"BEAMLINE" PROGRAM

"CHART" PROGRAM

FOR THE HP-71

CALCULATES: **MAXIMUM END MOMENTS**

MAXIMUM MIDSPAN MOMENT

MINIMUM MIDSPAN MOMENT

DEAD AND TOTAL LOAD REACTIONS

CHARTS THE MOMENTS OF ANY BEAM

by R.V. WINKEL CO.

BRIEF OF "BEAMLINE" AND "CHART" PROGRAMS:

The "BEAMLINE" program will analyze a continuous beam line (with or without end cantilevers) of an unlimited number of spans for dead load plus alternate and adjacent live load conditions. The resulting easy to read printout will display:

maximum and minimum end moments of beams and columns,
maximum and minimum beam midspan moments,
dead and total load beam reactions.

Also displayed are fixed end moments, simple beam midspan moments, simple beam end reactions, and relative joint stiffnesses.

"BEAMLINE" can also be used to analyze the beam line for total load conditions only, or for factored loads only.

The "CHART" program will analyze any particular span for moments from dead and/or total load conditions, and will display a chart of the span listing the moments of the span for span/30 increments. Midspan deflections for dead load and total load conditions are also given.

Enter any type of loading conditions, such as:

Full or partial rectangular, triangular or trapezoidal unit loadings,
Concentrated loadings,
Applied moment loadings.

Necessary for the operation of these programs are:

HP-71 with IL module and a 32k memory module,
80 column monitor and video interface device,
HP 9114 disk device,
HP 2225 Inkjet printer (using tractor fed paper).

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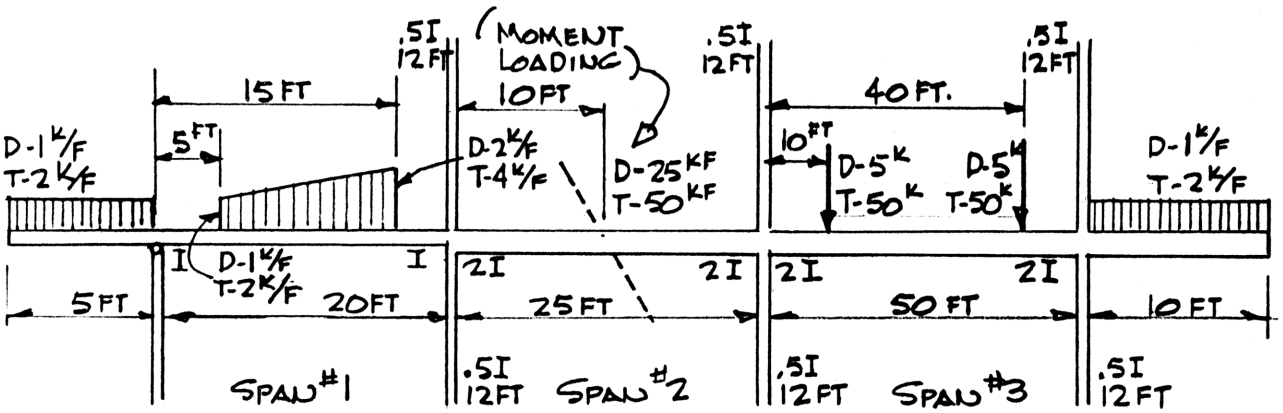
SAMPLE PROBLEM

We would like to analyze a line of beams of a warehouse with the following loading conditions:



BEAM LINE #5

Before running "BEAMLINE", position the perforation of the paper on the printer under the bail arm and press the blue button of the printer control panel.

DISPLAY	INPUT
	RUN BEAMLINE:TAPE

After the program is loaded into the HP-71, the program will search for and load the two lex files "KEYWAIT" and "REVLEX" into the HP-71 automatically, if they are not already in ram. It is best to keep these two files in a free port or on disk when not using these programs. The space in memory assigned to these files could conflict with the space assigned to other lex files.

Step (1) NUMBER OF SPANS?	3 ENDLINE

There are three spans so press "3" then "ENDLINE"

REDO THE INPUT? (Y/N)	ENDLINE

Pressing "ENDLINE" will accept the default "N". The number of spans can be changed by pressing "Y" then "ENDLINE".

The printer will print the approximate number of free bytes remaining in ram after most of the variables have been dimensioned. If this value is below 1500 bytes, the program will end. (The program requires about 220 bytes/span in dimensioning.)

NAME OF BEAM LINE?	WAREHOUSE, BEAM LINE #5

The User is allowed a maximum of 56 characters including spaces and punctuation.

Step (2)

☐ ALTERNATE LIVE LOADING? OR ENDLINE
NO ALTERNATE LOADING, TOTAL LOAD ONLY USED?

PUSH 'E' TO END THE PROGRAM

When it is desired to obtain moment values for alternate and adjacent live loadings scroll the cursor to "ALTERNATE LIVE LOADING" and press "ENDLINE". If it is desired to obtain results using total loads only, or factored loads only, then scroll cursor down to "NO ALTERNATE LOADING, TOTAL LOAD ONLY USED" and press "ENDLINE".

Program can be ended by pressing "E" whenever "PUSH 'E' TO END THE PROGRAM" is displayed on the screen.

We wish to use the alternate live loading routines and so "ENDLINE" was pressed when the cursor was next to "ALTERNATE LIVE LOADING".

☐ LEFT END CANTILEVER? OR ENDLINE
BEAM SPAN?

PUSH 'E' TO END THE PROGRAM

Since there is a left end cantilever "ENDLINE" was pressed when the cursor was next to "LEFT END CANTILEVER". If there were no left cantilever "ENDLINE" should be pressed when the cursor was next to "BEAM SPAN".
(See note above about "PUSH 'E' TO END THE PROGRAM".)

REDO THE INPUT? (Y/N) ENDLINE
("Y" stands for "YES" and "N" stands for "NO".)
If it is desired to enter different information, press "Y" then "ENDLINE" to return to step (2), otherwise press "ENDLINE" to accept the default letter "N".

Step (3)
LEFT END CANTILEVER
LENGTH OR SPAN? (ft.) 5

REDO THE INPUT? (Y/N) ENDLINE
The length of the left cantilever is 5 ft.

Step (4)

☐ UNIT-UNIFORM LOADS ENDLINE
CONCENTRATED LOADS
MOMENT LOADS
GO ON TO NEXT BEAM

PUSH 'E' TO END THE PROGRAM

The loading on the left cantilever is a uniform load so "ENDLINE" was pressed when the cursor was next to "UNIT-UNIFORM LOADS".

REDO THE INPUT? (Y/N) ENDLINE

At the left side of the monitor screen two diagrams will be displayed. One shows a uniform load across the entire cantilever (Type 1), while the other shows a partial trapezoidal load (Type 2). The cantilever has type 1 loading.

TYPE 1?? (Y/N) Y ENDLINE
DEAD LOAD w?? (k/ft) 1 ENDLINE
TOTAL LOAD w?? (k/ft) 2 ENDLINE

REDO THE INPUT? (Y/N) ENDLINE

The cantilever is loaded with a 1 k/ft dead load and a 2 k/ft total load.

The program will return to step (4) so that additional loads can be entered.

Since there are no additional loads on the left cantilever, position the cursor next to "GO ON TO NEXT BEAM" then press "ENDLINE".

REDO THE INPUT? (Y/N) ENDLINE

Step (5)
BEAM SPAN #1
LENGTH OR SPAN? (ft.) 20

REDO THE INPUT? (Y/N) ENDLINE

The first beam span is 20 ft. long and has unit loading.

Step (6)
☐ UNIT-UNIFORM LOADS ENDLINE
CONCENTRATED LOADS
MOMENT LOADS
GO ON TO NEXT BEAM

PUSH 'E' TO END PROGRAM

REDO THE INPUT? (Y/N) ENDLINE

Two diagrams will be shown on the screen. One diagram will display a uniform load over the entire span (Type 1). The other will display a partial trapezoidal load (Type 2).
The loading on Beam #1 is Type 2.

TYPE 1? (Y/N) N ENDLINE
DEAD LOAD w1? (k/ft) 1 ENDLINE

It does not matter if w1 is larger, smaller or equal to w2. The program will adjust values accordingly.

