CALCULATOR PROGRAMS 1

HEWLETT PACKARD
PROGRAMMABLE CALCULATORS

STRUCTURAL PROGRAMS
FOR
HP41C

CALPRO
CALCULATOR PROGRAMS
3119 WATERLICK ROAD
LYNCHBURG, VIRGINIA 24502
804-237-3825

These calculator programs are designed for the solution of specific Structural Engineering problems within the capabilities of the HP-41C Hewlett Packard calculators. It is most important that all data and program applications be supplemented by professional judgment of qualified engineering personnel. No responsibility is assumed by the writer for any errors, mistakes, misrepresentations that may occur when using these programs.

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Hewlett Packard Programmable Calculators

HEWLETT PACKARD
PROGRAMMABLE CALCULATORS

STRUCTURAL PROGRAMS FOR HP41C

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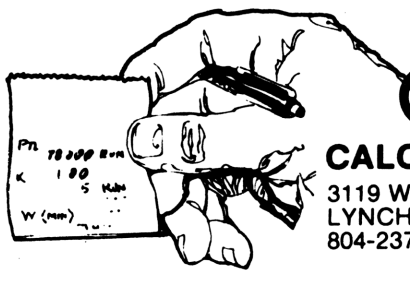

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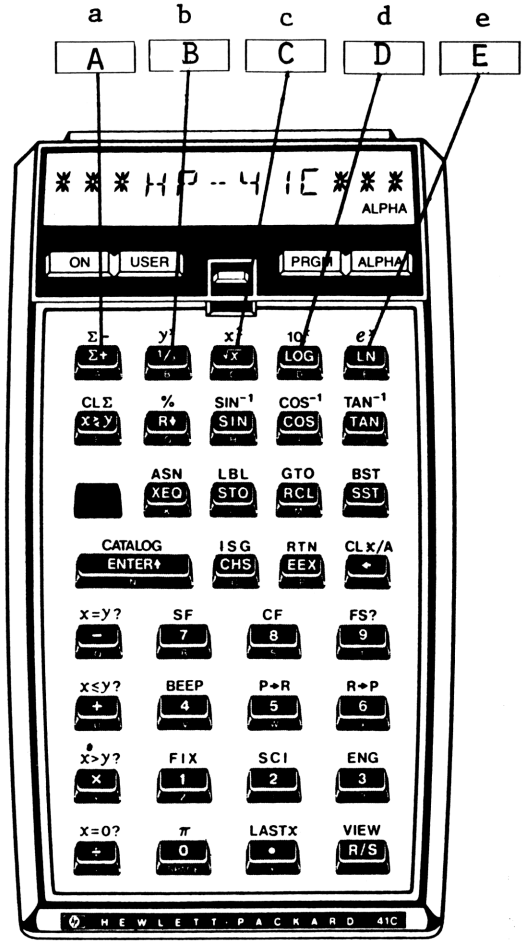
STRUCTURAL PROGRAMS

CONTENTS

KEY LAYOUT FOR USE WITH PROGRAMS



PROGRAM EXECUTION REQUIRES HP-41C CALCULATOR, CARD READER, PRINTER AND TWO ADDITIONAL MEMORY MODULES

HANDY REFERENCE

Working Stress Design Versus Ultimate Strength Design in Programs

Steel Percentage P = $\frac{P_b}{2}$

Factor Safety or Load Factor = 1.7

Beam Shear

USD

$v_u = \frac{V_u}{\phi bd} = 2\sqrt{f'c}$ $\qquad v_{(allow)} = \frac{v_u}{1.7} \times \phi = \frac{V_u}{1.7bd} = \frac{2\phi\sqrt{f'c}}{1.7}$

WSD

$v_{(allow)} = 55\% \times 2\sqrt{f'c} = 1.1\sqrt{f'c}$ $\qquad \phi = 0.85$

Punching Shear

USD

$v_u = \frac{V_u}{\phi bd} = 4\sqrt{f'c}$ $\qquad v_{(allow)} = \frac{v_u \times \phi}{1.7} = \frac{V_u}{1.7bd} = \frac{4\phi\sqrt{f'c}}{1.7}$

WSD

$v_{(allow)} = 50\% \times 4\sqrt{f'c} = 2\sqrt{f'c}$ $\qquad \phi = 0.85$

CONCRETE STRENGTH		f'c = 3000 PSI		f'c = 4000 PSI		f'c = 5000 PSI	
Factor	f_y	WSD	USD	WSD	USD	WSD	USD
a	40,000 PSI	1.44	$\frac{2.56}{1.7} = 1.51$	1.44	1.51	1.44	1.51
	60,000 PSI	1.76	$\frac{3.94}{1.7} = 2.32$	1.76	2.32	1.76	2.32
K	40,000 PSI	226	$\frac{575}{1.7} = 338$	324	$\frac{767}{1.7} = 451$	426	$\frac{895}{1.7} = 526$
	60,000 PSI	204	$\frac{497}{1.7} = 292$	295	$\frac{662}{1.7} = 389$	390	$\frac{794}{1.7} = 467$
Beam v_c		60 PSI	$\frac{110}{2} = 55$ PSI	70 PSI	$\frac{126}{2} = 63$ PSI	78 PSI	$\frac{141}{2} = 71$ PSI
Footing v_o		110 PSI	$\frac{220}{2} = 110$ PSI	126 PSI	126 PSI	141 PSI	141 PSI

RETAINING WALLS "RETWALL"
PROGRAM DESCRIPTION

Program divides stem into 10 equal parts and calculates the moment, section thickness, required and minimum reinforcement for a vertical wall of constant or uniformly varying thickness with a horizontal backfill with or without a surcharge loading; stem shear; overturning moment; base shear; factor safety; weight; resultant location; toe and heel pressures, shear and reinforcement; passive pressure and key depth if required. Will also handle concentrated loads and moments on walls. Uses Working Stress or Ultimate Strength Design divided by the appropriate load factor per ACI 318-77.

This program uses Working Stress Design (Alternate Design Method) or Ultimate Strength Design (Load Factor Design) when divided by the load factor of 1.7 to determine the reinforcement and moment capacities. Remember that both "K" and "a" must be divided by the appropriate load factor prior to entry into the calculator. Sheet iii-1 has been included in the front of this manual for ready reference of WSD and USD values for "a", "K", "v_o" and "v_c" for 3000 PSI, 4000 PSI, and 5000 PSI concrete.

The footing or wall thickness is not increased internally, so the actual moments and shears must be compared with the allowables to insure that footing and wall can resist the loads with an adequate factor of safety. The program will not design for compressive reinforcement so the actual moments should never exceed the allowable moments.

The program will automatically use the surcharge loading to calculate the stem moments, shears, reinforcement, overturning moment, etc. but will not include the surcharge in the resisting moment or total wall weight unless Label D is pushed (sets flag zero). Most references suggest, however, that the surcharge not be included in the wall weight or resisting moment, which means that you could normally forget Label D.

The CRSI Design Handbook or other sources can be used to obtain preliminary design parameters for use in the wall and footing.

If the footing that you input produces a heel pressure less than zero at the tip of the heel, the program will automatically increment the toe and heel projections as required until a positive pressure exists on tip of footing heel. You as the designer can increment both heel and toe projections, hold the toe projection or hold the heel projection. Do this as follows:

Increment both heel (HP) and toe (TP) projections

> Push Label A (This clears flags 1 and 2)
> Then enter your data as shown on the calculation sheet

Hold toe (TP) projection

> Push Label B (This sets flag 1 and clears flag 2)
> Then enter your data as shown on the calculation sheet

Hold heel (HP) projection

> Push Label C (This sets flag 2 and clears flag 1)
> Then enter your data as shown on the calculation sheet

The concentrated load on the retaining wall is not used by the program to increase or reduce the wall reinforcement. However, the concentrated load is used in determining the resisting moment and total wall weight and is therefore used to design the footing. The position (Z) of this load is determined from the toe and will be incremented internally when the toe projection is changed.

When you have a sloping wall, the triangular wedge of soil above the rear face of wall is treated as concrete by the program. The P and Z may be used to correct the resisting moment when the slope is large. It can normally be ignored for small slopes.

The design of the key is based upon obtaining a 1.5 safety factor against sliding. The resistance to sliding is based upon the coefficient of friction (0.45) times the total wall and soil weight (W) and the resistance from passive pressure. Passive pressure is calculated using 300 PSF/foot of depth.

$1.5 \times \text{BASE SHEAR} = \text{Coef of Friction} \times W + 0.3\ H^2/2$

Weight of concrete = 150 LBS/FT^3
Weight of soil = 100 LBS/FT^3

H = Height of wall above footing (feet)

STMT = Stem thickness at top of wall (inches)

D1 = Centerline of reinforcement to back face of wall (inches)

D = Total slope of back face of stem (inches)

Soil H = Equivalent fluid pressure of soil on rear of wall (kips/ft^3)

HS = Height of surcharge (feet)

$a = f_s j/12{,}000$ for Working Stress Design

$= a_u/1.7 = \phi\ f_y\ (1 - .59w)/(12{,}000 \times 1.7)$ for Ultimate Strength Design

$K = \frac{1}{2} f_c kj = M/F = M/bd^2$ for Working Stress Design

$= M_u/(F \times 1.7) = \phi\ f'_c\ w(1 - .59w)/1.7 = K_u/1.7$ for Ultimate Strength Design

M (allow) = KF (Kip FT)

v = Shear at bottom of stem, or face of stem for heel or toe

TP = Toe projection (feet)

HP = Heel projection (feet)

FTG = Footing thickness (feet)

M_o = Overturning moment (Kip-feet)

BASE SHEAR = Total horizontal force on rear of wall (kips)

SHT = Depth of soil on toe (feet)

FTG WIDTH = Total footing width (feet)

M_R = Resisting moment of wall, footing and earth about toe (Kip-feet)

W = Total weight of stem, footing and earth on heel and toe (kips)

$\bar{x}$ = Location of resultant from toe (feet)

f_p = Soil pressure on tips of heel or toe (Kips/FT^2)

A_s = Area of reinforcement (square inches)

If you should desire a printout of the prompting statements along with the numerical results, set your printer to the normal mode.

The main program may be addressed directly by the execute key (XEQ) and the program name "RETWALL". Flag eleven has been set causing the program to initialize immediately upon entry of program cards.

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PUSH LABEL A, INCREMENTS HEEL AND TOE
PUSH LABEL B, HOLDS TOE PROJECTION (TP)
PUSH LABEL C, HOLDS HEEL PROJECTION (HP)
PUSH LABEL D IF SURCHARGE IS TO BE INCLUDED IN RESISTING MOMENT.

1

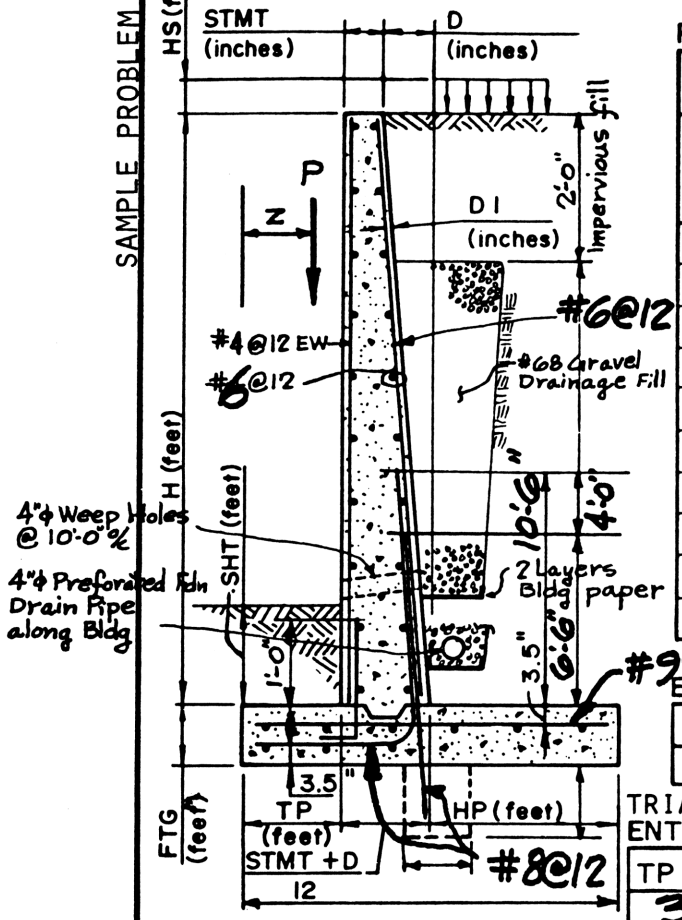
PROJECT: _____ RAN BY: _____ DATE: _____

SAMPLE PROBLEM

$f'_c = 3000$ #/in²
$f_s = 60{,}000$ #/in²

ENTER (R/S)

H (feet)	STMT	D I (inch)	D (inch)	Soil H	HS	a
20.0 '	12.0 "	2.5 "	10.0 "	0.03 K/ft²	2.0 '	1.76



PRINT

STEM DESIGN

Nº	SECTION HEIGHT (FT)	MOMENT (KI)	SECTION THICK. (IN)	As (req'd) = M/ad	As (min.) = .0025bt
1	2.0	0.16	13.00	0.008 in²	0.39 in²
2	4.0	0.80	14.00	0.0395	0.420
3	6.0	2.16	15.00	0.0982	0.45
4	8.0	4.48	16.00	0.1886	0.48
5	10.0	8.00	17.0	0.3135	0.51
6	12.0	12.96	18.0	0.475	0.54
7	14.0	19.60	19.0	0.674	0.57
8	16.0	28.16	20.0	0.914	0.60
9	18.0	38.88	21.0	1.1941	0.63
10	20.0	52.00	22.0	1.515	0.66

ℓ #8@6" (A_s = 1.58)

ENTER(R/S) PRINT ENTER(R/S)

K	M (allow)	V	SHT (feet)
204	77.57 KI	0.0308 K/in²	1.00 '

TRIAL FOOTING
ENTER(R/S) PRINT ENTER(R/S)

TP (feet)	HP (feet)	FTG WIDTH	FTG	P	Z
3.0 '	5.0 '	9.833 '	1.833 '	0 K	0 '

PRINT

M_0	BASE SHEAR
66.34 KI	8.46 K

PRINT FOOTING REQUIRED (FIX 08)

TP (feet)	HP (feet)	FTG WIDTH	FTG
4.0 '	6.0 '	11.833 '	1.833 '

PRINT

M_R (kft.)	FACTOR SAFE. OVERTURNING	W	$\bar{X}$ LOCAT. OF RESULTANT	fp (max.)	fp (min.)	
153.09 KI	2.3078	21.153 K	4.10 FT	3.433 K/in²	0.1421 K/in²	

PRINT

M (heel)	A_s (heel)	M (allow)	V (heel)			USE
31.97 KI/'	0.982 in²	69.78 KI	0.0405 K/in²			#9@12

PRINT

M (toe)	As (toe)	V (toe)	USE	COEF. OF FRICTION	Passive Press.	KEY DEPTH
21.499 KI	0.660 in²	0.0451 K/in²	#8@12	0.45	3.503 K	2.0 FT

WEEP HOLES	FDN. PIPE			KEY SIZE	FOOTING TEMP STEEL TOP	BOT
4"ϕ @ 10'-0" c/c	4"ϕ PREFORATED			1'-10" x 2'-0"	#7@12	#7@12

Shear Not Problem !!

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PUSH LABEL A, INCREMENTS HEEL AND TOE
PUSH LABEL B, HOLDS TOE PROJECTION (TP)
PUSH LABEL C, HOLDS HEEL PROJECTION (HP)
PUSH LABEL D IF SURCHARGE IS TO BE INCLUDED IN RESISTING MOMENT.

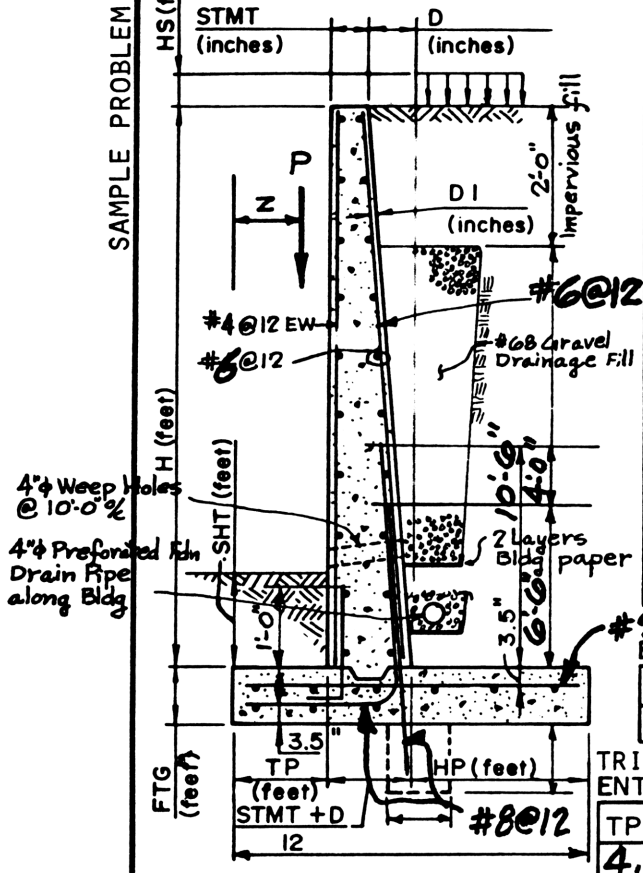
1

PROJECT: _____ RAN BY: _____ DATE __

SAMPLE PROBLEM

ENTER (R/S)

f'_c = 3000 #/□	H (feet)	STMT	D I(inch)	D(inch)	Soil H	HS	a
f_s = 60,000 #/□	20 '	12 "	2.5 "	10 "	0.03 K/□	2.0 '	1.76



PRINT

STEM DESIGN

Nº	SECTION HEIGHT (FT)	MOMENT (KI)	SECTION THICK. (IN)	As (req'd) = M/ad	As (min) = .0025bt
1	2.0	0.16	13.0	0.0087□	0.39□
2	4.0	0.80	14.0	0.0395	0.420
3	6.0	2.16	15.0	0.0982	0.450
4	8.0	4.48	16.0	0.1886	0.480
5	10.0	8.00	17.0	0.3135	0.510
6	12.0	12.96	18.0	0.475	0.540
7	14.0	19.60	19.0	0.6749	0.570
8	16.0	28.16	20.0	0.9143	0.60
9	18.0	38.88	21.0	1.1941	0.63
10	20.0	52.00	22.0	1.5152	0.66

ℓ #8@6" (As=1.58)

ENTER(R/S) PRINT ENTER(R/S)

K	M(allow)	V	SHT (feet)
204	77.57 KI	0.0308 K/□	1.00 '

TRIAL FOOTING

ENTER(R/S) PRINT ENTER(R/S)

TP (feet)	HP (feet)	FTG WIDTH	FTG	P	Z
4.0 '	5.5 '	11.3333 '	1.833 '	0 K	0 '

PRINT FOOTING REQUIRED (FIX 08)

TP (feet)	HP (feet)	FTG WIDTH	FTG
4.0 '	5.75 '	11.583 '	1.833 '

PRINT

M_O	BASE SHEAR
66.34 KI	8.460 K

PRINT

M_R (k.ft.)	FACTOR SAFE. OVERTURNING	W	$\bar{X}$ LOCAT. OF RESULTANT	fp (max.)	fp (min.)	
146.43 KI	2.2074	20.584 K	3.891 FT	3.526 K/□	0.0275 K/□	

PRINT

M (heel)	A_s (heel)	M (allow)	V (heel)			USE
30.89 KI/'	0.9488□	69.78 KI	0.0409 K/□			#9@12

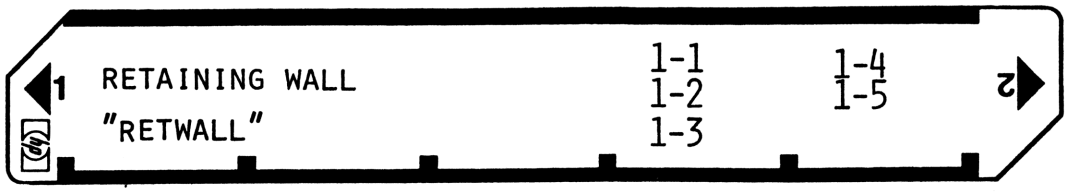
PRINT

M (toe)	As (toe)	V (toe)	USE	COEF. OF FRICTION	Passive Press.	KEY DEPTH
21.99 KI	0.675□	0.0454 K/□	#8@12	0.45	3.5037 K	2.0 FT

WEEP HOLES	FDN. PIPE			KEY SIZE	FOOTING TEMP STEEL TOP	BOT
4"ϕ @ 10'-0"c	4"ϕ PREFORATED			1'-10" x 2'-0"	#7@12	#7@12

Shear Not Problem!!

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	TURN PRINTER ON			
	MANUAL MODE - DISPLAYS PROMPTING			
	STATEMENTS ONLY			
	NORMAL MODE - DISPLAYS AND PRINTS			
	PROMPTING STATEMENTS			
2	TURN CALCULATOR ON (USER MODE)		ON	
3	PUSH XEQ ALPHA SIZE ALPHA 060 TO			
	PARTITION PROGRAM REGISTERS (SKIP			
	THIS STEP IF CALCULATOR PARTI-			
	TIONED FROM LAST PROGRAM)			
4	LOAD PREPROGRAMMED MAGNETIC CARDS			
5	PUSH LABEL A - INCREMENTS BOTH HEEL			
	AND TOE PROJECTION		A	
	PUSH LABEL B - INCREMENTS HEEL PRO-			
	JECTION AND HOLDS TOE PROJECTION		B	
	PUSH LABEL C - INCREMENTS TOE PRO-			
	JECTION AND HOLDS HEEL PROJECTION		C	
	PUSH LABEL D - ADDS SURCHARGE TO RE-			
	SISTING MOMENT		D	
6	PROCEED TO CALCULATION SHEET			
7	ENTER DATA AND PUSH R/S KEY	DATA	R/S	
8	REPEAT STEP 7 UNTIL PROBLEM COMPLETED			

Program Listing

HP-41c

STEP	KEY ENTRY	KEY CODE	COMMENTS
01	LBL "RETWALL"		Retaining Wall
02	CF 00		
03	LBL A		Increments Heel and Toe
04	CF 01		
05	CF 02		
06	GTO F		
07	LBL B		Hold Toe and Increments Heel
08	"HOLD TOE"		
09	AVIEW		
10	SF 01		
11	CF 02		
12	GTO F		
13	LBL C		Hold Heel and Increments Toe
14	"HOLD HEEL"		
15	AVIEW		
16	SF 02		
17	CF 01		
18	GTO F		
19	LBL D		Adds Surcharge to resisting Moment if Flag ϕ Set
20	"ADD SURCHARGE"		
21	AVIEW		
22	SF 00		
23	STOP		
24	LBL F		
25	SF 11		
26	SF 12		
27	"=CALPRO="		
28	PRA		
29	"CALCULATOR PRO"		
30	"I-GRAMS"		
31	PRA		
32	CF 12		
33	ADV		
34	"H"		
35	PROMPT	←	Enter H
36	PRX		
37	10		
38	/		H/10
39	STO 20		
40	STO 00		
41	"STMT"		
42	PROMPT	←	Enter Stmt
43	PRX		
44	STO 01		
45	STO 03		
46	"D1"		
47	PROMPT	←	Enter D1
48	PRX		
49	STO 02		
50	"D"		
51	PROMPT	←	Enter D
52	PRX		
53	10		
54	/		D/10
55	STO 21		
56	"SOIL H"		
57	PROMPT		
58	PRX	←	Enter Soil H
59	STO 04		
60	"HS"		
61	PROMPT	←	Enter HS
62	PRX		
63	STO 05		
64	"a"		
65	PROMPT	←	Enter a = fs'j/12000
66	PRX		
67	STO 06		
68	1		
69	STO 09		start Count
70	LBL 11		
71	ADV		
72	RCL 09		
73	PRX	→	Print Count
74	RCL 00		
75	PRX	→	Print H_N Distance from top of wall
76	X↑2		
77	RCL 04		
78	*		
79	2		
80	/		$M = \text{Soil H} \times \frac{(H_N)^2}{2}\left[H_S + \frac{H_N}{3}\right]$
81	RCL 05		
82	RCL 00		
83	3		
84	/		
85	+		
86	*		
87	PRX	→	Print M
88	STO 22		
89	RCL 03		
90	RCL 21		
91	+		
92	PRX	→	Print STMT+D_N
93	STO 03		
94	RCL 02		
95	-		
96	STO 08		$d = (\text{STMT}+D_N) - D1$ Effective Depth
97	/		
98	RCL 06		
99	/		
100	PRX	→	Print $A_S = \frac{M}{ad}$
101	RCL 03		
102	.03		
103	*		
104	PRX	→	$A_{S(min)} = .0025bd = .03d$
105	RCL 20		
106	ST+ 00		
107	1		

REGISTERS

00 H_N	01 STMT / TP	02 D1 / HP	03 STMT+D_N	04 Soil H	05 HS	06 a	07 MR	08 d / W	09 Count / FTG
10 Mo	11	12 P	13 Z	14	15 FTG WIDTH	16	17	18	19
20 H/10	21 D/10	22 M/K	23 $V_{base\ shear}$	24 M	25 SHT	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59

HP-41C

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
108	ST+	09	
109	RCL	09	
110	11		
111	-		
112	X<0?		Bottom of Wall? H_{10}
113	GTO	11	
114	ADV		
115	"K"		
116	PROMPT		Enter K
117	PRX		
118	STO	22	
119	RCL	08	
120	X↑2		
121	*		
122	3		
123	10↑X		
124	/		
125	"M ALLOW"		
126	AVIEW		
127	PRX		$M(allow) = \frac{d^2 K(12)}{12000}$
128	RCL	00	
129	RCL	20	
130	-		
131	STO	00	$H_{10} = H_{11} - H_N$ Height of wall
132	2		
133	/		
134	RCL	05	
135	+		
136	RCL	00	
137	*		
138	RCL	04	$v = \frac{\text{Soil H} \times H_N \left(H_S + \frac{H_N}{3}\right)}{12'' \times d_N}$
139	*		
140	12		
141	/		$\frac{STMT+D}{12}$
142	RCL	08	
143	/		
144	"V"		
145	AVIEW		
146	PRX		Print v
147	"SHT"		
148	PROMPT		Enter SHT
149	PRX		
150	STO	25	
151	ADV		
152	"TRIAL FOOTING"		Trial Footing
153	AVIEW		
154	"TP"		
155	PROMPT		Enter TP
156	PRX		
157	STO	01	
158	"H P"		
159	PROMPT		Enter HP
160	PRX		
161	STO	02	
162	+		
163	RCL	03	
164	12		
165	/		
166	+		
167	"FTG WIDTH"		
168	AVIEW		
169	PRX		Print FTG WIDTH
170	STO	15	
171	"FTG"		
172	PROMPT		Enter FTG
173	PRX		
174	STO	09	
175	RCL	00	
176	+		
177	STO	20	FTG + H
178	X↑2		
179	RCL	04	
180	*		Soil H x $\frac{H^2}{2}$
181	2		
182	/		
183	RCL	05	
184	RCL	20	$M_o = \text{Soil H} \times \frac{H^2}{2} \times \left(H_S + \frac{H}{3}\right)$
185	3		
186	/		
187	+		
188	*		M_o
189	STO	10	
190	RCL	20	
191	2		
192	/		
193	RCL	05	
194	+		
195	RCL	04	
196	*		
197	RCL	20	
198	*		
199	STO	23	
200	12		
201	ST/	03	
202	"P"		
203	PROMPT		Enter "P"
204	PRX		
205	STO	12	
206	"Z"		
207	PROMPT		Enter Z
208	PRX		
209	STO	13	
210	♦LBL	G	
211	RCL	05	
212	RCL	00	
213	FS?	00	
214	+		
215	.1		
216	*		
217	RCL	02	
218	*		

Add Surcharge in Resisting Moment if Flag 0 set

LABELS

A ✓	B ✓	C ✓	D ✓	E
F ✓	G ✓	H ✓	I	J ✓
a	b	c	d	e
01 ✓	02 ✓	03	04	05
06	07	08	09	10
11 ✓	12	13 ✓	14	15
16	17	18	19	20
21	22	23	24	25

FLAGS

0 ✓	1 ✓
2 ✓	3
4	5
6	7
8	9
16	17
24	25

SET STATUS

FLAGS (ON / OFF)

	ON	OFF
0	☐	■
1	☐	■
2	☐	■
3	☐	■

TRIG: DEG ■ GRAD ☐ RAD ☐

DISP: FIX ■ SCI ☐ ENG ☐ n 4

10	11 ✓	12 ✓	13	14	15
18	19	20	21	22	23
26	27	28	29	30	31

STEP	KEY ENTRY	KEY CODE	COMMENTS
		219 STO 08	$Wgt = 0.1 \times HP(H+H_S)$
		220 LASTX	
		221 2	
		222 /	
		223 RCL 01	$M_N = Wgt \times \left(\frac{HP}{2} + TP + \frac{STMT + D_N}{12}\right)$
		224 +	
		225 RCL 03	
		226 +	
		227 *	
		228 STO 07	M_N
		229 .15	
		230 RCL 00	
		231 *	$Wgt\ Stem = .15H \times \left(\frac{STMT+D_N}{12}\right)$
		232 RCL 03	
		233 *	
		234 ST+ 08	
		235 LASTX	Moment Arm $= wgt \times \left(\frac{HP}{2} + TP + \frac{STMT+D}{12 \times 2}\right)$
		236 2	
		237 /	
		238 RCL 01	
		239 +	
		240 *	
		241 ST+ 07	M_{wall}
		242 .15	
		243 RCL 09	
		244 *	
		245 RCL 15	
		246 *	
		247 ST+ 08	$wgt\ Ftg = .15 \times FTG \times (FTG\ WIDTH)$
		248 LASTX	
		249 *	
		250 2	$M(FTG)$
		251 /	
		252 ST+ 07	$M_{Footing}$
		253 .1	
		254 RCL 25	
		255 *	
		256 RCL 01	
		257 *	
		258 ST+ 08	W_{TOE}
		259 RCL 01	
		260 *	
		261 2	
		262 /	
		263 ST+ 07	M_{TOE}
		264 RCL 12	
		265 ST+ 08	P
		266 RCL 13	
		267 *	$MP = P \times Z$
		268 ST+ 07	
		269 RCL 07	
		270 RCL 08	
		271 /	
		272 STO 20	
		273 RCL 15	
		274 2	
		275 /	
		276 -	$e = \frac{M_R}{W} - \frac{Ftg\ Width}{2}$
		277 RCL 08	
		278 *	$M_{Net} = We - M_o$
		279 RCL 10	
		280 -	
		281 CHS	$\bar{X} = \frac{M_{net}}{W} + \frac{Ftg\ Width}{2}$
		282 STO 24	
		283 RCL 08	
		284 /	
		285 RCL 15	
		286 2	
		287 /	
		288 X<>Y	
		289 -	
		290 LASTX	
		291 ABS	$\frac{M_{net}}{W} - \frac{Ftg\ Width}{6}$ Check Kern
		292 RCL 15	Increment Ftg if outside of Kern
		293 6	
		294 /	
		295 -	
		296 X>0?	
		297 GTO H	
		298 RCL 10	
		299 "M-O"	
		300 AVIEW	
		301 PRX	→ Moverturning
		302 RCL 23	
		303 "BASE SHEAR"	
		304 AVIEW	
		305 PRX	→ Print Base Shear
		306 ADV	
		307 "FOOTING REQD"	Footing Req'd
		308 AVIEW	
		309 RCL 01	
		310 "TP"	
		311 AVIEW	
		312 PRX	→ Print TP
		313 RCL 02	
		314 "HP"	
		315 AVIEW	
		316 PRX	→ Print HP
		317 RCL 15	
		318 "FTG WIDTH"	
		319 AVIEW	
		320 PRX	→ Print FTG WIDTH
		321 RCL 09	
		322 "FTG"	
		323 AVIEW	
		324 PRX	→ Print FTG
		325 RCL 07	
		326 ADV	
		327 "M-R"	
		328 AVIEW	
		329 PRX	→ Print M_R
		330 RCL 10	
		331 /	
		332 "F.S."	
		333 AVIEW	
		334 PRX	→ Print Factor Safety overturning
		335 RCL 08	
		336 "W"	
		337 AVIEW	
		338 PRX	→ Print W Weight
		339 RCL 07	
		340 RCL 10	
		341 -	
		342 RCL 08	
		343 /	
		344 "X"	
		345 AVIEW	
		346 PRX	→ Print "$\bar{X}$" Location of Resultant
		347 RCL 24	
		348 RCL 15	$\bar{X} = \frac{M - M_o}{W}$
		349 /	
		350 6	$F_P = \frac{P}{A} \pm \frac{M}{S}$
		351 *	
		352 STO 20	$= \left(P \pm \frac{6M}{Ftg\ Width}\right)\left(\frac{1}{Ftg\ Width}\right)$
		353 RCL 08	
		354 +	
		355 RCL 15	
		356 /	
		357 "F P MAX"	$F_{P(max)}$
		358 AVIEW	

Program Listing

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STEP	KEY ENTRY	KEY CODE	COMMENTS
	359	PRX	Print Fp(max)
	360	STO 04	
	361	RCL 08	
	362	RCL 20	
	363	-	
	364	RCL 15	
	365	/	
	366	"F P MIN"	
	367	AVIEW	
	368	PRX	Print Fp(min)
	369	ADV	
	370	STO 03	
	371	-	
	372	RCL 15	
	373	/	
	374	RCL 02	
	375	X↑2	
	376	*	
	377	2	
	378	/	
	379	CHS	Triangular Load
	380	RCL 05	
	381	STO 24	
	382	RDN	
	383	STO 05	
	384	RCL 02	
	385	3	
	386	/	
	387	*	
	388	STO 07	M = W x HP/3
	389	RCL 24	
	390	RCL 00	
	391	+	
	392	.1	
	393	*	
	394	RCL 03	
	395	-	
	396	.15	
	397	RCL 09	
	398	*	
	399	+	
	400	RCL 02	
	401	*	
	402	ST+ 05	Rectangular Load on heel
	403	RCL 02	
	404	*	
	405	2	
	406	/	
	407	ST+ 07	Moment of Rect Load on Heel
	408	RCL 07	
	409	"HEEL"	
	410	AVIEW	
	411	"M"	
	412	AVIEW	
	413	PRX	Print M_{Heel}
	414	RCL 09	
	415	12	
	416	*	
	417	3.5	
	418	-	d = Ftg x 12 - 3.5
	419	STO 20	
	420	/	
	421	RCL 06	
	422	/	
	423	"A S HEEL"	
	424	AVIEW	
	425	PRX	Print $A_S = \frac{M}{ad}$
	426	RCL 20	
	427	X↑2	
	428	1000	
	429	/	
	430	RCL 22	
	431	*	
	432	"M ALLOW"	
	433	AVIEW	
	434	PRX	$M_{allow} = \frac{kd^2}{1000}$
	435	RCL 05	
	436	12	
	437	/	
	438	RCL 20	$V = \frac{V}{12d}$
	439	/	
	440	"V HEEL"	
	441	AVIEW	
	442	PRX	Print V_{Heel}
	443	ADV	
	444	RCL 25	
	445	.1	
	446	*	
	447	RCL 09	$V_{TOE} = [Fp(max) -$
	448	.15	Sht*.1 - FTG*.15]
	449	*	
	450	+	
	451	CHS	* TP
	452	RCL 04	Rectangular Load
	453	+	
	454	RCL 01	
	455	*	
	456	STO 05	stores Load
	457	RCL 01	
	458	*	
	459	2	
	460	/	
	461	STO 07	$M_{Toe} = \frac{W_{TOE}(TP)}{2}$
	462	RCL 04	
	463	RCL 03	
	464	-	
	465	RCL 15	Triangular Load
	466	/	on toe = $\frac{(TP)^2}{3}$
	467	RCL 01	
	468	X↑2	$*\left[\frac{Fp(max) - Fp(min)}{Ftg\ Width}\right]$
	469	*	
	470	2	
	471	/	
	472	ST- 05	
	473	RCL 01	
	474	3	
	475	/	
	476	*	
	477	ST- 07	$M_{Triangular\ Load} = W x \frac{TP}{3}$
	478	RCL 07	
	479	"TOE"	
	480	AVIEW	
	481	"M TOE"	
	482	AVIEW	
	483	PRX	M_{Toe}
	484	RCL 06	
	485	/	
	486	RCL 20	
	487	/	
	488	"A S TOE"	
	489	AVIEW	
	490	PRX	$A_S = \frac{M}{ad}$
	491	RCL 05	
	492	12	
	493	/	
	494	RCL 20	
	495	/	
	496	"V TOE"	
	497	AVIEW	
	498	PRX	$V_{Toe} = \frac{V_{Toe}}{bd}$

STEP	KEY ENTRY	KEY CODE	COMMENTS
	499	0	Start Shear key Design
	500	STO 06	
	501	RCL 23	
	502	1.5	Safety factor Sliding = 1.5
	503	*	
	504	RCL 08	
	505	.45	V*1.5 - 0.45W = 0
	506	"KEY"	
	507	AVIEW	
	508	"COEF FRICTION"	
	509	AVIEW	
	510	PRX	Print Coef of friction = 0.45
	511	*	
	512	-	
	513	STO 20	
	514	♦LBL 13	Increments Key depth in 3" Increments
	515	RCL 20	
	516	RCL 25	
	517	RCL 09	
	518	+	
	519	RCL 06	
	520	+	
	521	X↑2	
	522	.15	$P = \frac{0.3H^2}{2} = .15H^2$
	523	*	
	524	X>Y?	Stop when Passive Pressure exceeds Horiz Load *1.5
	525	GTO J	
	526	.25	
	527	ST+ 06	
	528	GTO 13	
	529	♦LBL J	
	530	"PASSIVE PRESSUR"	
	531	AVIEW	
	532	PRX	Passive Pressure
	533	RCL 06	
	534	"KEY DEPTH"	
	535	AVIEW	
	536	PRX	Print Key depth
	537	ADV	
	538	ADV	
	539	ADV	
	540	ADV	
	541	GTO A	Returns to A
	542	♦LBL H	Hold Toe? Hold Heel?
	543	.25	
	544	FS? 01	
	545	GTO 01	
	546	FS? 02	
	547	GTO 02	
	548	ST+ 13	Increments Heel, Toe, Z, Ftg Width, Ftg Width by 0.25 ~~feet~~
	549	ST+ 01	
	550	ST+ 02	
	551	ST+ 15	
	552	ST+ 15	
	553	GTO G	
	554	♦LBL 01	Increments Heel & Ftg Width by 3"
	555	ST+ 02	
	556	ST+ 15	
	557	GTO G	
	558	♦LBL 02	Increments Toe, Ftg Width, and Z by 3"
	559	ST+ 15	
	560	ST+ 13	
	561	ST+ 01	
	562	GTO 07	
	563	.END.	

