CIVIL ENGINEERS
POCKET COMPUTER MONTHLY

February 1983

GENERAL COMPUTATION PROGRAM

INSTRUCTIONS: PC-1

INPUT

Be sure Lines 100-500 have been fully erased. Enter program in Lines 100-500.

Press "Shift" A. Enter the number of Input Parameters (Note: 12 maximum). Press "Enter."

Enter value of each Input Parameter as it is called for on the display. Press "Enter". (Watch the display carefully; it will call for these values in alphabetical order beginning with "I").

Enter the number of Output Parameters (Note: 8 maximum). Press "Enter"

NOTE:
If user wishes to conserve memory in order that more program lines may be entered, the following procedure may be useful. Lines 501 through 560 may be erased, and an END statement substituted. After the program has run, all parameter values A thru Z may be recovered (on the display) in either DEF or RUN mode, by pressing the desired letter, then "Enter".

OUTPUT

Printer Version:

Results of computation will be printed on paper tape. First the answers (e.g., "A = ...," then "B = ...," etc.)

Then the input parameter values will be printed in a list, beginning with I, so as to permit verification of input.

Non-Printer Version:

The value of "A" will be displayed; press "Enter" to display each subsequent answer, through H.

Then press "Enter" to receive the following instructions:

REDISPLAY ANSWERS?
Press Shift SPC
RERUN?
Press Shift C
INPUT REVIEW?

When reviewing Input, press "Enter" to display each subsequent value.

CIVIL ENGINEERS POCKET COMPUTER MONTHLY

GENERAL COMPUTATION PROGRAM

INSTRUCTIONS: PC-2

1. Be sure Lines 100-1200 have been fully erased; then enter program in Lines 100-1200.

2. Press DEF A. At user option, enter a program title and press "Enter". If no title is desired press "Enter."

3. Enter number of Input Parameters (18 maximum). Press "Enter".

4. At user option, enter a label for each Input Parameter and press "Enter". If no program labels are desired, the program will assign the label "I" to parameter I, and so on; in the latter case, make no entry, just press "Enter."

5. Enter a value for each Input Parameter as it is called for in the display: Press "Enter". If, during a RERUN, "Enter" is pressed without a number having been entered, the computer will assume that the parameter values remain the same and will cease asking for them. Because of this feature, users should arrange the input parameter list so as to reduce repetition of input. For example if, in successive trials, user wishes to alter only one of the several input parameters, assign that one to "I"; then, when carrying out a RERUN, press DEF C, enter the new value for I; press "Enter"; then, when the next value is asked for (? in display), press "Enter" again, thereby avoiding the reentry of succeeding values of J,K, etc.

6. Display will ask for the Number of Output Parameters. Enter the required number (8 max.).

7. User may at his option label output parameters. If no labels are required, press "Enter"; in this case, output will be labelled A, B, ... H.

8. Answers are displayed. Using the "Printer" Version they are printed on paper tape. Using non-printer version, press "Enter" to receive each answer.

9. Non-Printer Version: Press "Enter" for instructions to rerun or redisplay.

REDISPLAY ANSWERS?
Press Shift SPC
RERUN?
Press Shift C
INPUT REVIEW?
Press Enter

When reviewing input, press "Enter" to display each subsequent value.

Note: Using GCP (PC-2) do not use the following parameter labels:

LF$	LF
IF$	IF
LN$	LN
PI$	PI
TO$	TO
IM$	ZZ
PT$	II
DI$	IZ
	YY

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GENERAL COMPUTATION PROGRAM

Our January issue introduced the General Computation Program (GCP). The program is used to solve formulas, which are written into the program by the user. The use of GCP eliminates the need to write a program for input of data and output of computation results; these parts of the program are already written.

Our favorite is the PC-2 printer version, where the input and output is documented, and can be labelled and titled. The other versions (PC-2 without printer; PC-1 with and without printer) are as easy to use; they also permit verification of input and output values, thus minimizing the likelihood of errors.

We believe that if the beginning programmer is provided with GCP, his entry into successful programming is eased, and the chances that he will frequently use the computer, are enhanced.

The examples provided below illustrate the usefulness of GCP. Whether the formulas are trivial or complex, the engineer must:

1) write the equation or equations into the program
2) input the parameter values
3) compute the results

If GCP is "waiting" in your PC's memory, it should take little time to rewrite the equations in BASIC Code using input parameters I-Z. Then GCP is run initially using DEF A, and repeatedly rerun using DEF C. (See attached detailed instructions.) Assuming the engineer has made no error in entry of formulas, the values of output parameters (A-H) will be correct.

