CIVIL ENGINEERS
POCKET COMPUTER MONTHLY

In this issue we will examine

1) trusses
2) wood members in combined axial and bending stress

Using the programs provided herein, and in previous issues, we will design 1) a wood truss, and 2) wood columns, beams and joists, in a pole building.

TRUSSES

In designing a truss, the truss configuration must be selected, that is, the pattern of truss members.

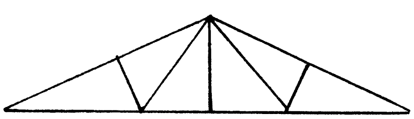
Commonly used truss patterns bear names such as Fink, Howe, Kingpost, Warren, Belgian, and Pratt.

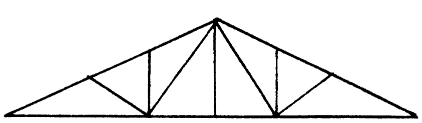
Their configurations are:

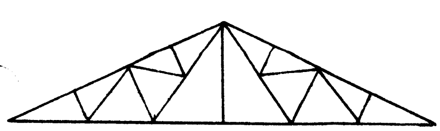
Triangular ("Pitched")

Parallel Chord ("Flat")

Fink





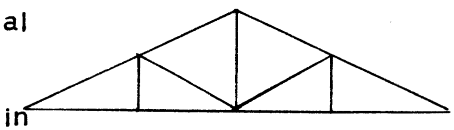


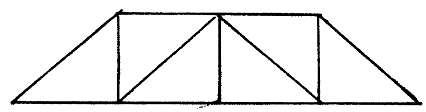
Fink configuration is not applicable to parallel chord trusses.

Triangular ("Pitched")

Parallel Chord ("Flat")

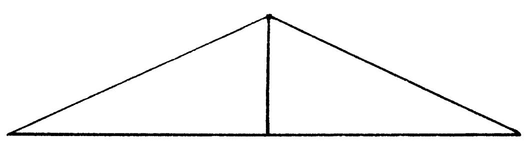
Howe





In the Howe truss the vertical web members are in tension under ordinary loading conditions; diagonal members are in compression. The tension members are thus shorter than the compression members. This is disadvantageous because compression members should ideally be as short as possible.

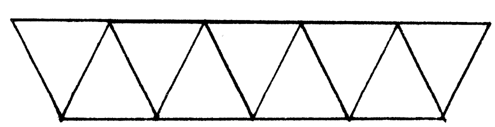
Kingpost



Kingpost configuration is not applicable to parallel chord trusses.

Warren

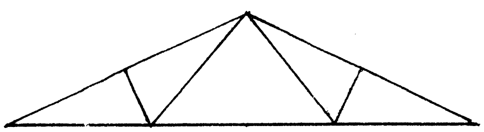
Warren configuration is not applicable to triangular trusses.



In Warren trusses, chord members are generally of equal length; also web members are of equal length. For ordinary loading conditions the web members are in alternate compression-tension-compression-tension, etc. Note that the Warren truss pattern is commonly used in design of steel bar joists.

Triangular ("Pitched") | Parallel Chord ("Flat")

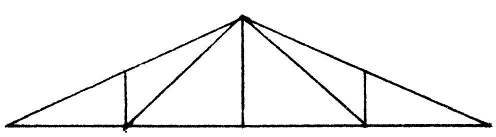
Belgian

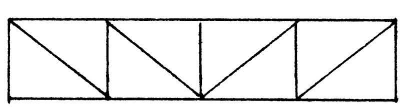


Belgian configuration is not applicable to parallel chord trusses.

In the Belgian truss, all compression web members are perpendicular to the top chord. Note that all compression web members are shorter than the tension members, and all web members extend from top to bottom chord.

Pratt





Under ordinary loading conditions the compression members in the Pratt truss are vertical and are shorter than the tension members, which overcomes the disadvantage inherent in the Howe Truss. The Pratt pattern is commonly used in parallel chord trusses of wood construction.

PROGRAM - PRATT TRUSS

```
2Ø "A" LPRINT "**PRATT TRUSS**":
   LPRINT
25 LPRINT "  BY H.C. HALL, PE":
   LPRINT
3Ø CLEAR:DIM C(15), X(2Ø), Y(2Ø),
   T(16Ø), GAM (2Ø), W(32)
45 TEXT:LPRINT:DEGREE:WAIT 2ØØ
```

An optional set of instructions is provided.

```
47 A$="N":BEEP 4: INPUT "DO U WANT
   INSTRUCTS? (Y/N)"; A$
48 IF A$="N" THEN 83
49 LPRINT " PGM SOLVES PRATT
   TRUSS:MEMBER GEOM/LGTH/FORCES;
   DRAWS FB DIAG TO SCALE"
5Ø LPRINT : LPRINT "X AXIS: BOT
   CHORD":LPRINT "Y AXIS: LEFT
   REACT":LPRINT
55 LPRINT "TOP & BOT CHORD NEED
   NOT BE PARALLEL": LPRINT
6Ø LPRINT "INPUT TRUSS DIMNS BUT
   BE CONSISTENT"
65 LPRINT "FOR EXAMPLE, INPUT
   FEET OR INCHES"
7Ø LPRINT"NOT BOTH": LPRINT
73 LPRINT "DESIGNATE":LPRINT "NO.
   OF PANELS":LPRINT "COUNTING
   FROM LEFT WHICH ARE TO HAVE"
76 LPRINT "UP-LEFT, DOWN-RIGHT
   WEB MEMBERS"
83 PRINT USING; "NO. OF PANLS WITH
   UP-LEFT"
84 PRINT "WEB DIAGS (FROM LEFT)"
```