FOOTING - AXIAL LOAD "FTGAL"

PROGRAM DESCRIPTION

Program calculates pier reinforcement, footing size, soil pressure, footing reinforcement, moments, shears, number of bars, area per bar, and punching shear for both square and rectangular footings. Uses Working Stress Design (Alternate Design Method) or Ultimate Strength Design (Load Factor Design) when divided by the appropriate load factors.

If you should desire a printout of the prompting statements along with the numerical results, set your printer to the mornal mode.

The main program may be addressed directly by the execute key (XEQ) and the program name "FTGAL". Flag eleven has been set causing the program to initialize immediately upon entry of program cards.

Working Stress Design (Alternate Design Method) or Ultimate Strength Design (Load Factor Design) when divided by the appropriate load factor can be used to determine the reinforcement, shear, and moment capacities. Remember that both "K" and "a" must be divided by the appropriate Load Factor prior to entry into the calculator. Sheet iii-1 has been included in the front of this manual for ready reference of WSD and USD Values for "a", "K", "v_o" and "v_c" for 3000 PSI, 4000 PSI, and 5000 PSI concrete.

For positive loads, footing size is increased until the external axial load, footing, earth, and pier loads yield a soil pressure less than the allowable soil bearing value.

All negative loads are multiplied by 1.5 to assure an adequate safety factor against uplift. The footing size is increased until a positive pressure exists on bottom of footing based on a soil weight of 100 LBS/FT^3 and concrete weight of 150 LBS/FT^3.

The footing thickness is not increased internally, so the actual moments and shears must be compared with the allowables to insure that footing is capable of carrying the load with an adequate factor of safety. Normally, the punching shears will govern first, the beam shears second and moments last.

The maximum punching shear is computed for a concrete strength of 3000 PSI so that a comparison can be made with the external axial load. When "V_o" is less than the axial load "P", you must either increase footing thickness and/or manually calculate the additional bearing capacity under footing within the punching shear area at "d/2". You must also increase footing thickness when the moment capacity or the beam shear exceeds the allowables.

Program will check several loads for the same footing without inputting the parameters each time. However, if the footing size is altered after you input the second load, simply re-enter the earlier load to obtain the new footing requirements.

Three inch clearance is used for all bars assuming a maximum bar size of 1"; d for main bars is 3.5" and 4.5" for transverse bars.

Where negative values occur for uplift loads, place this amount of steel in top of footing.

A_s (min) pier = .005 x gross pier area
footing = .002 x gross footing area

L = Footing length (feet)

W = Footing width (feet)

T = Footing thickness (feet)

Earth Thickness = Thickness of earth on top of footing (feet)

B = Width of pier (inches)

C = Length of pier (inches)

A_s = Area of reinforcement (in^2)

$a = f_s j/12000$ for Working Stress Design
$a_u/1.7 = \phi\, f_y\,(1 - .59w)/(12{,}000 \times 1.7)$ for Ultimate Strength Design

$K = \frac{1}{2} f_c k j = M/F = M/bd^2$ for Working Stress Design
$= M_u/(F \times 1.7) = \phi\, f'c\, w(1 - .59w)/1.7 = K_u/1.7$ for Ultimate Strength Design

P = External load (kips)

F_p = Actual soil bearing value under footing (KSF)

v = Shear (KSI)

M = Moment (Kip-feet)

Soil Brg Value = Allowable Soil Bearing Value

JOHN DOE & ASSOCIATES
CONSULTING STRUCTURAL ENGINEERS
111 YOUR STREET
ANYWHERE, U.S.A. 00000

JOB SAMPLE PROBLEM
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____
SCALE _____ COMM. NO. _____

FOOTING LOCATION FOOTING K-27 (PUSH LABEL A)
PUSH LABEL B FOR HOLDING WIDTH OF FOOTING.

FOOTING AXIAL LOAD **2**

ENTER (R/S)

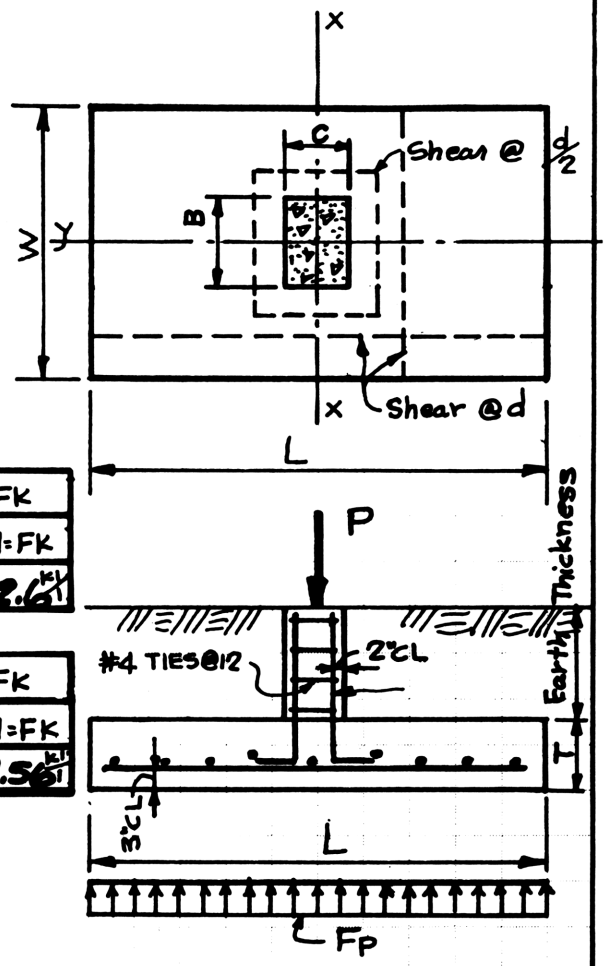
L	W	T	Earth Thickness	Soil Brg Value
6.0 FT	4.0 FT	1.17 FT	2 FT	3 K/□'

ENTER (R/S) PRINT ENTER (R/S)

B	C	As(Pier)	a	K
18 IN	16 IN	1.44 □"	1.76	204
		.005 BC		

ENTER (R/S) PRINT

P1	L	W	T	Fp
80 K	6.75 FT	4.75 FT	1.17 FT	2.8769 K/□'



FIRST LOAD P_1

BOTTOM MAIN FTG REINF — Mact ≤ FK

As(TOTAL)	Nº BARS	As/Bar	ν@d	As(min)	M(actual)	M=FK
2.349 □"	5	0.4698 □"	0.0366 K/□"	1.6006 □"	9.17 K'/'	22.6 K'/'

BOTTOM TRANSVERSE FTG REINF — Mact ≤ FK

As(TOTAL)	Nº BARS	As/Bar	ν@d	As(min)	M(actual)	M=FK
1.327 □"	7	0.1897 □"	0.0181 K/□"	2.2745 □"	3.30 K'/'	18.56 K'/'

Vallow @ ϕ=0.11 $b_o d$ — V ≥ P_1

111.4043 K

ENTER (R/S) FOR SECOND LOAD

P2	L	W	T	Fp
-4 K	6.75 FT	4.75 FT	1.170 FT	0.1940 K/□'

ENTER(R/S) PRINT
UPLIFT

SECOND LOAD P_2

BOTTOM MAIN FTG REINF — Mact ≤ FK

As(TOTAL)	Nº BARS	As/Bar	ν@d	As(min)	M(actual)	M=FK
-0.1699 □"	5	-0.0348 □"	-0.0026 K/□"	1.6006 □"	-0.663 K'/'	22.66 K'/'

BOTTOM TRANSVERSE FTG REINF — Mact ≤ FK — V ≥ P_2

(As(TOTAL)	Nº BARS	As/Bar	ν@d	As(min)	M(actual)	M=FK	Vallow @ ϕ=.11 $b_o d$
-0.096 □"	7	-0.0137 □"	-0.0013 K/□"	2.2745 □"	-0.239 K'/'	18.566 K'/'	111.4043 K

IF FOOTING PARAMETERS DO NOT CHANGE, YOU CAN ENTER AS MANY LOADS AS DESIRED WITH FOOTING SIZES AND REINFORCEMENT COMPUTED FOR EACH LOAD.

USE Ftg 6'-9" x 4'-9" w/ 6-#6 L.W,B ; 5-#4 L.W.,T
7-#4 S.W,B ; 7-#4 S.W.T

User Instructions

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	TURN PRINTER ON			
	MANUAL MODE - DISPLAYS PROMPTING			
	STATEMENTS ONLY			
	NORMAL MODE - DISPLAYS AND PRINTS			
	PROMPTING STATEMENTS			
2	TURN CALCULATOR ON (USER MODE)		ON	
3	PUSH XEQ ALPHA SIZE ALPHA 060 TO			
	PARTITION PROGRAM REGISTERS (SKIP			
	THIS STEP IF CALCULATOR PARTI-			
	TIONED FROM LAST PROGRAM)			
4	LOAD PREPROGRAMMED MAGNETIC CARDS			
5	PUSH LABEL A-FOOTING AXIAL LOAD -			
	INCREMENTS BOTH FOOTING LENGTH AND			
	WIDTH		A	
	PUSH LABEL B - FOOTING AXIAL LOAD -			
	HOLDS FOOTING WIDTH AND INCREMENTS			
	FOOTING LENGTH		B	
6	PROCEED TO CALCULATION SHEET			
7	ENTER DATA AND PUSH R/S KEY	DATA	R/S	
8	REPEAT STEP 7 UNTIL PROBLEM COMPLETED			

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Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
01	LBL "FTGAL"		Footing-axial Load "FTGAL"
02	LBL A		
03	SF 00		
04	LBL 11		
05	SF 11		
06	SF 12		
07	"=CALPRO="		
08	PRA		
09	"CALCULATOR PRO"		
10	"PROGRAMS"		
11	PRA		
12	CF 12		
13	ADV		
14	0		
15	STO 25		count
16	"L"		
17	XEQ 00		Enter L
18	"W"		
19	XEQ 00		Enter W
20	"T"		
21	XEQ 00		Enter T
22	"EARTH THICKNESS"		
23	XEQ 00		Earth Thickness
24	"SOIL BRG VALUE"		
25	XEQ 00		Soil Brg Value
26	ADV		
27	"B"		
28	XEQ 00		Enter B
29	"C"		
30	XEQ 00		Enter C
31	*		
32	.005		
33	*		
34	"A S"		
35	AVIEW		
36	PRX		Print $A_s = .005BC_{Pier}$
37	"a"		
38	XEQ 00		Enter a
39	"K"		
40	XEQ 00		Enter K
41	ADV		
42	LBL C		
43	"P"		
44	PROMPT		Enter P
45	PRX		
46	X<0?		If "P" negative
47	XEQ 02		increase by 1.5
48	STO 20		
49	"FOOTING SIZE"		Footing Size
50	AVIEW		
51	LBL 12		
52	RCL 00		
53	RCL 01		
54	*		
55	RCL 02		
56	.15		
57	*		
58	RCL 03		
59	.1		
60	*		
61	+		
62	*		
63	STO 09		
64	RCL 05		
65	RCL 06		
66	*		
67	144		
68	/		
69	RCL 03		
70	*		
71	.05		
72	*		
73	ST+ 09		
74	RCL 20		
75	RCL 09		
76	+		
77	RCL 00		
78	/		
79	RCL 01		
80	/		
81	STO 21		- soil pressure
82	X<0?		uplift on Footing?
83	GTO 03		
84	RCL 04		
85	X<=Y?		
86	GTO 03		soil pressure ≤ than allowable?
87	RCL 00		
88	"L"		
89	AVIEW		
90	PRX		Print L
91	RCL 01		
92	"W"		
93	AVIEW		
94	PRX		Print W
95	RCL 02		
96	"T"		
97	AVIEW		
98	PRX		Print T
99	RCL 03		
100	.1		
101	*		
102	RCL 02		
103	.15		
104	*		
105	+		
106	RCL 21		
107	"F P"		
108	AVIEW		
109	PRX		Print Fp soil Brg Value

Weight of $Ftg_1 = WL\left[0.15 \times T + 0.1 \times (\text{Earth Thickness})\right] + \frac{BC}{144}(\text{Earth Thickness})(0.05)$ Soil & Pier

REGISTERS

00 L	01 W	02 T	03 Earth Thickness	04 Soil Brg Value	05 B	06 C	07 a	08 K	09 Ftg Weight
10	11	12	13	14	15	16	17	18	19
20 P	21 W' Soil Pressure	22 W' soil Pressure causing Bending	23 d	24	25 Count / Moment Arm	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59

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Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
		110 ADV	
		111 X<>Y	
		112 -	
		113 STO 22	Soil pressure causing Bending
		114 RCL 00	
		115 RCL 06	
		116 XEQ 04	
		117 RCL 01	
		118 *	
		119 RCL 02	
		120 12	
		121 *	
		122 3.5	$d = T \times 12 - 3.5"$
		123 -	
		124 STO 23	
		125 /	
		126 RCL 07	
		127 /	
		128 "MAIN"	MAIN
		129 AVIEW	
		130 PRX	Print $A_s = \frac{M}{ad}$
		131 RCL 01	
		132 XEQ 05	
		133 RCL 01	
		134 XEQ 06	
		135 RCL 22	
		136 RCL 01	
		137 RCL 05	
		138 XEQ 04	
		139 RCL 00	
		140 *	
		141 RCL 23	
		142 1	
		143 -	
		144 STO 23	$d_T = d_M - 1"$
		145 /	
		146 RCL 07	
		147 /	
		148 "TRANSVERSE"	Transverse
		149 AVIEW	
		150 PRX	Print $A_s = \frac{M}{ad}$
		151 RCL 00	
		152 XEQ 05	
		153 RCL 00	
		154 XEQ 06	
		155 RCL 05	
		156 RCL 06	
		157 +	
		158 RCL 23	
		159 +	
		160 RCL 23	
		161 +	
		162 2	
		163 *	
		164 RCL 23	
		165 *	
		166 .11	
		167 *	
		168 "V ALLOW"	
		169 AVIEW	
		170 PRX	Print $V_{allow}(\frac{d}{2}) = 0.11 b_o d$
		171 ADV	
		172 ADV	
		173 ADV	
		174 GTO C	Go to C
		175♦LBL 00	Prints and Stores Data
		176 PROMPT	
		177 PRX	
		178 STO IND 25	
		179 ?ISZ	
		180 RTN	
		181♦LBL 02	Provide Safety Factor of 1.5 for uplift
		182 1.5	
		183 *	
		184 RTN	
		185♦LBL 03	Add 3" to Length
		186 .25	
		187 ST+ 00	Add 3" to width if Flag 0 set
		188 FS? 00	
		189 ST+ 01	
		190 GTO 12	
		191♦LBL 04	$M = W_x \times w_{Bending} \times \left[\frac{L - C/12}{2}\right]^2$
		192 12	
		193 /	
		194 -	
		195 2	
		196 /	
		197 STO 25	
		198 X↑2	
		199 *	
		200 2	
		201 /	
		202 STO 24	
		203 RTN	
		204♦LBL 05	
		205 1	
		206 +	
		207 INT	
		208 PRX	Print № Bars
		209 /	
		210 PRX	Print As/bar
		211 RCL 25	
		212 RCL 23	
		213 12	
		214 /	
		215 -	
		216 RCL 22	

LABELS

A ✓	B ✓	C ✓	D	E
F	G	H	I	J
a	b	c	d	e
00 ✓	02 ✓	03 ✓	04 ✓	05 ✓
06 ✓	07	08	09	10
11 ✓	12 ✓	13	14	15
16	17	18	19	20
21	22	23	24	25

FLAGS

0	1
2	3
4	5
6	7
8	9
16	17
24	25

SET STATUS

FLAGS (ON / OFF): 0 ■ □ ; 1 □ ■ ; 2 □ ■ ; 3 □ ■

TRIG: DEG ■ ; GRAD □ ; RAD □

DISP: FIX ■ ; SCI □ ; ENG □ ; n 4

10	11 ✓	12 ✓	13	14	15
18	19	20	21	22	23
26	27	28	29	30	31

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
		217 *	Beam Shear @ d
		218 12	$v = \frac{w' \times (L' - d/12)}{12'' \times d}$
		219 /	
		220 RCL 23	
		221 /	
		222 PRX →	Print Shear @ d from Face
		223 RTN	
		224◆LBL 06	
		225 RCL 02	
		226 *	
		227 .288	
		228 *	
		229 PRX →	$A_{s(min)} = .002WT$
		230 RCL 24	
		231 "MOMENT"	
		232 AVIEW	
		233 PRX →	Print Moment K'/FT
		234 RCL 08	
		235 RCL 23	
		236 X↑2	$M = \frac{bd^2}{12000} \times K$
		237 *	
		238 E3	
		239 /	
		240 PRX →	Print $M = FK$
		241 ADV	
		242 RTN	
		243◆LBL B	Clears flag 0 to Hold Footing Width
		244 CF 00	
		245 GTO 11	
		246 .END.	

ECCENTRICALLY LOADED FOOTING "ECCFTGC"
COMBINED LOADS
PROGRAM DESCRIPTION

Program calculates minimum and maximum pressures for three loading combination (D + L, D + W, D + L + W, or others) including axial loads, horizontal shear at top of pier, and moment; pier reinforcement; footing reinforcement each way top and bottom; number of bars; area of bars; and shears. This program will automatically increment footing size until soil bearing value or uplift requirements are satisfied. You can increment footing width and length or the length only. Uses Working Stress or Ultimate Strength Design divided by the appropriate load factor per ACI 318-77.

If you should desire a printout of the prompting statements along with the numerical results, set your printer to the normal mode.

The main program may be addressed directly by the execute key (XEQ) and the program name "ECCFTGC". Flag eleven has been set causing the program to initialize immediately upon entry of program cards.

Footing length and width are incremented in 3" increments until the actual soil bearing value is less than the allowable soil bearing value. When uplift exists the footing is also incremented until a positive pressure exists under the entire footing. A factor of safety is not applied internally to uplift loads and is usually not warranted if a moment and/or horizontal shear exists. If only an uplift load exists, apply a safety factor of 1.5 or use the "Footing-Axial Load" program.

Each loading condition is complete in itself, which means you can input any loading combination that you desire including D + L, D + W, D + L + W and others.

A three inch clearance is used for all bars assuming a maximum bar size of 1"; d for main bars is 3.5" and 4.5" for transverse bars.

This program uses Working Stress Design (Alternate Design Method) or Ultimate Strength Design (Load Factor Design) when divided by the load factor of 1.7 to determine the reinforcement and moment capacities. Remember that both "K" and "a" must be divided by the appropriate load factor prior to entry into the calculator. Sheet iii-1 has been included in the front of this manual for ready reference of WSD and USD values for "a", "K", "v_o" and "v_c" for 3000 PSI, 4000 PSI, and 5000 PSI concrete.

The footing or pier thickness is not increased internally, so the actual moments and shears must be compared with the allowables to insure that footing and pier can resist the loads with an adequate factor of safety. The program will not design for compressive reinforcement so the actual moments should never exceed the allowable moments.

Top reinforcement is designed to totally resist the earth and concrete load when lifted vertically, without regard to pressure on bottom which would serve to reduce the reinforcement required.

This program treats the pier within the ground as an earth load. If the pier is excessively large, add 0.05 K/FT^3 for volume below ground line and .15 K/FT^3 for volume above the ground line.

IMPORTANT! The maximum pressures must always occur on the toe as the moments and shears are determined from the toe pressures. The program will automatically check each of the three conditions for maximum moment and maximum shear. However, the maximum moments and shears do not have to occur in the same loading condition but must occur on the toe side of the footing. The results obtained by imputting the moment and shear on top of the pier in the opposite direction from that shown will give you moments and shears based on the mimimum pressure similar to the heel of a retaining wall.

Nomenclature:

Shear at d/2 = 0.11 x b_o x d

M_o = M + H (T + Earth thickness + Z)

$$F_p = \frac{P}{L \times W} \pm \frac{6M_o}{W \times L^2}$$

L = Footing length (feet)

W = Footing width (feet)

T = Footing thickness (feet)

Earth thickness = thickness of earth on footing (feet)

Z = Height of pier above the ground or floor line (feet)

P = Axial load (kips)

M = Overturning moment on pier (kip feet)

H = Horizontal load on top of pier (kips)

F_p = Actual soil pressure under footing (kips/SF)

B = Pier width (inches)

C = Pier length (inches)

A_s = Area of reinforcement; M/a x d or M/(a_u x 1.7 x d) (in^2)

v = Beam shear at face of pier or punching shear at d/2 ($kips/in^2$)

a = $f_s j/12000$ for Working Stress Design

= $a_u/1.7 = \phi f_y (1-.59w)/(12{,}000 \times 1.7)$ for Ultimate Strength Design

$K = \frac{1}{2} f_c kj = M/F = M/bd^2$ for Working Stress Design

= $M_u/(F \times 1.7) = \phi f'_c w (1-.59w)/1.7 = K_u/1.7$ for Ultimate Strength Design

$F = bd^2/12000$

f'_c = Compressive Concrete strength (PSI)

f_y = Yield Strength of reinforcement (PSI)

A_s (min) - Footing = .002 x Gross Footing Area
Pier = .005 x Gross Pier Area

JOHN DOE & ASSOCIATES
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111 YOUR STREET
ANYWHERE, U.S.A. 00000

JOB SAMPLE PROBLEM (3-3)
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____
SCALE _____ COMM. NO. _____

FOOTING LOCATIONS: (PUSH LABEL A) FOOTING B-7

ECCENTRICALLY LOADED FOOTING (COMBINED LOADS) 3

PUSH LABEL B FOR HOLDING WIDTH OF FOOTING.
ENTER (R/S)

DEAD + LIVE

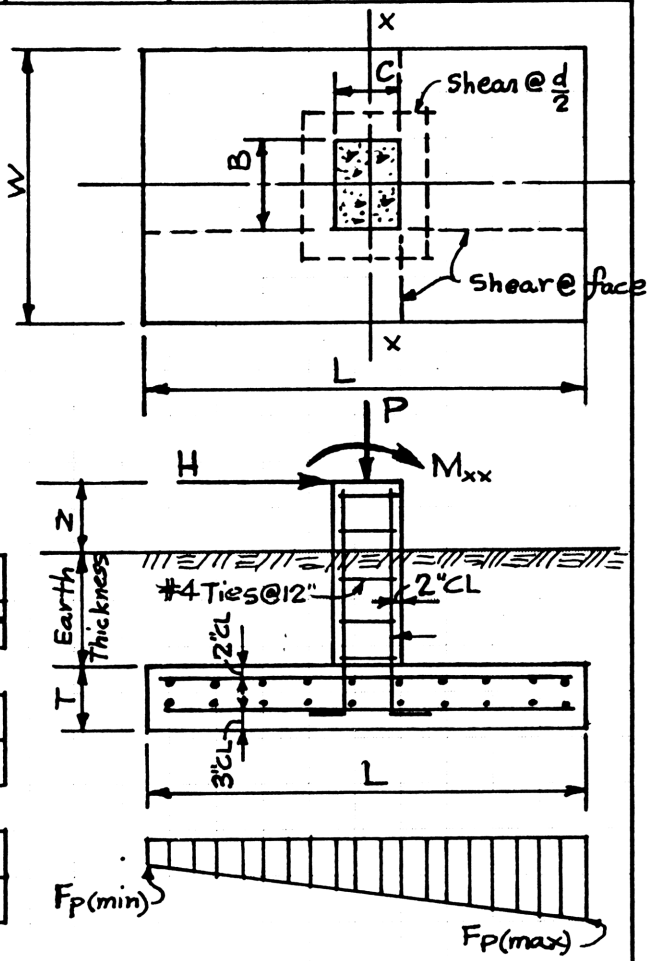
L	W	T	Earth Thick	Z	Soil Brg Value	P_{DL+LL}	M_{DL+LL}	H_{DL+LL}
4.0 FT	6.0 FT	1.5 FT	2.0 FT	3 FT	4 K/□'	150 K	20 K'	6 K

DEAD + WIND

P_{DL+WL}	M_{DL+WL}	H_{DL+WL}
75 K	5 K'	2 K

DEAD + LIVE + WIND

$P_{DL+LL+WL}$	$M_{DL+LL+WL}$	$H_{DL+LL+WL}$	$\frac{a_u}{1.7}$ (USD) a (WSD)	$\frac{K_u}{1.7}$ (USD) K (WSD)
125.0 K	7 K'	3 K	1.76	204



FOOTING REQUIRED (PRINT)

L	W	T
6.75 FT	8.75 FT	1.50 FT

DEAD + LIVE (PRINT)

P_{DL+LL}	M_{DL+LL}	H_{DL+LL}	$F_{P(max)}$	$F_{P(min)}$
150.0 K	20.0 K'	6.0 K	3.852 K/□'	2.076 K/□'

DEAD + WIND

P_{DL+WL}	M_{DL+WL}	H_{DL+WL}	$F_{P(max)}$	$F_{P(min)}$
75.0 K	5.0 K'	2.0 K	1.9657 K/□'	1.4239 K/□'

DEAD + LIVE + WIND

$P_{DL+LL+WL}$	$M_{DL+LL+WL}$	$H_{DL+LL+WL}$	$F_{P(max)}$	$F_{P(min)}$
125.0 K	7.0 K'	3.0 K	2.9402 K/□'	2.1426 K/□'

PIER; ENTER (R/S) PRINT

B	C	$A_{s(min)}$	$M_{(max)}$	A_s or A'_s	REINF	Ties	Sketch
16 IN	18 IN	1.44 □" .005 BC	50.0 K'	1.8939 □"	-#	#4@12	

BOTT MAIN FTG REINF				BOTT TRANSVERSE FTG REINF				BOTTOM MAIN		
$A_{s(TOTAL)}$	No. Bars	A_s/Bar	U face Pier	$A_{s(TOTAL)}$	No. Bars	A_s/Bar	U face Pier	$A_{s(min)}$	$M_{(max)}$	M=FK
3.7771 □"	9	0.4197 □"	0.0465 K/□'	6.6954 □"	7	0.9565 □"	0.0785 K/□'	3.780 □"	11.016 K'	42.891 K'

IF HIGH, INCREASE FTG T

BOTTOM TRANSVERSE			TOP MAIN REINF			TOP TRANSVERSE REINF			Value $\frac{d}{2}$ $= 0.11 b_o d$	f'_c
$A_{s(min)}$	$M_{(max)}$	M=FK	A_s	No. Bars	A_s/Bar	A_s	No. Bars	A_s/Bar		
2.916 □"	23.56 K'	37.176 K'	0.502 □"	9	0.0558 □"	0.8302 □"	7	0.1186 □"	190.96 K	3,000 #/□"

INCREASE FTG THICKNESS !!!

$f_y = 60{,}000$ #/□"

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	TURN PRINTER ON			
	MANUAL MODE - DISPLAYS PROMPTING			
	STATEMENTS ONLY			
	NORMAL MODE - DISPLAYS AND PRINTS			
	PROMPTING STATEMENTS			
2	TURN CALCULATOR ON (USER MODE)		ON	
3	PUSH XEQ ALPHA SIZE ALPHA 030 TO			
	PARTITION PROGRAM REGISTERS (SKIP			
	THIS STEP IF CALCULATOR PARTI-			
	TIONED FROM LAST PROGRAM)			
4	LOAD PREPROGRAMMED MAGNETIC CARDS			
5	PUSH LABEL A - ECCENTRICALLY LOADED			
	FOOTING, INCREMENTS FOOTING LENGTH			
	AND WIDTH		A	
	PUSH LABEL B - ECCENTRICALLY LOADED			
	FOOTING, INCREMENTS FOOTING LENGTH			
	AND HOLDS WIDTH		B	
6	PROCEED TO CALCULATION SHEET			
7	ENTER DATA AND PUSH R/S KEY	DATA	R/S	
8	REPEAT STEP 7 UNTIL PROBLEM COMPLETED			

HP-41C

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
01	LBL "ECCFTGC"		Eccentrically Loaded Footing "ECCFTGC"
02	LBL A		
03	SF 00		
04	GTO F		
05	LBL B		Clear Flag 0 to Hold width
06	CF 00		
07	LBL F		
08	SF 11		
09	SF 12		
10	"=CALPRO="		
11	PRA		
12	"CALCULATOR PRO"		
13	"PROGRAMS"		
14	PRA		
15	CF 12		
16	ADV		
17	"L"		
18	PROMPT	←	Enter L
19	PRX		
20	STO 00		
21	"W"		
22	PROMPT	←	Enter W
23	PRX		
24	STO 01		
25	"T"		
26	PROMPT	←	Enter T
27	PRX		
28	STO 02		
29	"EARTH THICK"		
30	PROMPT	←	Earth thickness
31	PRX		
32	STO 03		
33	"Z"		
34	PROMPT	←	Enter Z
35	PRX		
36	+		
37	+		
38	STO 24		
39	"SOIL BRG"		
40	PROMPT	←	Enter Soil Brg Value
41	PRX		
42	STO 21		
43	"DEAD + LIVE"		Dead + Live Load
44	PRA		
45	"P"		
46	PROMPT	←	P_{DL+LL}
47	PRX		
48	STO 10		
49	"M"		
50	PROMPT	←	M_{DL+LL}
51	PRX		
52	STO 11		
53	"H"		
54	PROMPT	←	H_{DL+LL}
55	PRX		
56	STO 12		
57	"DEAD + WIND"		Dead + Wind Load
58	PRA		
59	"P"		
60	PROMPT	←	P_{DL+WL}
61	PRX		
62	STO 13		
63	"M"		
64	PROMPT	←	M_{DL+WL}
65	PRX		
66	STO 14		
67	"H"		
68	PROMPT	←	H_{DL+WL}
69	PRX		
70	STO 15		
71	"DEAD+LIVE+WIND"		Dead + Live + Wind
72	PRA		
73	"P"		
74	PROMPT	←	$P_{DL+LL+WL}$
75	PRX		
76	STO 16		
77	"M"		
78	PROMPT	←	$M_{DL+LL+WL}$
79	PRX		
80	STO 17		
81	"H"		
82	PROMPT	←	$H_{DL+LL+WL}$
83	PRX		
84	STO 18		
85	"a"		
86	PROMPT	←	Enter a
87	PRX		
88	STO 26		
89	"K"		
90	PROMPT	←	Enter K
91	PRX		
92	STO 27		
93	ADV		
94	"FOOTING REQD"		Footing Required
95	AVIEW		
96	LBL 15		
97	10		
98	STO 25		
99	XEQ 11		Calculates DL+LL Footing Requirements
100	XEQ 12		
101	ST+ 04		
102	ST- 05		
103	RDN		
104	ST+ 04		
105	ST+ 05		
106	RCL 04		
107	RCL 21		
108	X>Y?		Checks for Toe Pressure > Soil Brg Value
109	GTO 16		

DL+LL REGISTERS DL+LL DL+WL DL+WL DL+LL+WL DL+LL+WL

00 L	01 W	02 T / W	03 Earth Thickness	04 f_p max / d main	05 f_p min	06 f_p max / d Trans	07 f_p min	08 f_p max	09 f_p min
10 P_{DL+LL} / (L-C)/2	11 M_{DL+LL} / M	12 H_{DL+LL} / V	13 P_{DL+WL} / (W-B)/2	14 M_{DL+WL} / M	15 H_{DL+WL} / V	16 $P_{DL+LL+WL}$	17 $M_{DL+LL+WL}$	18 $H_{DL+WL+WL}$	19 Pier Mom Arm
20 B	21 Soil Brg / C	22 Area W V	23 Sxx / M	24 T+Z+Earth Thickness	25 Count / L	26 a	27 K	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59

HP-41C

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
	110 XEQ 13		
	111 GTO 15		
	112♦LBL 16		Check Heel pressure if<0, and then increments Ftg if<0.
	113 RCL 05		
	114 X>0?		
	115 GTO 16		
	116 XEQ 13		
	117 GTO 15		
	118♦LBL 16		Calculates DL+WL Footing Requirements
	119 XEQ 12		
	120 ST+ 06		
	121 ST- 07		
	122 RDN		
	123 ST+ 06		
	124 ST+ 07		
	125 RCL 06		Checks for Toe Pressure > soil Pressure
	126 RCL 21		
	127 X>Y?		
	128 GTO 16		
	129 XEQ 13		
	130 GTO 15		
	131♦LBL 16		Check Heel pressure <0 ; then increments footing if <0
	132 RCL 07		
	133 X>0?		
	134 GTO 16		
	135 XEQ 13		
	136 GTO 15		
	137♦LBL 16		Calculates DL+LL+WL Footing Requirements
	138 XEQ 12		
	139 ST+ 08		
	140 ST- 09		
	141 RDN		
	142 ST+ 08		
	143 ST+ 09		
	144 RCL 08		
	145 RCL 21		Checks for Toe Pressure > soil Pressure
	146 X>Y?		
	147 GTO 16		
	148 XEQ 13		
	149 GTO 15		
	150♦LBL 16		Check Heel pressure <0; then increments footing if <0
	151 RCL 09		
	152 X>0?		
	153 GTO 16		
	154 XEQ 13		
	155 GTO 15		
	156♦LBL 16		Footing Required
	157 RCL 00		
	158 "L"		
	159 PRA		
	160 PRX		Print L
	161 RCL 01		
	162 "W"		
	163 PRA		
	164 PRX		Print W
	165 RCL 02		
	166 "T"		
	167 PRA		
	168 PRX		Print T
	169 10		
	170 STO 25		
	171 "DEAD + LIVE"		Dead + Live
	172 PRA		
	173 XEQ 18		P_{DL+LL}
	174 XEQ 18		M_{DL+LL}
	175 XEQ 18		H_{DL+LL}
	176 RCL 04		
	177 "F P"		
	178 PRA		
	179 PRX		Fp max
	180 RCL 05		
	181 PRX		Fp min
	182 "DEAD + WIND"		Dead + Wind
	183 PRA		
	184 XEQ 18		P_{DL+WL}
	185 XEQ 18		M_{DL+WL}
	186 XEQ 18		H_{DL+WL}
	187 RCL 06		
	188 "F P"		
	189 PRA		
	190 PRX		Fp max
	191 RCL 07		
	192 PRX		Fp min
	193 "DEAD+LIVE+WIND"		Dead + Live + Wind
	194 PRA		
	195 XEQ 18		$P_{DL+LL+WL}$
	196 XEQ 18		$M_{DL+LL+WL}$
	197 XEQ 18		$H_{DL+LL+WL}$
	198 RCL 08		
	199 "F P"		
	200 PRA		
	201 PRX		Fpmax
	202 RCL 09		
	203 PRX		Fpmin
	204 GTO G		
	205♦LBL 11		Footing and Earth weight $0.1\left(\frac{\text{Earth}}{\text{THK}}\right)+0.15T$
	206 .1		
	207 RCL 03		
	208 *		
	209 .15		
	210 RCL 02		
	211 *		
	212 +		
	213 STO 04		Store DL Pressure in 04, 05, 06, 07, 08, 09
	214 STO 05		