This month's software includes:

1) Hazen Williams Formula
2) Wood Foundation Wall
3) Steel Beam-Column

HAZEN WILLIAMS FORMULA - HEAD LOSS IN A PIPE

One of the ways in which civil engineers solve the Hazen-Williams formula (friction head loss for turbulent pressure flow of water at 60° F in a pipe) is by use of the nomograph. With GCP, however, the formulas can easily be typed in and solved repeatedly. In contrast with the nomograph method, varying values of C (Hazen-Williams coefficient of pipe roughness) can be readily accomodated.

$$A = \pi d^2/4$$

$$V = \frac{Q\ 144}{7.48 A\ 60}$$

$$h_f = \frac{10.44\ L}{d^{4.8655}} \left(\frac{Q}{C}\right)^{1.85}$$

L = pipe length, ft.

V = Flow, avg. velocity, fps.

Q = flow in pipe, gpm

A = pipe area, $in.^2$

C = Hazen-Williams pipe coefficient. Some examples are:

Plain steel and cast iron (except corrugated metal pipe)	100
Concrete	100
Vitrified Clay	100
Cement-Asbestos	140
Plastic	130
Corrugated metal pipe	60

d = Pipe inside diameter, inches

h_f = head loss, ft.

The four variables d, C, Q and L, are assigned to I, J, K & L. The program is as follows:

PROGRAM LISTING (PC-1 & PC-2):

```
100  A=π*I∧2/4                    (pipe area)
110  B=K/7.48/A/60*144            (velocity)
120  C=10.44*L/I∧4.8655*
     (K/J)∧1.85                   (head loss)
```

In our listings, we have taken pains to slash all zeros (Ø), so as to distinguish from the letter O. Also note the difference between the letter I, and the numeral 1.

WOOD FOUNDATION WALL

Ref: "All-Weather Wood Foundation System Manual", National Forest Products Association.

Design of a treated wood stud foundation wall with ½" min. treated plywood exterior sheathing with double plate top and bottom (the bottom plate is a "footing plate", often wider than the wall). This is a combined-axial-and-bending stress type of problem. It is a trial-and-error design process—lengthy and time-consuming without the aid of a computer.

Parameter Designations:

Input:

I = d = Stud Depth, in.
J = b = Stud Thickness or lesser dimn., in.
K = s = Stud Spacing, in.
L = F_b = Allowable Bending Stress, psi
M = F_c = Allowable Comp. Stress, parallel to grain, psi
N = F_v = Allowable Shear Stress, psi
O = E = Modulus of Elasticity, psi
P = Vertical Load per foot of wall, lb.
Q = Height of Fill, near side, ft.
R = Height of Fill, far side, ft.
S = Length of Stud, ft.
T = Width of Wood Footing Plate, inches
U = Load Factor, Vertical Load (PC-2)
V = Load Factor, Horizontal Load(PC-2)
W = Length of Wall, ft. (PC-2)

Output:

A = Interaction Number
B = f_v = Shear stress, psi
C = F_c' = Allowable Comp. stress, psi, adjusted for L/d ratio
D = Racking Force, lb.
E = Bending Stress in footing plate, psi.
F = R_b = Bot. Reaction, lb.
G = R_t = Top Reaction, lb.
H = Base Pressure, psi

The program solves for an interaction number, to be less than or equal to unity (1). If greater than unity, program prints the message "Stud Overstress." If the stud is overstressed in shear, the program prints "Stud Overstress: Shear." If the footing plate is wider than the wall and is overstressed in bending, the program prints "Footing Plate Overstress: Bending."

If the base pressure exceeds 3000 psi, the program prints "Overstress: Base Pressure." This latter decision is arbitrary — not controlled by code or spec. Therefore if the engineer/designer desires a larger or smaller value of base pressure than 3000 psf, Line 3ØØ may be changed accordingly.

The program uses an equivalent fluid density (EFD) equal to 30 psf for sand, and 45 psf for clay. Sand or any non-cohesive material would probably be evaluated according to Rankine active earth pressure theory using the parameter Ø (angle of internal friction). EFD = $k\gamma$ where $k = \tan^2(45-\phi/2)$, and γ = in-situ density of the retained granular material (<u>not</u> dry density). The designer may use any values of Ø and γ; the choice of these values will result in a unique EFD value. Our value, 30 pcf, is consistent with a density of about 100 pcf and a Ø angle of about 33°. Substitute your value in place of H=30 in Line 11Ø.

The lateral pressure associated with clay depends strongly on the nature and properties of the clay material, on the manner of placement of the backfill, and on the soil's moisture content. Clay placed as uncompacted chunky backfill can become wet and soft, resulting in very high lateral pressure. The program incorporates an equivalent fluid density of 45 psf for clay. If another value is desired, change Line 11Ø accordingly.

We strongly prefer non-cohesive (sand) backfill for two reasons: 1) clay exhibits higher lateral pressure; 2) clay exhibits poorer drainage.

The parameter Ø (phi) should not be confused with a slashed zero!