DISTANCE a? (ft) 5 ENDLINE
DEAD LOAD w2? (k/ft) 2 ENDLINE
DISTANCE b? (ft) 15 ENDLINE

```
TOTAL LOAD w1? (k/ft)                    2  ENDLINE
DISTANCE a? (ft)                         5  ENDLINE
TOTAL LOAD w2? (k/ft)                    4  ENDLINE
DISTANCE b? (ft)                         15  ENDLINE

REDO THE INPUT? (Y/N)                    ENDLINE
----------------------------------------+----------------------------------------
```

The program will go back to Step (6) for additional loads.
Since there are no additional loads, position the cursor next to "GO ON TO NEXT BEAM" and press "ENDLINE".

```
REDO THE INPUT? (Y/N)                    ENDLINE
----------------------------------------+----------------------------------------
```

Step (7) Input for joint stiffness calulations for Beam Span #1 follow.

```
JOINT STIFFNESS CALCULATIONS
LEFT JOINT
LLLLLLLLLLLLLLLLLLLLLLLLLLL
MOMENT OF INERTIA, UPPER COLUMN?         ENDLINE
```

Since there is no upper column, press "ENDLINE" to accept the default value of "0".

```
MOMENT OF INERTIA, RIGHT BEAM?           1  ENDLINE
```

Calculations for stiffness are based on the value of 4EI/L. This reduces to I/L. Relative values for I can be used. Moment of inertia of Beam #1 has been assigned a value of 1. Other beams and columns have assigned values for moment of inertia with reference to Beam #1.

```
LENGTH OF RIGHT BEAM = 20.00
MOMENT OF INERTIA, LOWER COLUMN?         ENDLINE
```

Since the lower column is designated as pin ended and contributes no stiffness to the joint, the default value of "0" is the correct value.

```
REDO THE INPUT? (Y/N)                    ENDLINE
----------------------------------------+----------------------------------------
```

Input for the right joint of Beam Span #1 is entered here.

```
JOINT STIFFNESS CALCULATIONS
RIGHT JOINT
RRRRRRRRRRRRRRRRRRRRRRRRRRR
MOMENT OF INERTIA, LEFT BEAM?            1  ENDLINE
LENGTH OF LEFT BEAM = 20.00
MOMENT OF INERTIA, UPPER COLUMN?         .5  ENDLINE
LENGTH OF UPPER COLUMN? (ft)             12  ENDLINE
MOMENT OF INERTIA, RIGHT BEAM?           2  ENDLINE
LENGTH OF RIGHT BEAM? (ft)               25  ENDLINE
MOMENT OF INERTIA, LOWER COLUMN?         .5  ENDLINE
LENGTH OF LOWER COLUMN? (ft)             12  ENDLINE

REDO THE INPUT? (Y/N)                    ENDLINE

----------------------------------------+----------------------------------------
```

Step (8)

BEAM SPAN #2
SPAN LENGTH? (ft) 25 ENDLINE

REDO THE INPUT? (Y/N) ENDLINE

Step(9)
UNIT-UNIFORM LOADS
CONCENTRATED LOADS
☐ MOMENT LOADS ENDLINE
GO ON TO NEXT BEAM

PUSH 'E' TO END PROGRAM

Loading for Span #2 consists of applied moments only. The dead load of the structure has been omitted to simplify this Sample Problem.

REDO THE INPUT? (Y/N) ENDLINE

A diagram of an applied moment on a beam can be seen at the right side of the screen.
DEAD LOAD MOMENT? (k-ft) 25 ENDLINE
DISTANCE a? (ft) 10 ENDLINE
CLOCKWISE MOMENT? (Y/N) N ENDLINE

This moment is applied in a counterclockwise direction.

TOTAL LOAD MOMENT? (k-ft) 50 ENDLINE
DISTANCE a? (ft) 10 ENDLINE
CLOCKWISE MOMENT? (Y/N) N ENDLINE

It is possible to have a live load moment and a dead load moment in opposite directions on the same beam, applied at the same point. The User must enter the information correctly however, to obtain correct results.

REDO THE INPUT? (Y/N) ENDLINE

The program will return to Step (9) for more loads.
Since there are no additional loads on Span #2, line the cursor next to "GO ON TO NEXT BEAM" and press "ENDLINE".

Step (10) Input for stiffness calculations of the right joint of Span #2 must be entered here. The left joint has been covered previously.
JOINT STIFFNESS CALCULATIONS
RIGHT JOINT
RRRRRRRRRRRRRRRRRRRRRRRRRRRR
MOMENT OF INERTIA, LEFT BEAM? 2 ENDLINE
LENGTH OF LEFT BEAM = 25.00
MOMENT OF INERTIA, UPPER COLUMN? .5 ENDLINE
LENGTH OF UPPER COLUMN? (ft) 12 ENDLINE
MOMENT OF INERTIA, RIGHT BEAM? 2 ENDLINE
LENGTH OF RIGHT BEAM? (ft) 50 ENDLINE
MOMENT OF INERTIA, LOWER COLUMN? .5 ENDLINE
LENGTH OF LOWER COLUMN (ft) 12 ENDLINE

```
REDO THE INPUT? (Y/N)                    ENDLINE
----------------------------------------+----------------------------------------
Step (11)
BEAM SPAN #3
SPAN LENGTH? (ft)                        50  END LINE

REDO THE INPUT? (Y/N)                    ENDLINE
----------------------------------------+----------------------------------------
Step (12) Span #3 is loaded with two concentrated loads.
   UNIT-UNIFORM LOADS
 ☐CONCENTRATED LOADS                     ENDLINE
   MOMENT LOADS
   GO ON TO NEXT BEAM

PUSH 'E' TO END THE PROGRAM

REDO THE INPUT? (Y/N)                    ENDLINE
----------------------------------------+----------------------------------------
The diagram on the right side of the screen displays a beam with a concentrated
load.
DEAD LOAD P? (kips)                      5  ENDLINE
DISTANCE a? (ft)                         10  ENDLINE
TOTAL LOAD P? (kips)                     50  ENDLINE
DISTANCE a?(ft)                          10  END LINE

REDO THE INPUT? (Y/N)                    ENDLINE
----------------------------------------+----------------------------------------
Now for the other concentrated load:
   UNIT-UNIFORM LOADS
 ☐CONCENTRATED LOADS                     ENDLINE
   MOMENT LOADS
   GO ON TO NEXT BEAM

PUSH 'E' TO END THE PROGRAM

REDO THE INPUT? (Y/N)                    ENDLINE
----------------------------------------+----------------------------------------
Diagram is displayed on the right.
DEAD LOAD P? (kips)                      5  END LINE
DISTANCE a? (ft)                         40  ENDLINE
TOTAL LOAD P? (kips)                     50  ENDLINE
DISTANCE a? (ft)                         40  ENDLINE

REDO THE INPUT? (Y/N)                    ENDLINE
----------------------------------------+----------------------------------------
The program again branches to Step (12).
Since there are no more loads on Span #3, line the cursor next to "GO ON TO NEXT
BEAM" and press "ENDLINE"
----------------------------------------+----------------------------------------
Step (13)
Input for stiffness calculations of right joint of Span #3 follows.
JOINT STIFFNESS CALCULATIONS
```

```
RIGHT JOINT
RRRRRRRRRRRRRRRRRRRRRRRRRRR
MOMENT OF INERTIA, LEFT BEAM?            2  ENDLINE
LENGTH OF LEFT BEAM = 50.00
MOMENT OF INERTIA, UPPER COLUMN?         .5  ENDLINE
LENGTH OF UPPER COLUMN? (ft)             12  ENDLINE
MOMENT OF INERTIA, LOWER COLUMN?         .5  ENDLINE
LENGTH OF LOWER COLUMN? (ft)             12  ENDLINE

REDO THE INPUT? (Y/N)                    ENDLINE
----------------------------------------+----------------------------------------
   END OF BEAM LINE? OR
 ☐ RIGHT END CANTILEVER?                 ENDLINE
```

Since there is a right end cantilever to the beam line, the cursor is to be lined up with "RIGHT END CANTILEVER", then press "ENDLINE".

```
PUSH 'E' TO END THE PROGRAM

REDO THE INPUT? (Y/N)                    ENDLINE
----------------------------------------+----------------------------------------
Step (14)
LENGTH OF CANTILEVER? (ft)               10  ENDLINE

REDO THE INPUT? (Y/N)                    ENDLINE
----------------------------------------+----------------------------------------
Step (15)
 ☐ UNIT-UNIFORM LOADS                    ENDLINE
   CONCENTRATED LOADS
   MOMENT LOADS
   GO ON TO NEXT BEAM

PUSH 'E' TO END THE PROGRAM

REDO THE INPUT? (Y/N)                    ENDLINE
----------------------------------------+----------------------------------------
```

Two diagrams are displayed on the right side of the screen. Type 1 diagram displays a uniform load over the entire span. Type 2 diagram shows a partial trapezoidal load on the span. (As stated before about Type 2 loading, w1 can be larger, equal to, or smaller than w2.)
The loading on the cantilever is Type 1.

```
TYPE 1?? (Y/N)                           Y  ENDLINE
DEAD LOAD w?? (k/ft)                     1  ENDLINE
TOTAL LOAD w?? (k/ft)                    2  ENDLINE

REDO THE INPUT? (Y/N)                    ENDLINE
----------------------------------------+----------------------------------------
```

The program will branch back to Step (15).
Since there are no more loads, line the cursor with "GO ON TO NEXT BEAM" and press "ENDLINE".

