discharge (DISCH) = 100 cfs
   
   Number of depths (NDEPTH) = 6
   
   Flow depth(s) (Y(I) for I = 1, NDEPTHS) = 1, 1.43, 2.5, 4, 5.27, 6.5 ft
b. **Output:**

**INPUT H6124 - SPECIFIC ENERGY AND FORCE-TRAP,RECT,TRIA-OPEN CHANNEL**

AA-ENTER CHANNEL BOTTOM WIDTH IN FT (ZERO IF TRIA SECT).
=3.51
AB-ENTER CHANNEL SIDE SLOPE (ZERO IF RECT SECT).
=0
AC-ENTER DISCHARGE IN CFS.
=100
AD-ENTER THE NUMBER OF DEPTH(S) FOR WHICH SPECIFIC FORCE AND ENERGY ARE TO BE CALCULATED. MUST NOT EXCEED 25 DEPTHS.
=6
AE-ENTER THE 6 DEPTH(S) SEPARATED BY COMMAS.
=1,1.43,2.5,4,5.27,6.5

**OUTPUT H6124 - SPECIFIC ENERGY AND FORCE OF A RECT. OPEN CHANNEL**

BOTTOM WIDTH = 3.51 FT.
SIDE SLOPE = 0. H:1V
DISCHARGE = 100.00 CFS.

<table>
<thead>
<tr>
<th>DEPTH (FT)</th>
<th>SPECIFIC ENERGY (FT)</th>
<th>SPECIFIC FORCE (FT×3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>13.60</td>
<td>90.23</td>
</tr>
<tr>
<td>1.43</td>
<td>7.59</td>
<td>65.46</td>
</tr>
<tr>
<td>2.50</td>
<td>4.52</td>
<td>46.36</td>
</tr>
<tr>
<td>4.00</td>
<td>4.79</td>
<td>50.20</td>
</tr>
<tr>
<td>5.27</td>
<td>5.72</td>
<td>65.53</td>
</tr>
<tr>
<td>6.50</td>
<td>6.80</td>
<td>87.76</td>
</tr>
</tbody>
</table>

ENTER RERUN OR STOP
=STOP
H6124

REF: ER 1110-1-10 - ENGINEERING AND DESIGN - Engineering and Computer Program Library Standards and Documentation, Appendix C

PART III: FILE DOCUMENTATION

1. REVISION LOG: N/A

2. TITLE: H6124 - Specific Energy and Specific Force in Either a Trapezoidal, Triangular, or Rectangular Open Channel


4. NUMERICAL AND LOGICAL ANALYSIS: No special numerical techniques used.

5. SUBROUTINES NOT DOCUMENTED IN ABSTRACT: None

6. MISCELLANEOUS: The program is part of the CORPS computer system. CORPS is an acronym standing for Conversationally Oriented Real-Time Program-Generating System. The program is now operational on the WES G635, Vicksburg, MS; HIS 66/80, Macon, GA; and Boeing CDC, Seattle, WA.

The source listing on page 9 contains the first line run command and brief for H6124. This first line run command runs the binary H6124B of the source listing on pages 10-11 (Fortran source of H6124) and attaches the WESLIB routines HACCT and RERUN.
0001##RUN WESLIB/CORPS/H6124B.R;WESLIB/RERUN.R;WESLIB/HACCT.R

0800 63 THIS PROGRAM COMPUTES THE SPECIFIC FORCE AND ENERGY FOR A TRAPEZOIDAL, TRIANGULAR, OR RECTANGULAR CROSS-SECTION. INPUTS REQUIRED ARE BOTTOM WIDTH IN FT (ZERO IF TRIANGULAR), SIDE SLOPE EXPRESSED AS THE COTANGENT OF THE ACUTE ANGLE WITH RESPECT TO THE HORIZONTAL (ZERO IF RECTANGULAR), DISCHARGE IN CFS, THE NUMBER OF DEPTHS FOR WHICH THE SPECIFIC FORCE AND ENERGY ARE TO BE COMPUTED, AND THE DEPTHS. OUTPUT INCLUDES THE GIVEN DATA, TYPE OF CROSS-SECTION, AND A TABLE OF DEPTH(S) AND CORRESPONDING SPECIFIC FORCE AND ENERGY.