LABELS

A ✓	B ✓	C	D	E
F ✓	G ✓	H ✓	I	J
a	b	c	d	e
01	02	03	04	05
06	07	✓	✓	10
11 ✓	12 ✓	13 ✓	14 ✓	15 ✓
16 ✓	17	18 ✓	19	20
21 ✓	22 ✓	23	24	25

FLAGS

0 ✓	1
2	3
4	5
6	7
8	9
16	17
24	25

SET STATUS

FLAGS (ON / OFF): 0 ■ □ · 1 □ ■ · 2 □ ■ · 3 □ ■

TRIG: DEG ■ · GRAD □ · RAD □

DISP: FIX ■ · SCI □ · ENG □ · n 4

10	11 ✓	12 ✓	13	14	15
18	19	20	21	22	23
26	27	28	29	30	31

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
		215 STO 06	
		216 STO 07	
		217 STO 08	
		218 STO 09	
		219 RCL 00	
		220 RCL 01	
		221 *	
		222 STO 22	Area = L×W
		223 RCL 00	$S = Area \times \frac{L}{6}$
		224 *	
		225 6	
		226 /	
		227 STO 23	
		228 RTN	
		229*LBL 12	
		230 RCL IND 25	Finds P/A
		231 RCL 22	
		232 /	
		233 ?ISZ	
		234 RCL IND 25	Finds M/S
		235 ?ISZ	
		236 RCL IND 25	
		237 RCL 24	Changes H to Moment
		238 *	
		239 +	$\frac{M + H(T + \frac{Earth}{THK} + Z)}{S}$
		240 RCL 23	
		241 /	
		242 ?ISZ	
		243 RTN	
		244*LBL 13	Adds 3" to Ftg Length
		245 .25	
		246 ST+ 00	Adds 3" to Ftg width if Flag 6 set
		247 FS? 00	
		248 ST+ 01	
		249 RTN	
		250*LBL 18	Prints Values
		251 RCL IND 25	
		252 PRX	
		253 ?ISZ	
		254 RTN	
		255*LBL G	
		256 "PIER"	Pier
		257 PRA	
		258 "B"	
		259 PROMPT	Enter B
		260 PRX	
		261 STO 20	
		262 "C"	
		263 PROMPT	Enter C
		264 PRX	
		265 STO 21	
		266 *	
		267 .005	
		268 *	
		269 "A S"	
		270 PRA	
		271 PRX	$A_{S_{min}} = .005\ BC$
		272 RCL 00	
		273 STO 25	
		274 RCL 01	
		275 STO 22	
		276 RCL 24	Moment Arm
		277 RCL 02	
		278 -	
		279 STO 19	
		280 RCL 12	
		281 *	
		282 RCL 11	
		283 +	
		284 STO 23	M_{DL+LL}
		285 RCL 15	
		286 RCL 19	
		287 *	
		288 RCL 14	
		289 +	
		290 RCL 23	
		291 X<=Y?	
		292 X<>Y	
		293 STO 23	M_{DL+WL}
		294 RCL 18	
		295 RCL 19	
		296 *	
		297 RCL 17	
		298 +	$M_{DL+LL+WL}$
		299 RCL 23	
		300 X<=Y?	
		301 X<>Y	
		302 "M"	
		303 PRA	
		304 PRX	Prints Mmax
		305 RCL 21	
		306 3	
		307 -	d = C-3"
		308 /	
		309 XEQ 29	Print A_S
		310 ADV	
		311 0	Zero in Storage Registers
		312 STO 11	
		313 STO 12	
		314 STO 14	
		315 STO 15	
		316 RCL 25	
		317 RCL 21	
		318 "BOTTOM"	Bottom
		319 PRA	
		320 XEQ 28	C/12"
		321 STO 21	
		322 -	
		323 2	
		324 /	
		325 STO 10	(L-C)/2
		326 RCL 22	
		327 RCL 20	
		328 XEQ 28	
		329 STO 20	
		330 -	
		331 2	
		332 /	
		333 STO 13	(W-B)/2
		334 .1	
		335 RCL 03	
		336 *	
		337 .15	Calculate Unit weight of soil & Footing
		338 RCL 02	
		339 *	
		340 +	
		341 STO 03	
		342 XEQ 21	DL+LL Moments & Shears
		343 RCL 06	
		344 STO 04	
		345 RCL 07	
		346 STO 05	
		347 XEQ 21	DL+WL Moments & Shears
		348 RCL 08	
		349 STO 04	
		350 RCL 09	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	351	STO 05	DL+LL+WL Moment & Shears
	352	XEQ 21	
	353	11	
	354	STO 25	
	355	RCL IND 25	Recalls M_{max}
	356	RCL 02	
	357	12	
	358	*	$d = T \times 12 - 3.5$
	359	3.5	
	360	-	
	361	STO 04	
	362	/	
	363	RCL 01	
	364	*	
	365	XEQ 29	→ Print $A_S = \frac{M}{ad} \times W$
	366	RCL 01	
	367	XEQ 22	→ Bars & Area/Bar
	368	RCL 04	
	369	/	
	370	PRX	→ Prints shear $= \frac{V}{12d}$
	371	?ISZ	
	372	?ISZ	
	373	RCL IND 25	$M_{Transverse}$
	374	RCL 00	
	375	*	
	376	RCL 04	
	377	1	
	378	-	
	379	STO 06	$d_{Trans} = d - 1''$
	380	/	
	381	XEQ 29	→ Print $A_S = \frac{M}{ad} \times L$
	382	RCL 00	
	383	XEQ 22	→ Bars & Area/Bar
	384	RCL 06	
	385	/	
	386	PRX	→ Prints shear $= \frac{V}{12d}$
	387	GTO H	
	388	*LBL 21	Calculates Triangular Shear
	389	10	
	390	STO 25	
	391	RCL 04	
	392	RCL 05	
	393	-	
	394	RCL 00	
	395	/	
	396	RCL IND 25	$V_\Delta = \frac{fp_{max} - fp_{min}}{2L}\left(\frac{L-C}{2}\right)^2$
	397	*	
	398	RCL IND 25	
	399	*	
	400	2	
	401	/	
	402	STO 22	
	403	RCL IND 25	$M_\Delta = \frac{VL}{3}$
	404	*	
	405	3	
	406	/	
	407	STO 23	Rectangular Shear
	408	RCL 04	
	409	RCL 03	
	410	-	$[fp_{max} - wg^+]$
	411	RCL IND 25	$\times \frac{L-C}{2} = V$
	412	*	
	413	RCL 22	
	414	-	
	415	STO 22	
	416	LASTX	$M_{Rectangular} = \frac{VL}{2}$
	417	+	
	418	RCL IND 25	
	419	*	
	420	2	
	421	/	
	422	RCL 23	M
	423	-	
	424	?ISZ	Stores M_{max} during Each Call
	425	RCL IND 25	
	426	X<=Y?	
	427	X<>Y	
	428	STO IND 25	
	429	?ISZ	
	430	RCL 22	Stores V_{max}
	431	RCL IND 25	
	432	X<=Y?	
	433	X<>Y	
	434	STO IND 25	
	435	?ISZ	
	436	RCL 04	Calculates Transverse shear Max @ Toe
	437	RCL 03	
	438	-	
	439	RCL IND 25	
	440	*	
	441	?ISZ	
	442	?ISZ	Store Max shear
	443	RCL IND 25	
	444	X<=Y?	
	445	X<>Y	
	446	STO IND 25	
	447	LASTX	Calculates M_{max} then stores & Returns
	448	*	
	449	2	
	450	/	
	451	?DSZ	
	452	STO IND 25	
	453	RTN	
	454	*LBL 22	Calculates Nº of Reinf Bars
	455	1	
	456	+	
	457	INT	
	458	"BARS"	
	459	PRA	
	460	PRX	→ Bars
	461	/	
	462	"A S/BAR"	
	463	PRA	
	464	PRX	→ As/Bar
	465	?ISZ	
	466	RCL IND 25	
	467	*LBL 28	Divides by 12
	468	12	
	469	/	
	470	RTN	
	471	*LBL 29	
	472	"A S"	
	473	PRA	
	474	RCL 26	
	475	/	
	476	PRX	→ Print $A_S = \frac{M}{ad}$
	477	RTN	
	478	*LBL H	
	479	ADV	
	480	RCL 02	
	481	RCL 01	
	482	*	
	483	.288	
	484	*	
	485	PRX	→ $A_S = 0.002 \times 144 \times W \times T$

STEP	KEY ENTRY	KEY CODE	COMMENTS
	486	11	
	487	STO 25	
	488	RCL IND 25	
	489	PRX	Print M_{max} @ Toe
	490	RCL 04	
	491	X↑2	
	492	RCL 27	
	493	*	
	494	1000	
	495	/	
	496	PRX	$M_{allow} = FK = \frac{bd^2}{12000} \times k$
	497	RCL 02	
	498	RCL 00	
	499	*	
	500	.288	
	501	*	
	502	ADV	
	503	PRX	$A_S = 0.002 \times 144 \times L \times T$
	504	14	
	505	STO 25	
	506	RCL IND 25	
	507	PRX	M_{max} Transverse
	508	RCL 06	
	509	X↑2	
	510	RCL 27	
	511	*	
	512	1000	
	513	/	
	514	PRX	$M_{allow} = \frac{bd^2}{12000} \times k$
	515	10	
	516	STO 25	
	517	RCL 03	Ftg wgt & Soil wgt = w
	518	RCL IND 25	
	519	X↑2	
	520	*	
	521	2	
	522	/	$M = wL^2/2$
	523	RCL 04	
	524	/	
	525	RCL 01	
	526	*	
	527	"TOP"	Top
	528	PRA	
	529	XEQ 29	$A_S = \frac{M}{ad} \times W$
	530	RCL 01	
	531	XEQ 22	Nº & Area of Bars
	532	13	
	533	STO 25	
	534	RCL 03	
	535	RCL IND 25	
	536	X↑2	
	537	*	
	538	2	
	539	/	
	540	RCL 06	
	541	/	
	542	RCL 00	
	543	*	
	544	XEQ 29	Print $A_S = \frac{M}{ad}$
	545	RCL 00	
	546	XEQ 22	Nº & Area of bar
	547	ADV	
	548	RCL 21	
	549	12	
	550	*	
	551	RCL 04	
	552	+	
	553	RCL 20	
	554	12	
	555	*	
	556	RCL 06	
	557	+	
	558	+	
	559	RCL 04	
	560	RCL 06	
	561	+	
	562	*	
	563	.11	
	564	*	
	565	"V ALLOW"	
	566	PRA	
	567	PRX	Print Vallow on footing
	568	ADV	
	569	ADV	
	570	GTO A	
	571	.END.	

$b_o = [(B+C) \times 12 + d_{main} + d_{Transverse}] \times 2$

$V_{allow} = b_o d \times v_c$

$v_c = 2\sqrt{f'_c} = 0.11\sqrt{f'_c}$

ECCENTRICALLY LOADED FOOTING "ECCFTGI"
INDIVIDUAL LOADS
PROGRAM DESCRIPTION

Program combines loads (D + L, D + W, and D + L + W) then calculates mimimum and maximum pressures for three loading combinations including axial loads, horizontal shear at top of pier, and moment; pier reinforcement, footing reinforcement each way top and bottom; number of bars; areas of bars; shears. This program will automatically increment footing size until soil bearing value or uplift requirements are satisfied. You can increment footing width and length or the length only. Uses Working Stress or Ultimate Strength Design divided by the appropriate load factor per ACI 318-77.

If you should desire a printout of the prompting statements along with the numerical results, set your printer to the normal mode.

The main program may be addressed directly by the execute key (XEQ) and the program name "ECCFTGI". Flag eleven has been set causing the program to initialize immediately upon entry of program cards.

Footing length and width are incremented in 3" increments until the actual soil bearing value is less than the allowable soil bearing value. When uplift exists the footing is also incremented until a positive pressure exists under the entire footing. A factor of safety is not applied internally to uplift loads and is usually not warranted if a moment and/or horizontal shear exists. If only an uplift load exists, apply a safety factor of 1.5 or use the "Footing-Axial Load" program.

This program will combine the loads into three combinations D + L, D + W, D + L + W and then analyzes the footing.

Three inch clearance is used for all bars assuming a maximum bar size of 1"; d for main bars is 3.5" and 4.5" for transverse bars.

This program used Working Stress Design (Alternate Design Method) or Ultimate Strength Design (Load Factor Design) when divided by the load factor of 1.7 to determine the reinforcement and moment capacities. Remember that both "K" and "a" must be divided by the appropriate load factor prior to entry into the calculator. Sheet iii-1 has been included in the front of this manual for ready reference of WSD and USD values for "a", "K", "v_o", and "v_c" for 3000 PSI, 4000 PSI, 4000 PSI, and 5000 PSI concrete.

The footing or pier thickness is not increased internally, so the actual moments and shears must be compared with the allowables to insure that footing and pier can resist the loads with an adequate factor of safety. The program will not design for compressive reinforcement so the actual moments should never exceed the allowable moments.

Top reinforcement is designed to totally resist the earth and concrete load when lifted vertically, without regard to pressure on bottom which would serve to reduce the reinforcement required.

This program treats the pier within the ground as an earth load. If the pier is excessively large, add 0.05 K/FT^3 for volume above the ground line.

IMPORTANT! The maximum pressures must always occur on the toe as the moments and shears are determined from the toe pressures. The program will automatically check each of the three conditions for maximum moment and maximum shear. However, the maximum moments and shears do not have to occur in the same loading condition but must occur on the toe side of the footing. The results obtained by imputting the moment and shear on top of the pier in the opposite direction from that shown will give you moments and shears based on the minimum pressure similar to the heel of a retaining wall.

Nomenclature:

Shear at d/2 = 0.11 x b_o x d

M_o = M + H (T + Earth thickness + Z)

$$F_p = \frac{P}{L \times W} \pm \frac{6M_o}{W \times L^2}$$

L = Footing length (feet)

W = Footing width (feet)

T = Footing thickness (feet)

Earth thickness = thickness of earth on footing (feet)

Z = Height of pier above the ground or floor line (feet)

P = Axial load (kips)

M = Overturning moment on pier (kip feet)

H = Horizontal load on top of pier (kips)

F_p = Actual soil pressure under footing (kips/SF)

B = Pier width (inches)

C = Pier length (inches)

A_s = Area of reinforcement; M/a x d or M/(a_u x 1.7 x d) (in^2)

v = Beam shear at face of pier or punching shear at d/2 ($kips/in^2$)

a = $f_s j/12000$ for Working Stress Design

= $a_u/1.7 = \phi f_y (1-.59w)/12{,}000 \times 1.7)$ for Ultimate Strength Design

K = $\frac{1}{2} f_c kj = M/F = M/bd^2$ for Working Stress Design

= $M_u/(F \times 1.7) = \phi f'_c w(1-.59w)/1.7 = K_u/1.7$ for Ultimate Strength Design

F = $bd^2/12000$

f'_c = Compressive Concrete strength (PSI)

f_y = Yield Strength of reinforcement (PSI)

A_s (min) - Footing = .002 x Gross Footing Area
Pier = .005 x Gross Pier Area

JOHN DOE AND ASSOCIATES
CONSULTING STRUCTURAL ENGINEERS
111 YOUR STREET
ANYWHERE, U.S.A.

JOB SAMPLE PROBLEM (4-3)
SHEET NO. ____ OF ____
CALCULATED BY ____ DATE ____
CHECKED BY ____ DATE ____
SCALE ____ COMM. NO. ____

FOOTING LOCATIONS: (PUSH LABEL A) FOOTING Z2

ECCENTRICALLY LOADED FOOTING (INDIVIDUAL LOADS) **4**

PUSH LABEL B FOR HOLDING WIDTH OF FOOTING.
ENTER (R/S)

DEAD LOAD

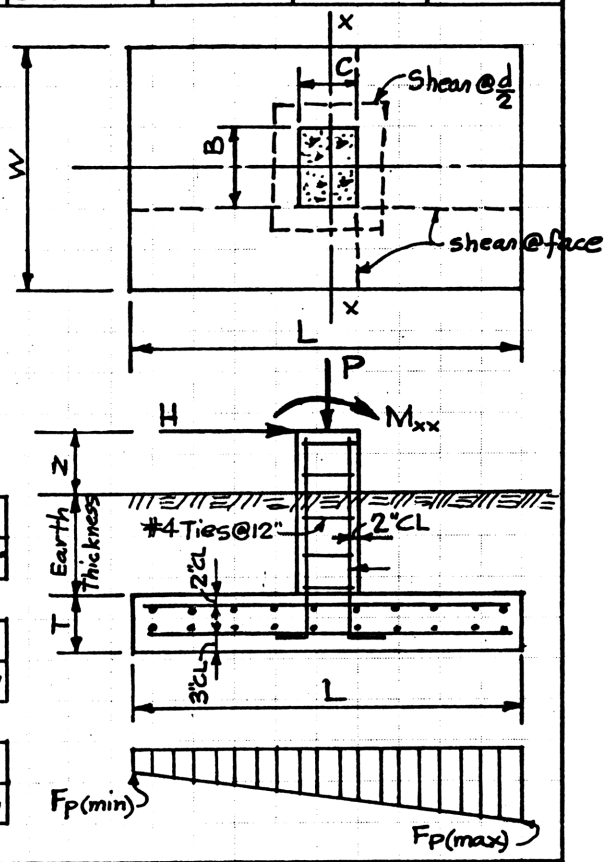
L	W	T	Earth Thick	Z	Soil Brg Value	P_{DL}	M_{DL}	H_{DL}
4.0 FT	6.0 FT	1.67 FT	2.0 FT	1.0 FT	3.0 K/□'	100 K	10 K'	2.0 K

LIVE LOAD

P_{LL}	M_{LL}	H_{LL}
50 K	5.0 K'	1.0 K

WIND LOAD

P_{WL}	M_{WL}	H_{WL}	$\frac{a_u}{1.7}$ (USD) a (WSD)	$\frac{K_u}{1.7}$ (USD) K (WSD)
-25 K	-10 K'	-0.5 K	1.44	226



FOOTING REQUIRED (PRINT)

L	W	T
7.5 FT	9.5 FT	1.67 FT

DEAD + LIVE (PRINT)

P_{DL+LL}	M_{DL+LL}	H_{DL+LL}	$F_{P(max)}$	$F_{P(min)}$
150 K	15 K'	3 K	2.8815 K/□'	2.23 K/□'

DEAD + WIND

P_{DL+WL}	M_{DL+WL}	H_{DL+WL}	$F_{P(max)}$	$F_{P(min)}$
75 K	0.0 K'	1.5 K	1.5818 K/□'	1.4245 K/□'

DEAD + LIVE + WIND

$P_{DL+LL+WL}$	$M_{DL+LL+WL}$	$H_{DL+LL+WL}$	$F_{P(max)}$	$F_{P(min)}$
125 K	5.0 K'	2.5 K	2.3921 K/□'	2.0177 K/□'

PIER; ENTER (R/S) PRINT

B	C	$A_{s(min)}$	M(max)	A_s or A'_s	REINF	Ties	Sketch
16 IN	18 IN	1.44 □" .005 BC	24 K'	1.1111 □"	-#	#4@12	

BOTT MAIN FTG REINF				BOTT TRANSVERSE FTG REINF				BOTTOM MAIN		
$A_{s(TOTAL)}$	No. Bars	A_s/Bar	U face Pier	$A_{s(TOTAL)}$	No. Bars	A_s/Bar	U face Pier	$A_{s(min)}$	M(max)	M=FK
4.2075 □"	10	0.4207 □"	0.0348 K/□'	6.7925 □"	8	0.8491 □"	0.053 K/□'	4.5691 □"	10.548 K'	61.827 K'

BOTTOM TRANSVERSE			TOP MAIN REINF			TOP TRANSVERSE REINF			Vallowed $\frac{d}{2}$	
$A_{s(min)}$	M(max)	M=FK	A_s	No. Bars	A_s/Bar	A_s	No. Bars	A_s/Bar	=allb$_o$d	f'_c
3.6072 □"	20.266 K'	54.57 K'	0.8086 □"	10	0.0809 □"	1.2598 □"	8	0.1573 □"	233.18 K	3,000 #/□'

f_y = 40,000 #/□'

HP-41C

User Instructions

NO. CARDS

ECCENTRICALLY LOADED FOOTING 4-1 4-4
INDIVIDUAL LOADS 4-2 4-5
"ECCFTGI" 4-3

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	TURN PRINTER ON				
	MANUAL MODE - DISPLAYS PROMPTING				
	STATEMENTS ONLY				
	NORMAL MODE - DISPLAYS AND PRINTS				
	PROMPTING STATEMENTS				
2	TURN CALCULATOR ON (USER MODE)			ON	
3	PUSH XEQ ALPHA SIZE ALPHA 030 TO				
	PARTITION PROGRAM REGISTERS (SKIP				
	THIS STEP IF CALCULATOR PARTI-				
	TIONED FROM LAST PROGRAM)				
4	LOAD PREPROGRAMMED MAGNETIC CARDS				
5	PUSH LABEL A - ECCENTRICALLY LOADED				
	FOOTING, INCREMENTS FOOTING LENGTH				
	AND WIDTH			A	
	PUSH LABEL B - ECCENTRICALLY LOADED				
	FOOTING, INCREMENTS FOOTING LENGTH				
	AND HOLDS WIDTH			B	
6	PROCEED TO CALCULATION SHEET				
7	ENTER DATA AND PUSH R/S KEY	DATA		R/S	
8	REPEAT STEP 7 UNTIL PROBLEM COMPLETED				

HP-41c

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
	01♦LBL "ECCFTGI"		Eccentrically Loaded Footing "ECCFTGI"
	02♦LBL A		
	03 SF 00		
	04 GTO F		
	05♦LBL B		Clear Flag 0 to Hold Width
	06 CF 00		
	07♦LBL F		
	08 SF 11		
	09 SF 12		
	10 "=CALPRO="		
	11 PRA		
	12 "CALCULATOR PRO"		
	13 "PGRAMS"		
	14 PRA		
	15 CF 12		
	16 ADV		
	17 "L"		
	18 PROMPT		Enter L
	19 PRX		
	20 STO 00		
	21 "W"		
	22 PROMPT		Enter W
	23 PRX		
	24 STO 01		
	25 "T"		
	26 PROMPT		Enter T
	27 PRX		
	28 STO 02		
	29 "EARTH THICK"		
	30 PROMPT		Earth thickness
	31 PRX		
	32 STO 03		
	33 "Z"		
	34 PROMPT		Enter Z
	35 PRX		
	36 +		
	37 +		
	38 STO 24		
	39 "SOIL BPG"		
	40 PROMPT		Enter Soil Brg Value
	41 PRX		
	42 STO 21		
	43 "DEAD"		Dead Load
	44 PRA		
	45 "P"		
	46 PROMPT		P_{DL}
	47 PRX		
	48 STO 10		
	49 STO 13		
	50 STO 16		
	51 "M"		
	52 PROMPT		M_{DL}
	53 PRX		
	54 STO 11		
	55 STO 14		
	56 STO 17		
	57 "H"		
	58 PROMPT		H_{DL}
	59 PRX		
	60 STO 12		
	61 STO 15		
	62 STO 18		
	63 "LIVE"		Live Load
	64 PRA		
	65 "P"		
	66 PROMPT		Enter P_{LL}
	67 PRX		
	68 ST+ 10		
	69 ST+ 16		
	70 "M"		
	71 PROMPT		M_{LL}
	72 PRX		
	73 ST+ 11		
	74 ST+ 17		
	75 "H"		
	76 PROMPT		H_{LL}
	77 PRX		
	78 ST+ 12		
	79 ST+ 18		
	80 "WIND"		Wind Load
	81 PRA		
	82 "P"		
	83 PROMPT		P_{WL}
	84 PRX		
	85 ST+ 13		
	86 ST+ 16		
	87 "M"		
	88 PROMPT		M_{WL}
	89 PRX		
	90 ST+ 14		
	91 ST+ 17		
	92 "H"		
	93 PROMPT		H_{WL}
	94 PRX		
	95 ST+ 15		
	96 ST+ 18		
	97 "a"		Enter a
	98 PROMPT		
	99 PRX		
	100 STO 26		
	101 "K"		Enter K
	102 PROMPT		
	103 PRX		
	104 STO 27		
	105 ADV		Footing Required
	106 "FOOTING REQD"		
	107 AVIEW		
	108♦LBL 15		
	109 10		
	110 STO 25		Calculates DL+LL Footing Requirements
	111 XEQ 11		
	112 XEQ 12		
	113 ST+ 04		
	114 ST- 05		
	115 RDN		
	116 ST+ 04		
	117 ST+ 05		
	118 RCL 04		
	119 RCL 21		Checks for Toe Pressure > Soil Brg Value
	120 X>Y?		
	121 GTO 16		

DL+LL REGISTERS DL+LL DL+WL DL+LL+WL

00 L	01 W	02 T / W	03 Earth Thickness	04 $f_{p\,max}$ / d_{main}	05 $f_{p\,min}$	06 $f_{p\,max}$ / d_{Trans}	07 $f_{p\,min}$	08 $f_{p\,max}$	09 $f_{p\,min}$
10 P_{DL+LL} / (L-c)/2	11 M_{DL+LL} / M	12 H_{DL+LL} / V	13 P_{DL+WL} / (W-B)/2	14 M_{DL+WL} / M	15 H_{DL+WL} / V	16 $P_{DL+LL+WL}$	17 $M_{DL+LL+WL}$	18 $H_{DL+WL+WL}$	19 Pier Mom Arm
20 B	21 Soil Brg / c	22 Area / W/V	23 Sxx / M	24 T+Z+Earth Thickness	25 Count / L	26 a	27 K	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
	122 XEQ 13		
	123 GTO 15		
	124♦LBL 16		Check Heel pressu
	125 RCL 05		if<0, and then
	126 X>0?		increments Ftg
	127 GTO 16		if<0.
	128 XEQ 13		
	129 GTO 15		
	130♦LBL 16		Calculates DL+WL
	131 XEQ 12		Footing Requiremen
	132 ST+ 06		
	133 ST- 07		
	134 RDN		
	135 ST+ 06		
	136 ST+ 07		
	137 RCL 06		
	138 RCL 21		Checks for Toe
	139 X>Y?		Pressure > Soil
	140 GTO 16		Pressure
	141 XEQ 13		
	142 GTO 15		
	143♦LBL 16		Check Heel pressu
	144 RCL 07		<0 ; then increme
	145 X>0?		footing if<0
	146 GTO 16		
	147 XEQ 13		
	148 GTO 15		
	149♦LBL 16		Calculates DL+LL+WL
	150 XEQ 12		Footing Requirement
	151 ST+ 08		
	152 ST- 09		
	153 RDN		
	154 ST+ 08		
	155 ST+ 09		
	156 RCL 08		
	157 RCL 21		
	158 X>Y?		Checks for Toe
	159 GTO 16		Pressure > soil
	160 XEQ 13		Pressure
	161 GTO 15		
	162♦LBL 16		Check Heel pressu
	163 RCL 09		<0; then
	164 X>0?		increments
	165 GTO 16		footing if<0
	166 XEQ 13		
	167 GTO 15		
	168♦LBL 16		Footing Required
	169 RCL 00		
	170 "L"		
	171 PRA		
	172 PRX		Print L
	173 RCL 01		
	174 "W"		
	175 PRA		
	176 PRX		Print W
	177 RCL 02		
	178 "T"		
	179 PRA		
	180 PRX		Print T
	181 10		
	182 STO 25		
	183 "DEAD + LIVE"		Dead + Live
	184 PRA		
	185 XEQ 18		P_{DL+LL}
	186 XEQ 18		M_{DL+LL}
	187 XEQ 18		H_{DL+LL}
	188 RCL 04		
	189 "F P"		
	190 PRA		
	191 PRX		Fp max
	192 RCL 05		
	193 PRX		Fp min
	194 "DEAD + WIND"		Dead + Wind
	195 PRA		
	196 XEQ 18		P_{DL+WL}
	197 XEQ 18		M_{DL+WL}
	198 XEQ 18		H_{DL+WL}
	199 RCL 06		
	200 "F P"		
	201 PRA		
	202 PRX		Fp max
	203 RCL 07		
	204 PRX		Fp min
	205 "DEAD+LIVE+WIND"		Dead + Live + Wind
	206 PRA		
	207 XEQ 18		$P_{DL+LL+WL}$
	208 XEQ 18		$M_{DL+LL+WL}$
	209 XEQ 18		$H_{DL+LL+WL}$
	210 RCL 08		
	211 "F P"		
	212 PRA		
	213 PRX		Fpmax
	214 RCL 09		
	215 PRX		Fpmin
	216 GTO G		
	217♦LBL 11		Footing and
	218 .1		Earth weight
	219 RCL 03		$0.1\left(\frac{\text{Earth}}{THK}\right)+0.15T$
	220 *		
	221 .15		
	222 RCL 02		
	223 *		
	224 +		
	225 STO 04		store DL Pressure
	226 STO 05		in 04, 05, 06, 07, 08, 09

LABELS

A ✓	B ✓	C	D	E
F ✓	G ✓	H ✓	I	J
a	b	c	d	e
01	02	03	04	05
06	07	✓	✓	10
11 ✓	12 ✓	13 ✓	14 ✓	15 ✓
16 ✓	17	18 ✓	19	20
21 ✓	22 ✓	23	24	25

FLAGS

0 ✓	1
2	3
4	5
6	7
8	9
16	17
24	25

SET STATUS

FLAGS (ON / OFF)

	ON	OFF
0	■	□
1	□	■
2	□	■
3	□	■

TRIG: DEG ■ GRAD □ RAD □

DISP: FIX ■ SCI □ ENG □ n 4

10	11 ✓	12 ✓	13	14	15
18	19	20	21	22	23
26	27	28	29	30	31

STEP	KEY ENTRY	KEY CODE	COMMENTS
	227	STO 06	
	228	STO 07	
	229	STO 08	
	230	STO 09	
	231	RCL 00	
	232	RCL 01	
	233	*	
	234	STO 22	Area = L x W
	235	RCL 00	S = Area x L/6
	236	*	
	237	6	
	238	/	
	239	STO 23	
	240	RTN	
	241	*LBL 12	
	242	RCL IND 25	Finds P/A
	243	RCL 22	
	244	/	
	245	?ISZ	
	246	RCL IND 25	Finds M/S
	247	?ISZ	
	248	RCL IND 25	
	249	RCL 24	Changes H to Moment
	250	*	
	251	+	
	252	RCL 23	$\frac{M + H(T + {}^{Earth}_{THK} + Z)}{S}$
	253	/	
	254	?ISZ	
	255	RTN	
	256	*LBL 13	Adds 3" to Ftg Length
	257	.25	
	258	ST+ 00	
	259	FS? 00	Adds 3" to Ftg width if Flag 0 set
	260	ST+ 01	
	261	RTN	
	262	*LBL 18	
	263	RCL IND 25	Prints Values
	264	PRX	
	265	?ISZ	
	266	RTN	
	267	*LBL G	
	268	"PIER"	Pier
	269	PRA	
	270	"B"	
	271	PROMPT	Enter B
	272	PRX	
	273	STO 20	
	274	"C"	
	275	PROMPT	Enter C
	276	PRX	
	277	STO 21	
	278	*	
	279	.005	
	280	*	
	281	"A S"	
	282	PRA	
	283	PRX	$A_{S_{min}} = .005\ BC$
	284	RCL 00	
	285	STO 25	
	286	RCL 01	
	287	STO 22	
	288	RCL 24	
	289	RCL 02	Moment Arm
	290	-	
	291	STO 19	
	292	RCL 12	
	293	*	
	294	RCL 11	
	295	+	
	296	STO 23	M_{DL+LL}
	297	RCL 15	
	298	RCL 19	
	299	*	
	300	RCL 14	
	301	+	
	302	RCL 23	
	303	X(=Y?	
	304	X(>Y	
	305	STO 23	M_{DL+WL}
	306	RCL 18	
	307	RCL 19	
	308	*	
	309	RCL 17	
	310	+	$M_{DL+LL+WL}$
	311	RCL 23	
	312	X(=Y?	
	313	X(>Y	
	314	"M"	
	315	PRA	
	316	PRX	Prints Mmax
	317	RCL 21	
	318	3	
	319	-	d = C-3"
	320	/	
	321	XEQ 29	Print A_S
	322	ADV	
	323	0	Zero in Storage Registers
	324	STO 11	
	325	STO 12	
	326	STO 14	
	327	STO 15	
	328	RCL 25	
	329	RCL 21	
	330	"BOTTOM"	Bottom
	331	PRA	
	332	XEQ 28	C/12"
	333	STO 21	
	334	-	
	335	2	
	336	/	
	337	STO 10	(L-C)/2
	338	RCL 22	
	339	RCL 20	
	340	XEQ 28	
	341	STO 20	
	342	-	
	343	2	
	344	/	
	345	STO 13	(W-B)/2
	346	.1	
	347	RCL 03	
	348	*	
	349	.15	
	350	RCL 02	Calculate Unit weight of soil & Footing
	351	*	
	352	+	
	353	STO 03	
	354	XEQ 21	DL+LL Moments & Shears
	355	RCL 06	
	356	STO 04	
	357	RCL 07	
	358	STO 05	
	359	XEQ 21	DL+WL Moments & Shears
	360	RCL 08	
	361	STO 04	
	362	RCL 09	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	363	STO 05	DL+LL+WL Moment & Shears
	364	XEQ 21	
	365	11	
	366	STO 25	
	367	RCL IND 25	Recalls Mmax
	368	RCL 02	
	369	12	
	370	*	
	371	3.5	d = Tx12 − 3.5
	372	-	
	373	STO 04	
	374	/	
	375	RCL 01	
	376	*	
	377	XEQ 29	Print $A_S = \frac{M}{ad} \times W$
	378	RCL 01	
	379	XEQ 22	Bars & Area/Bar
	380	RCL 04	
	381	/	
	382	PRX	Prints shear = $\frac{V}{12d}$
	383	7ISZ	
	384	7ISZ	
	385	RCL IND 25	$M_{Transverse}$
	386	RCL 00	
	387	*	
	388	RCL 04	
	389	1	
	390	-	
	391	STO 06	$d_{Trans} = d - 1"$
	392	/	
	393	XEQ 29	Print $A_S = \frac{M}{ad} \times L$
	394	RCL 00	
	395	XEQ 22	Bars & Area/Bar
	396	RCL 06	
	397	/	
	398	PRX	Prints shear = $\frac{V}{12d}$
	399	GTO H	
	400	*LBL 21	Calculates Triangular Shear
	401	10	
	402	STO 25	
	403	RCL 04	
	404	RCL 05	
	405	-	
	406	RCL 00	
	407	/	
	408	RCL IND 25	$V_\Delta = \frac{fp_{max} - fp_{min}\left(\frac{L-C}{2}\right)}{2L}$
	409	*	
	410	RCL IND 25	
	411	*	
	412	2	
	413	/	
	414	STO 22	
	415	RCL IND 25	$M_\Delta = \frac{VL}{3}$
	416	*	
	417	3	
	418	/	
	419	STO 23	
	420	RCL 04	Rectangular Shear
	421	RCL 03	
	422	-	
	423	RCL IND 25	$[fp_{max} - wgt]$
	424	*	
	425	RCL 22	
	426	-	
	427	STO 22	
	428	LASTX	$\times \frac{L-C}{2} = V$
	429	+	
	430	RCL IND 25	$M_{Rectangular} = \frac{VL}{2}$
	431	*	
	432	2	M
	433	/	
	434	RCL 23	
	435	-	Stores Mmax during Each Call
	436	7ISZ	
	437	RCL IND 25	
	438	X<=Y?	
	439	X<>Y	
	440	STO IND 25	
	441	7ISZ	Stores Vmax
	442	RCL 22	
	443	RCL IND 25	
	444	X<=Y?	
	445	X<>Y	
	446	STO IND 25	
	447	7ISZ	Calculates Transverse shear Max @ Toe
	448	RCL 04	
	449	RCL 03	
	450	-	
	451	RCL IND 25	
	452	*	
	453	7ISZ	Store Max shear
	454	7ISZ	
	455	RCL IND 25	
	456	X<=Y?	
	457	X<>Y	
	458	STO IND 25	
	459	LASTX	Calculates Mmax then stores & Returns
	460	*	
	461	2	
	462	/	
	463	7DSZ	
	464	STO IND 25	
	465	RTN	
	466	*LBL 22	Calculates Nº of Reinf Bars
	467	1	
	468	+	
	469	INT	
	470	"BARS"	
	471	PRA	
	472	PRX	Bars
	473	/	
	474	"A S/BAR"	
	475	PRA	
	476	PRX	As/Bar
	477	7ISZ	
	478	RCL IND 25	
	479	*LBL 28	Divides by 12
	480	12	
	481	/	
	482	RTN	
	483	*LBL 29	
	484	"A S"	
	485	PRA	
	486	RCL 26	
	487	/	
	488	PRX	Print $A_S = \frac{M}{ad}$
	489	RTN	
	490	*LBL H	
	491	ADV	
	492	RCL 02	
	493	RCL 01	
	494	*	
	495	.288	
	496	*	
	497	PRX	$A_S = 0.002 \times 144 \times W \times T$

Program Listing

HP-41C

STEP	KEY ENTRY	KEY CODE	COMMENTS
		498 11	
		499 STO 25	
		500 RCL IND 25	
		501 PRX	Print M_{max} @ Toe
		502 RCL 04	
		503 X↑2	
		504 RCL 27	
		505 *	
		506 1000	
		507 /	
		508 PRX	$M_{allow} = FK = \frac{bd^2}{12000} \times k$
		509 RCL 02	
		510 RCL 00	
		511 *	
		512 .288	
		513 *	
		514 ADV	
		515 PRX	$A_S = 0.002 \times 144 \times L \times T$
		516 14	
		517 STO 25	
		518 RCL IND 25	
		519 PRX	M_{max} Transverse
		520 RCL 06	
		521 X↑2	
		522 RCL 27	
		523 *	
		524 1000	
		525 /	
		526 PRX	$M_{allow} = \frac{bd^2}{12000} \times k$
		527 10	
		528 STO 25	
		529 RCL 03	Ftg wgt & Soil wgt = w
		530 RCL IND 25	
		531 X↑2	
		532 *	
		533 2	
		534 /	$M = wL^2/2$
		535 RCL 04	
		536 /	
		537 RCL 01	
		538 *	
		539 "TOP"	Top
		540 PRA	
		541 XEQ 29	$A_S = \frac{M}{ad} \times W$
		542 RCL 01	
		543 XEQ 22	Nº & Area of Bars
		544 13	
		545 STO 25	
		546 RCL 03	
		547 RCL IND 25	
		548 X↑2	
		549 *	
		550 2	
		551 /	
		552 RCL 06	
		553 /	
		554 RCL 00	
		555 *	
		556 XEQ 29	Print $A_S = \frac{M}{ad}$
		557 RCL 00	
		558 XEQ 22	Nº & Area of bar
		559 ADV	
		560 RCL 21	
		561 12	
		562 *	
		563 RCL 04	
		564 +	
		565 RCL 20	
		566 12	
		567 *	
		568 RCL 06	
		569 +	
		570 +	
		571 RCL 04	
		572 RCL 06	
		573 +	
		574 *	
		575 .11	
		576 *	
		577 "V ALLOW"	
		578 PRA	
		579 PRX	Print Vallow on footing
		580 ADV	
		581 ADV	
		582 GTO A	
		583 .END.	