PROGRAM LISTING (PC-2):

```
100 INPUT "BACKFILL: (S)AND
    OR (C)LAY";BF$
110 H=30: IF BF$="C" LET H=45
```

In Line 120, the stud length (S) is converted to wall height. We add 3 in; change this, if necessary, to suit the wall geometry of your problem.

```
120 Y=S+3/12
```

Line 130 calculates the upper (G) and lower (F) reactions. The lower reaction must be resisted by the floor slab on grade, the upper reaction by the floor system. Line 140 calculates the maximum moment in the stud.

```
130 G=H*Q∧3/6/Y:F=H*Q∧2/2-G
140 E=G*(Y-Q+2*Q/3*(Q/3/Y)∧.5)
```

Line 150 calculates the "racking force" due to unbalanced soil pressure. Of course, wind forces are additive although momentary. In our experience, proper account of the racking force is vital; failure to do so can result in intolerable sidesway. Rectangular buildings with "walkout" basements are candidates for this kind of problem. The abutting sidewalls, interior walls, and fireplace masonry, can be mobilized to resist the racking force by means of proper attachment to the suspended floor system.

```
150 D=H*W/6/Y*(Q∧3-R∧3)
```

The analysis for axial force requires that the allowable axial stress be calculated. Since the studs are nailed to the plywood (See Table 1-A in the Manual) the critical dimension for buckling is the depth, or larger dimension of the stud.

Line 160 calculates the K parameter.

```
160 A=.671*(O/M)∧.5
```

Line 165 calculates L/d. The NFPA National Design Specification (Para. 3.7.1.3) permits reduction of the effective length (L) of the stud, acting as a column, where "column end conditions provide greater stability than pin-end conditions." We use 85%. You may change .85 to any factor you desire.

```
165 Z=.85*Y*12/I
```

Line 170 calculates the J parameter. Lines 180 and 190 assure that the value of J will lie between zero and one.

```
170 X=(Z-11)/(A-11)
180 IF X>1 LET X=1
190 IF X<0 LET X=0
```

Lines 220, 230 and 240 calculate the allowable compressive stress based on the L/d ratio.

If $L/d <= 11$, $F_c' = F_c$
If $L/d >= K$ the Euler condition applies and

$$F_c' = \frac{.3E}{(l/d)^2}$$

For $11 < L/d < K$

$$F_c' = F_c \left[1 - 1/3 \left(\frac{L/d}{K}\right)^4\right]$$

```
220 IF Z<=11 LET C=M:GOTO 250
230 IF Z>=A LET C=.3*O/Z∧2:
    GOTO 250
240 C=M*(1-(Z/A)∧4/3)
```

Lines 250, 260, and 270 calculate the compressive stress in the stud, then calculate the interaction number, assigning it to A. If A>1 a message is printed.

```
250 B=P/I/J*K/12:A=B/U/C
260 A=A+E*72/I/I/J*K/12/(L-X*B)/V
270 IF A>1 LPRINT"STUD OVER-
    STRESSED"
```

Lines 280 and 290 check for overstress in shear and if the allowable shear value is exceeded, a message is printed.

```
280 B=H*K/72/S*(Q-I/12)∧2*(3*Y-Q-
    I/6)
290 B=1.5*B/I/J/V:IF B>N LPRINT
    "STUD OVERSTRESSED:SHEAR"
```

Line 300 calculates base pressure. If base pressure exceeds 3000 psf, a message is printed.

```
300 H=12*P/T:IF H>3000 LPRINT
    "OVERSTRESS:BASE PRESSURE"
```

Line 310 calculates bending stress in the weak direction of the footing plate. If the footing plate is wider than the wall, bending stress will develop in the "overhangs"; this stress should not exceed one-third of the allowable shear stress. If it does, a message is printed. The program assumes that the footing plate is 1½ inches thick. If the overstress message is printed, thicken the plate, or reduce the extent of overhang by use of a "triple" plate, increasing the width in steps.

This formula is in the classical form: $f = \frac{M}{S}$

where:

$M = \frac{1}{2} wL^2$

L = extent of overhang, inches

w = unit base pressure, psi

$S = 1/6\ bd^2$

where:

b = 1 inch

d = 1½ inches

and, therefore:

$S = 3/8$

$f = M/S$

$f = 4/3\ wL^2$

$w = \frac{P}{12T}$

```
310 E=P*((T-1)/2)^2/T/9: IF E>N/3
    LPRINT "FOOTING PLATE
    OVERST: BENDING"
```

If the calculated stress exceeds one-third the allowable shear, and if you elect to use a thicker footing plate, divide the calculated stress, E, by the square of the thickness and multiply by 1.5^2 or 2.25. If, for example, you will use a 3 inch nominal thickness of footing plate (2.5" actual), this ratio would be $1.5^2/2.5^2$, or .36.

The above listing exceeds the capacity of PC-1. See page 9 for a revised listing which will run in PC-1 using GCP, with or without printer.

DESIGN OF A STEEL BEAM-COLUMN MEMBER FOR COMBINED AXIAL AND BENDING STRESS

Program applicable to rolled members, or welded plate (built-up) "H" or "I" - Shaped sections, designated "W" shapes. (Not valid for hybrid girders). The AISC procedure is, in our view, tedious and excessively time-consuming. It thus lends itself to computer solution.