Program requires user to input truss geometry/dimensions.

```
85 INPUT "NO. OF UP-LEFT PANLS=";
   J: LPRINT J:JP = J:LPRINT
86 JJ=2*J+1
87 IF J<1 LPRINT "ERROR-NEED AT
   LEAST ONE UP-LEFT PANEL": GO
   TO 85
88: INPUT "SPAN=";S:S=INT (1ØØØ *S
   +.5)/1ØØØ:LPRINT USING "######.##";
   S:LPRINT
9Ø INPUT "DEPTH, LEFT END=";A:
   LPRINT A
1ØØ INPUT "DEPTH, RIGHT END=";B:
   LPRINT B:LPRINT
```

```
115  INPUT "NO. OF PANELS=";M:
     USING:LPRINT M:M=M-1:LPRINT
117  IF J>M LPRINT "ERROR:TOO
     MANY UP-LEFT PANLS":GOTO
     85
12Ø  X(1)=Ø:USING
13Ø  BEEP 4:PRINT "INPUT PANEL
     WIDTHS":PRINT "PANELS 1 THRU
     ";M
135  FOR I=1 TOM:N=I+1:INPUT C(I):
     X(N)=X(I)+C(I):NEXT I
14Ø  FOR I=1 TOM:LPRINT USING
     "######.##"; C(I):NEXT I
142  KK=S-X(N):KK=INT (1ØØ*KK+.5)/1ØØ
143  LPRINT KK:LPRINT "------
     ------------":LPRINT"
                   ";S
145  N=M+1:LF 2
```

The angle of the top chord with the horizontal is computed as variable "PHI". Although PC-2 accomodates three letter variables, the variable is actually assigned to "PH".

```
155  PHI=ATN ((B-A)/S): PHI=INT
     (PHI*1ØØ+.5)/1ØØ
16Ø  FOR I=1 TO N
```

Program calculates lengths of vertical web members.

```
17Ø  Y(I)=A+X(I)*(B-A)/S:Y(I)=INT (1ØØ*
     Y(I)+.5)/1ØØ
18Ø  NEXT I
185  X(M+2)=S:Y(M+2)=B
186  LPRINT "ANGLE OF TOP CHORD
     W/HORZ= ";PHI:LPRINT"
       DEG"
```

Program prints out truss dimensions at user option.

```
187  B$="N":BEEP 4:INPUT "DOCUMENT
     DIMNS? (Y/N)";B$
19Ø  IF B$="N" THEN 2Ø2
192  LPRINT "SPAN=    ";S:LPRINT:
     LPRINT "TRUSS DEPTH AT LEFT
     END=";A:LPRINT
193  LPRINT "TRUSS DEPTH AT RIGHT
     END=":LPRINT B
198  LF 4:LPRINT "**PANEL DIMNS**":
     LPRINT
```

Program calculates member dimensions in subroutine 5000.

```
2Ø2  FOR I=1 TO J:U=Y(I):V=(X(I+1)-
     X(I)):GOSUB 5ØØØ
2Ø3  NEXT I
2Ø5  FOR I=(J+1) TO (M+1):U=Y(I+1):
     V=(X(I+1)-X(I)):GOSUB 5ØØØ
2Ø6  NEXT I
```

Lines 208 and 209 define the scaling factor, D, such that when the free body diagram is drawn, the average truss depth will not exceed 45 units, and the truss length will not exceed 400 units; this will permit the truss to be drawn correctly to a scale which is compatible with the PC-2's printer-plotter.

```
2Ø8  D=9Ø/(B+A):S=D*S:IF  S > 4ØØ  LET
     D=4ØØ/S*D:S=4ØØ
2Ø9  A=D*A:B=D*B:LF 8
21Ø  GRAPH:GLCURSOR (8Ø,Ø):SORGN
```

Printer-plotter draws free body diagram of truss.

```
215  COLOR 1
22Ø  LINE -(Ø,-S)-(B,-S)-(A,Ø)-(Ø,Ø)
23Ø  FOR I=1 TO M+1
235  F=D*X(I):G=D*Y(I)
24Ø  LINE (Ø,-F)-(G,-F)
25Ø  NEXT I
26Ø  FOR I=1 TO J
27Ø  F=D*X(I):G=D*Y(I):H=D*X(I+1)
28Ø  LINE (Ø,-H)-(G,-F)
29Ø  NEXT I
295  X(M+2)=S/D:Y(M+2)=B/D
3ØØ  K=M+2:P=J+2
31Ø  FOR I=K TO P STEP -1
32Ø  F=D*X(I):G=D*Y(I):H=D*X(I-1)
33Ø  LINE (G,-F)-(Ø,-H)
34Ø  NEXT I
```