Having completed the entry of the variables of this problem, the program will have the following printout of this problem.

WAREHOUSE, BEAM LINE #5 87/11/18 BEAMLINE,1.1

FIXED END MOMENTS:	DEAD LOAD (kf)		TOTAL LOAD (kf)	
JOINT 1	-12.50	-32.60	-25.00	-65.21
JOINT 2	-36.15	-3.00	-72.29	-6.00
JOINT 3	+8.00	-40.00	+16.00	-400.00
JOINT 4	-40.00	-50.00	-400.00	-100.00

SIMPLE BEAM MIDSPAN MOMENTS:	DEAD LOAD (kf)	TOTAL LOAD (kf)
LEFT CANTILEVER = 5.00 ft		
SPAN # 1 = 20.00 ft	56.25	112.50
SPAN # 2 = 25.00 ft	-12.50	-25.00
SPAN # 3 = 50.00 ft	50.00	500.00
RIGHT CANTILEVER = 10.00 ft		

SIMPLE BEAM SHEARS:	DEAD LOAD (k)		TOTAL LOAD (k)	
JOINT 1	5.00	7.08	10.00	14.17
JOINT 2	7.92	1.00	15.83	2.00
JOINT 3	-1.00	5.00	-2.00	50.00
JOINT 4	5.00	10.00	50.00	20.00

JOINT STIFFNESS:	LEFT BM.	UPPER COL.	RIGHT BM.	LOWER COL.
JOINT 1	0.0000	0.0000	1.0000	0.0000
JOINT 2	.2344	.1953	.3750	.1953
JOINT 3	.3934	.2049	.1967	.2049
JOINT 4	.3243	.3378	0.0000	.3378

OUTPUT	REACTIONS DL SHEAR	REACTIONS TL SHEAR	MAXIMUM JOINT MOMENTS		JOINT MOMENTS LL ON ODD No. SPANS	JOINT MOMENTS LL ON EVEN No. SPANS
(Column moments are positive when joint rotation is clockwise)						
CANTILVR	5.00k	10.00k	-25.00kf		-12.50kf	-25.00kf
UPPER COL				+0.00kf	+0.00kf	+0.00kf
JOINT 1						
LOWER COL			+0.00kf		+0.00kf	+0.00kf
RIGHT BM	5.85k	11.70k	-25.00kf		-12.50kf*	-25.00kfø
MAXIMUM MIDSPAN MOMENT =			+77.54kf			
* SPAN # 1 = 20.00 ft *						
MINIMUM MIDSPAN MOMENT =			+29.05kf			
LEFT BM	9.15k	18.30k	-74.35kf		-57.42kf*	-29.41kfø
UPPER COL				-20.25kf	-34.36kf	-8.78kf
JOINT 2						
LOWER COL			-20.25kf		-34.36kf	-8.78kf
RIGHT BM	1.00k	-3.31k	-33.86kf		+11.30kfø	-11.85kf*
MAXIMUM MIDSPAN MOMENT =			-30.31kf			
* SPAN # 2 = 25.00 ft *						
MINIMUM MIDSPAN MOMENT =			-90.34kf			
LEFT BM	-1.00k	3.31k	-166.57kf		-166.97kfø	+1.22kf*
UPPER COL				+98.03kf	+97.90kf	+10.64kf
JOINT 3						
LOWER COL			+98.03kf		+97.90kf	+10.64kf
RIGHT BM	5.07k	50.66k	-362.64kf		-362.77kf*	-20.06kfø
MAXIMUM MIDSPAN MOMENT =			+161.81kf			
* SPAN # 3 = 50.00 ft *						
MINIMUM MIDSPAN MOMENT =			+8.38kf			
LEFT BM	4.93k	49.34k	-329.82kf		-313.60kf*	-63.18kfø
UPPER COL				-114.91kf	-131.80kf	+18.41kf

```
JOINT  4    ■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■■  ■■■■■■■■■■■■■ ■■■■■■■■■■■■■
  LOWER COL          ¦      -114.91kf ■■                 -131.80kf       +18.41kf
  CANTILVR    10.00k ¦   20.00k   -100.00kf               -50.00kf     -100.00kf
                                      ■■                     ■              ■■
```

NOTES ON THE PRINTOUT

A Left beam values for the joint.

B Right beam values for the joint.

C Moments obtained from loading both beams at the joint with total loads, and loading the adjacent beams with dead load only.

D End reactions of the beams adjusted for shear developed from difference in maximum end moments.

E The double box beam indicates that the span is loaded with total load.

F The single box beam indicates that the span is loaded with dead load only.

G Negative shear indicates that the net force is upward.

H Note the negative midspan moments.

I Note the positive moments at the supports.

J "*" and "ø" are symbols used with the "CHART" program.

"CHART" PROGRAM PRELIMINARY DATA

Almost any type of beam can be analyzed by the chart program: continuous beams or simple beams. Cantilever beams are an exception.

Data for "CHART" is entered in two phases. The first phase is concerned with the limits of the chart. Expected maximum and minimum moments are entered, then moments at the supports are entered.

The second phase is concerned with dead and/or total loads and locations, much the same as "BEAMLINE" is.

The program calculates the moments of a simple beam with the applied loading for span/30 increments, then subtracts (or adds) moments due to end moments at that point. Deflections at midspan are calculated by the moment area method.

If "CHART" is being run as a result of the prompt at the end of the "BEAMLINE" program, then "BEAMLINE" will purge the "BEAMLINE" program from memory before loading "CHART" to conserve memory. "CHART" will run on less memory than "BEAMLINE" so "insufficient memory" traps have not been programed into "CHART".

Unless there is enough memory, "CHART" should be purged from memory before loading "BEAMLINE" into the HP-71.

SAMPLE PROBLEM

Before beginning the program, line the paper perforation on the printer under the bail arm.

It is desirable to chart span #1 of the example of "BEAMLINE".

DISPLAY	INPUT
	RUN CHART:TAPE
Step (1) NAME OF BEAM?	SPAN #1, BEAM LINE #5, WAREHOUSE

Sixty characters including spaces and punctuation can be used for the name.

MODULUS OF ELASTICITY? (psi)	3605000 ENDLINE

If it is desired to have the deflection calculated, enter values for moment of inertia and modulus of elasticity. Otherwise accept the default value "0" by pressing "ENDLINE".

MOMENT OF INERTIA OF BEAM? (in^4)	9216 ENDLINE
BEAM SPAN? (ft)	20 ENDLINE
REDO THE INPUT? (Y/N)	ENDLINE

Step (2)
FACTORED, TOTAL LOADS ONLY? (Y/N) N ENDLINE
We are interested in a chart of both the dead and total loads, so "N" was entered. If total loads only are to be considered, press "Y" then "ENDLINE".

At this point the parameters of the chart are to be entered. They do not need to be exact, only adequate.

MAXIMUM POSITIVE MOMENT? (kft) 80 ENDLINE
End spans probably will not have maximum moment at midspan. The output of "BEAMLINE" lists the maximum midspan moment at +77.54 kft. "80" is entered here hoping that the maximum moment does not exceed 80. If the maximum moment exceeds the entered value, a strange printout could result with *'s printed all over the chart.

MAXIMUM NEGATIVE MOMENT? (kft) -58 ENDLINE
The "-" can be omitted from this value since the program assumes that any value entered here is negative <u>except those values preceeded by "+".</u>

Step (3)
It is important to enter the exact values at this step from the "BEAMLINE" output. See the output of "BEAMLINE" for values of span #1 marked "*" and "ø".