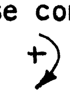
Ref: AISC "Manual of Steel Construction" (8th Edition) 1980. We suggest you have your manual handy.

This is a trial and error design process. Therefore, set up a table of several trial sections, listing I_x, I_y, A, F_y, d, b_f, t_f.

Parameter Designations:

I =	I_x	(Moment of Inertia, x, in.^{4})
J =	I_y	(Moment of Inertia, y, in.^{4})
K =	A	(Cross-Sect. Area, in.^{2})
L =	F_y	(Specified Min. Yield Stress, ksi)
M =	d	(Depth of Member, in.)
N =	b_f	(Flange Width, in.)
O =	t_f	(Flange Thickness, in.)
P =	P	(Applied Axial Load, kips)
Q =	$M_{int,x}$	(Max. Interior Moment-not at ends- in x direction, ft.-k)
R =	$M_{int,y}$	(Max. Interior Moment-not at ends- in y direction, ft.-k)
S =	$M_{T,x}$	(End Moment at upper/left end, x direction, ft.-k)
T =	$M_{T,y}$	(End Moment at upper/left end, y direction, ft.-k)
U =	$M_{B,x}$	(End Moment at lower/right end, x direction, ft.-k)
V =	$M_{B,y}$	(End Moment at lower/right end, y direction, ft.-k)
W =	K_x	(Effective Length Factor, x direction)
X =	K_y	(Effective Length Factor, y direction)
Y =	L_x	(Length, Unbraced, x direction, ft.)
Z =	L_y	(Length, Unbraced, y direction, ft.)

Note: Use consistent sign convention for moments.



PROGRAM LISTING (PC-2 with added memory):

Calculate F_b, x and y directions (Pp. 5-20 and 5-21)

Check for compactness: To determine F_{bx} and F_{by} carry out four tests, as follows:

```
100  VV=1: FB=2*L/3: GB=3/4*L
```

Flanges must be continuously connected to webs.

The depth-thickness ratio of the web shall not exceed values defined in (1.5-4a) and (1.5-4b). Pg. 5-20.

```
110  WT=(K-2*N*O)/(M-O)
120  AX=P/K: IF AX/L<= .16 AND
     M/WT>640/L^.5*(1-3.74*AX/L)
     LET FB=.6*L:GB=FB: GOTO 160
130  IF AX/ L>.16 AND M/WT>
      257/L^.5 LET FB=.6*L:GB=FB:
     GO TO 160
```

The laterally unsupported length of the compression flange shall not exceed the following values: $76b_f / F_y^{0.5}$ nor $20000\ A_f / (d\ F_y)$ where: A_f =Area of Flange (We assume that the unbraced length in the y direction, represents the laterally unsupported length of the compression flange.)

```
140  IF  12*Z> 76*N/ L^.5  LET  FB=.6*L:
     GB=FB: GOTO 160
150  IF   12*Z > 20000*N*O/ M/ L   LET
     FB=.6*L:GB=FB
```

The width-thickness ratio of unstiffened projecting elements of the compression flange shall not exceed $65/F_y^{0.5}$

```
160  IF N/2/O> 95/L^.5 LET FB=.6*L:
     GB=FB:GOTO 210
170  IF N/2/O<=65/L^.5 GOTO 300
180  FB=.6*L:GB=FB
190  IF L<=65 LET FB=L*(.79-.002*
     N/2/O*L^.5):GB=L*(1.075-.005*N/
     2/O*L^.5)
200  GOTO 300
```

Calculate Q_s (See Pg. 5-94, C2-3 and C2-4)

```
210  IF N/2/O>176/L^.5  LET VV=20000/
     (L*(N/2/O)^2): GOTO 230
220  VV=1.415 - .00437*N/2/O*L^.5
230  IF VV>1 LET VV=1
```

Calculate two values of KL/r, select larger value, and determine whether KL/r> 200. If so, print message and stop program.

```
300  AE=W*Y*12/(I/K)^.5:BE=X*Z*12/
     (J/K)^.5
310  CE=AE:IF BE>CE LET CE=BE
320  IF CE>200 LPRINT "KL/R>
      200: INVALID":END
330  IF FB<(2*L/3) OR GB<(3*L/4)
     LPRINT "SECT NOT COMPACT":
     LPRINT
```

Calculate C_c and Allowable Axial Stress, F_a

```
400  EE = (58E3*π^2/ (VV*L))^.5:
     IF CE>EE LET FA= 12*π^2
      *29 E3/23/CE^2: GOTO 430
410  FA=(1-CE^2/EE^2/2)*L
420  FA=FA/(5/3+3/8*CE/EE-CE^3
      /8/EE^ 3)
```