In lines 350 and 355 the reaction arrows are drawn.

```
35Ø  GLCURSOR (Ø,Ø):GOSUB 2ØØØ
355  GLCURSOR (Ø,-S):GOSUB 2ØØØ
```

Lines 360-380 draw load arrows for bottom chord.

```
360  FOR I=2 TO M+1
370  F=D*X(I):GLCURSOR (Ø,-F): GOSUB
     3ØØØ
380  NEXT I
```

Lines 39Ø-43Ø draw load arrows for top chord.

```
390  FOR I=2 TO M+1
400  F=D*X(I):G=D*Y(I)
410  GLCURSOR (G,-F)
420  GOSUB 4ØØØ
430  NEXT I
435  GLCURSOR (-5Ø,Ø):SORGN
```

Lines 440 prints title.

```
44Ø  COLOR 2:ROTATE 1:LPRINT "FREE
     BODY DIAG-PRATT TRUSS"
45Ø  G=50+1.5*A:GLCURSOR (G,1ØØ):
     SORGN:COLOR Ø
```

Lines 460-500 identify panel numbers.

```
46Ø  ROTATE 1:LPRINT "PANEL #":
     GLCURSOR (Ø,-7Ø):SORGN
48Ø  FOR I=1 TO (M+1)
49Ø  F=(X(I+1)-X(I))/3+X(I):F=D*F:
     GLCURSOR (Ø,-F):USING
5ØØ  ROTATE 1:CSIZE 3:LPRINT I:NEXT I
```

Lines 510-523 identify left and right reactions, and the span.

```
51Ø  G=G-15:GLCURSOR (-G,-1Ø):
     SORGN:ROTATE 1:CSIZE 2:LPRINT
     "RL":F=S+25
52Ø  GLCURSOR (Ø,-F):SORGN: ROTATE
     1:LPRINT "RR"
523  GLCURSOR (15,(Ø.7*F)):SORGN:
     ROTATE 1:LPRINT "SPAN="; INT
     (S/D*1ØØØ)/1ØØØ
525  ROTATE Ø:TEXT:LF 15
```

Program requires user to input truss loads.

```
53Ø  LPRINT:LPRINT "INPUT TOTAL
     LOADS:":LPRINT "TOP, THEN
     BOTTOM":LPRINT "LEFT TO RIGHT,
     ON"
54Ø LPRINT "INTERIOR PANEL POINTS"
545 O=2:N=Ø
55Ø FOR I=2 TO (2*M) STEP 2: O=O+2:
    N=N+1:V=I+1:USING
555 LPRINT:LPRINT "PANEL PT "; (N+1):
    USING "######.##"
56Ø LPRINT "TOP LOAD=":INPUT W(V):
    LPRINT W(V):LPRINT "BOT LOAD=":
    INPUT W(O):LPRINT W(O)
565 Q=Q+X(N+1)*W (V)+W(O)*X(N+1):
    R=R+W(V)+W(O)
57Ø NEXT I
```

Program calculates and prints left and right reactions.

```
571 RR=INT (Q/S*D*1ØØ+.5)/100:RL=INT
    ((R-RR)*1ØØ+.5)/1ØØ
572 LPRINT:LPRINT:LPRINT
    "**REACTIONS**"
575 LPRINT USING "######.##";" RL=
    ";RL:LPRINT "         RR= ";RR
577 N=Ø:GAM (Ø)=Ø
58Ø J=(J-1)*1Ø+1
587 W(2)=-RL:T(7)=Ø:W(1)=Ø:V=Ø
59Ø T(2)=Ø:T(3)=Ø:LF 7
```

Title "Member Forces" is printed.

```
592 GRAPH:ROTATE 1: COLOR 1:
    GLCURSOR (2ØØ,Ø):LPRINT "MEMBER
    FORCES":GLCURSOR (17Ø,Ø):LPRINT
    "+=COMP; - = TENS":TEXT
595 LF 5
```

Program calculates member forces in each "up-left" panel.

```
6ØØ FOR I=1 TO J STEP 1Ø
61Ø T(I)=W(V+2)
63Ø T(I+3)=T(I+2)*SIN GAM(N)-T(I):
    T(I+3)=INT (1ØØ*T(I+3)+.5)/1ØØ
64Ø T(I+4)=T(I+1)+T(I+2)*COS GAM (N):
    T(I+4)=INT (T(I+4)*1ØØ+.5)/1ØØ
67Ø T(I+11)=T(I+4)
68Ø T(I+7)=W(V+1)
69Ø T(I+5)=T(I+3):N=N+1:V=V+2
7ØØ T(I+9)=(T(I+5)-T(I+7))/(COS GAM (N)*
    TAN PHI+SIN GAM(N))
7Ø5 T(I+8)=T(I+6)+T(I+9)*COS GAM (N)/
    COS PHI
71Ø T(I+9)=INT (T(I+9)*1ØØ+.5)/1ØØ
```

```
715  T(I+8)=INT (T(I+8)*1ØØ+.5)/1ØØ
```