$b_o = [(B+C) \times 12 + d_{main} + d_{Transverse}] \times 2$

$V_{allow} = b_o d \times v_c$

$v_c = 2\sqrt{f'_c} = 0.11 f'_c$

POLE FOUNDATIONS "POLEFDN"
PROGRAM DESCRIPTION

Program calculates length of pole foundation, soil pressures, shear reinforcement for 4, 6, and 8 bar arrangements; anchor bolts for 4 and 8 bolt arrangement.

If you should desire a printout of the prompting statements along with the numerical results, set your printer to the normal mode.

The main program may be addressed directly by the execute key (XEQ) and the program name "POLEFDN". Flag eleven has been set causing the program to initialize immediately upon entry of program cards.

Program automatically returns to Label A for your next pole foundation.

The soil pressures are assumed to load the pole foundation with the parabolic load distribution and is computed utilizing formulas developed by Mr. E. Czerniak, AM.ASCE in his paper "Resistance to Overturning of Single, Short Piles" published in ST-2*, pages 1188-1 through 23. This paper should be referred to for derivation of formulas and the passive pressures to be used in the program for various soils.

The pole height and diameter is only for general information and is not used in program.

The required reinforcement, shears, etc. are computed based upon a square column inscribed within the round foundation. However, the minimum reinforcement is based upon the round concrete section.

The concrete stress used by the program is 3000 PSI; However, the steel stress f_y can be grade 40 (f_y = 40,000 PSI) or grade 60 (f_y = 60,000 PSI) reinforcement. Select as follows:

Label C:	a = 1.44 K = 226 f'c = 3000 PSI f_y = 40,000 PSI	Working Stress Design	Label D:	a = 1.76 K = 204 f'c = 3000 PSI f_y = 60,000 PSI	Working Stress Design

If you fail to select a steel stress, the program will automatically use f_y = 40,000 PSI. Both concrete stress and f_y selected will be printed for your information.

f'c = 3000 PSI concrete strength

f_y = 40,000 PSI or 60,000 PSI steel strength

K = 226 for f_y = 40,000 PSI
    204 for f_y = 60,000 PSI

a = $f_s j/12{,}000$ = 1.44 for f_y = 40,000 PSI
                    1.76 for f_y = 60,000 PSI

Mallow = FK = K x $bd^2/12{,}000$

H_o = Horizontal Force applied to pole (kips)

B = Height of horizontal force above top of pole foundation (feet)

C = Height of pole foundation above the ground line (feet)

Z = Erosion allowance (feet)

E = B + C + Z

D = Footing diameter (feet)

R = Passive Pressure ($K/ft^3/ft$ depth)

M_o = Overturning moment (kip-feet)

L = Length of foundation (feet)

f = Earth pressure (kips/SF)

V = Shear (kips)

v = Shear ($kips/in^2$)

A_s = Area of reinforcement (in^2)

A = Area of each bolt required (in^2)

*ST-2; Journal of the Structural Division of the American Society of Civil Engineers, Vol. 83, No. ST-2, March, 1957.

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JOB SAMPLE PROBLEM
SHEET NO. ____ OF ____
CALCULATED BY ____ DATE ____
CHECKED BY ____ DATE ____
SCALE ____ COMM. NO.

POLE LOCATION (PUSH LABEL A) POLE #45

POLE FOUNDATION (AUGERED - ROUND) 1 of 2 | 5

POLE HEIGHT = ____ FT.
POLE DIAMETER = ____ IN @ BASE
H_o =

M_{BASE} =

H_o = 1.0 K ENTER (R/S)

B = 15.5 FT (ENTER R/S) = $\frac{M_{BASE}}{H_o}$ =

C = 1.00 FT (ENTER R/S)

Z = 1.00 FT (ENTER R/S); E = 17.5 FT (Print)

D (DIAMETER FTG) = 2.0 FT (ENTER R/S)

R (PASSIVE PRESSURE) = 0.30 K/ft' (ENTER R/S)

$M_o = H_o \times E$ = 17.5 KI (PRINT)

$$L^3 - 14.14\frac{H_o L}{RD} - 18.85\frac{M_o}{RD} = 0$$

L (MIN. INITIAL) = 8.0 FT (ENTER R/S) L = 9.2 FT (REQ'D)

L (actual) = 10.0 FT ENTER (R/S)

a (pivot point) = $\frac{4EL + 3L^2}{6E + 4L}$ = 6.8966 FT (PRINT)

$f_1 = \frac{1.178(4M_o + 3H_oL)^2}{L^2D(3M_o + 2H_oL)}$ = 0.8124 K/ft'; f_1 (allow) = 1.0345 K/ft' = R × a/2

$f_2 = 9.425(2M_o + H_oL)/L^2D$ = 2.1206 K/ft'; f_2 (allow) = 3.00 K/ft' = R × L

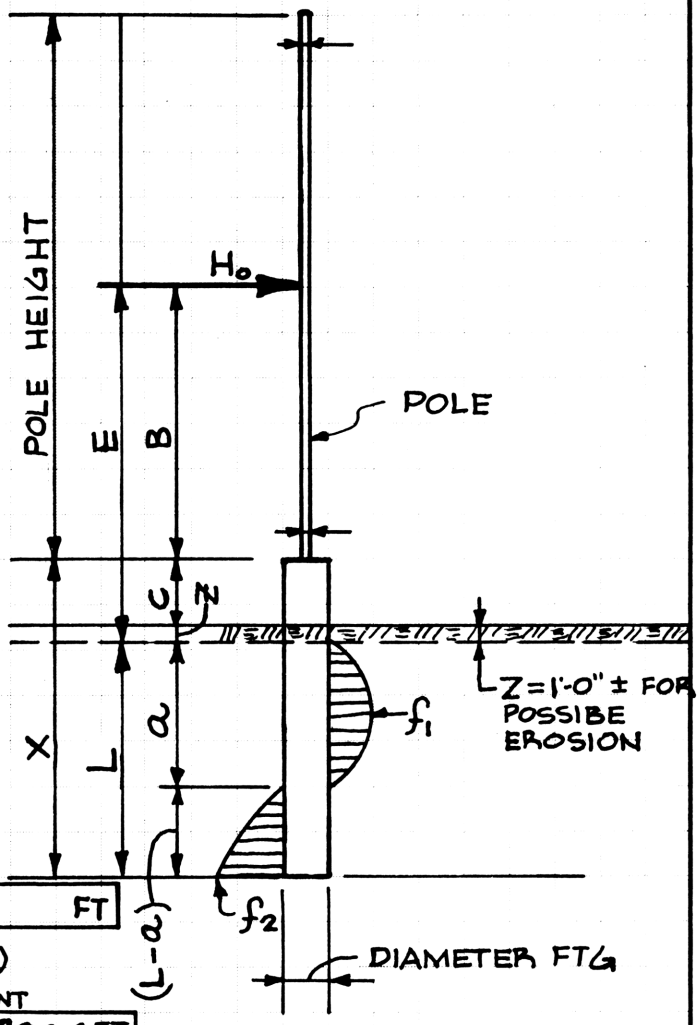
$V_{(MAX)} = H_o\left[1 - 3\left(\frac{4E}{L}+3\right)\left(\frac{a}{L}\right)^2 + 4\left(\frac{3E}{L}+2\right)\left(\frac{a}{L}\right)^3\right]$ = -3.7562 K

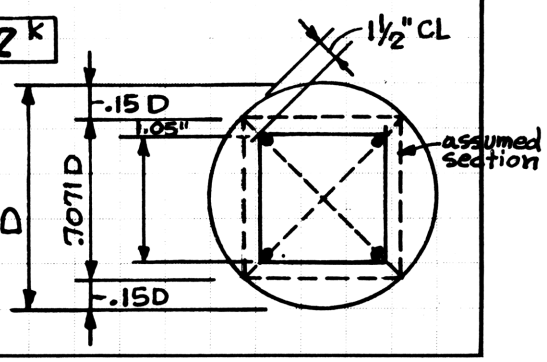
$v_{(MAX)} = \frac{V(max)}{D^2 \times (12)^2 \times (.7071)^2}$ = -0.013 K/in²

$M_{(a/2)} = M_o + H_o\frac{a}{2} - H_oL\left[\left(\frac{4E}{L}+3\right)\left(\frac{a}{2L}\right)^3 + \left(\frac{3E}{L}+2\right)\left(\frac{a}{2L}\right)^4\right]$ (≈0 ; ≈0)

$= M_o + H_o\frac{a}{2}$ = 20.9483 KI

$A_s = M/ad - M/1.44d$ = 0.9698 in²
(= M/1.76d)





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JOB SAMPLE PROBLEM (5-3)
SHEET NO. ____ OF ____
CALCULATED BY ____ DATE ____
CHECKED BY ____ DATE ____
SCALE ____ COMM. NO.

POLE LOCATION POLE #45

POLE FOUNDATION (AUGERED-ROUND) 2 of 2 | 5

PRINT

$A_s(min) = .005 \times \pi D^2 \times 144/4 =$ **2.2698 □"**

$b = D*12*.7071 =$ **17.00 "**

$A_s = \frac{M}{ad} = \frac{M}{a\,d} =$ **1.1481 □"/Bar** (4 BARS TYPE III) **0.3233 □"/Bar** (8 BARS TYPE I)

$d = ((D*12) - 2.82) \times 0.7071 =$ **15.0 "**

$M(allow) = Kbd^2/12000 \geq K*(D*12*.7071)\,d^2/12000 =$ **72.0375 K'**

$v(allow) = 0.060\ K/□"$

M(@ BOTT OF POLE) $= Ho \times B =$ **15.5 K'**

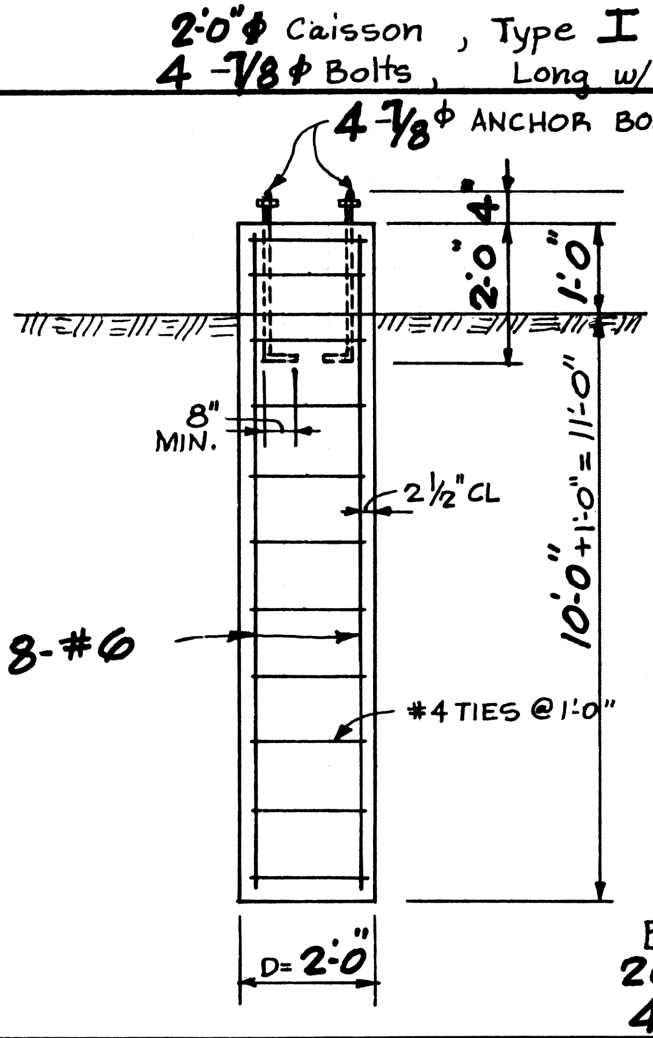
BOLT SPACING (ENTER (R/S)) = **16.0 "**

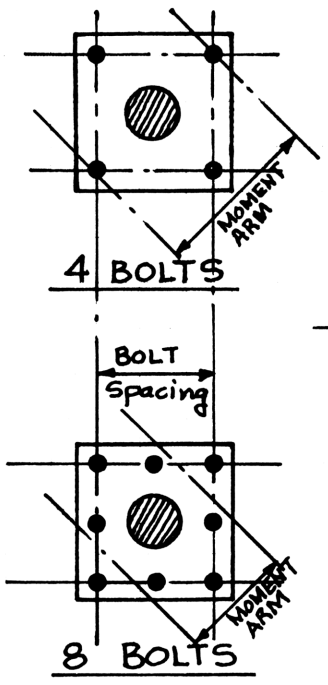
$A_{(each\ Bolt\ for\ 4\ Bolts)} = \frac{12M}{Bolt\ Spacing \times 2 \times 20} =$ **.2906 □"/Bolt**

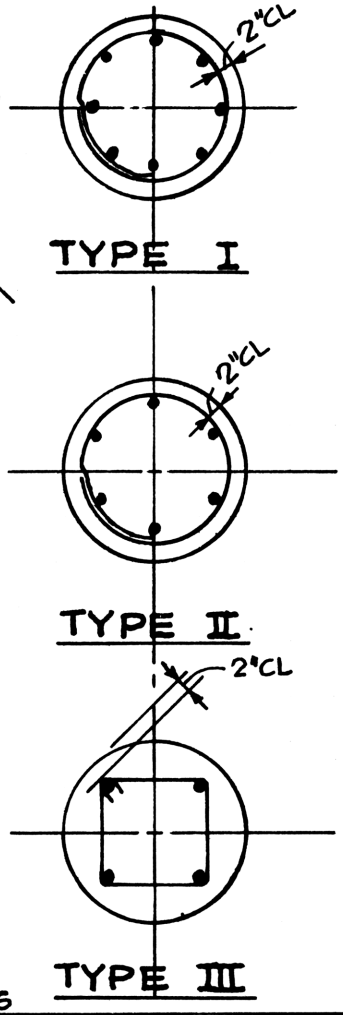
$= \frac{12M}{Bolt\ Spacing \times 1.414 \times 20} =$ **.4110 □"/Bolt**

$A_{(each\ Bolt\ for\ 8\ Bolts)} = \frac{12M}{3 \times B.S. \times 20 \times .9421} =$ **.2055 □"/Bolt**

USE $f'c$ = 3000 PSI, f_y = 40,000 PSI
Reinf w/ 8 -#6 VERTS
#4 TIES @ 12"c
2'-0"ϕ Caisson, Type I
4 -⅞ϕ Bolts, Long w/ 8" HOOK







Base ℄ Size
20 " Square w/
4 -⅞"ϕ Anchor Bolts

JOB

SHEET NO. OF

CALCULATED BY DATE

CHECKED BY DATE

SCALE COMM. NO.

ACI 318-63 "BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE"

ANCHOR BOLTS

$f'_c = 3000$ PSI

$f_s = 20{,}000$ PSI

TENSION DEVELOPMENT LENGTH $= 2 \times \frac{A_s f_s}{\Sigma_o u} \geq \frac{A_s f_s}{\Sigma_o \times 160}$

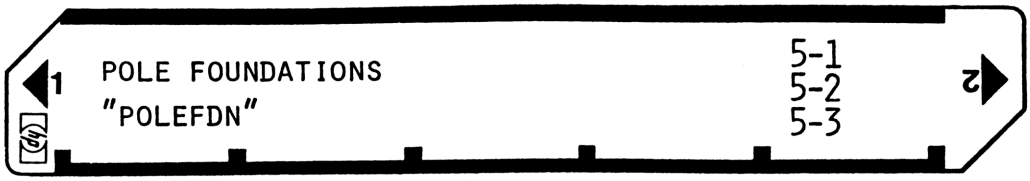
$$l = \frac{2 A_s \times 20{,}000}{\pi D \times \frac{4.8\sqrt{f'_c}}{D}} = \frac{2 \times 20{,}000\, A_s}{\pi \times 4.8\sqrt{3000}}$$

$$= \frac{40{,}000\, A_s}{825.95} = 48.4293\, A_s$$

OR $$l = \frac{A_s f_s}{\Sigma_o 160} = \frac{20{,}000 A_s}{\pi D \times 160} = 39.7887 \frac{A_s}{D}$$

BOLT SIZE	GROSS AREA	ROOT AREA	TENSILE AREA	TENSILE As / GROSS As	DEVELOPMENT LENGTH	
					GROSS AREA	TENSILE STRESS
3/8"ϕ	.110 □"	.068 □"	.078 □"	.7091	11.68"	8.28"
1/2"ϕ	.196	.126	.142	.7245	15.60"	11.30"
5/8"ϕ	.307	.202	.226	.7362	19.55"	14.39"
3/4"ϕ	.442	.302	.334	.7557	23.45"	17.72"
7/8"ϕ	.601	.419	.462	.7687	29.11"	22.38"
1"ϕ	.785	.551	.606	.772	38.02"	29.35"
1 1/8"ϕ	.994	.693	.763	.7676	48.14"	36.96"
1 1/4"ϕ	1.227	.890	.969	.7897	59.43"	46.93"
1 3/8"ϕ	1.485	1.05	1.16	.7811	71.92"	56.18"
1 1/2"ϕ	1.767	1.29	1.41	.798	85.58"	68.29"

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	TURN PRINTER ON			
	MANUAL MODE - DISPLAYS PROMPTING			
	STATEMENTS ONLY			
	NORMAL MODE - DISPLAYS AND PRINTS			
	PROMPTING STATEMENTS			
2	TURN CALCULATOR ON (USER MODE)		ON	
3	PUSH XEQ ALPHA SIZE ALPHA 060 TO			
	PARTITION PROGRAM REGISTERS (SKIP			
	THIS STEP IF CALCULATOR PARTI-			
	TIONED FROM LAST PROGRAM)			
4	LOAD PREPROGRAMMED MAGNETIC CARDS			
5	PUSH LABEL C FOR f_y = 40,000 PSI		C	
	PUSH LABEL D FOR f_y = 60,000 PSI		D	
	PUSH LABEL A FOR POLE FOUNDATION		A	
6	PROCEED TO CALCULATION SHEET			
7	ENTER DATA AND PUSH R/S KEY	DATA	R/S	
8	REPEAT STEP 7 UNTIL PROBLEM COMPLETED			

HP-41c

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
01	♦LBL "POLEFDN"		Pole Foundation "POLEFDN"
02	♦LBL A		
03	SF 11		
04	SF 12		
05	"=CALPRO="		
06	PRA		
07	"CALCULATOR PRO"		
08	"I-GRAMS"		
09	PRA		
10	CF 12		
11	ADV		
12	"H O"		
13	PROMPT		Enter H_o
14	PRX		
15	STO 20		
16	"B"		
17	PROMPT		Enter B
18	PRX		
19	STO 00		
20	"C"		
21	PROMPT		Enter C
22	PRX		
23	STO 01		
24	"Z"		
25	PROMPT		Enter Z
26	PRX		
27	STO 02		
28	+		
29	+		
30	"E"		
31	AVIEW		
32	PRX		Print E
33	STO 03		
34	"D"		
35	PROMPT		Enter D
36	PRX		
37	STO 23		
38	"R"		
39	PROMPT		Enter R (Passive Pressure)
40	PRX		
41	STO 24		
42	RCL 20		
43	RCL 03		
44	*		
45	"M O"		
46	AVIEW		
47	PRX		Print $M_o = H_o E$
48	STO 21		
49	18.85		
50	*		$\frac{18.85\,M_o}{RD}$
51	RCL 24		
52	/		
53	RCL 23		
54	/		
55	STO 05		
56	14.14		
57	RCL 20		
58	*		
59	RCL 24		$\frac{14.14\,H_o}{RD}$
60	/		
61	RCL 23		
62	/		
63	STO 04		
64	ADV		
65	"L MIN"		
66	PROMPT		$L_{(Trial)}$
67	PRX		
68	STO 06		
69	♦LBL B		
70	RCL 06		
71	3		
72	Y↑X		$L^3 - \frac{14.14 H_o L}{RD} - \frac{18.85 M_o}{RD} \geq 0 = X$
73	RCL 04		
74	RCL 06		
75	*		
76	-		
77	RCL 05		
78	-		
79	X>0?		
80	GTO 16		
81	.1		Add 0.1 ft to L
82	ST+ 06		GTO B if X<0?
83	GTO B		
84	♦LBL 16		
85	RCL 06		
86	"L REQD"		
87	AVIEW		
88	PRX		Print L req'd
89	"L ACTUAL"		
90	PROMPT		
91	PRX		Print L (actually used)
92	STO 07		
93	ADV		
94	RCL 03		
95	*		
96	4		
97	*		
98	3		
99	RCL 07		
100	X↑2		$a = \frac{4EL + 3L^2}{6E + 4L}$
101	*		
102	+		
103	6		
104	RCL 03		
105	*		
106	4		
107	RCL 07		
108	*		
109	+		
110	/		

REGISTERS

00 B	01 C	02 Z	03 E	04 14.14/RD	05 18.85M$_o$/RD	06 L req'd	07 L selected	08 a	09 8.5D
10	11	12	13	14	15	16	17	18	19
20 H_o	21 M_o	22	23 D	24 R Passive Pressure	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
	111	"a PIVOT"	
	112	AVIEW	
	113	PRX	Print a
	114	STO 08	
	115	3	
	116	RCL 20	
	117	*	
	118	RCL 07	
	119	*	
	120	RCL 21	
	121	4	
	122	*	
	123	+	
	124	X↑2	
	125	1.178	
	126	*	$f_1 = \frac{1.178(4M_o+3H_oL)^2}{L^2D(3M_o+2H_oL)}$
	127	RCL 07	
	128	X↑2	
	129	/	
	130	RCL 23	
	131	/	
	132	RCL 20	
	133	RCL 07	
	134	*	
	135	2	
	136	*	
	137	3	
	138	RCL 21	
	139	*	
	140	+	
	141	/	
	142	"F 1"	
	143	AVIEW	
	144	PRX	Print f_1
	145	RCL 24	
	146	RCL 08	
	147	*	
	148	2	
	149	/	
	150	PRX	$f_{1(max)} = \frac{B \times a}{2}$
	151	RCL 21	
	152	2	
	153	*	
	154	RCL 20	
	155	RCL 07	
	156	*	$f_2 = \frac{9.425(2M_o+H_oL)}{L^2D}$
	157	+	
	158	9.425	
	159	*	
	160	RCL 07	
	161	X↑2	
	162	/	
	163	RCL 23	
	164	/	
	165	"F 2"	
	166	AVIEW	
	167	PRX	Print f_2
	168	RCL 24	
	169	RCL 07	
	170	*	
	171	PRX	Print $f_{2(max)} = R \times L$
	172	ADV	
	173	1	
	174	STO 06	
	175	RCL 08	
	176	RCL 07	
	177	/	
	178	STO 09	
	179	X↑2	
	180	3	
	181	*	
	182	4	
	183	RCL 03	
	184	*	
	185	RCL 07	
	186	/	
	187	3	
	188	+	
	189	*	
	190	ST- 06	
	191	RCL 09	
	192	3	
	193	Y↑X	
	194	4	
	195	*	
	196	RCL 03	
	197	3	
	198	*	
	199	RCL 07	
	200	/	
	201	2	
	202	+	
	203	*	
	204	ST+ 06	
	205	RCL 20	
	206	ST* 06	
	207	RCL 06	
	208	"V MAX"	
	209	AVIEW	
	210	PRX	Print V
	211	RCL 23	
	212	8.5	
	213	*	
	214	STO 09	
	215	X↑2	
	216	/	
	217	PRX	Print $v = \frac{V}{bd}$
	218	FC? 00	
	219	XEQ C	
	220	RCL 21	
	221	RCL 20	
	222	RCL 08	

$$V = H_o\left[1 - 3\left(\frac{4E}{L}+3\right)\left(\frac{a}{L}\right)^2 + 4\left(\frac{3E}{L}+2\right)\left(\frac{a}{L}\right)^3\right]$$

$$= \frac{V}{D^2(12x.7071)^2}$$

LABELS

A ✓	B ✓	C ✓	D ✓	E
F	G	H	I	J
a	b	c	d	e
01	02	03	04	05
06	07	08	09	10
11	12	13	14	15
16 ✓	17	18	19	20
21	22	23	24	25

FLAGS

0 ✓	1
2	3
4	5
6	7
8	9
16	17
24	25

SET STATUS

FLAGS: ON / OFF
0 ☐ ■
1 ☐ ■
2 ☐ ■
3 ☐ ■

TRIG: DEG ■ GRAD ☐ RAD ☐

DISP: FIX ■ SCI ☐ ENG ☐ n 4

10	11 ✓	12 ✓	13	14	15
18	19	20	21	22	23
26	27	28	29	30	31

Program Listing

HP-41c

PAGE 5-8

STEP	KEY ENTRY	KEY CODE	COMMENTS
		223 *	
		224 2	
		225 /	
		226 +	
		227 "M a/2"	
		228 AVIEW	
		229 PRX	Print M_{max}
		230 RCL 26	
		231 /	
		232 RCL 09	
		233 2	
		234 -	
		235 STO 23	
		236 /	
		237 PRX	Print $A_s = \frac{M}{ad}$
		238 "PAGE 2 OF 2"	
		239 AVIEW	
		240 STO 25	
		241 .005	
		242 PI	
		243 *	
		244 RCL 09	
		245 .7071	
		246 /	
		247 STO 06	
		248 X↑2	
		249 *	
		250 4	
		251 /	
		252 "A S"	
		253 AVIEW	
		254 PRX	$As_{min} = \frac{0.005\pi D^2}{4}$
		255 RCL 09	
		256 "b"	
		257 AVIEW	
		258 PRX	b=
		259 RCL 23	
		260 2	
		261 -	
		262 .2121	
		263 *	
		264 RCL 23	
		265 +	
		266 RCL 23	
		267 /	
		268 RCL 25	
		269 *	
		270 "A S"	
		271 AVIEW	
		272 PRX	Print A_s for an 4 bar group
		273 RCL 25	
		274 3	
		275 /	
		276 PRX	Print A_s for an 8 bar group = $A_s/3$
		277 RCL 23	
		278 "d"	
		279 AVIEW	
		280 PRX	Print d
		281 X↑2	
		282 RCL 09	
		283 *	
		284 RCL 27	
		285 *	
		286 12000	
		287 /	
		288 "M ALLOW"	
		289 AVIEW	
		290 PRX	Print = $\frac{Kbd^2}{12000}$
		291 ADV	

$M_{max} = M_o + \frac{H_o a}{2}$

A_s (4 bars @ 45°) $= A_s\left[\frac{(d-2")(.2121)+d}{d}\right]$

STEP	KEY ENTRY	KEY CODE	COMMENTS
		292 RCL 20	
		293 RCL 06	
		294 *	
		295 "M"	
		296 AVIEW	
		297 PRX	Print M @ Base of Pole = $H_o B$
		298 12	
		299 *	
		300 "BOLT SPACING"	
		301 PROMPT	Enter Bolt Spacing
		302 PRX	
		303 STO 22	
		304 /	
		305 40	
		306 /	
		307 "AREA BOLT"	
		308 AVIEW	
		309 PRX	Print A_s per Bolt ⊥
		310 .7071	
		311 /	
		312 PRX	Print As for bolt across diagonal
		313 .5	
		314 *	
		315 PRX	Print As for 8 Bolt group across diagonal
		316 "Fc"	
		317 AVIEW	
		318 RCL 28	
		319 PRX	Print F_c
		320 "FY"	
		321 AVIEW	
		322 RCL 29	
		323 PRX	Print fy
		324 ADV	
		325 ADV	
		326 ADV	
		327 ADV	
		328 ADV	
		329 GTO A	Return to A
		330 *LBL C	f'_c = 3000 PSI
		331 SF 00	f_y = 40,000 PSI
		332 1.44	a = 1.44
		333 STO 26	K = 226
		334 226	
		335 STO 27	f'_c = 3000 PSI
		336 3000	
		337 STO 28	f_y = 40,000 PSI
		338 40000	
		339 STO 29	
		340 RTN	
		341 *LBL D	
		342 SF 00	
		343 1.76	a = 1.76
		344 STO 26	
		345 204	K = 204
		346 STO 27	
		347 3000	f'_c = 3000 PSI
		348 STO 28	
		349 60000	f_y = 60,000 PSI
		350 STO 29	
		351 GTO A	
		352 .END.	

BEARING PLATES/BASE PLATES "PLATES"

PROGRAM DESCRIPTION

Bearing Plates

Program calculates the minimum plate width, bearing stress, "n" and thickness required for a bearing plate of uniform thickness for an allowable steel stress of 27 KSI.

Base Plates

Program calculates the area of base plate required for a concrete bearing stress of 750 PSI, actual bearing stress, the maximum "n" or "m", the plate thickness required for an allowable steel stress of 27 KSI.

Program automatically returns to beginning of program ready for the next bearing plate or base plate.

P_{TL} = Total load (KIPS)

K = Toe of fillet (inches)

L = Length of plates (inches)

F_p = Bearing stress under plate (KSI)

n or m = Moment arm (inches)

t = Plate thickness (inches)

B_f = Flange width (inches)

Depth (D) = Column depth (inches)

$$t = \sqrt{\frac{3F_p\, n^2}{27}} = \sqrt{\frac{F_p\, n^2}{9}} \quad \text{or} \quad \sqrt{\frac{F_p\, m^2}{9}}$$

F_b = 27 KSI for all plates

$n = \frac{W}{2} - k$ (bearing plates)

$m = \frac{W - 0.95D}{2}$ (base plates)

$n = \frac{L - 0.8B_f}{2}$ (base plates)

If you should desire a printout of the prompting statements along with the numerical results, set your printer to the normal mode.

The main program may be addressed directly by the execute key (XEQ) and the program name "PLATES". Flag eleven has been set causing the program to initialize immediately upon entry of program cards.

A trial length and width are printed to aid you in a rapid selection of the plate length and width. This trial length and width is equal to the square root of the required plate area.

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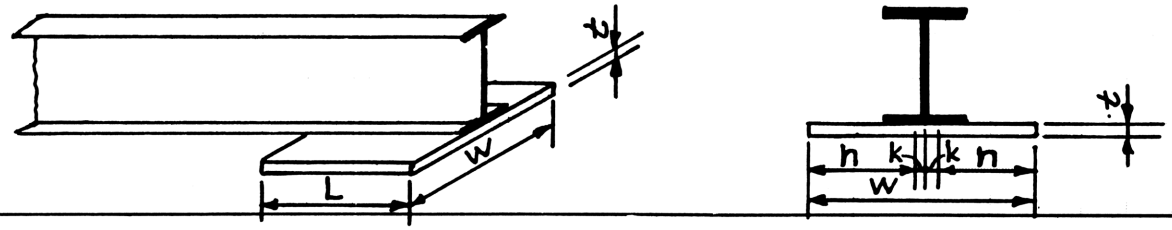
JOB SAMPLE PROBLEM
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____
SCALE _____ COMM. NO.