END MOMENTS WITHOUT LIVE LOAD: ('ø' MARKED VALUES)
LEFT END MOMENT (kft) -25 ENDLINE
The "-" can be omitted. If the value is positive (as with Span #2), the value <u>must</u> be preceeded with "+".

RIGHT END MOMENT? (kft) 29.41 ENDLINE

END MOMENTS FROM FACTORED, TOTAL LOADS: ('*' MARKED VALUES)
LEFT END MOMENT (kft) 12.5 ENDLINE
RIGHT END MOMENT? (kft) 57.42 ENDLINE

REDO THE INPUT? (Y/N) ENDLINE

Step (4)

☐UNIT LOAD? OR ENDLINE
CONCENTRATED LOAD? OR
MOMENT LOAD? OR
END PROGRAM? OR
GO TO THE CHART?
Line the cursor next to "UNIT LOAD?" and press "ENDLINE" to enter the unit load on span #1.

REDO THE INPUT? (Y/N) ENDLINE

You will see at the right side of the screen two diagrams. Type 1 diagram displays a beam with uniform load over the entire span. Type 2 diagram displays a trapezoidal unit load over part of the span. The loading of this span is Type 2.

```
TYPE 1?? (Y/N)                          N  ENDLINE

DEAD LOAD w1? (k/ft)                    1  ENDLINE
```

The value for w1 can be larger, equal to, or smaller than w2.

```
DISTANCE a? (ft)                        5  ENDLINE
DEAD LOAD w2? (k/ft)                    2  ENDLINE
DISTANCE b? (ft)                        15  ENDLINE

FACTORED, TOTAL LOAD w1?? (k/ft)        2  ENDLINE
DISTANCE a? (ft)                        5  ENDLINE
FACTORED, TOTAL LOAD w2?? (k/ft)        4  ENDLINE
DISTANCE b? (ft)                        15  ENDLINE

REDO THE INPUT? (Y/N)                   ENDLINE
-------------------------------------+-------------------------------------
```

The program will branch back to step (4) at this point to receive more loadings.

Since there are no more loads, line the cursor next to "GO TO THE CHART" and press "ENDLINE".

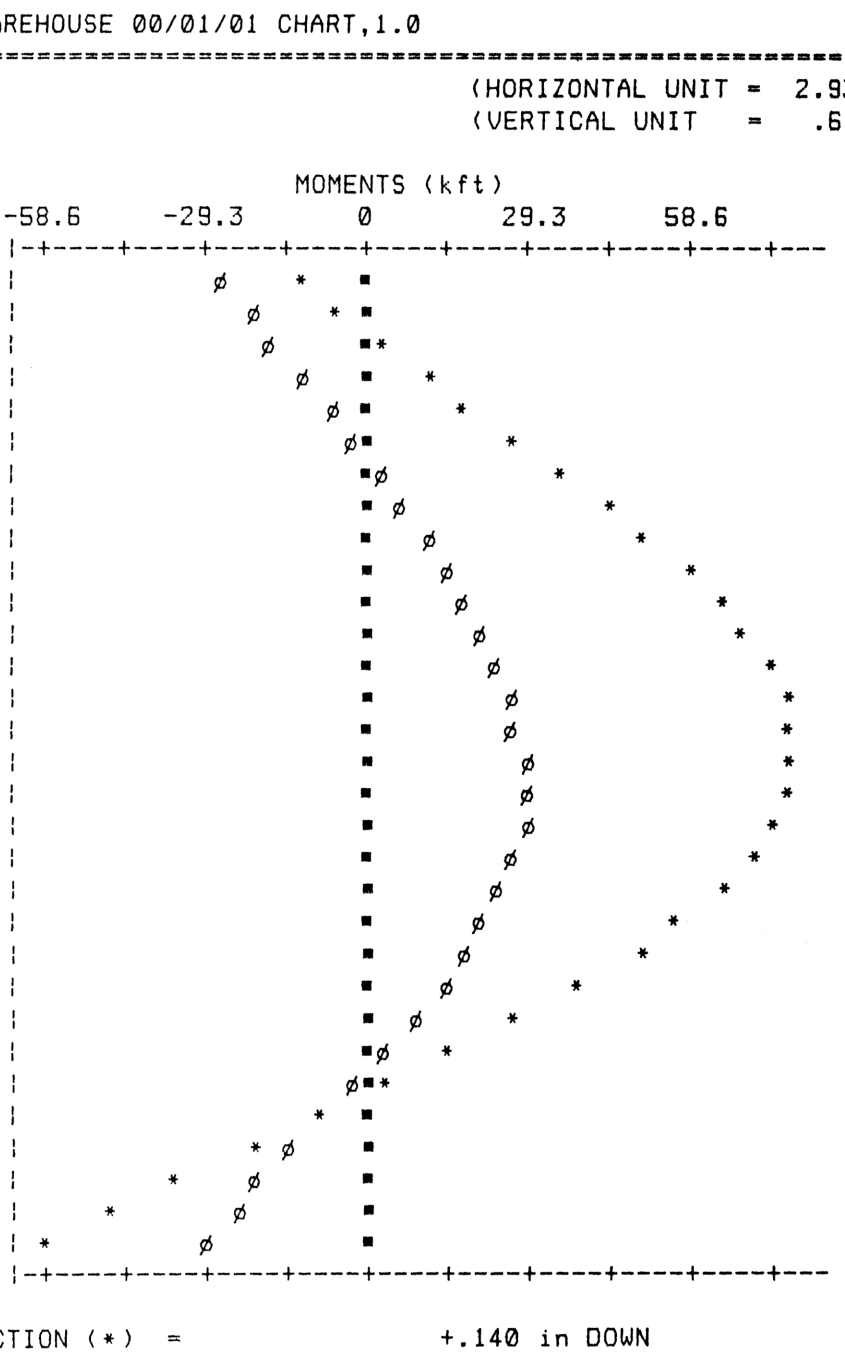
The HP-71 will do a few little calculations and will produce the following chart.

SPAN #1, BEAM LINE #5, WAREHOUSE 00/01/01 CHART,1.0

(HORIZONTAL UNIT = 2.930)
(VERTICAL UNIT = .667)

DIST FROM LEFT SUPPT (ft)	BEAM MOM WITH MAX POS. MOM (*) (kft)	BEAM MOM WITH MIN POS. MOM (ø) (kft)
0.000	-12.50	-25.00
.667	-4.55	-20.42
1.333	+3.39	-15.85
2.000	+11.34	-11.27
2.667	+19.29	-6.70
3.333	+27.24	-2.12
4.000	+35.18	+2.45
4.667	+43.13	+7.03
5.333	+50.96	+11.55
6.000	+57.99	+15.66
6.667	+64.04	+19.29
7.333	+69.05	+22.39
8.000	+72.97	+24.95
8.667	+75.72	+26.93
9.333	+77.27	+28.31
10.000	+77.54	+29.04
10.667	+76.48	+29.12
11.333	+74.02	+28.49
12.000	+70.11	+27.14
12.667	+64.70	+25.03
13.333	+57.71	+22.14
14.000	+49.09	+18.43
14.667	+38.78	+13.88
15.333	+26.95	+8.56
16.000	+14.90	+3.14
16.667	+2.84	-2.29
17.333	-9.21	-7.71
18.000	-21.26	-13.14
18.667	-33.31	-18.56
19.333	-45.37	-23.99
20.000	-57.42	-29.41

MOMENTS (kft)