Program draws up-left panels and represents the member forces.

```
72Ø  GOSUB 599Ø
74Ø  T(I+16)=T(I+8):T(I+12)=T(I+9): NEXT
     I
75Ø  K=1Ø*(M+1)+1:T(K+1)=Ø:T(K+2)=Ø:
     T(K+6)=Ø:N=M+1:V=(M+2)*2:W(V)=-RR
76Ø  W(V-1)=Ø:GAM (M+2)=Ø
77Ø  GRAPH:COLOR 1:USING:GLCURSOR
     (8Ø,Ø):SORGN:LINE -(1ØØ,Ø)
775  GLCURSOR (-3Ø,6Ø):ROTATE 1:
     LPRINT "VERT WEB MEM"
78Ø  GLCURSOR (5Ø,6Ø):COLOR 3: USING
     "#####.##":LPRINT W(JJ):TEXT:
     COLOR 1:LF 5
```

Program calculates member force in up-right panels.

```
8ØØ  FOR I=K TO (J+2Ø)STEP -1Ø
81Ø  T(I)=W(V)
83Ø  T(I+3)=T(I+2)* SIN GAM (N+1)-T(I)
835  T(I+3)=INT (T(I+3)*1ØØ+.5)/1ØØ
84Ø  T(I+4)=T(I+1)+T(I+2)*COS GAM (N+1):
     TEXT
85Ø  T(I+4)=INT (T(I+4)*1ØØ+.5)/1ØØ
87Ø  T(I-9)=T(I+4)
88Ø  T(I+7)=W(V-1)
89Ø  T(I+5)=T(I+3):V=V-2
9ØØ  T(I+9)=(T(I+5)-T(I+7))/(COS GAM
     (N) * TAN PHI+SIN GAM (N))
9Ø5  T(I+9)=INT (T(I+9)*1ØØ+.5)/1ØØ
91Ø  T(I+8)=T(I+6)+T(I+9)*COS GAM (N)/
     COS PHI
92Ø  T(I+8)=INT (T(I+8)*1ØØ+.5)/1ØØ
94Ø  T(I-4)=T(I+8):T(I-8)=T(I+9):N=N-1:
     NEXT I
945  N=JP+1
```

Program draws up-right panels and represents member forces.

```
95Ø  FOR I=(J+2Ø) TO KSTEP 1Ø: GOSUB
     61ØØ
96Ø  N=N+1:NEXT I
999  LF 4:COLOR Ø:END
```

Subroutines 2ØØØ, 3ØØØ and 4ØØØ draw arrows.

```
2ØØØ  RLINE (-3Ø,Ø)-(3Ø,Ø)-(-5,5)-(Ø,-1Ø)
      -(5,5):RETURN
3ØØØ  RLINE (-3Ø,Ø)-(5,-5)-(Ø,1Ø)- (-5,-5)
      -(25,Ø):RETURN
4ØØØ  RLINE (3Ø,Ø)-(-3Ø,Ø)-(5,-5)-(Ø,1Ø)
      -(-5,-5):RETURN
```

Subroutine 5ØØØ calculates angle of web member, length of web diagonal, and length of top chord.

```
5ØØØ  GAM(I)=ATN (U/V):Z=√(U∧2+V∧2):
      ZZ=V/COS PHI
5ØØ5  GAM (I)=INT (1ØØ*GAM(I)+.5)/1ØØ:
      Z=INT (1ØØ*Z+.5)/1ØØ:ZZ=INT (1ØØ*
      ZZ+.5)/1ØØ
5ØØ7  IF B$="N" THEN 5Ø5Ø
5Ø1Ø  LPRINT USING; "PANEL ";I:
      LPRINT "WEB ANGLE W/ HORIZ":
      LPRINT "=";USING "#####.##";
      GAM (I)
5Ø15  LPRINT "LGTH,WEB DIAG":
      LPRINT "= ";Z
5Ø25  LPRINT "LGTH, TOP CHORD":
      LPRINT "= ";ZZ
5Ø3Ø  LPRINT "LGTH BOT CHORD":
      LPRINT "= ";V
5Ø4Ø  LPRINT "LGTH, VERT MEM":
      LPRINT "= ";U: LPRINT
5Ø5Ø  RETURN
```

Subroutine 599Ø draws up-left panel and represents member forces.

```
599Ø  GRAPH:USING:COLOR 1
6ØØ7  GLCURSOR (8Ø,Ø):SORGN
6Ø1Ø  LINE -(Ø,1ØØ)-(1ØØ,1ØØ)-(1ØØ,Ø)
6Ø2Ø  LINE (1ØØ,1ØØ)-(1Ø,1Ø):GLCURSOR
      (-1Ø,9Ø):SORGN
6Ø3Ø  GLCURSOR (-25,Ø):ROTATE 1:
      LPRINT "PANEL #";N:COLOR
      3:USING "#####.##"
6Ø4Ø  GLCURSOR (15,1Ø):LPRINT -T(I+4):
      GLCURSOR (7Ø,Ø):LPRINT -T(I+9):
      GLCURSOR (55,75):LPRINT T(I+5)
6Ø43  GLCURSOR (115,1Ø):LPRINT T(I+8)
6Ø45  TEXT:LF 8:GRAPH
6Ø5Ø  RETURN
```