Calculate Euler Stress in X(GA) and Y(HA) directions. (Modify for wind loading if applicable).

```
430  GA=π^2*29E3/AE^2*12/23
440  HA=π^2*29E3/BE^2*12/23
450  INPUT "WIND LOAD INVOLVED?
     (Y/N)"; AA$:IF AA$="Y" LET
     GA=4/3*GA:HA=4/3*HA
```

Calculate C_m (Coefficient used in interaction formula) in x and y directions.

```
490  Y1=S:Z1=U:IF ABS S<ABS U
     LET Y1=U:Z1=S
500  IF W>1 LET CM=.85:GOTO 535
510  IF ABS Q<ABS Y1 LET CM=
     .6-.4*Z1/Y1:GOTO 535
520  IF S<>0 AND U<>0 LET CM=
     .85:GOTO 535
530  CM=1
```

```
540 YZ=T:ZY=V: IF ABS T< ABS V
    LET YZ=V:ZY=T
550 IF X> 1 LET CN=.85:GOTO 590
560 IF ABS R< ABS YZ LET CN=
    .6-.4*ZY/YZ:GOTO 590
570 IF T<>0 AND V<>0 LET  CN=.85:
    GOTO 590
580 CN=1
590 IF CN<.4 LET CN= .4
```

Calculate f_{bx}

```
600 IF ABS Q>ABS Y1 LET BX=12*Q/I*
    M/2:GOTO 620
610 BX=12*Y1/I *M/2: IF BX> FB
    LPRINT "OVERSTRESS:BENDING:
    X DIRECTION"
```

Calculate f_{by}

```
620 IF ABS R>ABS YZ LET BY=12*R
    /J*M/2: GOTO 700
630 BY=12*YZ/J*M/2:IF BY>GB
    LPRINT "OVERSTRESS:BENDING,
    Y DIRECTION"
```

Calculate C_x (f_a/F_y)

```
700 CX = P/K/FA:IF P/K/VV >
    FA LPRINT "OVERSTRESS:AXIAL"
```

Calculate Interaction Number

```
710 IB =VV:IF AA$="Y" LET IB=VV*4/3
715 IF CX<.15 LPRINT "AXIAL
    STRESS RATIO<.15"
720 IF CX<.15 LET IA=CX+BX/FB+BY/
    GB: IF IA>IB LPRINT "OVER-
    STRESS:INTERACTION (<.15)":GOTO
    760
730 IA=CX+CM*BX/FB/(1-P/K/GA)
    +CN*BY/GB/(1-P/K/HA): JA=IA
735 IF IA>IB LPRINT "OVERSTRESS:
    INTER"
740 IA=P/K/.6/L + BX/FB + BY/GB:IF
    IA>IB LPRINT "OVERSTRESS:
    INTERACTION"
750 KA=JA:IF IA>KA LET KA=IA:
    LPRINT "2ND FORMULA CRITI-
    CAL":GOTO 760
755 LPRINT "FIRST FORMULA
    CRITICAL"
760 A=KA:B=IB:C=P/K/VV:D=FA:E=BX:
    F=FB:G=BY:H=GB
```

Output:

A = Interaction Number
B = Maximum Allowable Interaction Number
C = Axial Stress, ksi
D = Allowable Axial, ksi
E = Bending Stress x, ksi
F = Allowable Bending x, ksi
G = Bending Stress, y, ksi
H = Allowable Bending, y, ksi

Note: The allowable axial stress (D) is the stress computed within the program, based on either the CRC formula (where $kL/r \leq C_c$), or the Euler formula (where $kL/r > C_c$). The CRC formula is modified by a variable safety factor (5/3 to 23/12), whereas the safety factor for the Euler formula is a constant, 23/12. C_c is the kL/r value at $F_y/2$.

CASSETTES

We offer Cassette tapes with documentation at $20 each for:

1) Statistics-Confidence Program,PC-1 or PC-2
2) GCP with or without Printer,PC-1 or PC-2
3) Wood Foundation Wall, PC-1 or PC-2
4) Steel Column, PC-1 or PC-2
5) Steel Beam-Column, PC-2
6) Accounts Receivable, PC-2-This program prints detailed invoices, including aging. Prepares summary of business during the time period. Suitable for up to five hourly categories of charge rates.

Note: Civil Engineers Pocket Computer Monthly supports Radio Shack's PC-1 and PC-2 (Sharp PC 1211 and PC 1500) We believe our software will be helpful to civil engineers who have other equipment.

The software provided in this issue is solely for educational and experimental purposes. It is supplied "as-is" without warranty of any kind. We do not assume any liability for any direct, indirect, incidental or consequential damages relating to the use or application of the programs or information contained herein.

CIVIL ENGINEERS POCKET COMPUTER MONTHLY

PROGRAMMERS TIP

GRAPHICS

The PC-2 printer-plotter operates using an X-Y or "Cartesian" coordinate system which obviously is designed for a much larger format than the 2¼" (5.7 cm) width of adding machine tape. The PC-2 (PC-1500) will no doubt drive a larger plotter. No doubt this has already been done.