PUSH LABEL A

BEARING PLATES

6A

	BEAM LOCATION	P_{TL}	BEAM SIZE	BEAM k	L (IN)	$F_{p(max)}$	$W_{(MIN)}$	W_{actual}	F_p actual	n	t	USE PL
1	A-6	60^k	-	1"	8"	0.20 k/in	37.5"	16"	.4688 k/in	7"	1.59"	1 3/4 x 8 x 16
2	B-7	100^k	-	1 3/8	10	0.20	50.0	18	.5556	7.625"	1.89"	2 x 10 x 18
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
		ENTER (R/S)		ENTER (R/S)	ENTER (R/S)	PRINT	PRINT	ENTER (R/S)	PRINT	PRINT	PRINT	



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JOB SAMPLE PROBLEM (6-3)

SHEET NO _____ OF _____

CALCULATED BY _____ DATE _____

CHECKED BY _____ DATE _____

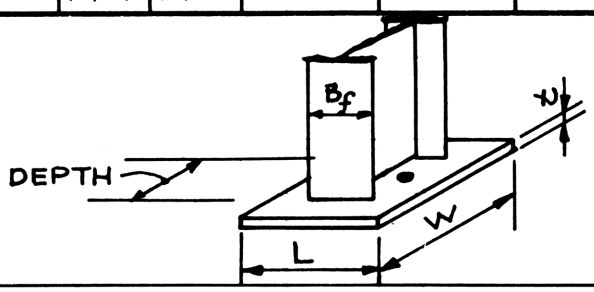
SCALE _____ COMM. NO.

PUSH LABEL B

BASE PLATES

6B

	COL NO.	"P" (AXIAL LOAD)	AREA (REQ'D)	PLATE SZE L	PLATE SZE W	"F_p"	COLUMN "B_f"	COLUMN DEPTH	"N" OR "M"	"t"	USE PLATE
1	A6	60 K	80 □"	10"	10"	0.60 K/□"	8"	8"	1.80"	0.4648"	½×10×10
2	B7	160	213.3	15	15	0.711	8	8	4.30	1.2087	1¼×15×15
3	H12	260	346.66	18	20	0.7222	8	10	5.80	1.6430	1¾×18×20
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
		ENTER (R/S)	PRINT	ENTER (R/S)	ENTER (R/S)	PRINT	ENTER (R/S)	ENTER (R/S)	PRINT	PRINT	



HP-41C

User Instructions

NO. CARDS 2

1	BEARING AND BASE PLATES	6-1
	"PLATE"	6-2

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	TURN PRINTER ON				
	MANUAL MODE - DISPLAYS PROMPTING				
	STATEMENTS ONLY				
	NORMAL MODE - DISPLAYS AND PRINTS				
	PROMPTING STATEMENTS				
2	TURN CALCULATOR ON (USER MODE)			ON	
3	PUSH [XEQ] [ALPHA] SIZE [ALPHA] 060 TO				
	PARTITION PROGRAM REGISTERS (SKIP				
	THIS STEP IF CALCULATOR PARTI-				
	TIONED FROM LAST PROGRAM)				
4	LOAD PREPROGRAMMED MAGNETIC CARDS				
5	PUSH LABEL A - BEARING PLATE			A	
	PUSH LABEL B - BASE PLATE			B	
6	PROCEED TO CALCULATION SHEET				
7	ENTER DATA AND PUSH R/S KEY			R/S	
8	REPEAT STEP 7 UNTIL PROBLEM COMPLETED				

HP-41c

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
01	LBL "PLATES"		"PLATES"
02	LBL 01		
03	SF 11		
04	SF 12		
05	"=CALPRO="		
06	PRA		
07	"CALCULATOR PRO"		
08	"I-GRAMS"		
09	PRA		
10	CF 12		
11	ADV		
12	RTN		
13	LBL A		Bearing Pl
14	XEQ 01		
15	"BEARING PL"		
16	PRA		
17	"P TL"		
18	PROMPT	←	Enter P_{TL}
19	PRX		
20	STO 26		
21	"K"		
22	PROMPT	←	Enter K_{beam}
23	STO 20		
24	PRX		
25	RCL 26		
26	"L"		
27	PROMPT	←	Enter L ∥ to Beam
28	PRX		
29	STO 21		
30	/		
31	STO 24		
32	"F P"		
33	PROMPT	←	Enter F_p max
34	PRX		
35	STO 22		
36	/		
37	"W (MIN)"		
38	PRA		
39	PRX	→	Print W min
40	"W"		
41	PROMPT	←	Enter W ⊥ to Beam
42	PRX		
43	STO 23		
44	RCL 24		
45	/		
46	1/X		
47	"F P"		
48	PRA		
49	PRX	→	Print $F_p = \frac{P_{TL}}{L \times W}$
50	RCL 23		
51	2		
52	/		
53	RCL 20		
54	-		
55	"N"		$n = \frac{W}{2} - K$
56	PRA		
57	PRX	→	Print n
58	X↑2		
59	*		
60	9		
61	/		
62	SQRT		
63	"THICKNESS"		
64	PRA		
65	PRX	→	Print $t = \sqrt{\frac{F_p n^2}{9}}$
66	ADV		
67	ADV		
68	GTO A		Return to A
69	LBL B		Base Pl
70	XEQ 01		
71	"BASE PL"		
72	PRA		
73	"P TL"		
74	PROMPT	←	Enter P_{TL}
75	PRX		
76	STO 26		
77	.75		
78	/		
79	"AREA REQD"		
80	PRA		
81	PRX	→	Print $A = \frac{P_{TL}}{0.75 \text{ k/in}^2}$
82	SQRT		
83	"TRIAL L OR W"		
84	PRA		
85	PRX	→	Print $L = \sqrt{A}$
86	"L"		
87	PROMPT	←	Enter L Length ∥ to Flange
88	PRX		
89	STO 21		
90	"W"		
91	PROMPT	←	Enter W ⊥ to Flange
92	PRX		
93	STO 23		
94	*		
95	1/X		
96	RCL 26		
97	*		
98	"F P"		
99	PRA		
100	PRX	→	Print $F_p = \frac{P_{TL}}{L \times W}$
101	STO 22		
102	RCL 22		
103	RCL 21		
104	"B F"		
105	PROMPT	←	Enter Bf
106	PRX		
107	STO 24		
108	.8		
109	*		
110	-		$\frac{L - 0.8 B_f}{2} = n$

REGISTERS

00	01	02	03	04	05	06	07	08	09
10	11	12	13	14	15	16	17	18	19
20 K	21 L Pl	22 F_p	23 W Pl	24 P/L / Bf	25 Depth	26 P_{TL}	27 ,	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59

HP-41C

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
		111 2	
		112 /	
		113 RCL 23	
		114 "DEPTH"	
		115 PROMPT	Enter Depth
		116 STO 25	
		117 .95	
		118 *	
		119 -	$\frac{W-0.95D}{2}=m$
		120 2	
		121 /	
		122 X>Y?	
		123 GTO 03	
		124 X<>Y	
		125♦LBL 03	
		126 "N OR M"	
		127 PRA	
		128 PRX	Print "m" or "n" (max. value)
		129 X↑2	
		130 RCL 22	
		131 *	
		132 9	
		133 /	
		134 SQRT	
		135 "THICKNESS"	
		136 PRA	
		137 PRX	Print $t=\sqrt{\frac{F_p n^2}{9}}$
		138 ADV	
		139 ADV	
		140 GTO B	Return to B
		141 .END.	

LABELS				
A ✓	B ✓	C	D	E
F	G	H	I	J
a	b	c	d	e
01 ✓	02	03 ✓	04	05
06	07	08	09	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

FLAGS	
0	1
2	3
4	5
6	7
8	9
10	11 ✓
12 ✓	13
14	15
16	17
18	19
20	21
22	23
24	25
26	27
28	29
30	31

SET STATUS

FLAGS	TRIG	DISP
ON OFF	DEG ■	FIX ■
0 □ ■	GRAD □	SCI □
1 □ ■	RAD □	ENG □
2 □ ■		n 4
3 □ ■		

SIMPLE SPAN BEAM/UNIFORM LOAD
SIMPLE SPAN BEAM/UNIFORMLY VARYING LOAD "ULUVL"
PROGRAM DESCRIPTION

Program calculates moment, reactions, moment of inertia for an L/360 allowable deflection, deflections, and bearing plate sizes using standard formulas.

If you should desire a printout of the prompting statements along with the numerical results, set your printer to the normal mode.

The main program may be addressed directly by the execute key (XEQ) and the program name "ULUVL". Flag eleven has been set causing the program to initialize immediately upon entry of program cards.

For the uniformly varying load the calculated moment at centerline is within 98% of maximum value for a triangular load and is exact for a uniform load. The point of zero shear or maximum moment is also calculated.

w - Load on beam (kips/FT) or width of bearing plate (inches)

L - Span length (feet) or length of bearing plate (inches)

R - Reactions (Kips)

M - Moment (Kip-feet)

I - Moment of inertia (in^4)

X - Point of Zero Shear (feet)

t - Plate thickness (inches)

F_p - Bearing pressure under plate ($Kips/in^2$)

F_y - 36.0 ($Kips/in^2$) for bearing plates

The programs and calculation sheets are primarily set up for steel beams but can be adapted to wood beams, concrete beams, basement walls, etc.

After designing a beam or bearing plate, control of program returns to Label A or the simple span beam with a uniform load.

Push Label C - The bearing plate program automatically recalls the left hand reaction so that it does not have to be entered. Then proceed with normal execution as noted on calculation sheet.

Push Label D - The bearing plate program automatically recalls the right hand reaction so that it does not have to be entered. Then proceed with normal execution as noted on the calculation sheet.

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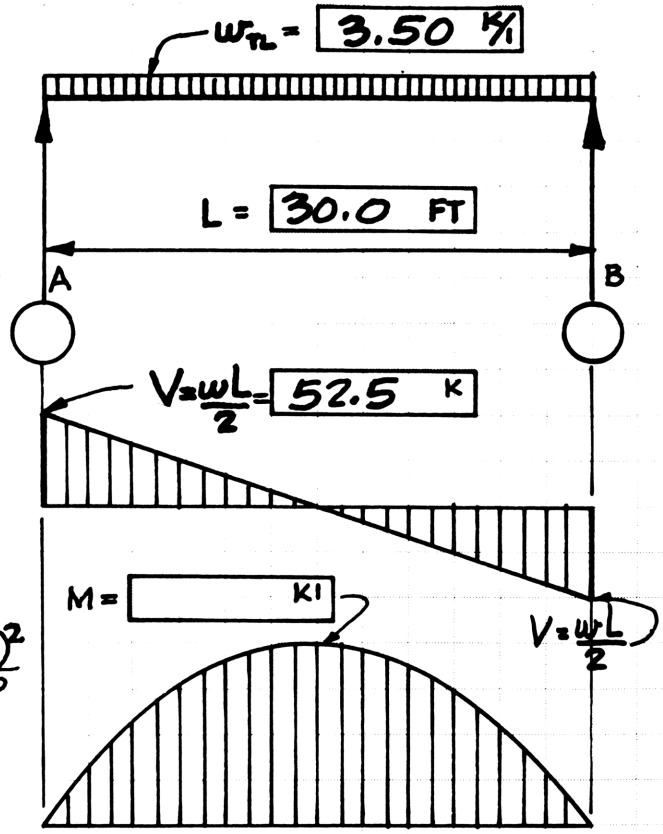
JOB SAMPLE PROBLEM (7-2)
SHEET NO. ____ OF ____
CALCULATED BY ____ DATE ____
CHECKED BY ____ DATE ____
SCALE ____ COMM. NO. ____

BEAM LOCATION: BEAM H 22 - J27
(PUSH LABEL A)

SIMPLE SPAN BEAM — 7A

w:



ENTER (R/S)
w_{DL} = 2.0 K/I ;
ENTER (R/S)
w_{LL} = 1.5 K/I

PRINT
w_{TL} = 3.5 K/I ;
ENTER(R/S)
L = 30.0 FT

PRINT
$R = \frac{wL}{2}$ = 52.5 K

R_{DL} = 30.0 K

R_{LL} = 22.5 K

$M = \frac{wL^2}{8}$ = 393.75 KI

$I_{(req'd\ for\ \Delta = L/360)} = \frac{5 \times 360 w L^3 (12")^2}{384 \times 29000}$
$= 0.0232759\, w L^3$
= 2199.57 IN^4

USE ⟹ [ ]

M_R = KI

L_c = FT

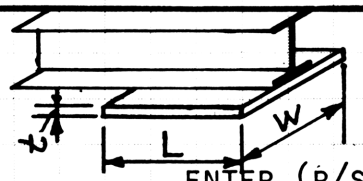
L_u = FT

I_{xx} = 3000 IN^4 ENTER (R/S)

$\Delta = \frac{5wL^4}{384EI} = \frac{I_{360}}{I_{xx}} \times \frac{L \times 12"/I}{360}$

Δ_{TL} = .7332 IN ; Δ_{LL} = .3142 IN

BEARING ⊥
(PUSH LABEL C)



PRINT
R_{TL} = 52.5 K ;
ENTER (R/S)
$k_{(beam)}$ = 1.0 IN

ENTER (R/S)
$L_{(⊥)}$ = 8.0 IN ;
ENTER (R/S)
$F_{p(max)}$ = 0.2 K/□"

PRINT
$W_{(MIN)\ ALLOW}$ = 32.812 IN ;
ENTER (R/S)
$W_{(⊥)}$ = 16.0 IN

PRINT
$F_{P(⊥)}$ = .4102 K/□" ;
PRINT
t = 1.4943 IN

USE ⊥ ⊥ 1.5 x 8 x 16

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JOB SAMPLE PROBLEM
SHEET NO. ____ OF ____
CALCULATED BY ____ DATE ____
CHECKED BY ____ DATE ____
SCALE ____ COMM. NO.

BEAM LOCATION: BEAM B7-D7
(PUSH LABEL B)

SIMPLE SPAN BEAM
UNIFORMLY VARYING LOAD **7B**

w_A =

ENTER (R/S)
w_A = 0.5 K/I

w_B =

ENTER (R/S)
w_B = 3.5 K/I

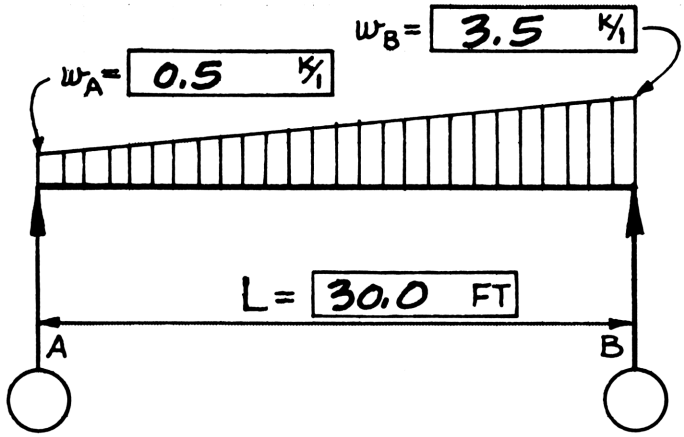
ENTER (R/S)
L = 30 FT

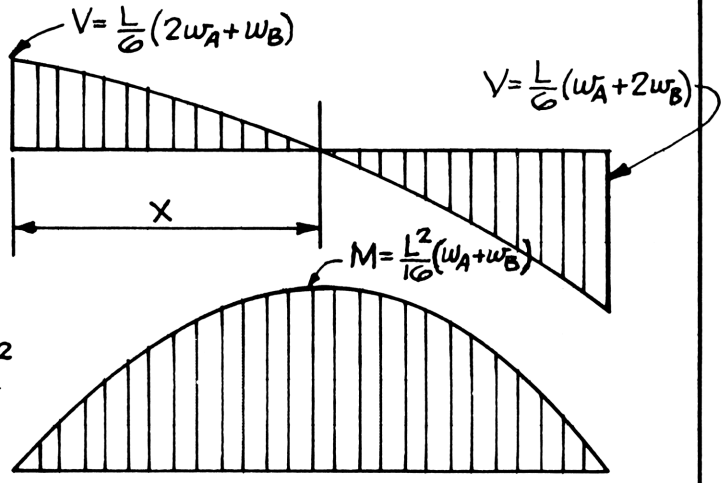
PRINT
$R_A = \frac{L}{6}(2w_A + w_B)$ = 22.5 K

$R_B = \frac{L}{6}(w_A + 2w_B)$ = 37.5 K

$+M_{\mathbb{E}} = \frac{L^2}{16}(w_A + w_B)$ = 225.0 KI *

$I_{(req'd\ for\ \Delta = \frac{L}{360})} = \frac{5 \times 360 (w_A + w_B) L^3 (12"/')^2}{768 \times 29000}$
$= 0.011637931\ (w_A + w_B)\ L^3$
= 1256.89 IN^4 *





BEAM [ ]

M_R = KI

L_C = FT

L_U = FT

I_{xx} = 1500 IN^4 ENTER (R/S)

$\Delta_{\mathbb{E}}$ = 0.8379 = $5L^4(w_A + w_B)/768EI = \frac{I_{360}}{I_{xx}} \times \frac{L \times 12"/'}{360} = \frac{I_{360}}{I_{xx}} \times \frac{L}{30}$

$\frac{(w_B - w_A)}{2L} X^2 + w_A X - R_A = 0$

IF $w_A = w_B$ THEN $X = L/2$

IF $w_A \neq w_B$ THEN

$$X = L\left(\sqrt{\left(\frac{w_A}{w_B - w_A}\right)^2 + \frac{2w_A + w_B}{3(w_B - w_A)}} - \frac{w_A}{w_B - w_A}\right)$$

X = 16.7945 FT

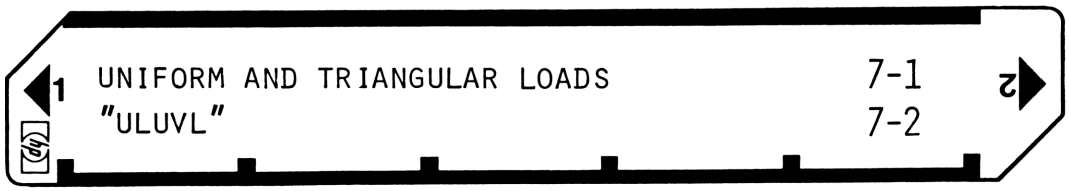
* THESE VALUES ARE WITHIN 98% MAXIMUM.

BEARING PL (PUSH LABEL C FOR R_A; LABEL D FOR R_B)

PRINT: R_{TL} = 22.5 K; ENTER (R/S): $K_{(beam)}$ = 1.0 IN; ENTER (R/S): $L_{(PL)}$ = 5.0 IN; ENTER (R/S): $F_{P(max)}$ = 0.20 K/I; $W_{(MIN)}$ = 22.5 IN

ENTER (R/S): $W_{(PL)}$ = 12.0 IN; F_P = 0.375 K/I"; t = 1.0206 IN; USE PL 1 1/8 x 12 x 5

User Instructions

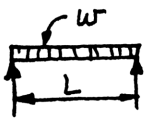


STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	TURN PRINTER ON			
	MANUAL MODE - DISPLAYS PROMPTING			
	STATEMENTS ONLY			
	NORMAL MODE - DISPLAYS AND PRINTS			
	PROMPTING STATEMENTS			
2	TURN CALCULATOR ON (USER MODE)		ON	
3	PUSH XEQ ALPHA SIZE ALPHA 060 TO			
	PARTITION PROGRAM REGISTERS (SKIP			
	THIS STEP IF CALCULATOR PARTI-			
	TIONED FROM LAST PROGRAM)			
4	LOAD PREPROGRAMMED MAGNETIC CARDS			
5	PUSH LABEL A - UNIFORM LOAD ON SIMPLE			
	SPAN BEAM		A	
	PUSH LABEL B - UNIFORMLY VARYING LOAD			
	ON SIMPLE SPAN BEAM		B	
	PUSH LABEL C - BEARING PLATE FOR LEFT			
	HAND REACTION (R_A)		C	
	PUSH LABEL D - BEARING PLATE FOR RIGHT			
	HAND REACTION (R_B)		D	
6	PROCEED TO CALCULATION SHEET			
7	ENTER DATA AND PUSH R/S KEY	DATA	R/S	
8	REPEAT STEP 7 UNTIL PROBLEM COMPLETED			

HP-41c

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
01	LBL "ULUVL"		"ULUVL"
02	LBL A		
03	SF 11		
04	SF 12		
05	"=CALPRO="		
06	PRA		
07	"CALCULATOR PRO"		
08	"I-GRAMS"		
09	PRA		
10	CF 12		
11	"W-DL"		
12	PROMPT		Enter w_{DL}
13	PRX		
14	STO 00		
15	"W-LL"		
16	PROMPT		Enter w_{LL}
17	PRX		
18	STO 01		
19	+		
20	ADV		
21	PRX		Print w_{TL}
22	STO 02		
23	"L"		
24	PROMPT		Enter L
25	PRX		
26	STO 03		
27	2		
28	/		
29	*		
30	"REACTIONS"		
31	PRA		
32	PRX		Print $R_{TL}=\frac{wL}{2}$
33	STO 04		
34	RCL 03		
35	2		
36	/		
37	ENTER↑		
38	ENTER↑		
39	RCL 00		
40	*		
41	PRX		Print R_{DL}
42	X<>Y		
43	RCL 01		
44	*		
45	PRX		Print R_{LL}
46	+		
47	RCL 03		
48	*		
49	4		
50	/		
51	"MOMENT"		
52	PRA		
53	PRX		Print $M_{TL}=\frac{wL^2}{8}$
54	.0232759		
55	RCL 02		
56	*		
57	RCL 03		
58	3		
59	Y↑X		
60	*		
61	"I REQD"		
62	PRA		
63	PRX		$I_{1/360}=0.0232759 \times wL^3$
64	"I XX"		
65	PROMPT		Enter I_{xx}
66	PRX		
67	/		
68	RCL 03		
69	*		
70	30		
71	/		
72	"DEFLECTION"		
73	PRA		
74	PRX		Print Δ_{TL} max.
75	RCL 01		
76	*		
77	RCL 02		
78	/		
79	PRX		Print Δ_{LL} max
80	ADV		
81	ADV		
82	GTO A		Return to A
83	LBL B		Uniformly Varying Load
84	"W-A"		
85	PROMPT		Enter w_A
86	PRX		
87	STO 05		
88	"W-B"		
89	PROMPT		Enter w_B
90	PRX		
91	STO 06		
92	"L"		
93	PROMPT		Enter L
94	PRX		
95	STO 07		
96	RCL 05		
97	2		
98	*		
99	RCL 06		
100	"R"		"R"
101	PRA		
102	+		
103	RCL 07		
104	*		
105	6		
106	/		
107	PRX		Print $R_A=\frac{L}{6}(2w_A+w_B)$
108	STO 04		
109	RCL 05		
110	RCL 06		
111	2		
112	*		
113	+		



Simple Span Beam

REGISTERS

00 w_{DL}/R	01 w_{LL}	02 w_{TL}	03 L	04 R_{TL}	05 w_A	06 w_B	07 L	08	09 R_B
10	11	12	13	14	15	16	17	18	19
20 K	21 L_{FE}	22 F_P	23 W_{FE}	24	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59

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Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
114	RCL	07	
115	*		
116	6		
117	/		
118	PRX		Print $R_B = \frac{L}{6}(W_A + 2W_B)$
119	STO	09	
120	RCL	05	
121	RCL	06	
122	+		
123	RCL	07	
124	X↑2		
125	*		
126	ENTER↑		
127	ENTER↑		
128	16		
129	/		
130	"MOMENT"		
131	PRA		
132	PRX		Print $M_{\mathbb{E}} = \frac{L^2}{16}(W_A + W_B)$
133	X<>Y		
134	RCL	07	
135	*		
136	.011637931		
137	*		
138	"I REQD"		
139	PRA		
140	PRX		Print $I_{L/360}$ req'd $= 0.011637931 w L^3$
141	"I XX"		
142	PROMPT		Enter I_{xx}
143	PRX		
144	/		
145	RCL	07	
146	*		
147	30		
148	/		
149	PRX		Print $\Delta_{\mathbb{E}}$
150	RCL	05	
151	RCL	06	
152	X=Y?		
153	GTO	13	set $x = L/2$
154	RCL	05	
155	-		
156	1/X		
157	*		
158	STO	08	$x \neq L/2$
159	X↑2		
160	RCL	05	
161	RCL	05	
162	+		
163	RCL	06	
164	+		
165	3		
166	/		
167	RCL	06	
168	RCL	05	
169	-		
170	/		
171	+		
172	SQRT		
173	RCL	08	
174	-		
175	RCL	07	
176	*		
177	GTO	14	
178	LBL	13	
179	RCL	07	$x = L/2$
180	2		
181	/		
182	LBL	14	
183	"X"		
184	PRA		
185	PRX		Print x (point of zero shear)
186	ADV		
187	ADV		
188	GTO	A	Return to A
189	LBL	C	Recall $R_{A_{TL}}$
190	"R-A"		
191	RCL	04	
192	GTO	a	
193	LBL	D	Recall $R_{B_{TL}}$
194	"R-B"		
195	RCL	09	
196	LBL	a	
197	PRA		
198	PRX		Print R
199	STO	00	
200	"K"		
201	PROMPT		Enter K_{beam}
202	STO	20	
203	PRX		
204	RCL	00	
205	"L"		
206	PROMPT		Enter L ∥ to Beam
207	PRX		
208	STO	21	
209	/		
210	STO	24	
211	"F P"		
212	PROMPT		Enter Fp
213	PRX		
214	STO	22	
215	/		
216	PRX		Print Wmin
217	"W"		
218	PROMPT		Enter Wused
219	PRX		
220	STO	23	
221	RCL	24	
222	/		

LABELS

A ✓	B ✓	C ✓	D ✓	E
F	G	H	I	J
a ✓	b	c	d	e
01	02	03	04	05
06	07	08	09	10
11	12	13 ✓	14 ✓	15
16	17	18	19	20
21	22	23	24	25

FLAGS

0	1
2	3
4	5
6	7
8	9
16	17
24	25

SET STATUS

FLAGS: ON OFF
0 ☐ ■
1 ☐ ■
2 ☐ ■
3 ☐ ■

TRIG: DEG ■ GRAD ☐ RAD ☐

DISP: FIX ■ SCI ☐ ENG ☐ n 4

10	11 ✓	12 ✓	13	14	15
18	19	20	21	22	23
26	27	28	29	30	31

Program Listing

HP-41C

STEP	KEY ENTRY	KEY CODE	COMMENTS
		223 1/X	
		224 PRX	Print $F_p = \frac{R}{WL}$
		225 RCL 23	
		226 2	
		227 /	
		228 RCL 20	$n = \frac{W}{2} - K$
		229 -	
		230 X↑2	
		231 *	
		232 9	
		233 /	
		234 SQRT	
		235 PRX	Print $t = \sqrt{\frac{F_p n^2}{9}}$
		236 ADV	
		237 ADV	
		238 GTO A	Return to A
		239 .END.	

STEP	KEY ENTRY	KEY CODE	COMMENTS

OVERHANGING BEAM "OVERBM"
PROGRAM DESCRIPTION

Program calculates positive and negative moments, inflection points, deflection of interior span and cantilever using standard formulas.

If you should desire a printout of the prompting statements along with the numerical results, set your printer to the normal mode.

The main program may be addressed directly by the execute key (XEQ) and the program name "OVERBM". Flag eleven has been set causing the program to initialize immediately upon entry of program cards.

w - Uniform load (kips/ft)

P - Concentrated load (kips)

L - Span length (feet)

a - Cantilever length (feet)

M - Moment (kip-ft)

R - Reactions (kips)

Δ - Deflection (inches)

Program and calculation sheet has been primarily set up for a steel beam, but can be easily adapted to wood or concrete beams.

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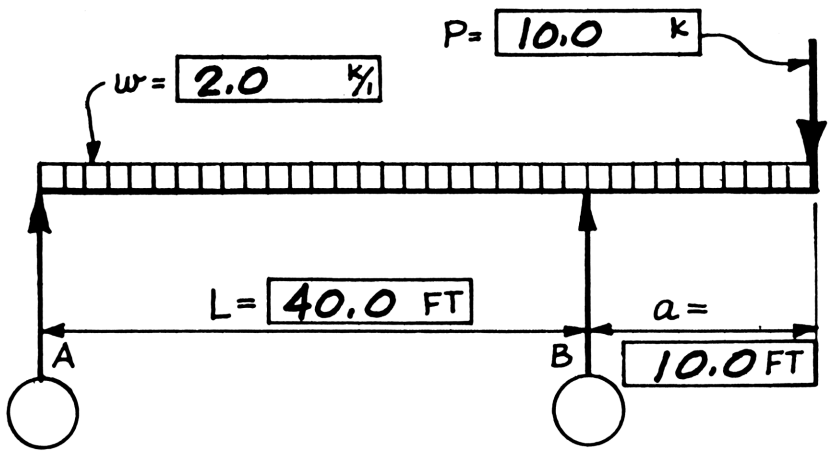
JOB SAMPLE PROBLEM
SHEET NO ____ OF ____
CALCULATED BY ____ DATE ____
CHECKED BY ____ DATE ____
SCALE ____ COMM. NO. ____

BEAM LOCATION: BEAM R12 - T14
(PUSH LABEL A)

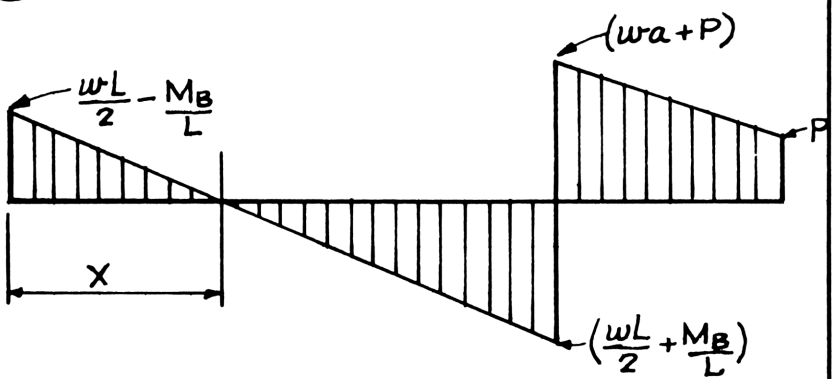
OVERHANGING BEAM **8**

P =

w =



ENTER (R/S)
w = 2.0 K/I
ENTER (R/S)
P = 10.0 K
ENTER (R/S)
L = 40.0 FT
ENTER (R/S)
a = 10.0 FT

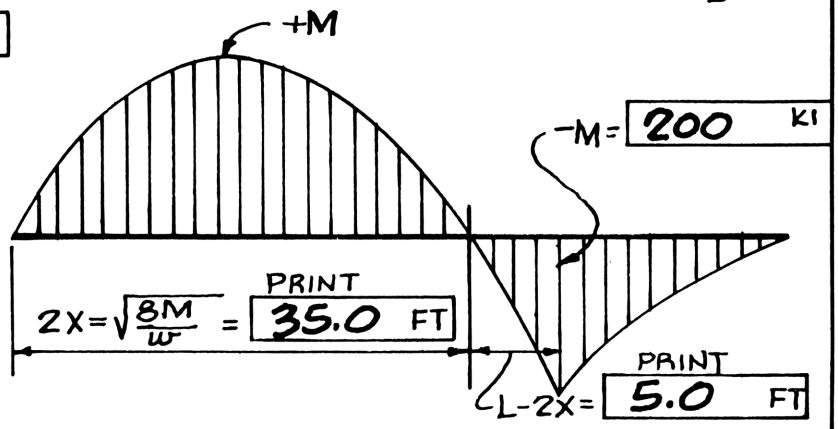


PRINT
$-M_B = Pa + \frac{wa^2}{2}$ = 200 KI

$R_A = \frac{wL}{2} - \frac{M_B}{L}$ = 35 K

$R_B = \frac{wL}{2} + \frac{M_B}{L} + wa + P$ = 75 K

$+M = (R_A)^2/2w$ = 306.25 KI



BEAM
M_R = KI
L_C = FT
L_U = FT
I_X = 1000 IN^4 ENTER (R/S)

PRINT
$\Delta(L/360)$ = 1.333 IN

$\Delta(a/360)$ = 0.333 IN

Δ_x = 2.7739 IN $= \frac{X}{6EIL}\left[\left(\frac{w}{4}\right)\left(L^4 - 2L^2X^2 + LX^3 - 2a^2L^2 + 2a^2X^2\right) - Pa\left(L^2 - X^2\right)\right]$

Δ_P = -1.2414 IN $= \frac{wa}{24EI}\left(4a^2L - L^3 + 3a^3\right) + \frac{Pa^2}{3EI}(L+a)$

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User Instructions

NO. CARDS 2

1	OVERHANGING BEAM	8-1	2
	"OVERBM"	8-2	

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	TURN PRINTER ON				
	MANUAL MODE - DISPLAYS PROMPTING				
	STATEMENTS ONLY				
	NORMAL MODE - DISPLAYS AND PRINTS				
	PROMPTING STATEMENTS				
2	TURN CALCULATOR ON (USER MODE)			ON	
3	PUSH [XEQ] [ALPHA] SIZE [ALPHA] 060 TO				
	PARTITION PROGRAM REGISTERS (SKIP				
	THIS STEP IF CALCULATOR PARTI-				
	TIONED FROM LAST PROGRAM)				
4	LOAD PREPROGRAMMED MAGNETIC CARDS				
5	PUSH LABEL A (KEY A)			A	
6	PROCEED TO CALCULATION SHEET				
7	ENTER DATA AND PUSH R/S KEY	DATA		R/S	
8	REPEAT STEP 7 UNTIL PROBLEM				
	COMPLETED				

HP-41C

Program Listing

PAGE 8-4

STEP	KEY ENTRY	KEY CODE	COMMENTS
	01♦LBL "OVERBM"		Overhanging Beam "Overbm"
	02♦LBL A		
	03 SF 11		
	04 SF 12		
	05 "=CALPRO="		
	06 PRA		
	07 "CALCULATOR PRO"		
	08 "I-GRAMS"		
	09 PRA		
	10 CF 12		
	11 ADV		
	12 "W K/FT"		
	13 PROMPT		Enter w
	14 PRX		
	15 CLRG		
	16 STO 20		
	17 "P KIPS"		
	18 PROMPT		Enter P
	19 PRX		
	20 STO 21		
	21 "L"		
	22 PROMPT		Enter L
	23 PRX		
	24 STO 22		
	25 "a FT"		
	26 PROMPT		Enter a
	27 PRX		
	28 STO 23		
	29 ADV		
	30 RCL 20		
	31 *		
	32 2		
	33 /		
	34 RCL 21		
	35 +		
	36 RCL 23		
	37 *		
	38 "-M-B"		
	39 PRA		
	40 PRX		Print $-M_B = Pa + \frac{wa^2}{2}$
	41 STO 00		
	42 RCL 20		
	43 RCL 22		
	44 *		
	45 2		
	46 /		
	47 RCL 00		
	48 RCL 22		
	49 /		
	50 -		
	51 "REACTIONS"		
	52 PRA		
	53 PRX		$R_A = \frac{wL}{2} - \frac{M_B}{L}$
	54 STO 01		
	55 LASTX		
	56 2		
	57 *		
	58 +		
	59 RCL 20		
	60 RCL 23		
	61 *		
	62 +		
	63 RCL 21		
	64 +		
	65 PRX		$R_B = \frac{wL}{2} + \frac{M_B}{L} + wa + P$
	66 STO 02		
	67 RCL 01		
	68 X<0?		
	69 GTO 15		Skip if uplift all across beam ($R_A \leq 0$)
	70 X↑2		
	71 2		
	72 /		
	73 RCL 20		
	74 /		
	75 STO 03		$+M = \frac{R_A^2}{2w}$
	76 8		
	77 RCL 03		
	78 *		
	79 RCL 20		
	80 /		
	81 SQRT		$2X = \sqrt{\frac{8M}{w}}$
	82 STO 04		
	83 RCL 22		
	84 -		
	85 CHS		$L-2X$
	86 STO 05		
	87♦LBL 15		
	88 RCL 03		
	89 "+M"		
	90 PRA		
	91 PRX		Print +M
	92 ADV		
	93 RCL 04		
	94 "INFLECTION POIN"		
	95 "-T"		
	96 PRA		
	97 PRX		Print 2X
	98 RCL 05		
	99 PRX		Print L-2X
	100 ADV		
	101 "I XX"		
	102 PROMPT		Enter I_{xx}
	103 PRX		
	104 STO 24		
	105 "DEFLECTION"		Deflection
	106 PRA		
	107 RCL 22		
	108 30		Prints L/360
	109 /		
	110 PRX		
	111 STO 06		
	112 RCL 23		
	113 30		

REGISTERS

00 −M	01 R_A	02 R_B	03 +M	04 2X / 2X×12/2	05 L-2X	06 L/360	07 a/360	08	09
10	11	12	13	14	15	16	17	18	19
20 w	21 P	22 L / L×12	23 a / a×12	24 I_{xx}	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59

HP-41c

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
		114 /	
		115 PRX	Print $a/360$
		116 STO 07	
		117 ADV	
		118 RCL 04	
		119 X=0?	
		120 RCL 22	
		121 6	
		122 *	
		123 STO 04	$2X \times \frac{12}{2} = X(in)$
		124 12	
		125 ST/ 20	$w/12''_1$
		126 ST* 22	$L \times 12''_1$
		127 ST* 23	$a \times 12''_1$
		128 RCL 22	
		129 4	
		130 Y↑X	
		131 RCL 22	
		132 X↑2	
		133 RCL 04	
		134 X↑2	
		135 *	
		136 2	
		137 *	
		138 -	
		139 RCL 04	
		140 3	
		141 Y↑X	
		142 RCL 22	
		143 *	
		144 +	
		145 RCL 23	
		146 X↑2	
		147 RCL 22	
		148 X↑2	
		149 *	
		150 2	
		151 *	
		152 -	
		153 RCL 04	
		154 X↑2	
		155 RCL 23	
		156 X↑2	
		157 *	
		158 2	
		159 *	
		160 +	
		161 RCL 20	
		162 *	
		163 4	
		164 /	
		165 RCL 22	
		166 X↑2	
		167 RCL 04	
		168 X↑2	
		169 -	
		170 RCL 23	
		171 *	
		172 RCL 21	
		173 *	
		174 -	
		175 RCL 04	
		176 *	
		177 RCL 22	
		178 /	
		179 RCL 24	
		180 /	
		181 174000	
		182 /	
		183 PRX	Print Δ_x
		184 RCL 23	
		185 X↑2	
		186 RCL 22	
		187 *	
		188 4	
		189 *	
		190 RCL 22	
		191 3	
		192 Y↑X	
		193 -	
		194 RCL 23	
		195 3	
		196 Y↑X	
		197 3	
		198 *	
		199 +	
		200 RCL 23	
		201 *	
		202 RCL 20	
		203 *	
		204 RCL 24	
		205 /	
		206 696000	
		207 /	
		208 RCL 22	
		209 RCL 23	
		210 +	
		211 RCL 23	
		212 X↑2	
		213 *	
		214 RCL 21	
		215 *	
		216 RCL 24	
		217 /	
		218 87000	
		219 /	
		220 +	
		221 PRX	Print Δ_P
		222 ADV	
		223 ADV	
		224 ADV	
		225 ADV	
		226 GTO A	
		227 .END.	

$$\Delta_x = \frac{X\left(12\frac{in}{Ft}\right)^3}{6EI_{xx}}\left[\frac{\left(\frac{w}{4}\right)}{4}\left[L^4 - 2L^2x^2 + Lx^3 - 2a^2L^2 + 2a^2x^2\right) - Pa\left(L^2 - x^2\right)\right]$$

$$\Delta_P = \frac{wa\left(12\frac{in}{Ft}\right)^3}{24EI_{xx}}\left(4a^2L - L^3 + 3a^3\right) + \frac{Pa^2\left(12\frac{in}{Ft}\right)^3}{3EI_{xx}}(L+a)$$

LABELS

A ✓	B	C	D	E	0	1
F	G	H	I	J	2	3
a	b	c	d	e	4	5
01	02	03	04	05	6	7
06	07	08	09	10	8	9
11	12	13	14	15 ✓	16	17
16	17	18	19	20	24	25
21	22	23	24	25		

FLAGS

10	11 ✓	12 ✓	13	14	15
18	19	20	21	22	23
26	27	28	29	30	31

SET STATUS

FLAGS			TRIG		DISP	
	ON	OFF				
0	☐	■	DEG	■	FIX	■
1	☐	■	GRAD	☐	SCI	☐
2	☐	■	RAD	☐	ENG	☐
3	☐	■			n 4	

BEAM - UNIFORMLY DISTRIBUTED LOAD "UDLVEM" AND VARIABLE END MOMENTS PROGRAM DESCRIPTION

Program calculates maximum positive moment, reactions, inflection points, maximum deflection and L/360 deflection limitation using standard formulas.