Subroutine 61ØØ draws up-right panel and represents member forces.

```
61ØØ GRAPH:USING:COLOR 1
611Ø GLCURSOR (8Ø,Ø):SORGN
612Ø LINE -(Ø,-1ØØ)-(1ØØ,-1ØØ)-(1ØØ,Ø)
613Ø GLCURSOR (1ØØ,-1ØØ)
614Ø LINE -(15,-15):GLCURSOR (-1Ø,Ø):
     SORGN
615Ø GLCURSOR (-25,Ø):ROTATE 1
616Ø LPRINT "PANEL #";N:COLOR 3:
     USING "#####.##"
617Ø GLCURSOR (15,1Ø):LPRINT -T(I+4)
618Ø GLCURSOR (75,2Ø):LPRINT -T(I+9)
619Ø GLCURSOR (115,1Ø):LPRINT T(I+8)
6195 GLCURSOR (55,-4Ø):LPRINT T(I+5)
62ØØ TEXT:LF 1:RETURN
```

GCP PROGRAM - RECTANGULAR WOOD MEMBERS-COMBINED AXIAL COMPRESSION AND FLEXURAL LOADING - X AND Y DIRECTIONS - SIDE LOADING AND ECCENTRICITY - PC-1/PC-2

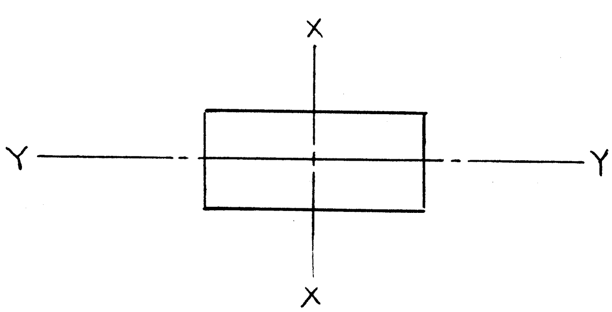
Ref: "National Design Specification for Wood Construction," 1977 Edition, National Forest Products Association, Washington, D.C.

This combined axial and bending stress type of problem is a trial-and-error design process, lengthy and time consuming without the aid of a computer.

If a truss compression chord, 2 x 4 or smaller, (in combined axial load and flexural bending) is subjected to bending such that the edge to which the plywood is attached is in flexural compression, and if the truss is not used in "wet service conditions", and if the wood is seasoned to 19% moisture content or less, use C_T (buckling stiffness factor):

$$C_T = 1 + .002 * l_e$$

where l_e = effective buckling length used in the design of the chord for compressive loading, inches. For l_e values greater than 96", C_T is calculated using l_e = 96"



References herein to the x-x axis and the y-y axis are intended to pertain to the "strong" way and the "weak" way, resp.,of a rectangular section. See diagram.

Parameter Designations:

Input:

I = Actual Member Depth (greater dimn.), in.
J = Actual Member Thickness, in.
K = Unbraced Length, x-x, ft.
L = Unbraced Length, y-y, ft.
M = F_b = Allowable Stress, psi
N = F_c = Allowable Compressive Stress, psi
O = E = Modulus of Elasticity, psi
P = Axial Load on Member, lb.
Q = Load Factor, Transverse Load
R = Load Factor, Axial Load
S = Bending Moment, Max, x direction, ft-lb
T = Bending Moment, Max, y direction, ft-lb
U = Eccentricity, x-x, inches
V = Eccentricity, y-y, inches
W = End Restraint Coef., x-x axis
X = End Restraint Coef., y-y axis

Determine whether member being designed is a truss compression chord, and whether member dimensions qualify for modification using the Buckling Stiffness Factor. *See Errata June Pg. 6*

```
1ØØ  WAIT 5ØØ: INPUT "TRUSS
     COMPR. CHORD? (Y/N)";H$:IF
     H$="N" THEN 112
11Ø  H$="N":IF I<=4 AND J<=2
     LET H$ = "Y"
112  IF Q=0 LET Q=1
114  IF R=0 LET R=1
116  IF W=0 LET W=1
118  IF X=0 LET X=1
12Ø  G=W*K*12/I:F=X*L*12/J:C=1
13Ø  E=G:IF F> G LET E=F
14Ø  IF E> 5Ø PRINT "L/D> 5Ø:
     COLUMN INVALID": BEEP
     4:END
```

Calculate Buckling Stiffness Factor (C_T= 1 + .002*l_e) It is assumed that, for this case, the plywood will be fastened to the narrow edge of the chord; no lateral bending will be involved. Therefore the bending moment in the y direction must equal zero.

```
150 IF T<>0 THEN 170
160 IF H$="Y" LET C=1+.002*12*K*W:
    IF (K*W)>8LET C=1+.002*96
```

Calculate K and J values

```
170  A=.671 * √(O/N): A=A* √ C
180 G=(G-11)/(A-11)
183 IF G<0LET G=0
186 IF G>1LET G=1
190 F=(F-11)/(A-11)
193 IF F<0LET F=0
196 IF F>1LET F=1
```

Calculate F_c

```
200  IF E>=A LET Y=.3*O/E/E

210  IF E>11 AND E<A LET Y=N*(1-
     (E/A)^4/3)
215  IF Y=0 LET Y=N
```

Calculate f_c and Interaction Number for Compression modified by Axial Load Factor

```
220  B=P/I/J/R/Y
```

Modify Interaction Number for Bending in x and y directions

```
230  D=(S*12*6/J/I/I/Q+B*Y*(6+1.5 *G)
     *U/I)/(M-G*B*Y)
240  D=D+(T*12*6/I/J/J/Q+B*Y*(6 +1.5
     *F)*V/J)/(M-F*B*Y)
250  A =B+D
```

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.