In the "unrotated" mode, the X direction is limited to a width of 215, whereas the range for which the plotter is theoretically capable, is from -2047 to +2047. The plotter will plot in the "minus Y" direction (feeding tape <u>out</u>) to the full extent, -2047, just over 16" (41 cm). However, it will plot in the "plus Y" direction (rewinding tape back into the roll) only about 500 (4" or 20 cm.).

In the GRAPH mode, the program must use SORGN to reset the origin. The following commands use either LINE, which requires SORGN, or RLINE, which does not.

To illustrate:

The program:

```
10 GRAPH: LINE (Ø,Ø)-(2Ø,2Ø)
```

will draw a diagonal line up to the right from X=Ø, Y=Ø to X=2Ø, Y=2Ø. The initial (Ø,Ø) may be omitted without any consequences. Thus:

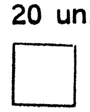
```
1Ø GRAPH:LINE-(2Ø,2Ø)
```

will draw the same line.

The program:

```
1Ø GRAPH:LINE-(2Ø,Ø)-(2Ø,2Ø)-(Ø,2Ø)-
    (Ø,Ø)
```

will draw a square, 20 units on a side.



Draw the same square, offset 100 units in the X direction; use the SORGN command as follows:

```
1Ø GRAPH:LINE -(1ØØ,Ø),9:SORGN
2Ø LINE -(2Ø,Ø)-(2Ø,2Ø)-(Ø,2Ø)-(Ø,Ø),Ø
```

Note that the use of ",9" will move the pen to the specified X and Y coordinates (1ØØ,Ø) without drawing a line.

Because ",9" moved the pen in the "up" position; the use of ",Ø" is required to restore the pen to the "draw" mode. (The use of ",1" through ",8" will cause dashes of varying lengths to be drawn.)

The LINE command is indispensible for any plot work which requires an origin, such as the plotting of a curve. See below.

We can draw the same square using the RLINE command. RLINE does not reference itself to the origin; rather, it relates only to the current position of the pen at the end of <u>each</u> straight line.

```
1Ø GRAPH:RLINE-(2Ø,Ø)-(Ø,2Ø)-
    (-2Ø,Ø)-(Ø,-2Ø)
```

will draw the square.

In order to offset the square 100 units to the right

```
1Ø GRAPH:RLINE-(1ØØ,Ø),9
2Ø RLINE -(2Ø,Ø)-(Ø,2Ø)-(-2Ø,Ø)- (Ø,-2Ø),Ø
```

We find use of RLINE to be convenient, for example, in drawing arrows.

```
10 GRAPH:RLINE - (1ØØ,Ø)-(Ø,-1Ø)-
    (1Ø,1Ø)-(-1Ø,1Ø)-(Ø,-1Ø)
```

will draw this arrow:

The general form of the statement using either LINE or RLINE, is as follows:

```
LINE (Ø,Ø)-(85,85),Ø,1,B
```

The first digit after the parentheses (zero in this case) denotes the line: solid, dashed, or "pen-up". The second digit (1 in this case) denotes the color: Ø denotes black; 1 denotes blue; 2 denotes green; 3 denotes red.

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The use of B will cause a square to be drawn, as follows:

```
1Ø GRAPH:LINE (Ø,Ø)-(2Ø,2Ø),Ø,Ø,B
```

where (Ø,Ø)-(2Ø,2Ø) are points on diagonally opposite corners of the square. As before, the initial (Ø,Ø) can be omitted; it is implied. This feature is very useful; for example, a small box can be plotted using a subroutine with RLINE, to plot data points on a graphical representation of data. Assuming that the pen is at the location of the data point, a command such as GOSUB 5ØØØ would draw a small black square (5 on a side). Subroutine 5ØØØ would read:

```
5ØØØ RLINE-(5,5),Ø,Ø,B:RETURN
```

A subroutine may be similarly used to plot, a triangle in lieu of a square, at a data point.

The plotting of curves requires that very short lines be drawn in succession. Each point is calculated according to the equation of the curve being plotted.

Example: Plot $Y=\frac{X^2}{225}$ from X=zero to 225.

X equals either A2 (latter point), or A1 (former point). Line 1Ø initializes X and Y.

```
1Ø A1=Ø:B1=Ø:GRAPH
```

Line 15 draws the abcissa and the ordinate.

```
15 RLINE-(2ØØ,Ø)-(-2ØØ,Ø)-(Ø,25Ø)-
   (Ø,-25Ø)
```

In Line 2Ø the chosen increment for X is 15. User may specify any increment desired.

```
2Ø A2=A1+15
```

Line 3Ø limits X to 225 maximum.

```
3Ø IF A2>225 THEN 99
```

Line 4Ø uses the above formula to calculate each new value of Y (B2), based on the new value of X (A2).

```
4Ø B2=A2∧2/225
```

Line 5Ø draws a short straight line (It is actually drawing the curve in short segments.)