MIDSPAN TOTAL LOAD DEFLECTION (*) = +.140 in DOWN
MIDSPAN DEAD LOAD DEFLECTION (ø) = +.045 in DOWN

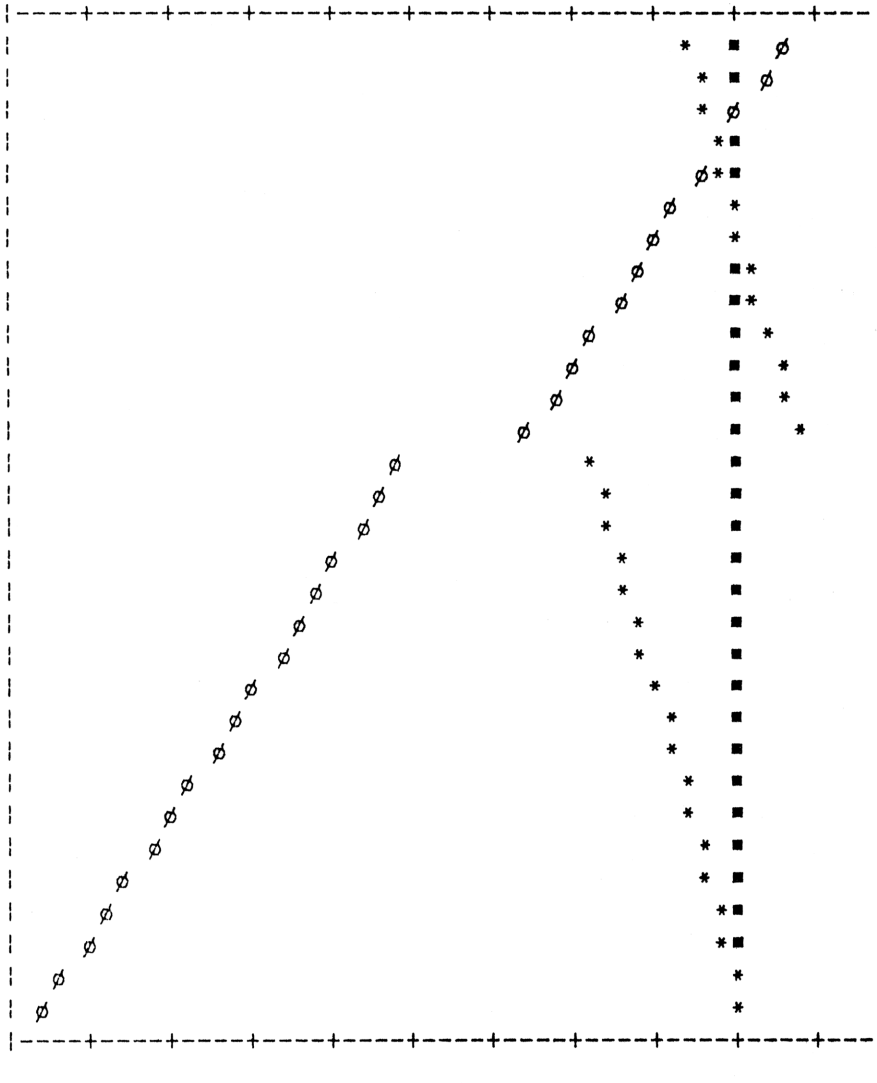
SPAN / 360 = .667 in
SPAN / 240 = 1.000 in
MODULUS OF ELASTICITY = 3,605,000 MOMENT OF INERTIA = 9,216.00

CHART OF SPAN #2

SPAN #2, BEAM LINE #5, WAREHOUSE 00/01/01 CHART,1.0

(HORIZONTAL UNIT = 3.870)
(VERTICAL UNIT = .833)

DIST FROM LEFT SUPPT (ft)	BEAM MOM WITH MAX POS. MOM (*) (kft)	BEAM MOM WITH MIN POS. MOM (ø) (kft)
0.000	-11.85	+11.30
.833	-9.75	+6.19
1.667	-7.65	+1.08
2.500	-5.54	-4.03
3.333	-3.44	-9.14
4.167	-1.34	-14.25
5.000	+.76	-19.35
5.833	+2.87	-24.46
6.667	+4.97	-29.57
7.500	+7.07	-34.68
8.333	+9.17	-39.79
9.167	+11.28	-44.90
10.000	+13.38	-50.01
10.833	-34.52	-80.12
11.667	-32.42	-85.23
12.500	-30.32	-90.34
13.333	-28.21	-95.44
14.167	-26.11	-100.55
15.000	-24.01	-105.66
15.833	-21.91	-110.77
16.667	-19.80	-115.88
17.500	-17.70	-120.99
18.333	-15.60	-126.10
19.167	-13.50	-131.21
20.000	-11.39	-136.32
20.833	-9.29	-141.43
21.667	-7.19	-146.53
22.500	-5.09	-151.64
23.333	-2.98	-156.75
24.167	-.88	-161.86
25.000	+1.22	-166.97



MIDSPAN TOTAL LOAD DEFLECTION (*) = -.026 in UP
MIDSPAN DEAD LOAD DEFLECTION (ø) = -.166 in UP

SPAN / 360 = .833 in
SPAN / 240 = 1.250 in
MODULUS OF ELASTICITY = 3,605,000 MOMENT OF INERTIA = 18,432.00

ADDITIONAL NOTES ON "BEAMLINE" AND "CHART"

"BEAMLINE" requires the lex files "KEYWAIT" and "REVLEX".
"CHART" requires the lex file "KEYWAIT".

Maximum numbers of digits that the programs can output are as follows:

	Allowable number of digits left of the decimal point
"BEAMLINE" program:	
Number of spans	3
Length of span	4
Shear values	4
Moment values	5
"CHART" program:	
Deflection value	3
Moment of inertia values	6
Modulus of elasticity values	10
Length of span values	2
Moment values	5

The User is advised to exit the programs through the methods furnished by the programs. It is not uncommon for the HP-71 to crash (memory loss) when these programs are suspended, ended, then started again.

References used to prepare these programs include:

1. "Continuity in Concrete Building Frames", Portland Cement Association, 1959, Skokie, Illinois.

2. "Tables and Formulas for Fixed End Moments of Members of Constant Moment of Inertia", Paul Rogers, 1953, Frederick Ungar Publishing Company, New York.

3. "Formulas for Stress and Strain", Raymond J. Roark, 1954, McGraw-Hill Book Company, New Jersey.

"BEAMLINE" program calculates maximum and minimum moments with the following loading patterns:

Maximum moments at a support will occur when the beams are loaded with live load on both sides of the support, and the adjacent spans are not loaded with live load.

Maximum midspan moment occurs when a span is loaded with live load, and the adjacent spans are not loaded with live load.

Minimum midspan moment occurs when a span is not loaded with live load, but the adjacent spans are loaded.

Maximum or minimum positive moments may not occur at midspan of a beam. The User should be familiar enough with structural design to recognize when this is critical to the safety of his or her design. The "CHART" program can be used to locate the maximum and minimum values, as well as the points of inflection.

The process used by "BEAMLINE" to obtain the results is a two cycle moment-

distribution of the beamline, similar to the process described in Reference 1. Although the two cycle moment-distribution is not as refined as a 6 cycle distribution, it is generally accurate to within 5% of the 6 cycle method.