WORKED OUT EXAMPLES

In this issue we will provide design examples for the superstructure of a wood building

PRATT TRUSS

```
   *****PRATT*****
   *****TRUSS*****

   BY H.C. HALL,PE


 PGM SOLVES PRATT
TRUSS:MEMBER GEOM/
LGTH/FORCES;DRAWS
FB DIAG TO SCALE.

X AXIS:BOT CHORD
Y AXIS:LEFT REACT

TOP&BOT CHD NEED
NOT BE PARALLEL.

INPUT TRUSS DIMNS
BUT BE CONSISTENT
FOR EXAMPLE, INPUT
FEET OR INCHES
NOT BOTH

DESIGNATE
NO.OF PANELS
COUNTING FROM LEFT
WHICH ARE TO HAVE
UP-LEFT,DOWN-RIGHT
WEB MEMBERS
```

The user has the option of printing out a set of instructions.

The program provides a complete analysis of truss geometry, as well as analysis up to the point where the individual web and chord members are to be selected.

The program draws a free body diagram of the truss to scale.

Member forces are represented on a sketch of the panel; each panel is drawn and the member forces superimposed thereon.

Note: Dimensions <u>must</u> be in consistent units. In this example, all units are feet.

The program will design a 30 ft. truss consisting of six equal panels.

1. The program documents all input.

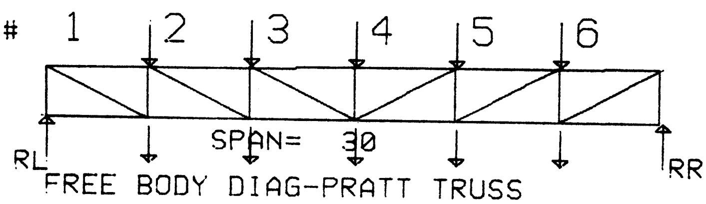
3	No. of "up-left" panels
30.00	Span
2.50	Depth at left end
2.66	Depth at right end
6	Total Number of panels
5.00	Width of Panel #1
5.00	Width of Panel #2
5.00	Width of Panel #3
5.00	Width of Panel #4
5.00	Width of Panel #5
5.00	Width of Panel #6

30.00	Sum of Panel Widths = Span

2. At this point, the program asks the user whether truss dimensions are to be documented. User will answer "yes" if all details of the truss' panel dimensions are desired; this procedure is somewhat time-consuming, and the user may not wish to have all these dimensions printed out each time the program is run.

```
ANGLE OF TOP CHORD
 W/HORZ=        0.31
       DEG
SPAN=       30.00

TRUSS DEPTH AT LEF
T END=       2.50

TRUSS DEPTH AT RIG
HT END=
                2.66


**PANEL DIMNS**

PANEL  1
WEB ANGLE W/HORIZ
=   26.56
LGTH:WEB DIAG
=     5.59
LGTH,TOP CHORD
=     5.00
LGTH,BOT CHORD
=     5.00
LGTH,VERT MEM
=     2.50

PANEL  2
WEB ANGLE W/HORIZ
=   26.83
LGTH:WEB DIAG
=     5.60
LGTH,TOP CHORD
=     5.00
LGTH,BOT CHORD
=     5.00
LGTH,VERT MEM
=     2.53

PANEL  3
WEB ANGLE W/HORIZ
=   27.11
LGTH:WEB DIAG
=     5.62
LGTH,TOP CHORD
=     5.00
LGTH,BOT CHORD
=     5.00
LGTH,VERT MEM
=     2.56

PANEL  4
WEB ANGLE W/HORIZ
=   27.56
LGTH:WEB DIAG
=     5.64
LGTH,TOP CHORD
=     5.00
LGTH,BOT CHORD
=     5.00
LGTH,VERT MEM
=     2.61

PANEL  5
WEB ANGLE W/HORIZ
=   27.83
LGTH:WEB DIAG
=     5.65
LGTH,TOP CHORD
=     5.00
LGTH,BOT CHORD
=     5.00
LGTH,VERT MEM
=     2.64

PANEL  6
WEB ANGLE W/HORIZ
=   28.07
LGTH:WEB DIAG
=     5.67
LGTH,TOP CHORD
=     5.00
LGTH,BOT CHORD
=     5.00
LGTH,VERT MEM
=     2.66
```

3. The free body diagram is drawn correctly to scale. Note that the program was written for a "parallel chord" truss. Although the chords need not be truly parallel, the program for drawing the free-body diagram will not necessarily accomodate a truss with a large angle between the top and bottom chords.