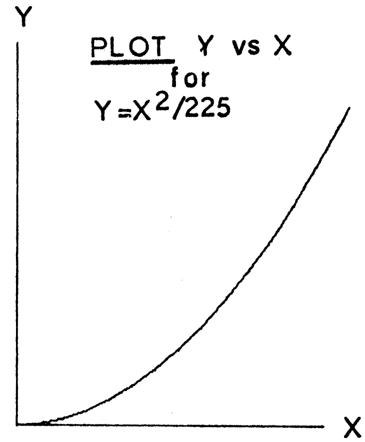
```
5Ø LINE (A1,B1)-(A2,B2)
```

Line 60 reassigns values of X and Y.

```
6Ø A1=A2:B1=B2
```

Line 7Ø loops back to Line 2Ø where X is incremented.

```
7Ø GOTO 2Ø
99 TEXT:LF 15:END
```



As PC-1 users are no doubt painfully aware, the PC-1 has a very limited memory capacity. If in using GCP you wish to conserve memory you may omit lines 5Ø1 through 54Ø and replace with 5Ø1:END. Then, to receive the value of A, press A then "Enter" while in the RUN mode, and so on. Your input data may also be reviewed (parameters I-T). This tip will be useful anytime you encounter a "tight fit" in programming your PC-1.

Of course, GCP in PC-2 may be modified similarly; in this case the lines after 12ØØ would be replaced by 12Ø1 END.

ERRATA

January Issue, Page 4, Line 300 should read:

```
300 IF U$<>"P" THEN 380
```

Page 7 and 10 PC-1 listing for GCP Line 20 I-Z" should read I-T"

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GCP LISTING (PC-1)

WOOD FOUNDATION WALL

```
100:U=1.15:V=.9:
    INPUT "BACKF
    ILL:S OR C?"
    ;X$:H=30:IF
    X$="C"LET H=
    45
120:Y=S+3/12:G=H
    QQQ/6/Y:F=HQ
    Q/2-G:E=G*(Y
    -Q+2*Q/3*(Q/
    3/Y)^.5):D=H
    /6/Y*(QQQ-RR
    R)
150:A=.671*(O/M)
    ^.5:Z=.85Y*1
    2/I:X=(Z-11)
    /(A-11):IF X
    >1LET X=1
190:IF X<OLET X=
    0
220:C=M*(1-(Z/A)
    ^4/3):IF Z<=
    11LET C=M:
    GOTO 250
230:IF Z>=ALET C
    =.3*O/ZZ
250:B=PK/I/J/12:
    A=B/U/C+72E/
    I/I/J*K/12/(
    L-XB)/V:B=HK
    /72/S*(Q-I/1
    2)^2*(3Y-Q-I
    /6)
310:B=1.5B/I/J/V
    :H=12P/T:E=P
    *((T-I)/2)^2
    /T/9:IF A<1
    IF B<NIF H<3
    000IF E<N/3
    PRINT "DES.O
    K!"
```

The input includes 12 parameters, I through T. The input parameters U, V, and W are thus omitted in this PC-1 version (See PC-2 parameter list on page 2). Line 100 defines U and V as 1.15 and 0.9, representing the Load Factors for vertical and horizontal loading, respectively. The parameter W in the PC-2 version denotes the length of the wall being designed; it is used in the calculation for Racking Force. In this PC-1 version, however, the value of Racking Force (Output Parameter D) is given in "pounds per foot of wall". Obviously, then, the designer must multiply this value by the length of wall in order to obtain the total Racking Force.

Line 310 tests for interaction number, shear, base pressure, and, bending stress in the footing plate. If the four "tests" are passed, program prints "Des. OK!" See the discussion on pages 3 and 4.

This PC-1 version of the Wood Foundation Wall Program was used to design the following wall:

```
DES.OK!
  GEN COM PGM
    RESULTS
A=
 9.545865295E-01
B=
      89.70486299
C=
      1146.222289
D=
          214.375
E=
      8.888888889
F=
          520.625
G=
          214.375
H=
             960.

              5.5
              1.5
              12.
            1500.
            1200.
              95.
         1600000.
             600.
               7.
               0.
             7.75
              7.5
```

The height of the wall is 8' (7'9" stud length plus 3").

The depth of retained material above the basement floor is 7'.

2x6 treated studs at 12" centers were used of #2SP (KD).

The vertical load from the superstructure is 600 lb. per ft.

The interaction number, 0.95, is less than 1, therefore is approved.

The basement is of the "walkout" type; the wall opposite to the wall being designed, retains no earth; the racking force was therefore based on zero retained height in the "far" wall. The racking force is 214.4 lb. per foot of wall. Thus for a wall of 85 ft. length, for example, the design must make provision for not less than 85 x 214.4= 18224lb. racking force.

The vertical stress at base of wall was only 960 psf, much less than the maximum, 3000 psf.

The bending stress in the "overhangs" of the footing plate was only 8.9 psi, much less than the maximum 95/3=31.7 psi.