If you should desire a printout of the prompting statements along with the numerical results, set your printer to the normal mode.

The main program may be addressed directly by the execute key (XEQ) and the program name "UDLVEM". Flag eleven has been set causing the program to initialize immediately upon entry of program cards.

w - Uniform load (Kips/ft), must be greater than zero

M_1 - Moment left side (kip-ft)

M_2 - Moment right side (kip-ft)

M_3 - Positive moment (kip-ft)

L - Span length (feet)

R - Reactions

X - Point of maximum positive moment (feet)

Δ - Deflection (inches)

Program and calculation sheet has been primarily set up for a steel beam, but can be easily adapted to wood or concrete beams.

Bearing Plates

The Bearing Plate program is the same as program number 6A except that labels are used to recall the reactions from storage. After pushing the label recalling the reaction, additional data will be input and printed per program 6A. Labels recall reactions as follows:

LABEL B - Recalls Reaction R_A

LABEL C - Recalls Reaction R_B

If you should enter an improper number for the bearing plate design or accidently push the wrong label, simply push the proper label and enter your data in the proper sequence.

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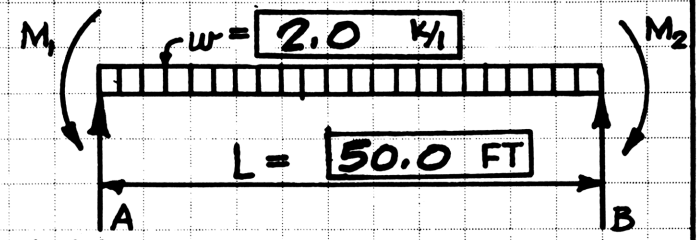
JOB SAMPLE PROBLEM
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____
SCALE _____ COMM. NO.

BEAM LOCATION (PUSH LABEL A) BEAM A1-A2

BEAM-UNIFORMLY DISTRIBUTED LOAD AND VARIABLE END MOMENTS 9

w: 2.0 K/I

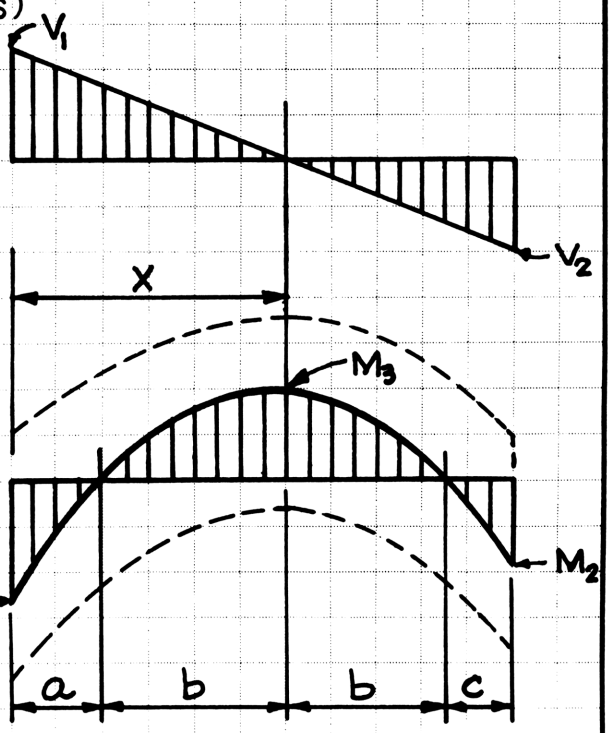


w = 2.0 K/I ENTER(R/S)
(w must be ≠ 0)

$-M_1$ = 200.0 KI ENTER(R/S)

$-M_2$ = 100.0 KI ENTER(R/S)

L = 50.0 FT ENTER(R/S)



Prints only for Positive Moments

PRINT

$R_1 = V_1 = \frac{wL}{2} + \frac{M_1 - M_2}{L}$ = 52.0 K

$R_2 = V_2 = \frac{wL}{2} - \frac{M_1 - M_2}{L}$ = 48.0 K

$+M_3 = \frac{wL^2}{8} - \frac{M_1 + M_2}{2} + \frac{(M_1 - M_2)^2}{2wL^2}$ = 476.0 KI

$X = R_1/w$ = 26.0 FT

$a = x - b$ = 4.182 FT

$b = \sqrt{M_3 \times \frac{8}{w \times 4}} = \sqrt{\frac{2M_3}{w}}$ = 21.817 FT

$c = L - a - 2b$ = 2.18 FT

BEAM

M_R = KI L_c = FT L_u = FT

I_x = 4000 IN⁴ ENTER (R/S)

$$\Delta_x = \frac{wx}{24EI}\left[x^3 - \left(2L + \frac{4M_1}{wL} - \frac{4M_2}{wL}\right)x^2 + \frac{12M_1 x}{w} + L^3 - \frac{8M_1 L}{w} - \frac{4M_2 L}{w}\right]$$

PRINT

Δ_x = 1.7259 IN ; $\Delta_{max} = \frac{L \times 12''}{360} = \frac{L}{30}$ = PRINT 1.6667 IN

User Instructions

1 BEAM: UNIFORM LOAD AND VARIABLE 9-1
END MOMENTS "UDLVEM" 9-2 2

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	TURN PRINTER ON			
	MANUAL MODE - DISPLAYS PROMPTING			
	STATEMENTS ONLY			
	NORMAL MODE - DISPLAYS AND PRINTS			
	PROMPTING STATEMENTS			
2	TURN CALCULATOR ON (USER MODE)		ON	
3	PUSH XEQ ALPHA SIZE ALPHA 060 TO			
	PARTITION PROGRAM REGISTERS (SKIP			
	THIS STEP IF CALCULATOR PARTI-			
	TIONED FROM LAST PROGRAM)			
4	LOAD PREPROGRAMMED MAGNETIC CARDS			
5	PUSH LABEL A - UNIFORM LOAD WITH			
	VARIABLE END MOMENTS		A	
	PUSH LABEL B - RECALLS REACTION R_A FOR			
	BEARING PLATE DESIGN		B	
	PUSH LABEL C RECALLS REACTION R_B FOR			
	BEARING PLATE DESIGN		C	
6	PROCEED TO CALCULATION SHEET			
7	ENTER DATA AND PUSH R/S KEY	DATA	R/S	
8	REPEAT STEP 7 UNTIL PROBLEM COMPLETED			

HP-41C

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
01	LBL "UDLVEM"		Uniform Load & Variable End Moments "UDLVEM"
02	LBL A		
03	SF 11		
04	SF 12		
05	"=CALPRO="		
06	PRA		
07	"CALCULATOR PRO"		
08	"PROGRAMS"		
09	PRA		
10	CF 12		
11	ADV		
12	"W K/FT"		
13	PROMPT		Enter w
14	PRX		
15	STO 20		
16	"M1 KIP-FT"		
17	PROMPT		Enter M_1
18	PRX		
19	STO 00		
20	"M2 KIP-FT"		
21	PROMPT		Enter M_2
22	PRX		
23	STO 01		
24	-		
25	"L"		
26	PROMPT		Enter L
27	PRX		
28	STO 21		
29	/		$\frac{M_1-M_2}{L}$
30	STO 09		
31	RCL 20		
32	RCL 21		
33	*		
34	2		
35	/		
36	+		
37	"REACTIONS"		
38	PRA		
39	PRX		$R_1=\frac{wL}{2}+\frac{M_1-M_2}{L}$
40	STO 02		
41	RCL 09		
42	2		
43	*		
44	-		
45	PRX		$R_2=\frac{wL}{2}-\frac{M_1-M_2}{L}$
46	STO 03		
47	RCL 02		
48	X↑2		
49	2		
50	/		
51	RCL 20		
52	/		
53	RCL 00		$+M_3=\frac{R_1^2}{2w}-M_1$
54	-		
55	"MOMENT"		
56	PRA		
57	PRX		Print M
58	STO 04		
59	RCL 02		
60	RCL 20		
61	/		
62	"X"		
63	PRA		
64	PRX		$X=\frac{R_1}{w}$
65	STO 05		
66	RCL 04		
67	X<0?		If $+M_3$ is negative skip to B
68	GTO 11		
69	RCL 05		
70	RCL 04		
71	2		
72	*		
73	RCL 20		
74	/		
75	SQRT		$b=\sqrt{\frac{2M_3}{w}}$
76	STO 07		
77	-		
78	"a"		
79	PRA		
80	PRX		Print $a=x-b$
81	STO 06		
82	RCL 07		
83	"b"		
84	PRA		
85	PRX		Print $b=\sqrt{\frac{2M_3}{w}}$
86	2		
87	*		
88	+		
89	RCL 21		
90	-		
91	CHS		
92	"c"		
93	PRA		
94	PRX		Print $c=L-a-2b$
95	LBL 11		
96	RCL 00		
97	12		
98	*		
99	STO 00		
100	RCL 01		
101	12		
102	*		
103	STO 01		
104	RCL 05		
105	12		
106	*		
107	STO 05		
108	RCL 20		
109	12		
110	/		
111	STO 20		
112	RCL 21		

REGISTERS

00 $-M_1/R$	01 $-M_2$	02 R_1	03 R_2	04 $+M_3$	05 X	06 a	07 b	08 Δx	09 $\frac{M_1-M_2}{L}$
10	11	12	13	14	15	16	17	18	19
20 w/k	21 L/L_{ft}	22 $F_{P(max)}$	23 W_{ft}	24 P/L	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59

HP-41C

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
		113 12	
		114 *	
		115 STO 21	
		116 RCL 05	
		117 3	
		118 Y↑X	
		119 STO 08	
		120 RCL 09	
		121 4	
		122 *	
		123 RCL 20	
		124 /	
		125 RCL 21	
		126 2	
		127 *	
		128 +	
		129 RCL 05	
		130 X↑2	
		131 *	
		132 ST- 08	
		133 RCL 00	
		134 RCL 05	
		135 *	
		136 12	
		137 *	
		138 RCL 20	
		139 /	
		140 ST+ 08	
		141 RCL 21	
		142 3	
		143 Y↑X	
		144 ST+ 08	
		145 RCL 00	
		146 RCL 21	
		147 *	
		148 RCL 20	
		149 /	
		150 8	
		151 *	
		152 ST- 08	
		153 RCL 01	
		154 RCL 21	
		155 *	
		156 RCL 20	
		157 /	
		158 4	
		159 *	
		160 ST- 08	
		161 RCL 20	
		162 RCL 05	
		163 *	
		164 24	
		165 /	
		166 29000	
		167 /	
		168 "I XX"	

$$\Delta_x = \frac{w^4 x (12^4)}{24 E I_{xx}} \left[x^3 - \left(2L + \frac{4M_1}{wL} - \frac{4M_2}{wL}\right) x^2 + \frac{12M_1 x}{w} + L^3 - \frac{8M_1 L}{w} - \frac{4M_2 L}{w} \right]$$

STEP	KEY ENTRY	KEY CODE	COMMENTS
		169 PROMPT	Enter I_{xx}
		170 PRX	
		171 STO 22	
		172 /	
		173 ST* 08	
		174 RCL 08	
		175 "DEFLECTION"	
		176 PRA	
		177 PRX	Print Δx
		178 RCL 21	
		179 360	
		180 /	
		181 PRX	Print $\Delta = L/360$
		182 ADV	
		183 GTO A	
		184 ↑LBL B	Recall R_1
		185 "R 1"	
		186 RCL 02	
		187 GTO a	
		188 ↑LBL C	Recall R_2
		189 "R 2"	
		190 RCL 03	
		191 ↑LBL a	Bearing ℄
		192 PRA	
		193 PRX	Print R
		194 STO 00	
		195 "K"	
		196 PROMPT	Enter K_{beam}
		197 STO 20	
		198 PRX	
		199 RCL 00	
		200 "L"	
		201 PROMPT	Enter L℄ ∥ to beam
		202 PRX	
		203 STO 21	
		204 /	
		205 STO 24	P/L
		206 "F P"	
		207 PROMPT	Enter F_p max
		208 PRX	
		209 STO 22	
		210 /	
		211 PRX	Print $W_{min} = \frac{R}{L \times F_p}$
		212 "W"	
		213 PROMPT	Enter W℄ ⊥ to Beam
		214 PRX	
		215 STO 23	
		216 RCL 24	
		217 /	
		218 1/X	
		219 PRX	Print $F_p = \frac{R}{W \times L}$
		220 RCL 23	
		221 2	

LABELS

A ✓	B ✓	C ✓	D	E
F	G	H	I	J
a ✓	b	c	d	e
01	02	03	04	05
06	07	08	09	10
11 ✓	12	13	14	15
16	17	18	19	20
21	22	23	24	25

FLAGS

0	1
2	3
4	5
6	7
8	9
16	17
24	25

SET STATUS

FLAGS (ON / OFF): 0 ☐ ■ · 1 ☐ ■ · 2 ☐ ■ · 3 ☐ ■

TRIG: DEG ■ · GRAD ☐ · RAD ☐

DISP: FIX ■ · SCI ☐ · ENG ☐ · n 4

10	11 ✓	12 ✓	13	14	15
18	19	20	21	22	23
26	27	28	29	30	31

STEP	KEY ENTRY	KEY CODE	COMMENTS
		222 /	$n = \frac{W_{tt}}{2} - k$
		223 RCL 20	
		224 -	
		225 X↑2	
		226 *	
		227 9	
		228 /	
		229 SQRT	$t_{tt} = \sqrt{\frac{F_p n^2}{9}}$
		230 PRX →	
		231 ADV	
		232 ADV	
		233 GTO C	GO TO C
		234 .END.	

PLASTIC DESIGN OF CONTINUOUS BEAMS "PLASDES"

PROGRAM DESCRIPTION

Program calculates reactions, plastic moments, inflection points, and the allowable unbraced distances using the AISC "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings" 1978 Edition and AISC PLASTIC DESIGN IN STEEL, 1959 Edition (Page A6).

If you should desire a printout of the prompting statements along with the numerical results, set your printer to the normal mode.

The main program may be addressed directly by the execute key (XEQ) and the program name "PLASDES". Flag eleven has been set causing the program to initialize immediately upon entry of program cards.

Factor Safety - 1.7

w - Uniform load (Kips/ft)

L - Span length (feet)

R - Reactions (kips)

r_y - Radius of gyration

l_{cr} - Critical unbraced distance

M_p - Plastic moment - 1.7M

Bearing Plates

The Bearing Plate program is the same as program number 6A except that labels are used to recall the reactions from storage. After pushing the label recalling the reaction, additional data will be input and printed per program 6A. Labels recall reactions as follows:

LABEL B - Recalls Reaction R_E

LABEL C - Recalls Reaction R_1

LABEL D - Recalls Reaction R_2

LABEL E - Recalls Reaction $R_3 = R_4 =$ etc.

If you should enter an improper number for the bearing plate design or accidentally push the wrong label, simply push the proper label and enter your data in the proper sequence per prompting statement.

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JOB SAMPLE PROBLEM
SHEET NO. _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____
SCALE _____ COMM. NO. _____

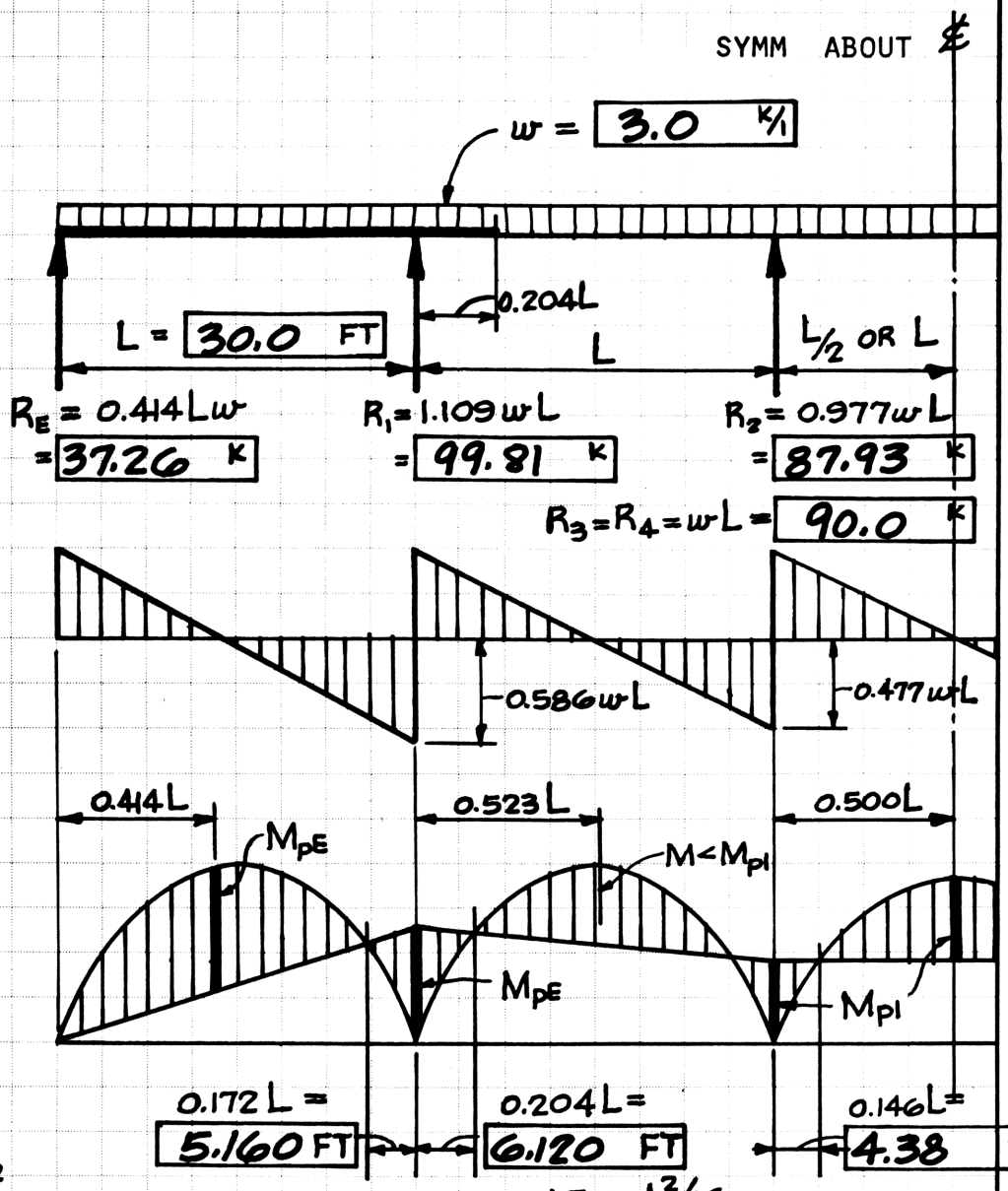
BEAM LOCATION: BEAM E7-E8-E9-E10-E11
(PUSH LABEL A)

PLASTIC DESIGN CONTINUOUS BEAMS **10**

w:

ENTER (R/S)
w = 3.0 K/I

ENTER (R/S)
L = 30.0 FT



$M_{pE} = 1.7 \times 0.0858\, wL^2$
= 393.82 KI PRINT

$M_{pI} = 1.7 \times wL^2/16$
= 286.875 KI PRINT

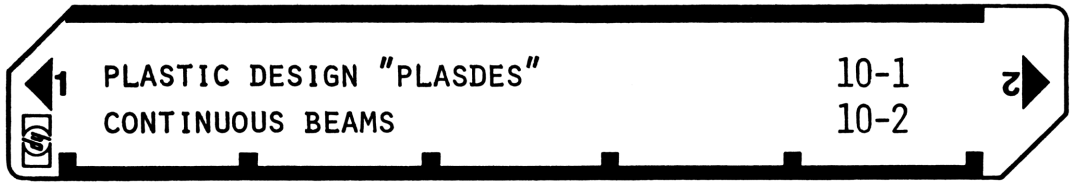
BEAM [ ]

M_p = [ ] KI
r_y = 1.0 IN ENTER (R/S)
$l_{cr_E} = \frac{63.2\, r_y}{12''/'} =$ 5.2667 FT PRINT

BEAM [ ]

M_p = [ ] KI
r_y = 2.0 IN ENTER (R/S)
$l_{cr_I} = \frac{63.2\, r_y}{12''/'} =$ 10.5333 FT PRINT

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	TURN PRINTER ON			
	MANUAL MODE - DISPLAYS PROMPTING		ON	
	STATEMENTS ONLY			
	NORMAL MODE - DISPLAYS AND PRINTS			
	PROMPTING STATEMENTS			
2	TURN CALCULATOR ON (USER MODE)			
3	PUSH XEQ ALPHA SIZE ALPHA 060 TO			
	PARTITION PROGRAM REGISTERS (SKIP			
	THIS STEP IF CALCULATOR PARTI-			
	TIONED FROM LAST PROGRAM)			
4	LOAD PREPROGRAMMED MAGNETIC CARDS			
5	PUSH LABEL A - PLASTIC DESIGN OF			
	CONTINUOUS BEAMS		A	
	PUSH LABEL B - RECALLS REACTION R_E FOR			
	BEARING PLATE DESIGN		B	
	PUSH LABEL C - RECALLS REACTION R_1 FOR			
	BEARING PLATE DESIGN		C	
	PUSH LABEL D - RECALLS REACTION R_2 FOR			
	BEARING PLATE DESIGN		D	
	PUSH LABEL E - RECALLS REACTION R_3 FOR			
	BEARING PLATE DESIGN		E	
6	PROCEED TO CALCULATION SHEET			
7	ENTER DATA AND PUSH R/S KEY	DATA	R/S	
8	REPEAT STEP 7 UNTIL PROBLEM COMPLETED			

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
	01♦LBL "PLASDES"		Plastic Design Continuous Beams "PLASDES"
	02♦LBL A		
	03 SF 11		
	04 SF 12		
	05 "=CALPRO="		
	06 PRA		
	07 "CALCULATOR PRO"		
	08 "PGRAMS"		
	09 PRA		
	10 CF 12		
	11 ADV		
	12 "W K/FT"		
	13 PROMPT		Enter w K/FT
	14 PRX		
	15 STO 20		
	16 "LENGTH"		
	17 PROMPT		Enter L
	18 PRX		
	19 ADV		
	20 "REACTIONS"		Reactions
	21 PRA		
	22 STO 21		
	23 *		wL
	24 STO 05		
	25 .414		
	26 *		
	27 PRX		$R_E = 0.414\,wL$
	28 STO 01		
	29 RCL 05		
	30 1.109		
	31 *		
	32 PRX		$R_1 = 1.109\,wL$
	33 STO 02		
	34 RCL 05		
	35 .977		
	36 *		
	37 PRX		$R_2 = 0.977\,wL$
	38 STO 03		
	39 RCL 05		
	40 PRX		$R_3 = wL$
	41 STO 04		
	42 ADV		
	43 "INFLECTION POIN"		Inflection Points
	44 "TS"		
	45 PRA		
	46 .172		
	47 RCL 21		
	48 *		
	49 PRX		Prints $= 0.172L$
	50 .204		
	51 RCL 21		
	52 *		
	53 PRX		Prints $= 0.204L$
	54 .146		
	55 RCL 21		
	56 *		
	57 PRX		Prints $0.146L$ Moments
	58 "MOMENTS"		
	59 PRA		
	60 1.7		
	61 RCL 20		
	62 *		
	63 RCL 21		
	64 X↑2		
	65 *		
	66 STO 06		
	67 .0858		
	68 *		
	69 PRX		$M_{pE} = 0.0858\,wL^2 \times 1.7$
	70 RCL 06		
	71 16		
	72 /		
	73 PRX		$M_{p_1} = 1.7 \times wL^2/16$
	74 ADV		
	75 "L CR END"		
	76 PRA		
	77 63.2		
	78 "R Y END"		
	79 PROMPT		Enter r_{y_E}
	80 PRX		
	81 *		
	82 12		
	83 /		
	84 PRX		Print $l_{cr_E} = \frac{63.2}{12} r_y$
	85 "L CR INTERIOR"		
	86 PRA		
	87 63.2		
	88 "R Y INTERIOR"		
	89 PROMPT		
	90 PRX		
	91 *		
	92 12		
	93 /		
	94 PRX		Print $l_{cr_1} = \frac{63.2}{12} r_y$
	95 ADV		
	96 ADV		
	97 ADV		
	98 ADV		
	99 GTO A		Returns to A
	100♦LBL B		Recalls R_E
	101 "R END"		
	102 PRA		
	103 RCL 01		
	104 GTO a		
	105♦LBL C		Recalls R_1
	106 "R 1"		
	107 PRA		
	108 RCL 02		
	109 GTO a		

REGISTERS

00 R	01 R_E	02 R_1	03 R_2	04 R_3	05 wL	06 $1.7wL^2$	07	08	09
10	11	12	13	14	15	16	17	18	19
20 W/k	21 L/L ft	22 $F_{P(max)}$	23 W ft	24 P/L	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
	110♦LBL D		Recalls R_2
	111 "R 2"		
	112 PRA		
	113 RCL 03		
	114 GTO a		
	115♦LBL E		Recalls R_3
	116 "R 3"		
	117 PRA		
	118 RCL 04		
	119♦LBL a		Bearing ℄ Print R
	120 PRX		
	121 STO 00		
	122 "K"		Enter k
	123 PROMPT		
	124 STO 20		
	125 PRX		
	126 RCL 00		
	127 "LENGTH"		Enter L℄ ∥ to Beam
	128 PROMPT		
	129 PRX		
	130 STO 21		
	131 /		
	132 STO 24		
	133 "F P"		Enter F_P
	134 PROMPT		
	135 PRX		
	136 STO 22		
	137 /		
	138 PRX		Print $W_{min} = \frac{R}{L F_P}$
	139 "WIDTH"		
	140 PROMPT		Enter W℄ ⊥ to Beam
	141 PRX		
	142 STO 23		
	143 RCL 24		
	144 /		
	145 1/X		
	146 PRX		Print F_P actual $= \frac{R}{W L}$
	147 RCL 23		
	148 2		
	149 /		
	150 RCL 20		$n = \frac{W_{℄}}{2} - k$
	151 -		
	152 X↑2		
	153 *		
	154 9		
	155 /		
	156 SQRT		$t_{℄} = \sqrt{\frac{F_P n^2}{9}}$
	157 PRX		
	158 ADV		
	159 ADV		
	160 GTO C		
	161 END		

STEP	KEY ENTRY	KEY CODE	COMMENTS
170			
180			
190			
200			
210			
220			

LABELS

A ✓	B ✓	C ✓	D ✓	E ✓
F	G	H	I	J
a ✓	b	c	d	e
01	02	03	04	05
06	07	08	09	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

FLAGS

0	1
2	3
4	5
6	7
8	9
10	11 ✓
12 ✓	13
14	15
16	17
18	19
20	21
22	23
24	25
26	27
28	29
30	31

SET STATUS

FLAGS		TRIG		DISP	
	ON OFF				
0	☐ ■	DEG	■	FIX	■
1	☐ ■	GRAD	☐	SCI	☐
2	☐ ■	RAD	☐	ENG	☐
3	☐ ■			n 4	

SIMPLE SPAN CONCRETE TEE BEAM "CONCBM"

PROGRAM DESCRIPTION

Program calculates reactions, moment, depth required, slab width, tensile and compressive reinforcements, shear, stirrups and spacing, using ultimate strength design (Load Factor Design). Can be used for slabs, rectangular and tee beams. (Conforms to ACI 318-78)

If you should desire a printout of the prompting statements along with the numerical results, set your printer to the normal mode.

The main program may be addressed directly by the execute key (XEQ) and the program name "CONCBM". Flag eleven has been set causing the program to initialize immediately upon entry of program cards.

Reactions are actual reactions and do not include any load factors.

Regardless of the flange width input, it will be checked to insure that flange width $\leq L/4 \times 12$

$\leq bw + 16\ H_f$

The program will print out a required total depth (D) based upon moment requirements, then you must select the total depth (D) that you desire to use and enter it through the R/S key.

The actual and allowable shears are printed so you can visually inspect the result to see if an increase or decrease in depth would be desirable.

If stirrup distance x = 0 (zero), then stirrups are not required. Number three (#3) stirrups are used to determine stirrup spacing; if other stirrup sizes are used, multiply s by $\left(\frac{A_s \text{ stirrup}}{0.22}\right)$. You must visually inspect that $C < H_f$. If the flange thickness required is greater than the actual thickness, then you must input a larger flange thickness or seek other means to analyze your beam.

The estimated dead weight of the beam must be input as this program does not calculate the dead weight of the beam.

For a rectangular section, the flange width is same as width of web.