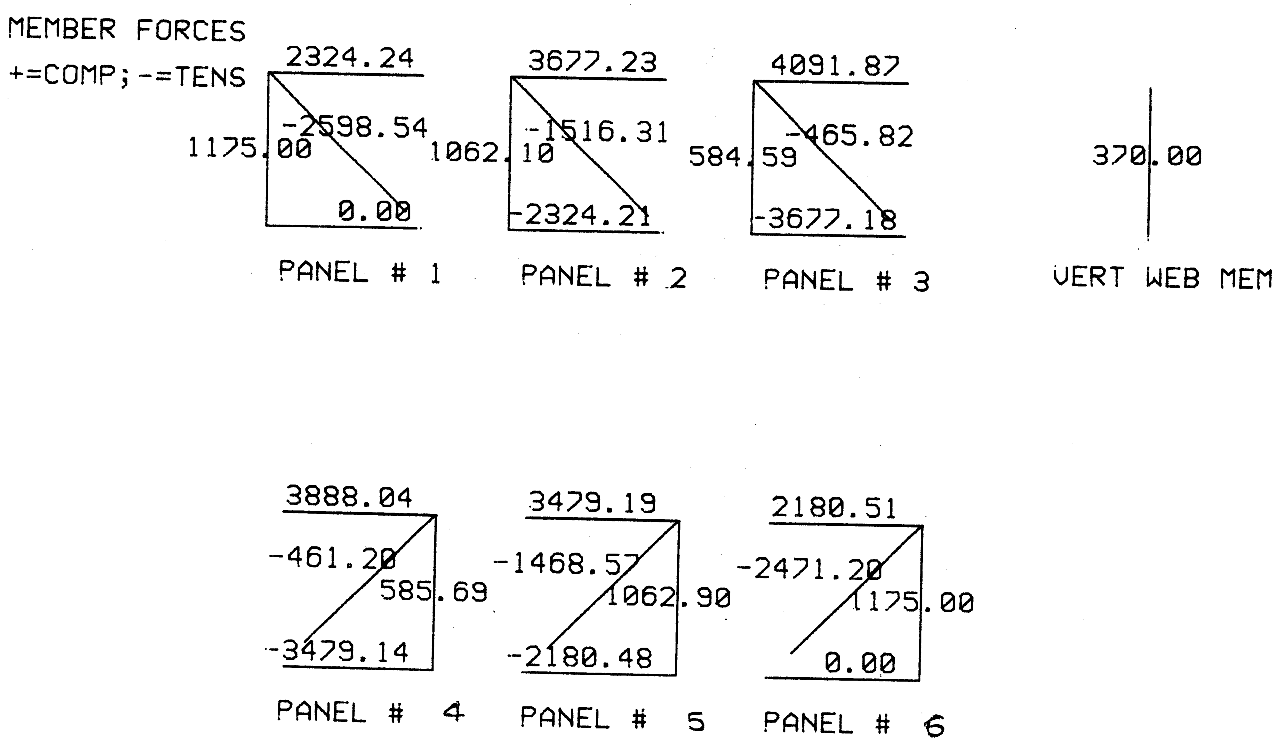
4. At this point the loads on top and bottom chords are input. Note that the numbers of the panel points are related to the panel number as follows: Panel Point #2 is to the left side of Panel #2, and so on.

```
INPUT TOTAL LOADS:
TOP, THEN BOTTOM
LEFT TO RIGHT, ON
INTERIOR PANEL POI
NTS

PANEL PT  2
TOP LOAD=
              370.00
BOT LOAD=
              100.00

PANEL PT  3
TOP LOAD=
              370.00
BOT LOAD=
              100.00

PANEL PT  4
TOP LOAD=
              370.00
BOT LOAD=
              100.00

PANEL PT  5
TOP LOAD=
              370.00
BOT LOAD=
              100.00

PANEL PT  6
TOP LOAD=
              370.00
BOT LOAD=
              100.00
```

5. The program prints out the reactions:

```
**REACTIONS**
    RL=    1175.00
    RR=    1175.00
```

6. The program now provides a sketch of each panel with member forces superimposed thereon.



This completes the analysis of the Pratt Truss. However, individual members must be analyzed.

ANALYSIS OF TOP CHORD

The enclosed GCP program designs the truss top chord for the critical area, Panels 3 and 4. It is found that a 2 x 4 is approved (Interaction Number =0.99) for #2 Southern Pine, Kiln Dried, for a maximum concentric load of 4200 lb. and a maximum moment, x direction, of 185 ft-lb. Note that, for this top chord, a continuous member is assumed, i.e., no butt joints at Panel Points 3, 4, or 5. Thus an end coefficient of 0.65 may be used. Based on this analysis, 2 x 4 members may be used throughout the truss.