The printout of the PC-2 version of the same design follows:

```
*WOOD FNDN WALL*
**   **   **   **

STUD DEPTH, IN =
              5.5
STUD WIDTH, IN =
              1.5
STUD SPCING, IN =
               12
ALLOW BENDING, PS =

             1500
ALLOW COMP, PSI =
             1200
ALLOW SHEAR, PSI =
               95
E, PSI =
          1600000
VERT LOAD/FT, LB =
              600
FILL HT, FT =
                7
FILL HT, FAR SIDE =

                0
STUD LGTH, FT =
             7.75
WIDTH, FTG PLATE =
              7.5
LD FACTOR, VERT =
             1.15
LD FACTOR, HOR =
              0.9
LGTH WALL, FT =
               85

COMP. RESULTS:

INTER.NO. =
   9.545865295E-01
SHEAR STRESS, PSI =

       89.70486299
ALLOW COMP, PSI =
       1146.222289
RACKING FORCE, LB =

         18221.875
BNDG:FTG PLT, PSI =

       8.888888889
BOT REACT, LB =
           520.625
TOP REACT, LB =
           214.375
BASE PRESS, PSF =
               960
```

NEWS

Radio Shack has released their new PC-4 selling for about $70. The RAM is only 544 steps, expandable to 1568. The variable memory is 26, expandable to 222. We've seen it: it's size is 6 1/2" x 2 3/4" x 3/8", about the same as PC-1. Its optional printer uses electro-thermal paper. With the computer connected to the optional cassette interface and the printer, the total dimensions of the system are only 6 3/4" x 7" x 1 7/16". Based on our observation, the PC-4 is much faster than PC-1; however, we are disappointed in the small size of the memory — even expanded. The version of BASIC in PC-4 is not exactly the same as either PC-1 or PC-2, although similar. For example, a MODE statement is unique to PC-4.

Sharp Electronic Corp. is marketing their PC-1250, which can be bought in the range of $95 to $110. It measures 5 5/16" x 2 3/4" x 3/8". With an 8-bit CPU microprocessor, it is fast. Memory is 2.2K (0.3K more than PC-1). This unit with expanded BASIC is an upgrade of PC-1. However, we are disappointed in the memory size.

Nonetheless PC-4 and PC-1250 are reasonable "starter" computers for students, and for anyone wishing to learn BASIC programming at the beginner's level. The keyboard is a significant improvement over PC-1. The added speed will be appreciated, and its version of BASIC is more powerful. PC-1 will, we believe, soon be removed from the market — it is obsolete after only about two years!

Other new hand-held equipment now appearing includes the Texas Instrument CC-40, the Epson HX-20, the Commodore HHC-4, and the Hewlett Packard HP-75C. It appears that manufacturers agree that there is a great future for portable computing equipment. Indeed the PC market in Japan is reported to be more active than in the US, with NEC and Toshiba producing their own advanced versions.

EXAMPLE PROBLEM

BEAM-COLUMN (PC-2)

```
*STEEL BEAM-COL*
**   **   **   **

MOM INERT,X,IN4 =
             1380
MOM INERT,Y,IN4 =
              495
AREA,IN2 =
             35.3
FY,KSI =
               36
DEPTH,IN =
            14.48
FLG WIDTH,IN =
            14.67
FLG THICKNESS    =

             0.94
AXIAL LOAD,K =
              200
INT MOM,X,FT-K =
              100
INT MOM,Y,FT-K =
                0
TOP MOM,X,FT-K =
              200
TOP MOM,Y,FT-K =
                0
BOT MOM,X,FT-K =
             -200
BOT MOM,Y,FT-K =
                0
KX =
                1
KY =
                1
COL LGTH,X,FT =
               20
COL LGTH,Y,FT =
               20
SECT NOT COMPACT

FIRST FORMULA
CRITICAL

COMP. RESULTS:

INTERACTION # =
       0.95013275
MAX INTERAC # =
                1
AXIAL STR,KSI =
       5.66572238
ALLOW AX STR,KSI =

      17.03024579
BNDG,X,KSI   =
      12.59130435
ALLOW BNDG,X =
             21.6
BNDG,Y,KSI =
                0
ALLOW BNDG =
             21.6
```

In the above example, a W14 x 120 is proposed for a 20 ft. beam-column, carrying 200k axial load and 200 ft-k end moment, strong way, top and bottom. No additional bracing. Top end-moment: positive or clockwise. Bottom end-moment: negative or counter-clockwise — an important consideration.

K_X and K_Y values are taken as 1, that is, the frame is braced; the column's effective length in both directions is taken to be the same as the true length. The interior moment, being less than either of the end moments, is not critical.

The column is successful: 0.95 is less than the maximum, 1.

In this example, no moment was imposed in the Y direction. Also, no wind loading was involved. The program will, however, account for the wind case, and for moments top, bottom, and intermediate, in both X and Y directions.