It is my wish that all future live loads on beams designed by this program will be as accurate.

```
      PART 1 IS FROM BEGINNING TO LINE 2620
      IMAGE STATEMENTS ARE NOT LISTED
==============================================================================
VARIABLE CROSS REFERENCE    PART ONE OF THREE PARTS                BEAMLINE
==============================================================================
F$    BUFFER OF EXISTING DELAY SETTING
   30  230
G$    SCRATCH
   40   70  160  230
N1$   VARIABLE USED IN Y/N DECISIONS
  120  130  140  150
-------
250 SUB WATAMESS !                                        *****WATAMESS*****

A     DISTANCE DEAD LOAD IS FROM SUPPORT
 1330 1380 1400 1490 1500 1520 1660 1730
A$    = CHR$(124)
  330  380 1210 1220 1230 1240 1250 1260 1270 1280 1600 1610 1620 1760 1770 1780
 2520 2530 2550 2560 2570 2580
A1    DISTANCE TOTAL LOAD IS FROM SUPPORT
 1340 1420 1440 1540 1550 1570 1680 1740
A1$   = "ALTERNATE LIVE LOADING"
  330  470  530  630
A2$   = "NO ALTERNATE LOADING, TOTAL LOAD ONLY USED"
  330  480  530  630
A3$   = "END OF BEAM LINE"
  260  400
A4$   = "PUSH 'E' TO END PROGRAM"
  330  470  540  670  970
A8$   = CHR$(27)&"%"&CHR$(0)
  330  380  450  520  540  620  650  670  750  760  800  840  890  920  970  990
 1090 1120 1180 1290 1470 1630 1710 1790 1910 2020 2120 2160 2320 2360 2390 2430
 2590
A9$   = CHR$(27)
  330  380  420  450  520  540  550  610  620  650  680  690  750  760  800  840
  890  920  980 1090 1120 1180 1470 1710 1910 2020 2120 2160 2320 2360 2390 2430
B     DISTANCE DEAD LOAD IS FROM SUPPORT
 1330 1400 1490 1500 1520
B$    = "LEFT END CANTILEVER"
  330  490  660  820  850
B1    DISTANCE TOTAL LOAD IS FROM SUPPORT
 1340 1440 1540 1550 1570
B1$   = "BEAM SPAN"
  330  490  660  860 2400
B2$   = "RIGHT END CANTILEVER"
  260  410
C     = A - B
 1490 1500 1510 1520 1530
C$    = "UNIT-UNIFORM LOADS"
  340  500  940
C1    = A1 - B1
 1540 1550 1560 1570 1580
C1$   = "CONCENTRATED LOADS"
  340  500  940
```

```
C3$    = "MOMENT LOADS"
  340  500  940
C4$    = "GO ON TO NEXT BEAM"
  340  510  940
C5$    = "JOINT STIFFNESS CALCULATIONS"
  260  400 2030 2170
C6$    = "LEFT JOINT"
  260  380 2030
C7$    = "RIGHT JOINT"
  260  390 2170
F9     APPROXIMATE NUMBER OF BYTES OF FREE MEMORY
  350  360  370
I1     RELATIVE MOMENT OF INERTIA, LEFT BEAM
 2010 2150 2190 2450 2490 2500
I2     RELATIVE MOMENT OF INERTIA, UPPER COLUMN
 2010 2040 2150 2210 2220 2460 2490 2500
I3     RELATIVE MOMENT OF INERTIA, RIGHT BEAM
 2010 2060 2150 2250 2260 2470 2490 2500
I4     RELATIVE MOMENT OF INERTIA, LOWER COLUMN
 2010 2080 2150 2280 2290 2480 2490 2500
I5     MOMENT OF INERTIA SUMMATION
 2490 2500
L      BEAM SPAN OR LENGTH
  830  850  860  900 1330 1340 1380 1420 1660 1680 2380 2390 2400
L1     LENGTH OF LEFT BEAM
 2010 2150 2200 2450
L2     LENGTH OF UPPER COLUMN
 2010 2050 2150 2230 2460
L3     LENGTH OF RIGHT BEAM
 2010 2070 2150 2270 2470
L4     LENGTH OF LOWER COLUMN
 2010 2090 2150 2300 2480
M(     BUFFER OF MIDSPAN DEAD LOAD MOMENTS
  300
M1(    BUFFER OF FIXED END DEAD LOAD MOMENTS
  300 1500 1520 1730 1920
M2(    BUFFER OF FIXED END TOTAL LOAD MOMENTS
  300 1550 1570 1740 1930
M3(    BUFFER OF MIDSPAN TOTAL LOAD MOMENTS
  300
M4     APPLIED DEAD LOAD MOMENT, SCRATCH
 1810 1920
M5     APPLIED TOTAL LOAD MOMENT, SCRATCH
 1850 1930
N      SPAN NUMBER
  520  810  860  900 1180 1990 2010 2130 2200 2240 2350 2370 2390 2400 2500
N$     NAME OF BEAM LINE
  310  420  440  450
N1$    VARIABLE USED IN Y/N DECISIONS
  260  280  290  770  780  790  870  880 1100 1110 1300 1310 1450 1460 1690 1700
 1820 1830 1840 1860 1870 1880 1890 1900 2100 2110 2310 2320 2330 2410 2420 2600
 2610
N2     MAXIMUM NUMBER OF SPANS
  270  300  310  360  630 2240 2350
```

```
P       CONCENTRATED DEAD LOAD
 1650 1730
P1      CONCENTRATED TOTAL LOAD
 1670 1740
Q$      VARIABLE CONTAINING USER ENTERED KEY
  560  570  580  590  600  700  710  720  730  740 1000 1010 1030 1040 1060 1070
 1080
S(      BUFFER OF BEAM SPANS OR LENGTHS
  300  900 2070 2200 2390
S1(     BUFFER OF STIFFNESSES
  300 2500
T1(     BUFFER OF DISTRIBUTED MOMENTS
  310
T2(     BUFFER OF DISTRIBUTED MOMENTS
  310
T3(     BUFFER OF DISTRIBUTED MOMENTS
  310
U(      SCRATCH BUFFER OF MOMENTS
  310
V1(     BUFFER OF END SHEARS
  310 1510 1530 1730
V2(     BUFFER OF END SHEARS
  310 1560 1580 1740


W1      UNIT DEAD LOAD
 1330 1370 1490 1500 1510 1520 1530
W2      UNIT DEAD LOAD
 1330 1390 1490 1500 1510 1520 1530
W3      UNIT TOTAL LOAD
 1340 1410 1540 1550 1560 1570 1580
W4      UNIT TOTAL LOAD
 1340 1430 1540 1550 1560 1570 1580
X       COUNTER VARIABLE
  530  550  570  580  610  680  690  710  720  810  820  980  990 1020 1030 1050
 1060 1150 1160 1170 1960 1970 1980
X4$     = TEN TIMES CHR$(246)
  340  390 1220 1270 1620 1770 2530 2570
X5$     = THREE TIMES CHR$(246)
  340  410 1220 1270 1620 1770
Y       COUNTER VARIABLE
  390  410
```

```
PART 2 IS FROM LINE 2620 TO LINE 5200
IMAGE STATEMENTS ARE NOT LISTED
A
 3330 3400 3410 3420 3430 3560 3710 3730 3800 3820 4290 4340 4360 4450 4460 4480
 4630 4700
A$
 3280 3290 3300 3490 3500 3510 3520 4180 4190 4210 4220 4230 4240 4560 4570 4580
 4730 4740 4750
A1
 3350 3440 3450 3460 3470 3610 3760 3780 3840 3860 4300 4380 4400 4500 4510 4530
 4650 4710
A3$
 3900
A4$
 3930
A8$
 2670 2900 3310 3380 3530 3670 3890 3930 3940 4010 4040 4090 4250 4430 4600 4680
 4760 4860
A9$
 2670 2900 3380 3670 3890 3930 4000 4010 4040 4090 4430 4680 4860
B
 3400 3410 3420 4290 4360 4450 4460 4480
B1
 3440 3450 3460 4300 4400 4500 4510 4530
B2$
 3900 4100
C
 2930 3040 3140 3210 3220 3250 4450 4460 4470 4480 4490
C1
 4500 4510 4520 4530 4540
D      = G/L
 3140 3160 3190
E      = H/L
 3140 3150 3180
E9     SCRATCH
 2700 2710 2750 2760 2940 2950 2980 2990 3050 3060 3090 3100 3170
F      SCRATCH
 2930 3040 3140 3210 3240 3250
F1     SCRATCH
 3250 3260
G      DISTANCE FROM SUPPORT TO DEAD LOAD
 2690 2740 2810 2830 2930 3020 3040 3140 3230
G9     DISTANCE FROM SUPPORT TO DEAD LOAD
 2850 2870 3020
H      DISTANCE FROM SUPPORT TO TOTAL LOAD
 2690 2740 2830 2930 3020 3040 3140
H9     DISTANCE FROM SUPPORT TO TOTAL LOAD
 2870 3020
L
 2690 2740 2810 2830 2850 2870 2930 3040 3140 3150 3160 3180 3190 3210 3230 3240
 3250 3260 3330 3350 3400 3410 3420 3430 3440 3450 3460 3560 3610 3710 3720 3730
 3760 3770 3780 3800 3810 3820 3840 3850 3860 4060 4100 4290 4300 4340 4360 4380
 4400 4630 4650
M(
 2730 2970 3010 3420 3430 3730 3740 3820 3830 5070
M1(
```

```
 2710 2950 2990 3400 3710 3800 4460 4480 4700 4880 4890 5010
M2(
 2760 3060 3100 3440 3760 3840 4510 4530 4710 4910 4920 5010 5200
M3(
 2780 3080 3120 3460 3470 3780 3790 3860 3870 5070
M4
 2700 2710 2750 2760 2940 2950 2980 2990 3050 3060 3090 3100 3200 3550 3710 3720
 3730 3740 3800 3810 3820 3830 4780 4880 4890 5200


M5
 3150 3170 3600 3760 3770 3780 3790 3840 3850 3860 3870 4810 4910 4920 5200
M6      END MOMENT
 3190 3200
M7      END MOMENT
 3180 3200
M8      END MOMENT
 3160 3170
M9      MIDSPAN MOMENT
 2700 2730 2750 2780 2940 2970 2980 3010 3050 3080 3090 3120 3230 3240 3260
N
 2710 2720 2730 2760 2770 2780 2950 2960 2970 2990 3000 3010 3060 3070 3080 3100
 3110 3120 3400 3410 3420 3430 3440 3450 3460 3470 3710 3720 3730 3740 3760 3770
 3780 3790 3800 3810 3820 3830 3840 3850 3860 3870 4100 5000 5010 5060 5070 5080
 5110 5120 5170
N$
 4950
N1$
 2650 2660 2880 2890 3360 3370 3570 3580 3590 3620 3630 3640 3650 3660 4020 4030
 4070 4080 4260 4270 4410 4420 4660 4670 4780 4790 4800 4810 4820 4830 4840 4850
N2
 4460 4470 4480 4490 4510 4520 4530 4540 4700 4710 4880 4890 4910 4920 5000 5060
 5090 5110 5170 5200
P
 3320 3400 3410 3420 3430 4620 4700
P1
 3340 3440 3450 3460 3470 4640 4710
Q$
 3950 3960 3970 3980 3990
Q5      TOTAL LOAD
 2860 3020
Q6      TOTAL LOAD
 2840 3020
R3      END REACTION
 2700 2720 2750 2770 2940 2960 2980 3000 3050 3070 3090 3110 3210 3220 3230
R4      END REACTION
 2700 2720 2750 2770 2940 2960 2980 3000 3050 3070 3090 3110 3220 3240 3260
S(
 4100 5050 5070 5090
S1(
 5170
U(
 5200
U1      SCRATCH
```