See pg 7 July

```
TRUSS COMP CHORD
**    **    **    **

MEMBER D, IN =
          3.5
MEMBER W, IN =
          1.5
UNBR.L,X,FT =
          4.3
UNBR.L,Y,FT =
            0
FB,PSI =
         1500
FC,PSI =
         1200
E,PSI =
      1600000
AX.LOAD,LB =
         4200
LD.FACT,TR =
         1.15
LD.FACT,AX =
         1.15
MOM,X,FT-LB =
          185
MOM,Y,FT-LB =
            0
ECC.,X,IN. =
            0
ECC.,Y,IN. =
            0
END COEF.,X =
  ~~0.65~~ 1
END COEF.,Y =
            1

COMP. RESULTS:

INTERACT.NO =
  ~~9.999408459E-01~~
  1.0776
```

ANALYSIS OF GLULAM BEAM

Check the design of a 6-3/4x21 glulam wood beam using Southern Pine, (Combination 16F-E1) carrying the wood Pratt trusses on a 30 ft. span, each side. Total load = 47 psf roof loading. Span = 20 ft.

GCP PROGRAM

I= beam width, in.
J= beam depth, in.
K= load, lb/ft
L= span, ft.
M= E, psi

```
100  A=K/8*L^2
110  B=I/6*J^2
120  C=12*A/B
130  D=3/2*K*L/2/I/J
140  E=B/2*J
150  F=5*K*L^4*12^3/384/M/E
```

```
**GLULAM  BEAM**
**    **   **    **

BM.WDTH, IN =
              6.75
BM.DPTH, IN. =
                21
LOAD, LB/FT. =
              1410
SPAN, FT. =
                20
E, PSI =
           1500000

COMP. RESULTS:

MOM, FT-LB. =
             70500
SEC.MOD, IN2 =
           496.125
BDG.STR, PSI =
        1705.21542
SHR.STR, PSI =
       149.2063492
M.INERT, IN3 =
         5209.3125
DEFLECT, IN =
       0.649605874
```

The calculated bending stress is 1705 psi. The duration factor for snow load is taken as 1.15. Therefore 1705/1.15=1483 psi which allows ample margin for self weight.

The calculated shear stress is 149 psi which is much less than the allowable 200 psi.

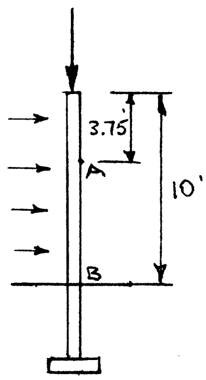
The deflection is 0.65 inches, which is about 1/360 X Span.

ANALYSIS OF POLE COLUMN

Check the design of a 4X6 treated wood pole (#2 Southern Pine, Kiln Dried) of 10 ft. height, 8 ft. spacing, located along an exterior column line. The column is embedded to a depth of 3'-6" and bears on a plain concrete footing pad, thus:

AXIAL LOAD 30/2*8*47 psf=5640 LB.

WIND LOAD 15 PSF



The moment at point A=9/128 wl^2=

$9/128*8*15*\overline{10}^2$=843.75 FT-LB

The moment at point B= 1/8 wl^2=15X$\overline{10}^2$=1500 FT-LB

We will assume, for purposes of analysis, that the unbraced height at point A is 10 ft., and at point B, 2 ft. Two analyses are therefore required. The design interaction number does not exceed 0.763; therefore, the design is satisfactory.

```
***WOOD   POLE***
**    **    **    **

MEMBER D, IN =
          5.5
MEMBER W, IN =
          3.5
UNB.HT, X, FT =
          10
UNB.HT, Y, FT =
          2
FB, PSI =
          1300
FC, PSI =
          1200
E, PSI =
          1600000
AX.LOAD, LB =
          5640
LD.FACT, TR =
          1.3333
```

```
LD.FACT, AX =
          1.15
MOM, X, FT-LB =
          843.75
MOM, Y, FT-LB =
          0
ECC., X, IN. =
          0
ECC., Y, IN. =
          0
END COEF., X =
          0.8    1
END COEF., Y =
          0.8    1

COMP. RESULTS:

INTERACT.NO =
          5.975103861E-01
          .6613
```

```
***WOOD   POLE***
**    **   **    **

MEMBER D, IN =
              5.5
MEMBER W, IN =
              3.5
UNB.HT, X, FT =
                2
UNB.HT, Y, FT =
                2
FB, PSI =
             1300
FC, PSI =
             1200
E, PSI =
          1600000
AX.LOAD, LB =
             5640
LD.FACT, TR =
           1.3333
```

```
LD.FACT, AX =
             1.15
MOM, X, FT-LB =
             1500
MOM, Y, FT-LB =
                0
ECC., X, IN. =
                0
ECC., Y, IN. =
                0
END COEF., X =
      0.8  (struck out; handwritten: 1)
END COEF., Y =
      0.8  (struck out; handwritten: 1)

COMP. RESULTS:

INTERACT.NO =
      0.762923303  (struck out; handwritten: .8571)
```

ANALYSIS OF JOISTS

Check the design of a 2 X 8 wood joist @ 24" centers, using #2 Southern Pine, KD on a 12 ft. span. Total load = 47 psf roof loading. Use the GCP Program on page 13.

```
GEN COM PGM
  RESULTS
A=
          1692.
B=
      13.140625
C=
    1545.131986 = fb
D=
    77.79310345 = fv
E=
    47.63476563
F=
 5.754284635E-01 = Δ
```

The calculated bending/shear stresses are less than the allowable values, considering the duration factor of 1.15.

The deflection is 0.57 inches, which is about 1/240 X Span.