Formulas

$\rho \leq \frac{\rho_b}{2}$

$w = 0.20$ for f_y = 40 KSI THRU 60 KSI

$K_u = \phi f'_c w(1 - 0.59w) = 0.9 f'_c (0.2)(1 - 0.59 \times 0.2)$

$= 0.1588 f'_c$

$F = \frac{M_u}{K_u} = \frac{b_w d^2}{12000}$

$d = \sqrt{\frac{12000 M_u}{K_u b_w}} = \sqrt{\frac{12000\ M_u}{0.1588\ f'_c b_w}} = \sqrt{\frac{75567\ M_u}{f'_c b_w}}$

$a_u = 0.9 f_y (1 - 0.59w)/12000$

$= 0.9 f_y (1 - 0.59(0.2))/12000$

$= f_y / 15117$

$M_u = F K_u = \frac{b_w d^2}{12000} \times 0.1588 f'_c$

$= \frac{b d^2 f'_c}{75567}$

$A_s = \frac{M_u}{a_u d} = \frac{15117\ M_u}{f_y d}$ for $M_u \leq K_u F$

$A'_s = \frac{12000\ M_u}{\phi (d - d') f_y} = \frac{13{,}333\ M_u}{(d - d') f_y}$

$A_s = \frac{M_u}{a_u d} + A'_s$ for $M_u \geq K_u F$

↑ balanced

$c/d = 1.18 \frac{w}{\beta_1} = 1.18 \times \frac{0.2}{0.85} = .2776$

$c = 0.28 d$

$V_u = \frac{w_{TL}}{0.85} (\text{Load Factor}) \left(\frac{L}{2} - \frac{d}{12} - \frac{\text{Support}}{2} \right)$

$v_u = \frac{V_u \times 1000}{b_w d}$; $v_c = 2\sqrt{f'_c}$

$V'_u = V_u - v_c b d$

$X = \frac{V'_u}{w_{TL} \times \text{Load Factor}}$

$S = X + 2d$; $s = \frac{A_v f_y}{v' b_w}$ or $s_{(max)} = d/2$

f'_c = Concrete strength (PSI)

f_y = Yield strength of reinforcement (PSI)

Load factor = 1.7

b_w = Width of beam web (inches)

H_f = Slab depth (inches)

b = Slab width (inches)

D1 = Distance from bottom of beam to centerline of tensile reinforcement (inches)

w = Uniform load per foot on beam (Kips/Ft)

L = Span length (FT)

R = Reactions (KIPS)

M_u = Ultimate moment (Kip-FT)

d = Effective depth; distance from centroid of tensile reinforcement to extreme fiber of compressive face (inches)

D = Total depth d + D1 (inches)

A_s = Area of tensile reinforcement (in^2)

A'_s = Area of compressive reinforcement (in^2)

V_u = Ultimate shear at distance d (KIPS)

v_u = Ultimate shear stress at distance d (LBS/in^2)

s = Stirrup spacing

S = Distance that stirrups are required out from face of support

$C = 1.18\ w/B_1\ d = 0.28d$

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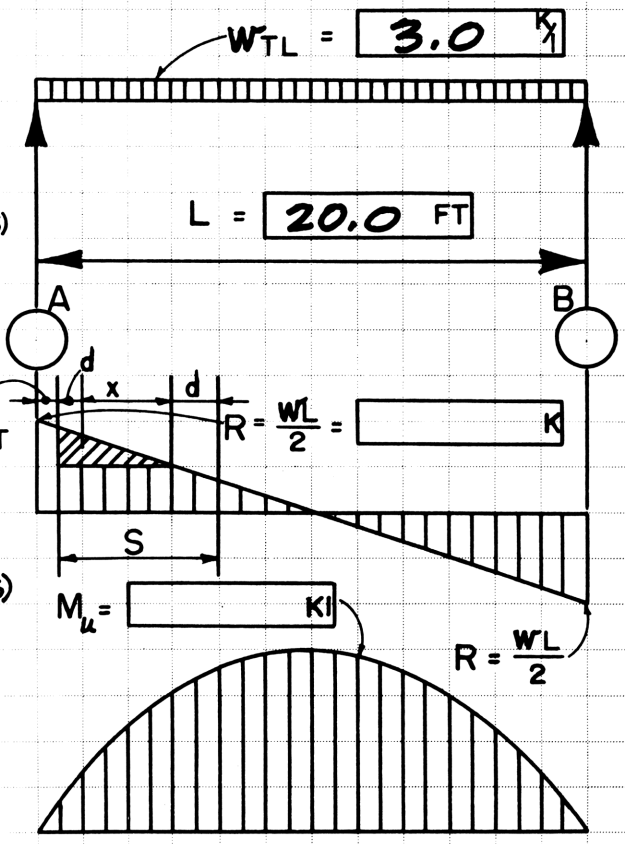
JOB SAMPLE PROBLEM (11-4)
SHEET NO. ____ OF ____
CALCULATED BY ____ DATE ____
CHECKED BY ____ DATE ____
SCALE ____ COMM. NO. ____

BEAM LOCATION BEAM A7-D7
(PUSH LABEL A)

SIMPLE SPAN CONCRETE BEAM

f'c	fy	LOAD FACTOR D.L.	LOAD FACTOR L.L.	BEAM WIDTH = b_w	SLAB DEPTH = H_f	SLAB WIDTH = b	Steel clearance d'
4000 #/□"	60,000 #/□"	1.7	1.7	12.0 IN	6.0 IN	100.0 IN	2.5 IN

W_{DL} = 2.0 K/l W_{LL} = 1.0 K/l



ENTER (R/S) W_{DL}	ENTER (R/S) W_{LL}	PRINT W_{TL}	ENTER (R/S) L
2.0 K/l	1.0 K/l	3.0 K/l	20.0 FT

PRINT R_{TL}	PRINT R_{DL}	PRINT R_{LL}
30.0 K	20.0 K	10.0 K

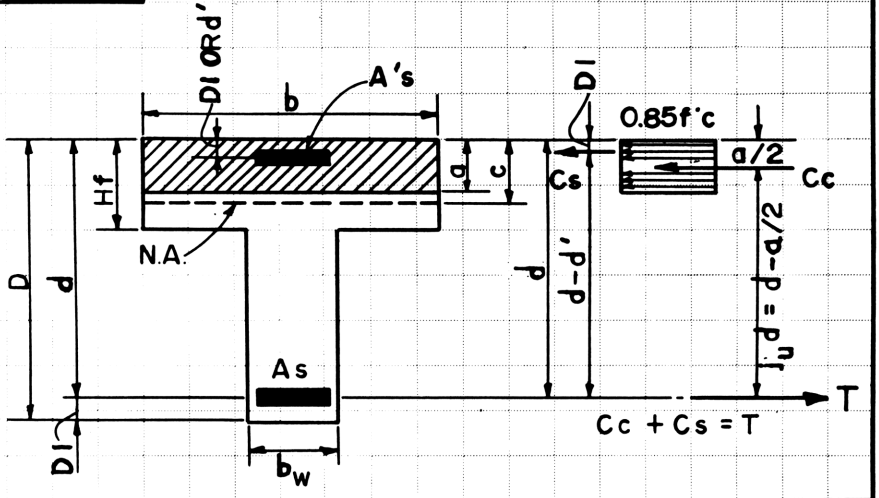
PRINT $M_u = 1.7 W_u \frac{L^2}{8}$	MAX SLAB WIDTH	D (REQ'D)	ENTER (R/S) D (USE)
255. KI	60 IN	11.4605 IN	20 IN

PRINT Mu=Ku F	A_s	USE	A'_s	USE
972.6 KI	3.67 □"	4-#9	0.00 □"	—

ENTER (R/S) PRINT 1/2 WIDTH OF SUPPORT	V_u (@ d)	$v_u = V_u/bd$
0.5 FT	48.25 K	229.76 #/□"

$v_c = 2\sqrt{f'c}$	$v_u = 8\sqrt{f'c}$	X
126.49 #/□"	505.96 #/□"	4.2523 FT

If X=0 stirrups not required
A_v = 2 x 0.11 = 0.22 □"; v ≥ 50 #/□"
S = distance stirrups req'd.



S = x + 2d	$s = \frac{A_v f_y}{v \cdot b_w}$	$s = d/2$	$C = 1.18 \frac{w}{\beta_1} d$	STIRRUPS
7.169 FT	10.65 IN	8.75 IN	4.9 IN	12 ; #3 @8"

≤ H_f

Use → 12 x 20 Bm w/ 4-#9 B

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	TURN PRINTER ON			
	MANUAL MODE - DISPLAYS PROMPTING		ON	
	STATEMENTS ONLY			
	NORMAL MODE - DISPLAYS AND PRINTS			
	PROMPTING STATEMENTS			
2	TURN CALCULATOR ON (USER MODE)			
3	PUSH XEQ ALPHA SIZE ALPHA 060 TO			
	PARTITION PROGRAM REGISTERS (SKIP			
	THIS STEP IF CALCULATOR PARTI-			
	TIONED FROM LAST PROGRAM)			
4	LOAD PREPROGRAMMED MAGNETIC CARDS			
5	PUSH LABEL A (KEY A)			
6	PROCEED TO CALCULATION SHEET			
7	ENTER DATA AND PUSH R/S KEY	DATA	R/S	
8	REPEAT STEP 7 UNTIL PROBLEM			
	COMPLETED			

HP-41c

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	01♦LBL "CONCBM"		Simple Span Concrete Beam "CONCBM"
	02♦LBL A		
	03 SF 11		
	04 SF 12		
	05 "=CALPRO="		
	06 PRA		
	07 "CALCULATOR PRO"		
	08 "PGRAMS"		
	09 PRA		
	10 CF 12		
	11 ADV		
	12 0.02001		Count
	13 STO 29		
	14 "F'c"		
	15 XEQ 15	←	Enter $f'c$
	16 "FY"		
	17 XEQ 15	←	Enter f_y
	18 "LOAD FACTOR"		
	19 XEQ 15	←	Enter Load Factor $_{DL}$
	20 STO 12		
	21 1		
	22 ST- 29		
	23 XEQ 15	←	$L.F_{LL}$
	24 "BM WIDTH"		
	25 XEQ 15	←	Beam Width b_w
	26 "SLAB DEPTH"		
	27 XEQ 15	←	Slab Depth H_f
	28 "SLAB WIDTH"		
	29 XEQ 15	←	Slab width b_w
	30 "D1"		
	31 XEQ 15	←	D1 (steel Clearance)
	32 ADV		
	33 "W DL"		
	34 XEQ 15	←	w_{DL}
	35 "W LL"		
	36 XEQ 15	←	w_{LL}
	37 +		
	38 "W TL"		
	39 PRA		
	40 STO IND 29		
	41 ISG 29		
	42 PRX	→	w_{TL}
	43 "LENGTH"		
	44 XEQ 15	←	Length
	45 STO 20		
	46 GTO B		
	47♦LBL 15		Reads, stores and Prints Data
	48 PROMPT		
	49 PRX		
	50 STO IND 29		
	51 ISG 29		
	52 RTN		
	53♦LBL B		
	54 *		
	55 2		
	56 /		
	57 STO 21		
	58 ADV		
	59 "REACTIONS"		
	60 PRA		
	61 PRX	→	$R_{TL} = w_{TL} L/2$
	62 RCL 07		
	63 RCL 09		
	64 /		
	65 *		
	66 PRX	→	R_{DL}
	67 STO 13		
	68 STO 15		
	69 RCL 21		
	70 -		
	71 CHS		
	72 PRX	→	R_{LL}
	73 STO 14		
	74 RCL 02		
	75 *		
	76 STO 16		
	77 RCL 12		
	78 ST* 15		
	79 RCL 15		
	80 RCL 16		
	81 +		$M_u = (w_{DL} \times L.F.) \frac{L^2}{8} + (w_{LL} \times L.F.) \frac{L^2}{8}$
	82 RCL 20		
	83 *		
	84 4		
	85 /		
	86 ADV		
	87 "M-U"		
	88 PRA		
	89 PRX	→	Print M_u
	90 STO 22		
	91 RCL 05		
	92 RCL 20		
	93 4		
	94 /		
	95 12		
	96 *		Flange width $\leq L/4 \times 12$
	97 X<=Y?		
	98 STO 05		
	99 RCL 05		
	100 RCL 04		
	101 16		
	102 *		$b_f \leq t_w + 16 H_f$
	103 RCL 03		
	104 +		
	105 X<=Y?		
	106 STO 05		
	107 RCL 22		
	108 75567		
	109 STO 11		
	110 *		

REGISTERS

00 $f'c$	01 f_y	02 Load factor LL	03 b_w beam width	04 H_f Slab Depth	05 b_f Slab Width	06 D1 Steel Centroid	07 w_{DL}	08 w_{LL}	09 w_{TL}
10	11 75567	12 Load factor DL	13 R_{DL}	14 R_{LL}	15 $R_{u_{DL}}$	16 $R_{u_{LL}}$	17	18	19
20 L	21 R_{TL}	22 M_u	23 d	24 $M_u = FK$	25 ϕ or M_u	26	27	28 U'	29 Count
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
		111 RCL 00	
		112 /	
		113 RCL 05	
	114	"MAX SLAB WIDTH"	
		115 PRA	
		116 PRX	Prints slab width b_w
		117 /	
		118 SQRT	$d=\sqrt{\frac{75567 M_u}{f'_c b_w}}$
		119 RCL 06	
		120 +	
	121	"D(REQUIRED)"	
		122 PRA	
		123 PRX	$d_{req'd}=\sqrt{\frac{12000 M_u}{K_u b}}$ without Compressive reinf
	124	"D (USE)"	
		125 PROMPT	Enter d(used)
		126 PRX	
		127 ADV	
	128	"M-U=KU-F"	
		129 PRA	
		130 RCL 06	
		131 -	
		132 STO 23	
		133 X↑2	
		134 RCL 05	
		135 *	
		136 RCL 00	
		137 *	
		138 RCL 11	
		139 /	
		140 STO 24	
		141 PRX	$M_u = F K_u = \frac{b d^2 f'_c}{75567}$
		142 RCL 22	
		143 -	
		144 X>0?	
		145 0-	
		146 STO 25	
		147 X=0?	
		148 GTO 11	
		149 GTO C	$M'_u = M_u - K_u F$
		150*LBL 11	
		151 RCL 22	
		152 STO 24	
		153*LBL C	
		154 RCL 24	
		155 RCL 23	$A_s = \frac{M_u}{a_u d} + A'_s = \frac{M_u \times 15117}{f_y d} + A'_s$
		156 /	
		157 RCL 01	
		158 /	
		159 RCL 11	
		160 5	$A'_s = \frac{M'_u \times 12000}{\phi (d-d') f_y}$
		161 /	
		162 *	
		163 RCL 25	
		164 13333	
		165 *	
		166 RCL 01	
		167 /	
		168 RCL 23	
		169 RCL 06	
		170 -	
		171 /	
		172 +	
	173	"AREA STEEL"	
		174 PRA	
		175 PRX	Print A_s
		176 LASTX	
		177 PRX	Print A'_s
		178 RCL 20	
		179 2	
		180 /	
		181 ADV	
	182	"1/2 WIDTH SUPPO"	
		183 "RT"	
		184 PROMPT	
		185 PRX	Enter ½ width of support
		186 "SHEAR"	
		187 PRA	
		188 -	
		189 RCL 23	
		190 12	
		191 /	
		192 -	
		193 RCL 20	
		194 2	
		195 /	
		196 /	
		197 RCL 15	
		198 RCL 16	
		199 +	
		200 .85	$V_u(@d) = w_{u_{TL}} \times L.F. \times \left(\frac{L}{2} - \frac{d}{12} - \frac{support}{2}\right) \times \frac{1}{0.85}$
		201 /	
		202 *	
		203 PRX	
		204 RCL 23	
		205 /	
		206 RCL 03	
		207 /	
		208 3	
		209 10↑X	
		210 *	
		211 PRX	Print $v_u = \frac{V_u \times 10^3}{b_w d}$
		212 ADV	
	213	"ALLOW SHEAR"	
		214 "PRA"	
		215 2	
		216 RCL 00	
		217 SQRT	
		218 *	
		219 PRX	Print $v_c = 2\sqrt{f'_c}$
		220 4	

LABELS

A ✓	B ✓	C ✓	D	E
F	G	H	I	J
a	b	c	d	e
01	02	03	04	05
06	07	08	09	10
11 ✓	12	13	14	15 ✓
16	17	18	19	20
21	22	23	24	25

FLAGS

0	1
2	3
4	5
6	7
8	9
16	17
24	25

SET STATUS

FLAGS: ON / OFF
0 ☐ ■
1 ☐ ■
2 ☐ ■
3 ☐ ■

TRIG: DEG ■ GRAD ☐ RAD ☐

DISP: FIX ■ SCI ☐ ENG ☐ n 4

10	11 ✓	12 ✓	13	14	15
18	19	20	21	22	23
26	27	28	29	30	31

STEP	KEY ENTRY	KEY CODE	COMMENTS
		221 *	
		222 PRX	Prints $v_{u_{max}} = 8\sqrt{f'_c}$
		223 4	
		224 /	
		225 -	
		226 STO 28	$v' = v_u - v_c$
		227 RCL 23	
		228 *	
		229 RCL 03	
		230 *	
		231 X<0?	
		232 0	
		233 RCL 07	
		234 RCL 12	
		235 *	
		236 RCL 08	
		237 RCL 02	
		238 *	
		239 +	
		240 /	
		241 E3	
		242 /	
		243 "X"	
		244 PRA	
		245 PRX	$X = \frac{V'_u}{W_{uTL}}$
		246 RCL 23	
		247 6	
		248 /	
		249 +	
		250 ADV	
		251 "STIRRUPS"	
		252 PRA	
		253 PRX	Prints $S = X + \frac{2d}{12}$
		254 50	v_z 50 psi
		255 RCL 28	
		256 X<=Y?	
		257 X<>Y	
		258 1/X	
		259 .22	$A_v = 0.22\square''$ (#3 ⌐¬)
		260 *	
		261 RCL 01	
		262 *	
		263 RCL 03	
		264 /	
		265 PRX	$S = \frac{A_v f_y}{v' b_w}$
		266 RCL 23	
		267 2	
		268 /	
		269 PRX	$S_{(max)} = d/2$
		270 .56	
		271 *	
		272 "C"	
		273 PRA	
		274 PRX	$C = 1.18\frac{w_d}{\beta_1}$
		275 ADV	$= \frac{1.18(.2)d}{0.85} = 0.28d$
		276 ADV	
		277 ADV	
		278 ADV	
		279 GTO A	Returns to A
		280 .END.	

STEP	KEY ENTRY	KEY CODE	COMMENTS

SECTION PROPERTIES "SECT"

PROGRAM DESCRIPTION

Program calculates the area, centroid top and bottom, moment of inertia, section modulus top and bottom, radius of gyration, and kern distances top and bottom. The program can handle any number of rectangles, triangles, circles, and known shapes such as angles, wide flange beams, etc. All types of sections can be added or subtracted with intermediate properties calculated at any time without affecting additional sections to be added. Ideal for built-up sections, composite construction, or sections with holes, etc.

If you should desire a printout of the prompting statements along with numerical results, set your printer to the normal mode.

The main program may be addressed directly by the execute key (XEQ) and the program name "SECT". Flag eleven (11) has set causing the program to initialize immediately upon entry of program cards.

LABEL a - Zeros all registers used to add or subtract properties of each element.

1. LABEL A - Prints "RECTANGLE"; rectangular sections, enter B, D, and Y. To subtract a section enter a negative B.

2. LABEL B - Prints "TRIANGLE"; triangular sections, enter B, D, and Y. To subtract a section enter a negative B.

3. LABEL C - Prints "ROUND"; round sections, enter RADIUS and Y. To subtract a section enter a negative RADIUS.

4. LABEL D - Prints "SPECIAL SECTION"; special sections with known properties about their own axis, enter Y, AREA, and I_g. To subtract a section enter a negative AREA and a negative I_g.

FORMULAS:

$A = B \times D$ (Rectangles)

$A = BD/2$ (Triangles)

$M = A \times Y$

$I_y = A \times Y^2 = MY$

$A = \pi R^2$ (Circles)

$I_g = \frac{BD^3}{12}$ (Rectangles)

$= \frac{BD^3}{36}$ (Triangles)

$= \frac{R^4\pi}{4}$ (Circles)

$N_b = \frac{M}{A}$

N_t = Total Depth - N_b

$I_n = I_y + I_g - \frac{M^2}{A}$

$S_t = \frac{I_n}{N_t}$

$S_b = \frac{I_n}{N_b}$

$$r = \sqrt{I_n/A}$$

$$K_t = \frac{I_n}{AN_b} \qquad K_b = \frac{I_n}{AN_t}$$

Program labels each section with a heading to insure that you are computing section properties for the proper section.

Any number of sections can be added or subtracted with intermediate properties calculated at any point. For intermediate properties, you must enter a total depth of only those sections included up to that point.

The base line for determining the Y-distance to neutral axis is the lowest point on the total shape to be input.

A = Area (sq. inches)

B = Width of rectangular or triangular section (inches)

D = Depth of section (inches)

Y = Distance from base line to neutral axis of section to be input (inches)

Radius = Radius of circle (inches)

I_g = Moment of inertia about the centroid of input section (in^4)

I_n = Moment of inertia about neutral axis (in^4)

N_b = Neutral axis measured from extreme fiber in bottom of section

N_t = Neutral axis measured from the extreme fiber in top of section

r = Radius of gyration (inches)

K_t = Kern distance above centroid (inches)

K_b = Kern distance below centroid (inches)

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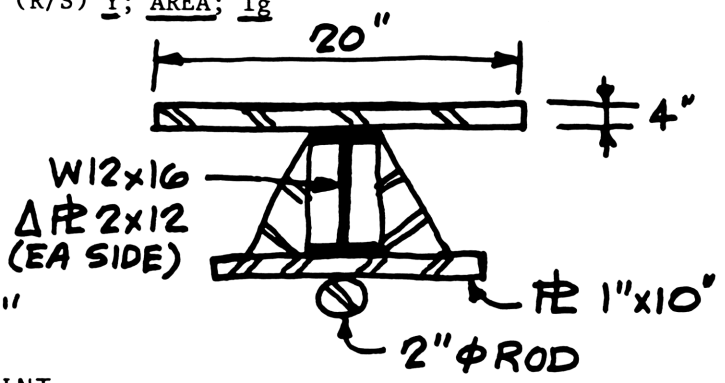
JOB SAMPLE PROBLEM
SHEET NO _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____
SCALE _____ COMM. NO.

SECTION PROPERTIES 12

(1) PUSH LABEL a TO START (ZEROS REGISTERS)
(1) RECTANGULAR SECTIONS--PUSH LABEL A, ENTER (R/S) B; D; Y
(2) TRIANGULAR SECTIONS--PUSH LABEL B, ENTER (R/S) B; D; Y
(3) ROUND SECTIONS--PUSH LABEL C, ENTER (R/S) RADIUS, Y
(4) SPECIAL SECTIONS--PUSH LABEL D, ENTER (R/S) Y; AREA; Ig

SKETCH

W12x16
d = 11.99" (Say 12")
A = 4.71
I_g = 103 in^4
Total depth = 4 + 12 + 1 + 2 = 19"



LBL		SECTION	ENTER(R/S) SIZE (B x D)	DISTANCE Y (IN)	PRINT A = B·D (IN^2)	M = A·Y (IN^3)	$I_y = AY^2 = MY$ (IN^4)	$I_g = \frac{BD^3}{12}$ (IN^4)
A	1	Top PL	20" x 4"	17"	80	1360	23,120	106.6667
A	2	Bot PL	10" x 1"	2.5"	10	25	62.5	0.8333
B	3	Triangles	4" x 12"	7.0"	24	168	1176	192.0
C	4	Round	1" RADIUS	1"	3.1416	3.1416	3.1416	0.7854
D	5	Beam	—" x —"	9"	4.71	42.39	381.51	103.0
(5)		(PUSH LABEL E)		TOTAL	121.85"	1598.5 IN^3	24743.1 IN^4	403.29 IN^4

$N_b = M/A =$ 13.1187 IN

TOTAL DEPTH = ENTER R/S 19 IN

N_t = TOTAL DEPTH − N_b = 5.8813 IN

$I_n = I_y + I_g - M^2/A =$ 4175.8 IN^4

$S_t = \frac{I_n}{N_t} =$ 710.01 IN^3 $S_b = \frac{I_n}{N_b} =$ 318.31 IN^3

$r = \sqrt{\frac{I_n}{A}} =$ 5.854 IN

$K_t = \frac{I_n}{AN_b} =$ 2.612 IN

$K_b = \frac{I_n}{AN_t} =$ 5.826 IN

1. To subtract a section simply put in a negative B (or a negative Area and negative I_g), or a negative RADIUS.
2. You can calculate Section Properties at any time by pushing E. It does not affect the registers for adding or deleting a section.

User Instructions

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	TURN PRINTER ON			
	MANUAL MODE - DISPLAYS PROMPTING		ON	
	STATEMENTS ONLY			
	NORMAL MODE - DISPLAYS AND PRINTS			
	PROMPTING STATEMENTS			
2	TURN CALCULATOR ON (USER MODE)			
3	PUSH XEQ ALPHA SIZE ALPHA 060 TO			
	PARTITION PROGRAM REGISTERS (SKIP			
	THIS STEP IF CALCULATOR PARTI-			
	TIONED FROM LAST PROGRAM)			
4	LOAD PREPROGRAMMED MAGNETIC CARDS			
5	PUSH LABEL a - CLEARS REGISTERS AND			
	PROCEEDS TO LABEL A		a	
	PUSH LABEL A - RECTANGULAR SECTIONS		A	
	PUSH LABEL B - TRIANGULAR SECTIONS		B	
	PUSH LABEL C - ROUND SECTIONS		C	
	PUSH LABEL D - SPECIAL SECTIONS		D	
	PUSH LABEL E - COMPUTES SECTION			
	PROPERTIES		E	
6	PROCEED TO CALCULATION SHEET			
7	ENTER DATA AND PUSH R/S KEY	DATA	R/S	
8	REPEAT STEP 7 UNTIL PROBLEM COMPLETED			

HP-41c

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
01	LBL "SECT"		Program Name "Sect"
02	LBL a		
03	SF 11		
04	SF 12		
05	"=CALPRO="		
06	PRA		
07	"CALCULATOR PRO"		
08	"+GRAMS"		
09	PRA		
10	CF 12		
11	ADV		
12	CLRG		Clears Registers
13	LBL A		
14	"RECTANGLE"		Rectangular Sections
15	PRA		
16	"B"		
17	PROMPT	←	Enter B
18	PRX		
19	STO 20		
20	"D"		
21	PROMPT	←	Enter D
22	PRX		
23	STO 21		
24	*		
25	ST+ 00		
26	"Y"		
27	PROMPT	←	Enter Y
28	PRX		
29	STO 22		
30	X<>Y		
31	PRX	→	Area = B·D
32	*		
33	ST+ 01		
34	PRX	→	M = A·Y
35	RCL 22		
36	*		
37	PRX	→	$I_y = AY^2$
38	ST+ 02		
39	RCL 20		
40	RCL 21		
41	3		
42	Y↑X		
43	*		
44	12		
45	/		
46	ST+ 03		
47	PRX	→	$I_g = \frac{BD^3}{12}$
48	ADV		
49	STOP		
50	LBL B		Triangular Sections
51	"TRIANGLE"		
52	PRA		
53	"B"		
54	PROMPT	←	Enter B
55	PRX		
56	STO 20		
57	"D"		
58	PROMPT	←	Enter D
59	PRX		
60	STO 21		
61	*		
62	2		
63	/		
64	ST+ 00		Area = B·D/2
65	"Y"		
66	PROMPT	←	Enter Y
67	PRX		
68	STO 22		
69	X<>Y		
70	PRX	→	Print Area = $\frac{BD}{2}$
71	*		
72	ST+ 01		
73	PRX	→	M = A·Y
74	RCL 22		
75	*		
76	PRX	→	$I_y = AY^2$
77	ST+ 02		
78	RCL 20		
79	RCL 21		
80	3		
81	Y↑X		
82	*		
83	36		
84	/		
85	ST+ 03		
86	PRX	→	$I = \frac{BD^3}{36}$
87	ADV		
88	STOP		
89	LBL C		Round Sections
90	"ROUND"		
91	PRA		
92	"RADIUS"		
93	PROMPT	←	Enter Radius
94	STO 20		
95	X<0?		
96	SF 00		
97	PRX	→	Print Radius
98	X↑2		
99	PI		
100	*		
101	FS? 00		Negative Radius?
102	CHS		
103	ST+ 00		
104	"Y"		
105	PROMPT	←	Enter Y
106	STO 22		
107	PRX	→	Y
108	X<>Y		
109	PRX	→	Area = πR^2
110	*		
111	PRX	→	M = AY

REGISTERS

00 Area	01 M	02 I_y	03 I_g	04 I_n	05 I_n/A	06	07	08	09
10	11	12	13	14	15	16	17	18	19
20 B/Rad	21 D	22 Y	23 N_b	24 N_T	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59

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Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
		112 ST+ 01	
		113 RCL 22	
		114 *	
		115 PRX	$I_y = AY^2$
		116 ST+ 02	
		117 RCL 20	
		118 4	
		119 Y↑X	
		120 PI	
		121 *	
		122 4	
		123 /	
		124 FS? 00	
		125 CHS	
		126 PRX	$I_g = \frac{\pi R^4}{4}$
		127 ST+ 03	
		128 ADV	
		129 CF 00	
		130 STOP	
		131 *LBL D	Special Section
		132 "SPECIAL SECTION"	
		133 PRA	
		134 "Y"	
		135 PROMPT	Enter Y
		136 PRX	
		137 STO 22	
		138 "AREA"	
		139 PROMPT	Enter Area
		140 PRX	
		141 ST+ 00	
		142 *	
		143 PRX	Print $M = A \cdot Y$
		144 ST+ 01	
		145 RCL 22	
		146 *	
		147 PRX	Prints $I_y = AY^2$
		148 ST+ 02	
		149 "I G"	
		150 PROMPT	Enter I_g
		151 PRX	
		152 ST+ 03	
		153 ADV	
		154 STOP	
		155 *LBL E	Section Properties
		156 "PROPERTIES"	
		157 PRA	
		158 RCL 00	
		159 PRX	ΣA
		160 RCL 01	
		161 PRX	ΣM
		162 RCL 02	
		163 PRX	ΣI_y
		164 RCL 03	
		165 PRX	ΣI_g
		166 ADV	
		167 RCL 01	
		168 RCL 00	
		169 /	
		170 PRX	$N_b = \frac{M}{A}$
		171 STO 23	
		172 "DEPTH"	
		173 PROMPT	Enter Total depth of Section
		174 PRX	
		175 -	
		176 CHS	
		177 PRX	N_T = Total depth $- N_b$
		178 STO 24	
		179 RCL 02	
		180 RCL 03	
		181 +	
		182 RCL 01	
		183 X↑2	
		184 RCL 00	
		185 /	
		186 -	
		187 PRX	$I_n = I_y + I_g - \frac{M^2}{A}$
		188 STO 04	
		189 RCL 24	
		190 /	
		191 PRX	$S_t = \frac{I_n}{N_T}$
		192 RCL 04	
		193 RCL 23	
		194 /	
		195 PRX	$S_b = \frac{I_n}{N_b}$
		196 RCL 04	
		197 RCL 00	
		198 /	
		199 STO 05	
		200 SQRT	
		201 PRX	$r = \sqrt{\frac{I_n}{A}}$
		202 ADV	
		203 RCL 05	
		204 RCL 23	
		205 /	
		206 PRX	Top Kern $K_T = I_n / A \cdot N_b$
		207 RCL 05	
		208 RCL 24	
		209 /	
		210 PRX	Bottom Kern $K_b = \frac{I_n}{A \cdot N_T}$
		211 ADV	
		212 ADV	
		213 ADV	
		214 ADV	
		215 STOP	
		216 .END.	
220			

LABELS

A ✓	B ✓	C ✓	D ✓	E ✓
F	G	H	I	J
a ✓	b	c	d	e
01	02	03	04	05
06	07	08	09	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

FLAGS

0 ✓	1
2	3
4	5
6	7
8	9
16	17
24	25

SET STATUS

FLAGS: ON OFF
0 ☐ ■
1 ☐ ■
2 ☐ ■
3 ☐ ■

TRIG: DEG ■ GRAD ☐ RAD ☐

DISP: FIX ■ SCI ☐ ENG ☐ n 4

10	11 ✓	12 ✓	13	14	15
18	19	20	21	22	23
26	27	28	29	30	31

FINK TRUSS "FINK"

PROGRAM DESCRIPTION

Program calcualtes reactions, panel point loads, member axial loads, bending moments in loaded members for varying roof slopes and camber required. Ideal for both steel and wood roof trusses.

If you should desire a printout of the prompting statements along with the numerical results, set your printer to the normal mode.

The main program may be addressed directly by the execute key (XEQ) and the program name "FINK". Flag eleven (11) has been set causing the program to initialize immediately upon entry of program cards.

Moment (Top Chord) = $WL^2/10$

Moment (Bottom Chord) = $WL^2/8$

Camber $= K_1 \frac{L^3}{H} + K_2 L^2/H$

$K_1 = 0.000032$ $\qquad H = \frac{L}{2} \times \frac{S}{12}$

$K_2 = 0.0028$

$= \frac{24L}{S} (0.000032L + .0028)$

Positive loads act down on top of chord, uplift loads must be input as a negative load.

Program uses the method of joints to solve truss axial loads.

L = Truss span (Feet)

S (Slope) = Amount of truss slope in 12 inches (Inches)

SLOPE (Degrees) - Roof slope converted to degrees

Truss Spacing = Centerline to centerline of adjacent trusses (Feet)

W Top Chord = Uniform roof load on top chord (PSF)

W Bot Chord = Uniform ceiling load on bottom chord (PSF)

R_A, R_F = Reactions (LBS)

P_{AB}, P_{EF}, P_{BC}, P_{CD}, P_{DE} = Panel point loads along top chord (LBS)

P_{AJ}, P_{GF}, P_{JH}, P_{HG}= Panel point loads along bottom chord (LBS)

AXIAL LOAD = Axial load in truss members (LBS) (- Compression, + Tension)

Moment = Moments in top and bottom chord (FT-LBS)

Camber = Inches

JOHN DOE & ASSOCIATES
CONSULTING STRUCTURAL ENGINEERS
111 YOUR STREET
ANYWHERE, U.S.A. 00000

JOB SAMPLE PROBLEM (13-2)

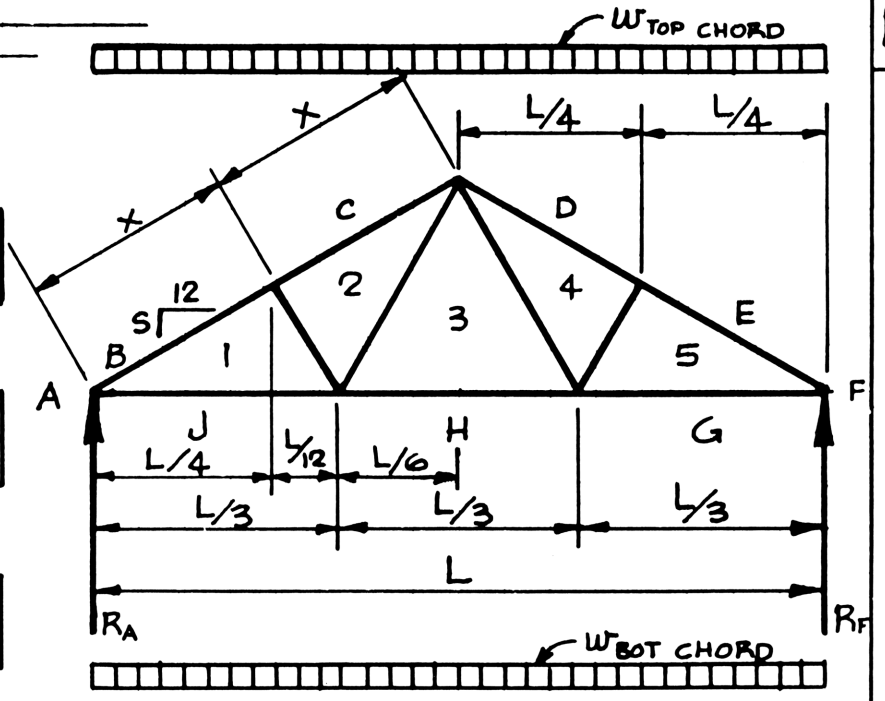
SHEET NO ____ OF ____

CALCULATED BY ____ DATE ____

CHECKED BY ____ DATE ____

SCALE ____ COMM NO.