BEAMLINE 2 OF PART 2

```
 3250 3260
V1(
 2720 2960 3000 3410 3720 3810 4470 4490 4700 5120
V2(
 2770 3070 3110 3450 3770 3850 4520 4540 4710 5120
W       UNIT DEAD LOAD
 2630 2690
W1
 2640 2740 4290 4330 4450 4460 4470 4480 4490
W2
 4290 4350 4450 4460 4470 4480 4490
W3
 4300 4370 4500 4510 4520 4530 4540
W4
 4300 4390 4500 4510 4520 4530 4540
W5      SCRATCH
 2690 2740 2820 2920 2930 3020 3030 3040 3140 3150 3180 3210 3220 3250 3260
W6      SCRATCH
 2690 2740 2800 2920 2930 3020 3030 3040 3140 3160 3190 3210 3220 3250
W7      SCRATCH
 2930 3040
W8      SCRATCH
 3140 3160 3190
W9      SCRATCH
 3140 3150 3180
X
 3930 3940 3960 3970 4050 4120 4130 4140
X4$
 3300 3510 4190 4230 4580 4740
X5$
 4190 4230 4580 4740
X9$     = CHR$(124)
 4990 5010 5050 5070 5090 5120
```

```
      PART 3 IS FROM LINE 5200 TO END
      IMAGE STATEMENTS ARE NOT LISTED
A     SCRATCH
 5390 5420 5440
A$    13 TIMES CHR$(252)
 5900 5910 6070 6470
A1$   = CHR$(252)
 5900 5990 6040 6090 6160 6180 6210 6230 6250 6270 6290 6310 6330 6340 6360 6370
 6380 6390 6440 6480 6510 6520
A9$
 6540 6550
B     SCRATCH
 5400 5410 5420 5430 5440
C     SCRATCH
 5390
D     SCRATCH
 5390
E1$   = CHR$(42)
 5900 6130 6150 6420 6430
E2$   = CHR$(214)
 5900 6130 6150 6420 6430
M(
 5650 5830
M1(
 5280 5290 5470 5480 5490 5510 5520 5540 5680 5690 5710 5720 5740
M2(
 5230 5240 5280 5290 5480 5490 5510 5520 5540 5670 5680 5690 5710 5720 5740
M3(
 5630 5850 5880
M4(   MINIMUM MIDSPAN MOMENT
 5210 5650 5830 5880 6360 6370
M5(   MAXIMUM MIDSPAN MOMENT
 5210 5630 5850 5880 6210 6230
N
 5220 5230 5240 5250 5270 5280 5290 5300 5310 5320 5330 5340 5350 5360 5370 5380
 5390 5400 5410 5420 5430 5440 5450 5470 5480 5490 5500 5510 5520 5530 5540 5550
 5560 5570 5580 5590 5600 5610 5620 5630 5640 5650 5660 5670 5680 5690 5700 5710
 5720 5730 5740 5750 5760 5770 5780 5790 5800 5810 5820 5830 5840 5850 5860 5870
 5880 6060 6070 6090 6110 6130 6150 6210 6230 6290 6310 6360 6370 6400 6420 6430
 6440 6460 6470 6480 6490 6500
N2
 5210 5220 5270 5310 5380 5500 5530 5550 5640 5660 5700 5730 5750 5840 5860 5870
 6060 6460
S(
 5410 5420 5430 5440 6290 6310
S1(
 5230 5240 5280 5290 5330 5340 5350 5360 5480 5490 5510 5520 5570 5580 5590 5600
 5680 5690 5710 5720 5770 5780 5790 5800
T1(
 5330 5340 5350 5360 5400 5880 6000 6040 6090 6110 6400 6440 6480 6490
T2(
 5570 5580 5590 5600 5630 5650 6020 6040 6090 6130 6150 6420 6430 6440 6480 6500
T3(
 5770 5780 5790 5800 5830 5850 6020 6040 6090 6130 6150 6420 6430 6440 6480 6500
U(
 5230 5240 5280 5290 5320 5330 5340 5350 5360 5470 5480 5490 5510 5520 5540 5560
```

```
 5570 5580 5590 5600 5670 5680 5690 5710 5720 5740 5760 5770 5780 5790 5800
U9      SCRATCH
 5320 5330 5340 5350 5360 5560 5570 5580 5590 5600 5760 5770 5780 5790 5800
V1(
 5390 5420 5440 6000 6110 6400 6490
V2(
 5390 5410 5430 6000 6110 6400 6490
X
 5910
X9$
 5950 6000 6040 6090 6110 6400 6440 6480 6490
Z       NUMBER USED AS A FLAG
 5490 5520 5540 5690 5720 5740
```

(PART 1 IS FROM BEGINNING TO LINE 2410)

```
==============================================================================
VARIABLE CROSS REFERENCE   PART 1 OF 2 PARTS                            CHART
==============================================================================
F$      = EXISTING DELAY SETTING
   20  100
N1$     = VARIABLE FOR Y/N DECISIONS
   80   90
Z9$     = SCRATCH
   30
-------
110 SUB NITEMARE !                                          *****NITEMARE*****

A       DISTANCE DEAD LOAD IS FROM SUPPORT
  990 1040 1060 1140 1170 1180 1210 1280 1290 1320 1660 1730 1760 1880 2020 2030
 2120 2130
A$      ='CHR$(124)'
  130  150  880  890  900  910  920  930  940 1610 1620 1630 1820 1830 1840 1850
A1      DISTANCE TOTAL LOAD IS FROM SUPPORT
 1000 1080 1100 1130 1400 1410 1440 1510 1520 1550 1680 1770 1800 1920 2070 2080
 2170 2180
A8$     = 'CHR$(27)&"%"&CHR$(0)'
  120  150  240  480  620  680  780  810  950 1120 1640 1710 1860 1970
A8(     MOMENT AREAS, DEAD LOAD
  120 2250 2280
A9$     = 'CHR$(27)'
  120  150  170  240  480  620  670  770  810 1120 1710 1970 1980
A9(     MOMENT AREAS, TOTAL LOAD
  120 2260 2290
B       DISTANCE DEAD LOAD IS FROM SUPPORT
  500  520  530  540  560  580  590  600  990 1060 1140 1160 1200 1230 1250 1270
 1310 1340 1360 1460 1570
B1      DISTANCE TOTAL LOAD IS FROM SUPPORT
 1000 1100 1130 1390 1430 1480 1500 1540 1590
C       = B - A
 1140 1150 1160 1210 1250 1260 1270 1320 1360
C1      = B1 - A1
 1130 1380 1390 1440 1480 1490 1500 1550 1590
C8      MOMENT AREA TIMES DISTANCE FROM MIDSPAN
 2270 2280 2300
C9      MOMENT AREA TIMES DISTANCE FROM MIDSPAN
 2270 2290 2310
D       SCRATCH
 2410
D6      DEFLECTION AT MIDSPAN
 2330
D7      DEFLECTION AT MIDSPAN
 2340
D8      DEFLECTION AT MIDSPAN
 2300 2330
D9      DEFLECTION AT MIDSPAN
 2310 2340
E1      MODULUS OF ELASTICITY
  200 2330 2340
G       SCRATCH
```