0999##FINISH
00001RUN W=:/CORPS/H6124B(NOGO)
10000CHARACTER TYPE=*4,HFILE=5
10010DIMENSION Y(25)
10020HFILE=5HH6124
10030LOX=1;LOZ=1
1004015000CALL HACCT(HFILE)
10050PRINT 1511
100601511FORMAT("INPUT H6124 - SPECIFIC ENERGY AND FORCE-TRAP,RECT,
10070&TRIA-OPEN CHANNEL"

10080GO TO(10,15),LQZ
1009010
10100PRINT 20
1011020FORMAT(48HAA-ENTER
254CHANNEL
298BOTTOM WIDTH IN FT(ZERO IF TRIA
10200&7H SECT).)
10130GO TO(30,15),LQZ
1014030PRINT 35
1015035FORMAT(47HAB-EHTER
254CHANNEL
297SIDE SLOPE(ZERO IF RECT
428SECT).)
1017040READ,BWID
1018045PRINT 50
1019050FORMAT(26HAC-ENTER DISCHARGE IN
325CFS.)
1020055READ,DISCH
1021060PRINT 65
1022065FORMAT(49HAD-ENTER THE NUMBER OF
332DEPTH(S) FOR WHICH SPECIFI
1023022HC FORCE AND ENERGY ARE/33HTO BE CALCULATED. MUST NOT EXCE
1024025HD25 DEPTHS.)
1025070READ,NDEPTHS
1026070FORMAT('NYDEPTHS='-25),75,75.80
1027080PRINT,"NUMBER DEPTHS > 25, RE-ENTER NUMBER < OR = 25"
10290GO TO 70
1030075GO TO(85,15),LQZ
1031085PRINT 90,NDEPTHS
1032090FORMAT("AE-ENTER THE ",I2,"DEPTH(S) SEPARATED BY COMMAS."")
1033095READ,(Y(I),I=I,NDEPTHS)
10340100GO TO(100,15),LQZ
10350105KXX=9
10360106CALL RERUN(KXX,LQY,JKL)
10370107GO TO(25,40,55,70,95,100),JKL
10380110TYPE=4HTRAP
10390115IF(BWID)105,110,115
10400110TYPE=4HTRIA
10410115IF(SSLOPE)115,120,115
10420120TYPE=4HRECT
10430125PRINT 125,TYRE,BWID,SSLOPE,DISCH
10440125FORMAT("OUTPUT H6124 - SPECIFIC ENERGY AND FORCE OF A
1045025HOPEN CHANNEL"/15HBOTTOM WIDTH = ,F9.2,4H FT.
10460/13HSIDE SLOPE = ,F11.2,4H;HV)12HDISCHARGE = ,F12.2,5H CFS.//
104705X,5HDEPT,H,2(4X,8HSPECIFIC)/14X,6HENERGY,6X,5HFORCE/5X,4H(FT),
104808X,4H(FT),6X,7H(FTX3))
10490 DO 140 I=1,NDEPTHS
10500 DEPTH=Y(I)
10510 CALL H6124(DISCH,BWID,SSLOPE,DEPTH,ENERGY,FORCE)
10520 140 PRINT 130,DEPTH,ENERGY,FORCE
10530 130 FORMAT((F9.2,F11.2,F12.2))
10540 PRINT, ""
10550 LOZ=2
10560 CHARACTER ZZZZZZ*2
10570 16000 PRINT, "ENTER RERUN OR STOP"
10580 READ 16001, ZZZZZ
10590 16001 FORMAT(A2)
10600 IF(ZZZZZZ.EQ.2HRE) GO TO 15000
10610 IF(ZZZZZZ.EQ.2HST) GO TO 20000
10620 PRINT, "ERROR *** RETYPE"
10630 GO TO 16000
10640 20000 STOP;END
20000 SUBROUTINE H6124(DISCH,BWID,SSLOPE,DEPTH,ENERGY,FORCE)
20010 G=32.2
20020 AREA=DEPTH*(BWID+SSLOPE*DEPTH)
20030 ENERGY=DEPTH*DISCH**2/(2.*G*AREA**2)
20040 FORCE=BWID*DEPTH**2/2.*SSLOPE*DEPTH**3/3.+DISCH**2/(G*AREA)
20050 RETURN
20060 END