FINK ROOF TRUSS T-4
(PUSH LABEL A) ____



ENTER (R/S)

L	S (SLOPE)	PRINT SLOPE (DEGREES)
30.0 FT	3 /12	14.0362°

ENTER (R/S)

TRUSS SPACING	W TOP CHORD	W BOT CHORD
2 FT	50 PSF	20 PSF

PRINT

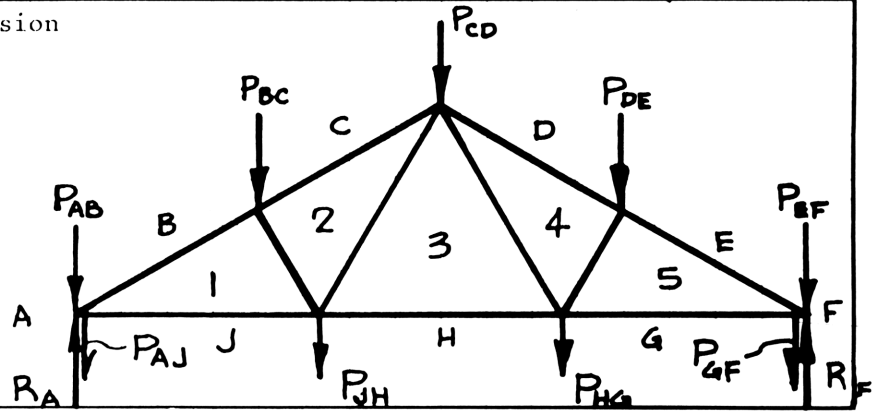
R_A, R_F	P_{AB}, P_{EF}	P_{BC}, P_{CD}, P_{DE}
2100 LB	375 LB	750 LB

PRINT

P_{AJ}, P_{GF}	P_{JH}, P_{HG}	
200 LB	400 LB	

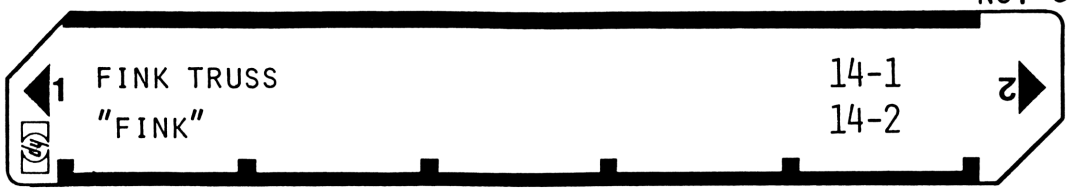
PRINT	TOP CHORD		BOTT CHORD		WEB MEMBERS	
MEMBER	B1, E5	C2, D4	J1, G5	H3	12, 45	23, 34
AXIAL LOAD	-6287.7	-5514.65	+6100	+4066.6	-937.5	+1604.17
MOMENT	562.5	562.5	500	500	—	—

AXIAL LOAD ..... LBS { - Compression, + Tension
MOMENT ..... FT LBS



CAMBER		
0.9024 IN		

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	TURN PRINTER ON			
	MANUAL MODE - DISPLAYS PROMPTING			
	STATEMENTS ONLY			
	NORMAL MODE - DISPLAYS AND PRINTS			
	PROMPTING STATEMENTS			
2	TURN CALCULATOR ON (USER MODE)		ON	
3	PUSH XEQ ALPHA SIZE ALPHA 060 TO			
	PARTITION PROGRAM REGISTERS (SKIP			
	THIS STEP IF CALCULATOR PARTI-			
	TIONED FROM LAST PROGRAM)			
4	LOAD PREPROGRAMMED MAGNETIC CARDS			
5	PUSH LABEL A (KEY A)			
6	PROCEED TO CALCULATION SHEET			
7	ENTER DATA AND PUSH R/S KEY	DATA	R/S	
8	REPEAT STEP 7 UNTIL PROBLEM			
	COMPLETED			

HP-41C

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
01	♦LBL "FINK"		FINK TRUSS "FINK"
02	♦LBL A		
03	SF 11		
04	SF 12		
05	"=CALPRO="		
06	PRA		
07	"CALCULATOR PRO"		
08	"PGRAMS"		
09	PRA		
10	CF 12		
11	ADV		
12	10		
13	STO 25		
14	"L"		
15	PROMPT		Enter L
16	STO 20		
17	PRX		
18	"SLOPE"		
19	PROMPT		Enter S (slope)
20	STO 21		
21	PRX		
22	12		
23	R-P		
24	RDN		
25	PRX		Print Slope in Degrees θ
26	ADV		
27	"SPACING"		
28	PROMPT		Truss Spacing
29	STO 22		
30	PRX		
31	"W TOP"		
32	PROMPT		Enter W_{TOP}
33	STO 23		
34	PRX		
35	"W BOT"		Enter W_{Bottom}
36	PROMPT		
37	STO 24		
38	PRX		
39	ADV		
40	+		
41	*		
42	RCL 20		
43	*		
44	2		
45	/		
46	"FORCES"		Forces
47	PRA		
48	PRX		Print $R_A = \frac{wL}{2}$
49	STO 00		
50	RCL 20		
51	RCL 22		
52	*		
53	8		
54	/		
55	RCL 23		
56	*		
57	PRX		Print P_{AB}
58	ST- 00		
59	2		
60	*		
61	PRX		Print P_{BC}
62	ADV		
63	STO 01		
64	RCL 20		
65	RCL 22		
66	*		
67	6		
68	/		
69	RCL 24		
70	*		
71	PRX		Print P_{Aj}
72	ST- 00		
73	2		
74	*		
75	PRX		Print P_{JH}
76	STO 02		
77	90		
78	RCL 00		
79	XEQ 02		
80	RCL 21		
81	12		
82	XEQ 03		
83	0		
84	RCL 25		
85	XEQ 04		
86	RCL 10		
87	RCL 04		
88	*		
89	STO 08		
90	RCL 10		
91	RCL 05		
92	*		
93	STO 09		
94	RCL 01		
95	ST+ 09		
96	RCL 20		$\frac{L}{4} \times 12 \times S$
97	4		
98	/		
99	RCL 21		$\frac{L}{12} \times 12$
100	*		
101	CHS		
102	RCL 20		
103	XEQ 04		
104	STO 27		
105	RCL 06		
106	STO 04		
107	*		
108	STO 08		
109	RCL 27		
110	RCL 07		
111	CHS		
112	STO 05		

REGISTERS

00 $R_A - P_{ai}$	01 P_{BC}	02 P_{JH}	03 $x_2y_1 - x_1y_2$	04 X_1	05 Y_1	06 X_2	07 Y_2	08 F_x	09 F_y
10 F_{B1}	11 F_{J1}	12 F_{C2}	13 F_{12}	14 F_{23}	15 F_{H3}	16 M_{Chord}^{Top}	17 M_{Chord}^{Bot}	18	19
20 L	21 S	22 Truss Spacing	23 W_{Chord}^{Top}	24 W_{chord}^{Bot}	25 Count	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
		113 CHS	
		114 *	
		115 STO 09	
		116 RCL 02	
		117 CHS	
		118 ST+ 09	
		119 RCL 11	
		120 CHS	
		121 ST+ 08	
		122 0	
		123 RCL 25	
		124 XEQ 04	
		125 ADV	
		126 "AXIAL LOAD"	Axial Loads
		127 PRA	
		128 RCL 10	
		129 PRX	Print F_{B1}
		130 RCL 12	
		131 CHS	
		132 STO 12	
		133 PRX	Print F_{C2}
		134 RCL 11	
		135 PRX	Print F_{J1}
		136 RCL 15	
		137 PRX	Print F_{H3}
		138 RCL 13	
		139 CHS	
		140 STO 13	
		141 PRX	Print F_{12}
		142 RCL 14	
		143 PRX	Print F_{23}
		144 ADV	
		145 "MOMENT"	Moment
		146 PRA	
		147 RCL 23	
		148 RCL 22	
		149 *	
		150 RCL 20	
		151 4	
		152 /	
		153 X↑2	
		154 *	
		155 10	
		156 /	
		157 STO 06	
		158 PRX	$M_T = wL^2/10$
		159 PRX	
		160 RCL 24	
		161 RCL 22	
		162 *	
		163 RCL 20	
		164 3	
		165 /	
		166 X↑2	
		167 *	
		168 8	
		169 /	
		170 STO 07	
		171 PRX	$M_{Bot\ chord} = wL^2/8$
		172 PRX	
		173 ADV	Camber
		174 "CAMBER"	
		175 PRA	
		176 .000032	
		177 RCL 20	
		178 *	
		179 .0028	
		180 +	
		181 RCL 20	$\Delta = \frac{24L}{5} \times (0.000032L + .0028)$
		182 *	
		183 24	
		184 *	
		185 RCL 21	
		186 /	
		187 PRX	Print Camber
		188 ADV	
		189 ADV	
		190 ADV	
		191 ADV	
		192 STOP	
		193 ↑LBL 02	Components of Force
		194 P-R	
		195 STO 08	
		196 X<>Y	
		197 STO 09	
		198 RTN	
		199 ↑LBL 03	Vector 1 Directional Cosines
		200 R-P	
		201 CLX	
		202 1	
		203 P-R	
		204 STO 04	
		205 X<>Y	
		206 STO 05	
		207 RTN	
		208 ↑LBL 04	Determine Forces Vector 2 Directional Cosines
		209 R-P	
		210 CLX	
		211 1	
		212 P-R	
		213 STO 06	
		214 X<>Y	
		215 STO 07	
		216 RCL 06	
		217 RCL 05	
		218 *	
		219 RCL 04	
		220 RCL 07	
		221 *	

LABELS

A ✓	B	C	D	E
F	G	H	I	J
a	b	c	d	e
01	02 ✓	03 ✓	04 ✓	05
06	07	08	09	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

FLAGS

0	1
2	3
4	5
6	7
8	9
16	17
24	25

SET STATUS

FLAGS: ON OFF
0 ☐ ■
1 ☐ ■
2 ☐ ■
3 ☐ ■

TRIG: DEG ■ GRAD ☐ RAD ☐

DISP: FIX ■ SCI ☐ ENG ☐ n 4

10	11 ✓	12 ✓	13	14	15
18	19	20	21	22	23
26	27	28	29	30	31

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
		222 -	
		223 STO 03	
		224 RCL 08	
		225 RCL 07	
		226 *	$X_2Y_1 - X_1Y_2 = Z$
		227 RCL 09	
		228 RCL 06	
		229 *	
		230 -	
		231 RCL 03	$\frac{F_x(x_1) - F_y(y_1)}{Z}$
		232 /	
		233 STO IND 25	
		234 RCL 09	
		235 RCL 04	
		236 *	
		237 RCL 08	
		238 RCL 05	
		239 *	
		240 -	
		241 RCL 03	
		242 /	
		243 ?ISZ	
		244 STO IND 25	
		245 ?ISZ	
		246 RTN	
		247 .END.	

WOOD COLUMNS "WOODCOL"

PROGRAM DESCRIPTION

This program computes the wood column size required for a given axial load and biaxial bending moments based on the 1977 Edition of the "National Design Specification for Wood Construction" by the National Forest Products Association. Columns are not considered to be braced about either axis within the column length.

If you should desire a printout of the prompting statements along with the numerical results, set your printer to the normal mode.

The main program may be addressed directly by the execute key (XEQ) and the program name "WOODCOL". Flag eleven (11) has been set causing the program to initialize immediately upon entry of program cards.

Members subjected to both flexure and axial tension are proportioned such that

$$\frac{f_t}{F_t} + \frac{f_{bxx}}{F_b} + \frac{f_{byy}}{F_b}$$ does not exceed the stress duration factor.

Members subjected to both flexure and axial compression are proportioned such that

$$\frac{f_c}{F_c'} + \frac{f_{bxx}}{F_b - Jf_c} + \frac{f_{byy}}{F_b - Jf_c}$$ does not exeed the stress duration factor.

$$F_c' = F_c\left[1 - \frac{1}{3}\left(\frac{L/D}{K}\right)^4\right] \leq F_c \text{ when } L/D < K$$

$$F_c' = \frac{0.30E}{(L/D)^2} \text{ when } L/D \geq K$$

$$J = \frac{(L/D) - 11}{K-11} \quad 0 \leq J \leq 1$$

$J = 0$ if $L/D \leq 11$

$0 < J < 1.0$ if $11 < L/D < K$

$J = 1.0$ if $L/D \geq K$

$$K = 0.671\sqrt{\frac{E}{F_c}}$$

Stress Duration Factors:

Permanent	0.90
Normal	1.00
Snow	1.15
Wind	1.33
Impact	2.00

P---+ Compression
- Tension

$L/D \leq 50$

When the depth of a rectangular bending member exceeds 12 inches, the design value for extreme fiber in bending, F_b, shall be multiplied by the size factor, C_F, as determined by the following formula:

$$C_F = \frac{12^{1/9}}{D}$$

When D equals	C_F equals
13.5 in.	0.987
15.5 in.	0.972
17.5 in.	0.959
19.5 in.	0.947
21.5 in.	0.937
23.5 in.	0.928
25.5 in.	0.920
27.5 in.	0.912

IMPORTANT: When Label B is pushed to hold dimension B, and L/B $\geq$ 50 about the weak axis, the calculator will continue to run without stopping. Code requirements cannot be satisfied until dimension B is incremented. The calculator will not print any answers until the L/D and L/B $\leq$ 50, $f_c \leq$ S.D.F. x F_c, $f_{bxx} \leq$ S.D.F. x F_b, and $f_{byy} \leq$ S.D.F. x F_b which are internally satisfied by incrementing B and D dimensions.

Pushing Label A will increment B and D dimensions by 2" each increment. Push Label B to increment member depth only. Actual member dimensions are required.

Unless the wood species changes from one column to the next, wood properties are not required to be input each time. Control returns to Label C ready for your next loading combination and member sizes. (P will be displayed)

F_b = Design value for extreme fiber stress in bending (PSI) for normal or repetitive member usage

F_t = Design value in tension parallel to grain (PSI)

F_c = Design value in compression parallel to grain (PSI)

E = Modulus of elasticity (PSI)

STRESS DURATION FACTOR = Adjustment factor for length of time of load application

P = Total axial load parallel to grain (LBS) (+ Compression; - Tension)

M_{xx} = Moment about the x-axis (FT-LBS)

M_{yy} = Moment about the y-axis (FT-LBS)

L = Actual length of member (FT) assuming pinned ends

B = Actual width of member (IN)

D = Actual depth of member (IN)

JOHN DOE & ASSOCIATES
CONSULTING STRUCTURAL ENGINEERS
111 YOUR STREET
ANYWHERE, U.S.A. 00000

JOB SAMPLE PROBLEM (14-3)
SHEET NO _____ OF _____
CALCULATED BY _____ DATE _____
CHECKED BY _____ DATE _____
SCALE _____ COMM. NO. _____

WOOD COLUMN LOCATION B-7 — 14
(PUSH LABEL A) _____
(PUSH LABEL B TO INCREMENT DEPTH (D) AND HOLD WIDTH B)
ENTER (R/S)

F_b	F_T	F_c	E	STRESS DURATION FACTOR	WOOD SPECIES
1400 PSI	825 PSI	975 PSI	1.6 x 10^6 PSI	1.15	#2 Southern Pine

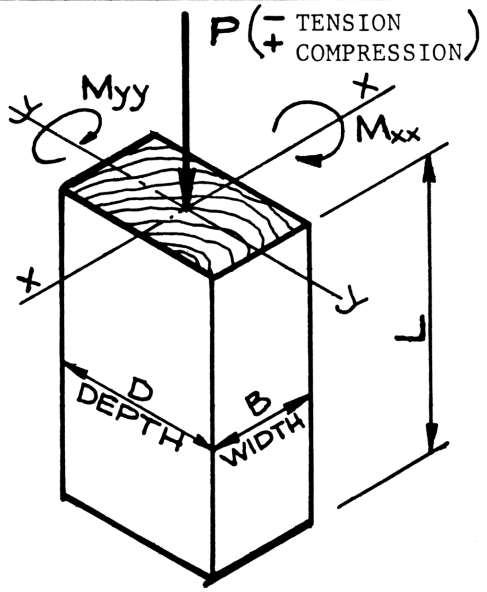
Enter 1.6

(LOCATION LBL C)
ENTER (R/S)

P	Mxx	Myy
30,000 LBS	400 FT-LBS.	300 FT-LBS

ENTER (R/S)

L	B (WIDTH)	D (DEPTH)
15.0 FT	3.5 IN	5.5 IN



PRINT

TRIAL	Tension / Comp	f_t/F_t / f_c/F'_c	f_{bxx}/F_b / $f_{bxx}/(F_b - J_x f_c)$	f_{byy}/F_b / $f_{byy}/(F_b - J_y f_c)$	$\Sigma_{TENSION}$ / Σ_{COMP}	MEMBER SIZE
1		1.6228	0.1141	0.1415	1.8785	5.5" x 7.5"
2		0.5416	0.0357	0.0381	0.6153	7.5" x 9.5"
3						" x "
4						" x "
5						" x "

USE 8x10

1. STRESS DURATION FACTOR:
   PERMANENT ..... 0.90 SNOW ..... 1.15 IMPACT 2.0
   NORMAL ..... 1.00 WIND 1.33
2. Fb Allowable bending stress for normal or repetitive member usage.
3. P + Indicates compression in program
   − Indicates tension in program
4. Mxx and Myy can be positive or negative. They are always converted ~~to a positive~~ moment in program.
5. B and D incremented by 2", unless Label B is pressed and then depth only is incremented by 2".
6. $L/D \leq 50$; $L/B \leq 50$
7. If the wood properties do not change, enter the next load, etc. (Program returns automatically to Label C ready for next column load).

User Instructions

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	TURN PRINTER ON			
	MANUAL MODE - DISPLAYS PROMPTING			
	STATEMENTS ONLY			
	NORMAL MODE - DISPLAYS AND PRINTS			
	PROMPTING STATEMENTS			
2	TURN CALCULATOR ON (USER MODE)		ON	
3	PUSH XEQ ALPHA SIZE ALPHA 060 TO			
	PARTITION PROGRAM REGISTERS (SKIP			
	THIS STEP IF CALCULATOR PARTI-			
	TIONED FROM LAST PROGRAM)			
4	LOAD PREPROGRAMMED MAGNETIC CARDS			
5	PUSH LABEL A - WOOD COLUMN; INCREMENTS			
	DEPTH AND WIDTH		A	
	PUSH LABEL B - WOOD COLUMN; INCREMENT			
	DEPTH AND HOLDS WIDTH		B	
	PUSH LABEL C - NEW LOADING CONDITION		C	
6	PROCEED TO CALCULATION SHEET			
7	ENTER DATA AND PUSH R/S KEY	DATA	R/S	
8	REPEAT STEP 7 UNTIL PROBLEM COMPLETED			

HP-41c

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
01	LBL "WOODCOL"		"WOODCOL"
02	LBL A		
03	SF 00		
04	LBL 10		
05	SF 11		
06	SF 12		
07	"=CALPRO="		
08	PRA		
09	"CALCULATOR PRO"		
10	"PGRAMS"		
11	PRA		
12	CF 12		
13	ADV		
14	"Fb"		
15	PROMPT		← Enter F_b
16	PRX		
17	STO 00		
18	"F T"		
19	PROMPT		← Enter F_T
20	PRX		
21	STO 01		
22	"Fc"		
23	PROMPT		← Enter F_c
24	PRX		
25	STO 02		
26	"E"		
27	PROMPT		← Enter E
28	E6		
29	*		
30	PRX		→ E x 10^6 psi
31	STO 03		
32	"S.D.F."		
33	PROMPT		← Enter Stress Duration Factor
34	PRX		
35	STO 04		
36	LBL 12		
37	LBL C		
38	ADV		
39	"P"		
40	PROMPT		← Enter P
41	PRX		
42	STO 20		
43	"MXX"		
44	PROMPT		← Enter Mxx
45	PRX		
46	STO 21		
47	"MYY"		
48	PROMPT		← Enter Myy
49	PRX		
50	STO 22		
51	ADV		
52	"LENGTH"		
53	PROMPT		← Enter L
54	PRX		
55	12		
56	*		L x 12 =
57	STO 23		
58	"B"		
59	PROMPT		← Enter B (Width)
60	STO 05		
61	PRX		
62	"D"		
63	PROMPT		← Enter D (Depth)
64	STO 06		
65	PRX		
66	ADV		
67	LBL 11		
68	RCL 23		
69	RCL 05		
70	RCL 06		
71	X<=Y?		B or D smaller
72	X<>Y		
73	RDN		
74	/		L/B or L/D Larger
75	STO 24		
76	50		
77	X<=Y?		L/D ≤ 50
78	GTO 01		
79	RCL 20		
80	RCL 05		
81	/		
82	RCL 06		
83	/		
84	STO 07		$f_c = \frac{P}{BD}$
85	RCL 02		
86	RCL 04		
87	*		
88	X<=Y?		$f_c \leq$ S.D.F. x F_c
89	GTO 01		
90	RCL 21		
91	72		
92	*		
93	RCL 05		$f_{bxx} = \frac{12M \times 6}{BD^2}$
94	/		
95	RCL 06		
96	X↑2		
97	/		
98	STO 08		f_{bxx}
99	RCL 00		
100	RCL 04		
101	*		
102	X<=Y?		$f_{bxx} \leq$ S.D.F. x F_b
103	GTO 01		
104	RCL 22		
105	72		
106	*		
107	RCL 06		$f_{byy} = \frac{12M \times 6}{B^2D}$
108	/		
109	RCL 05		

REGISTERS

00 F_b	01 F_T	02 F_c	03 E	04 Stress Duration Factor	05 B Col Width	06 D Col Depth	07 f_c or f_t	08 f_{bxx}	09 Σ
10	11	12	13	14	15	16	17	18	19
20 P	21 M_{xx}	22 M_{yy}	23 L (inches)	24 L/D	25 f_{byy}	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59

HP-41C

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
		110 X↑2	
		111 /	
		112 STO 25	f_{byy}
		113 RCL 00	
		114 RCL 04	
		115 *	
		116 X<=Y?	$f_{byy} \leq$ S.D.F. $\times F_b$
		117 GTO 01	
		118 RCL 07	
		119 X>0?	
		120 GTO 02	
		121 ABS	Tension Axial Load
		122 RCL 01	
		123 /	
		124 PRX →	Print f_t/F_T
		125 RCL 08	
		126 RCL 00	
		127 /	
		128 PRX →	Print f_{bxx}/F_b
		129 +	
		130 RCL 25	
		131 RCL 00	
		132 /	
		133 PRX →	Print f_{byy}/F_b
		134 +	
		135♦LBL 14	
		136♦LBL E	
		137 PRX →	Print Σ
		138 RCL 05	
		139 PRX →	Print B (width)
		140 RCL 06	
		141 PRX →	Print D (Depth)
		142 RDN	
		143 RDN	
Returns to "C"		144 XEQ 01 →	Check if $\frac{f_c}{F_c} + \frac{f_{bxx}}{F_b} + \frac{f_{byy}}{F_b} \leq$ Stress Duration Factor
		145 ADV	
		146 ADV	
		147 GTO 12	
		148♦LBL 01	
		149 ADV	
		150 RCL 04	Add 2" to depth
		151 X>Y?	
		152 RTN	Add 2" to Width when F♦ is set
		153 2	
		154 ST+ 06	
		155 FS? 00	
		156 ST+ 05	
		157 GTO 11	
		158♦LBL 02	
		159 XEQ 07	
		160 X>Y?	$L/D > k$
		161 GTO 09	
		162 X<>Y	$L/D \leq k$
		163 /	
		164 4	
		165 Y↑X	$F_c' = F_c\left[1 - \frac{1}{3}\left(\frac{L_D}{k}\right)^4\right]$
		166 3	
		167 /	
		168 CHS	
		169 1	
		170 +	
		171 RCL 02	
		172 *	
		173 GTO 08	
		174♦LBL 09	for $L/D \geq k$
		175 .3	
		176 RCL 03	$F_c' = \frac{0.3E}{(L/D)^2}$
		177 *	
		178 RCL 24	
		179 X↑2	
		180 /	
		181♦LBL 08	
		182 RCL 07	
		183 X<>Y	
		184 /	
		185 PRX →	Print f_c/F_c'
		186 STO 09	
		187 RCL 06	
		188 XEQ 03	
		189 RCL 07	
		190 *	
		191 RCL 00	
		192 X<>Y	
		193 -	
		194 RCL 08	
		195 X<>Y	
		196 /	
		197 PRX →	Print $\frac{f_{bxx}}{F_b - Jf_c}$
		198 ST+ 09	
		199 RCL 05	
		200 XEQ 03	
		201 RCL 07	
		202 *	
		203 RCL 00	
		204 X<>Y	
		205 -	
		206 RCL 25	
		207 X<>Y	
		208 /	
		209 PRX →	Print $\frac{f_{byy}}{F_b - Jf_c}$
		210 RCL 09	
		211 +	
		212 GTO 14	
		213♦LBL 03	
		214 RCL 23	
		215 X<>Y	

LABELS

A ✓	B ✓	C ✓	D	E ✓
F	G	H	I	J
a	b	c	d	e
01 ✓	02 ✓	03 ✓	04 ✓	05 ✓
06	07 ✓	08 ✓	09 ✓	10 ✓
11 ✓	12 ✓	13	14 ✓	15
16	17	18	19	20
21	22	23	24	25

FLAGS

0 ✓	1
2	3
4	5
6	7
8	9
16	17
24	25

SET STATUS

FLAGS: ON OFF
0 ☐ ■
1 ☐ ■
2 ☐ ■
3 ☐ ■

TRIG: DEG ■ GRAD ☐ RAD ☐

DISP: FIX ■ SCI ☐ ENG ☐ n 4

10	11 ✓	12 ✓	13	14	15
18	19	20	21	22	23
26	27	28	29	30	31

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
		216 /	$L/D < 11$ Set $j=0$
		217 STO 24	
		218 11	
		219 X<=Y?	
		220 GTO 04	
		221 0	
		222 RTN	
		223*LBL 04	$11 < L/D < K$ $K = 0.671\sqrt{\frac{E}{F_c}}$ $J = \frac{(L/D) - 11}{K - 11}$
		224 XEQ 07	
		225 X>Y?	
		226 GTO 05	
		227 11	
		228 -	
		229 X<>Y	
		230 11	
		231 -	
		232 /	
		233 RTN	
		234*LBL 05	$L/D \geq K$ Set $J=1$
		235 1	
		236 RTN	
		237*LBL 07	$K = 0.671\sqrt{\frac{E}{F_c}}$
		238 .671	
		239 RCL 03	
		240 RCL 02	
		241 /	
		242 SQRT	
		243 *	
		244 RCL 24	
		245 RTN	
		246*LBL B	Clears Flag ϕ to Hold Column Width
		247 CF 00	
		248 GTO 10	
		249 .END.	

FEET-INCHES-SIXTEENTHS "FT IN16"

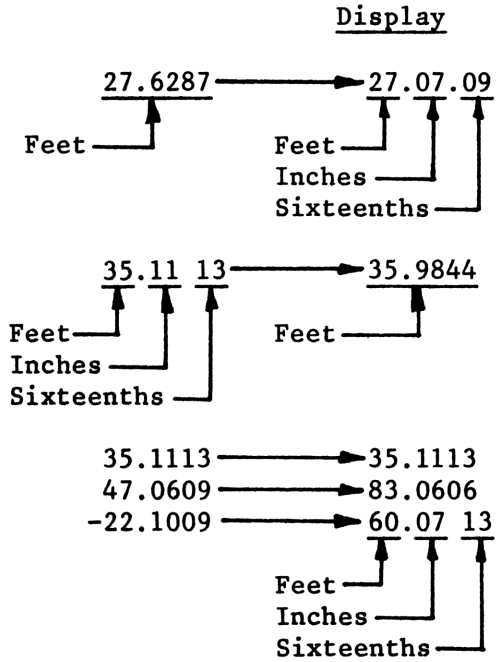
PROGRAM DESCRIPTION

Program converts decimal feet to feet-inches-sixteenths, converts feet-inches-sixteenths to decimal feet or simply adds feet-inches-sixteenths as a string of dimensions. You must first enter the number into the display prior to pushing the label key to convert or add your number.

The number in the display will be rounded off to even sixteenths of an inch, but the printed tape will contain the sixteenths and two numbers reflecting fractional sixteenths (not rounded).

1. Label A - Converts decimal feet to FT. IN 16^{ths}
2. Label B - Converts FT. IN 16^{ths} to a decimal number
3. Label C - Clears registers for adding dimensions in Label D and E
   Will not clear the display register
4. Label D or Label E - Sums a row of dimensions; all dimensions must be in FT. IN 16^{ths}. You can add a negative dimension provided the total is positive.

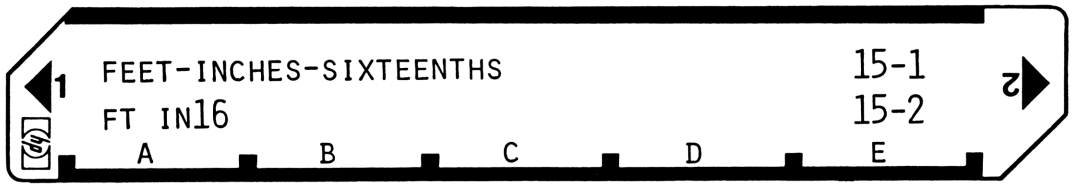
5. **EXAMPLE:**



Printed

```
FT.IN16>DECIMAL
        27.6287    ***
      27.070871    ***

DECIMAL>FT.IN16
        35.1113    ***
        35.9844    ***

CLEAR

ADD FT.IN16
        35.1113    ***
      35.111300    ***

ADD FT.IN16
        47.0609    ***
      83.060600    ***

ADD FT.IN16
       -22.1009    ***
      60.071300    ***
```

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	TURN PRINTER ON			
	MANUAL MODE - DISPLAYS PROMPTING			
	STATEMENTS ONLY			
	NORMAL MODE - DISPLAYS AND PRINTS			
	PROMPTING STATEMENTS			
2	TURN CALCULATOR ON (USER MODE)		ON	
3	PUSH XEQ ALPHA SIZE ALPHA 060 TO			
	PARTITION PROGRAM REGISTERS (SKIP			
	THIS STEP IF CALCULATOR PARTI-			
	TIONED FROM LAST PROGRAM)			
4	LOAD PREPROGRAMMED MAGNETIC CARDS			
5	PUSH LABEL A - CONVERTS DECIMAL FEET TO			
	FT. IN 16THS		A	
	PUSH LABEL B - CONVERTS FT. IN 16THS			
	TO DECIMAL FEET		B	
	PUSH LABEL C - CLEARS MEMORIES		C	
	PUSH LABEL D OR E - ADDS FT. IN 16THS		D	
			E	

HP-41c

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
01	LBL "FT IN16"		"CALPRO" Calculator Programs
02	SF 12		
03	"=CALPRO="		
04	PRA		
05	"CALCULATOR PRO"		
06	"+GRAMS"		
07	PRA		
08	CF 12		
09	LBL A		Changes Decimal Number to FT. IN 16ths
10	ADV		
11	STO 01		
12	"FT.IN16>DECIMAL"		
13	PRA		
14	RCL 01		
15	PRX		Print Number Feet
16	ENTER↑		
17	INT		Feet
18	STO 05		
19	-		
20	12		
21	*		
22	ENTER↑		
23	INT		
24	STO 06		Inches
25	-		
26	16		
27	*		
28	STO 07		16ths
29	RCL 05		
30	RCL 06		
31	100		
32	/		
33	+		
34	RCL 07		
35	10000		
36	/		
37	+		
38	FIX 6		
39	PRX		Prints FT. IN 16ths
40	FIX 4		
41	ADV		
42	RTN		
43	LBL B		Converts FT. IN16th To Decimal Feet
44	ADV		
45	"DECIMAL>FT.IN16"		
46	PRA		
47	PRX		Prints Number
48	ENTER↑		
49	STO 01		
50	INT		Feet
51	STO 05		
52	-		
53	100		
54	*		
55	ENTER↑		
56	INT		
57	STO 06		Inches
58	-		
59	100		
60	*		
61	STO 07		16ths
62	16		
63	/		
64	RCL 06		
65	+		
66	12		
67	/		
68	RCL 05		
69	+		
70	PRX		Prints Decimal Number
71	ADV		
72	RTN		
73	LBL C		Clears Registers 01, 02, 03, 04
74	"CLEAR"		
75	PRA		
76	0		
77	STO 01		
78	STO 02		
79	STO 03		
80	STO 04		
81	RDN		
82	RTN		
83	LBL D		Adds FT. IN 16ths
84	LBL E		
85	ADV		
86	STO 01		
87	"ADD FT.IN16"		
88	PRA		
89	RCL 01		
90	PRX		Prints Number
91	ENTER↑		
92	INT		Feet
93	ST+ 02		
94	-		
95	100		
96	*		
97	ENTER↑		
98	INT		
99	ST+ 03		Inches
100	-		
101	100		
102	*		
103	ST+ 04		16ths
104	RCL 04		
105	16		
106	/		
107	INT		
108	ST+ 03		Converts excess 16ths to Inches
109	16		
110	*		

REGISTERS

00	01 Stored Number	02 Feet	03 Inches	04 16ths	05 Feet	06 Inches	07 16ths	08	09
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59

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Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
		111 ST- 04	
		112 RCL 03	Converts excess Inches to Feet
		113 12	
		114 /	
		115 INT	
		116 ST+ 02	
		117 12	
		118 *	Check for negative 16ths; if negative add 16 and subtract one inch
		119 ST- 03	
		120 RCL 04	
		121 X<0?	Check for negative Inches; if negative add 12" and Subtract one Foot
		122 XEQ e	
		123 RCL 03	
		124 X<0?	
		125 XEQ d	
		126 RCL 02	
		127 RCL 03	
		128 100	
		129 /	
		130 +	
		131 RCL 04	
		132 10000	
		133 /	
		134 +	
		135 RCL 01	
		136 X<>Y	
		137 FIX 6	
		138 PRX	→ Print Σ of FT. IN 16ths
		139 FIX 4	
		140 ADV	
		141 RTN	
		142♦LBL d	Adds 12" to Reg 03 and subtracts one foot from Reg 02
		143 1	
		144 ST- 02	
		145 12	
		146 ST+ 03	
		147 RTN	
		148♦LBL e	Adds 16 to Reg 04 and Subtracts one Inch from Reg 03
		149 1	
		150 ST- 03	
		151 16	
		152 ST+ 04	
		153 RTN	
		154 STOP	
		155 .END.	
160			
170			
180			
190			
200			
210			
220			

LABELS

A ✓	B ✓	C	D	E
F	G	H	I	J
a	b	c	d ✓	e ✓
01	02	03	04	05
06	07	08	09	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

FLAGS

0	1
2	3
4	5
6	7
8	9
16	17
24	25

SET STATUS

FLAGS

	ON	OFF
0	☐	■
1	☐	■
2	☐	■
3	☐	■

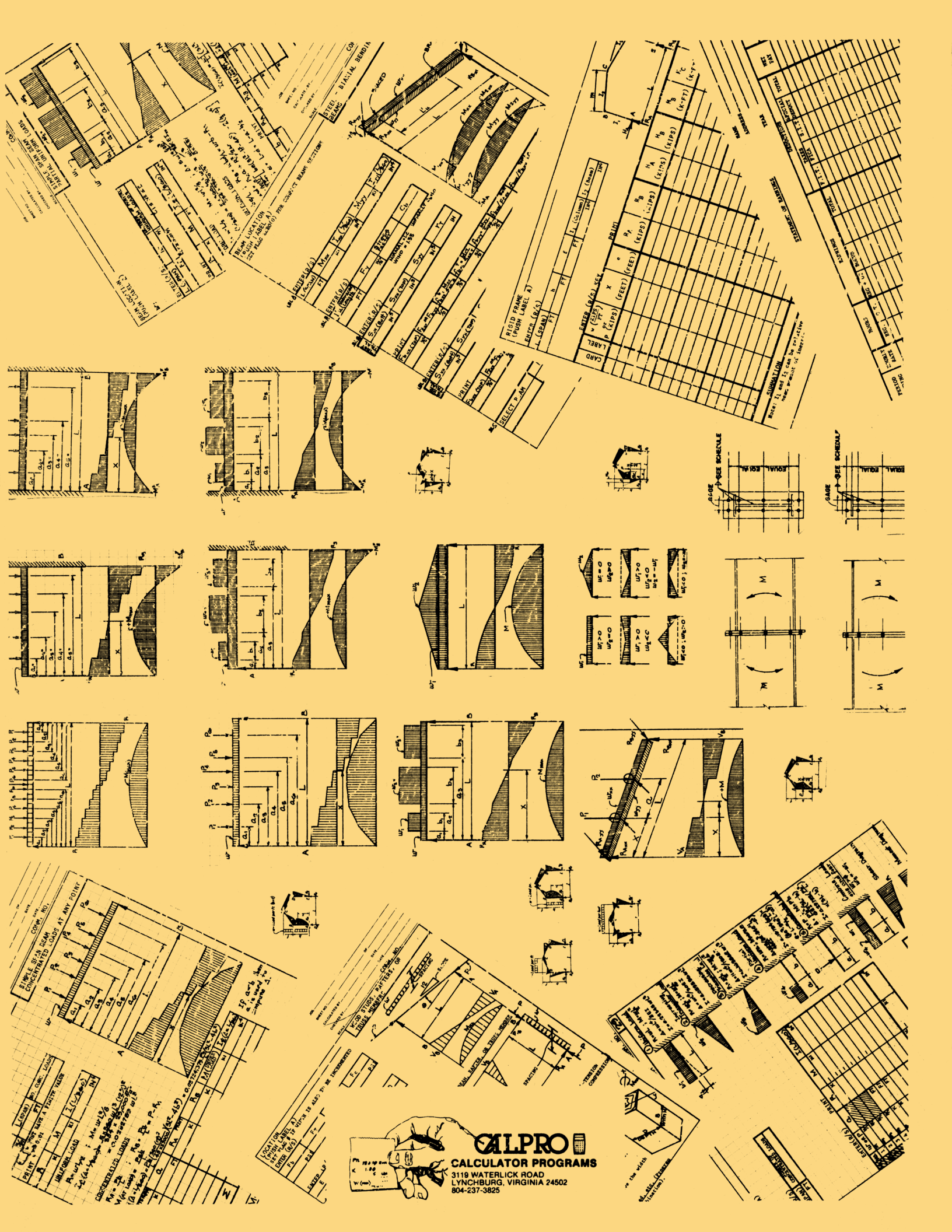
TRIG

DEG ■
GRAD ☐
RAD ☐

DISP

FIX ■
SCI ☐
ENG ☐
n 4

10	11	12	13	14	15
18	19	20	21	22	23
26	27	28	29	30	31


CALPRO
CALCULATOR PROGRAMS
3119 WATERLICK ROAD
LYNCHBURG, VIRGINIA 24502
804-237-3825