1170 1180 1200 1280 1290 1310 1400 1410 1430 1510 1520 1540 1730 1750 1770 1790
2020 2030 2050 2070 2080 2100 2120 2130 2150 2170 2180 2200

H **SCRATCH**
1200 1240 1310 1350 1430 1470 1540 1580

I4 **MOMENT OF INERTIA**
210 2330 2340

J **COUNTER VARIABLE**
2350 2360 2400

K$ **END MOMENTS**
290 310 320 330 340 350 360 370 380 400 410 420 430 440 450 460
470

K(**BUFFER OF END MOMENTS**
120 280 320 330 360 370 410 420 450 460 500 510 530 540 560 570
590 600 2370 2380 2410

L **BEAM SPAN**
220 990 1000 1040 1060 1080 1100 1160 1230 1240 1270 1340 1350 1390 1460 1470
1500 1570 1580 1660 1680 1730 1750 1770 1790 1880 1920 2020 2050 2070 2100 2120
2150 2170 2200 2250 2260 2280 2290 2300 2310

L1 **BEAM SPAN/30**
220 1170 1180 1200 1240 1280 1290 1310 1350 1400 1410 1430 1470 1510 1520 1540
1580 1730 1750 1770 1790 2030 2050 2080 2100 2130 2150 2180 2200 2250 2260 2280
2290

L2(**BUFFER OF BEAM UNIT LENGTHS**
120

M1(**BUFFER OF TOTAL LOAD MOMENTS**
120 510 530 540 1420 1450 1480 1530 1560 1590 1780 1800 2070 2090 2110 2170
2190 2210 2260

M2(**BUFFER OF DEAD LOAD MOMENTS**
120 570 590 600 1190 1220 1250 1300 1330 1360 1740 1760 2020 2040 2060 2120
2140 2160 2250

M8 **DEAD LOAD MOMENT**
1870 2020 2060 2120 2160

M9 **TOTAL LOAD MOMENT**
1910 2070 2110 2170 2210

N **SCRATCH**
1180 1190 1200 1220 1240 1250 1290 1300 1310 1330 1350 1360 1410 1420 1430 1450
1470 1480 1520 1530 1540 1560 1580 1590 1730 1740 1750 1760 1770 1780 1790 1800
2030 2040 2050 2060 2080 2090 2100 2110 2130 2140 2150 2160 2180 2190 2200 2210

N$ **BEAM NAME**
130 190

N1$ **VARIABLE USED IN Y/N DECISIONS**
130 230 240 250 260 470 490 790 800 960 970 1110 1130 1690 1700 1890
1900 1910 1930 1940 1950 1960 1980

P **CONCENTRATED DEAD LOAD**
1650 1730 1760

P1 **CONCENTRATED TOTAL LOAD**
1670 1770 1800

Q$ **KEY ENTERED BY THE USER**
690 700 720 740 750 760

R **SCRATCH**

```
 1160 1190 1220 1250 1270 1300 1330 1360 1390 1420 1450 1480 1500 1530 1560 1590
 1730 1740 1760 1770 1780 1800 2020 2040 2060 2070 2090 2110 2120 2140 2160 2170
 2190 2210
R8      DEAD LOAD REACTIONS
 2240 2250 2300
R9      TOTAL LOAD REACTIONS
 2240 2260 2310
T       SCRATCH
 2380
V       SCRATCH
 2350 2380 2390
W1      UNIT DEAD LOAD
  990 1030 1140 1150 1210 1220 1260 1320
W2      UNIT DEAD LOAD
  990 1050 1140 1150 1210 1260 1320 1330
W3      UNIT TOTAL LOAD
 1000 1070 1370 1380 1440 1450 1490 1550
W4      UNIT TOTAL LOAD
 1000 1090 1370 1380 1440 1490 1550 1560
W5      SCRATCH
 1320 1330 1550 1560
W6      SCRATCH
 1320 1330 1550 1560
W7      SCRATCH
 1210 1220 1320 1440 1450 1550
W8      SCRATCH
 1150 1160 1250 1260 1270 1360 1380 1390 1480 1490 1500 1590
W9      SCRATCH
 1150 1160 1250 1260 1270 1360 1380 1390 1480 1490 1500 1590
X       SCRATCH
  510  530  540  570  590  600  670  680  710  730  740  750  820  830  840  850
 1180 1190 1200 1210 1220 1240 1250 1290 1300 1310 1320 1330 1350 1360 1410 1420
 1430 1440 1450 1470 1480 1520 1530 1540 1550 1560 1580 1590 1730 1740 1750 1760
 1770 1780 1790 1800 2030 2040 2050 2060 2080 2090 2100 2110 2130 2140 2150 2160
 2180 2190 2200 2210 2240 2250 2260 2270 2280 2290 2360 2370 2380 2390
X4$     10 TIMES 'CHR$(246)'
  130  160  890  930 1630 1840
X5$     = 'CHR$(252)'
  130  140
X6$     = 'CHR$(124)'
  130  140
X7$     24 TIMES '='
  130
X8$     = 'CHR$(42)'
  130  140  400  440
X9      SCRATCH
 1210 1220 1320 1330 1440 1450 1550 1560
X9$     = 'CHR$(214)'
  130  140
Y       SCRATCH
  160  320  360  410  450
Y1      EXPECTED MAXIMUM POSITIVE MOMENT
  270 2410
```

PART 2 OF 2 STARTING WITH LINE 2410 (IMAGE STATEMENTS ARE OMITTED)

```
D
 2410
D4     = SPAN / 240
 3040 3130
D5     = SPAN / 360
 3040 3120
D6
 3090 3110
D7
 3060 3070
D8
 3210 3220
D9
 3170 3190
E1
 3140
E8$    SEGMENT OF THE CHART'S HORIZONTAL BORDER
 2700 2720 2730 3030
E9$    SEGMENT OF THE CHART'S HORIZONTAL BORDER
 2700 2730 3030
I4
 3140
K(
 2410 2420 2770 3250
K1     SCRATCH
 2410 2420 2460 2530 2600 2770 3250
L
 3040
L1
 2470 2540 2750
L2(
 2750 2760 3240
M1(
 2760 2770 3240 3250
M2(
 2760 2770
N$
 2440
Q1     SCRATCH
 2600 2620 2640 2660 2680
Q2     SCRATCH
 2600 2620 2640 2660
Q3     SCRATCH
 2600 2620 2640
Q4     SCRATCH
 2600 2620
Q6     SCRATCH
 2600 2640 2660 2680 2690
Q7     SCRATCH
 2600 2660 2680 2690
Q8     SCRATCH
 2600 2680 2690
```

Q9 **SCRATCH**
2600 2690
X **COUNTER VARIABLE**
2700 2720 2750 2760 2770 2840 3240 3250
X5$
2930 2940 2960 2970 2980 2990 3010 3020 3290 3300
X6$
2460 2470 2480 2490 2500 2530 2540 2560 2570 2590 2730 2760 3030 3240
X7$
2700 2730
X8$
2570 2860 2870 2880 2900 2910 2930 2940 2960 2970 2980 2990 3010 3020 3280 3290
3300
X9$
2570 2870 2880 2900 2910 2960 2970 2980 2990 3010 3020 3090
Y1
2410
Z1 **SCRATCH**
2420 2610 2620 2630 2640 2650 2660 2670 2680 2690 2710 2780 2790 2810 2820 2830
2850 2860 2870 2880 2890 2900 2910 2920 2930 2940 2950 2960 2970 2980 2990 3010
3020 3260 3270 3280 3290 3300
Z2 **SCRATCH**
2770 2780 2800 2810 2830 2890 2900 2910 2920 2930 2940 2950 2960 2970 2980 2990
3000 3010 3020 3250 3260 3270 3290 3300
Z3 **SCRATCH**
2770 2790 2800 2820 2850 2870 2880 2950 2960 2970 2980 2990 3000 3010 3020
Z9 **SCRATCH**
2710 2720