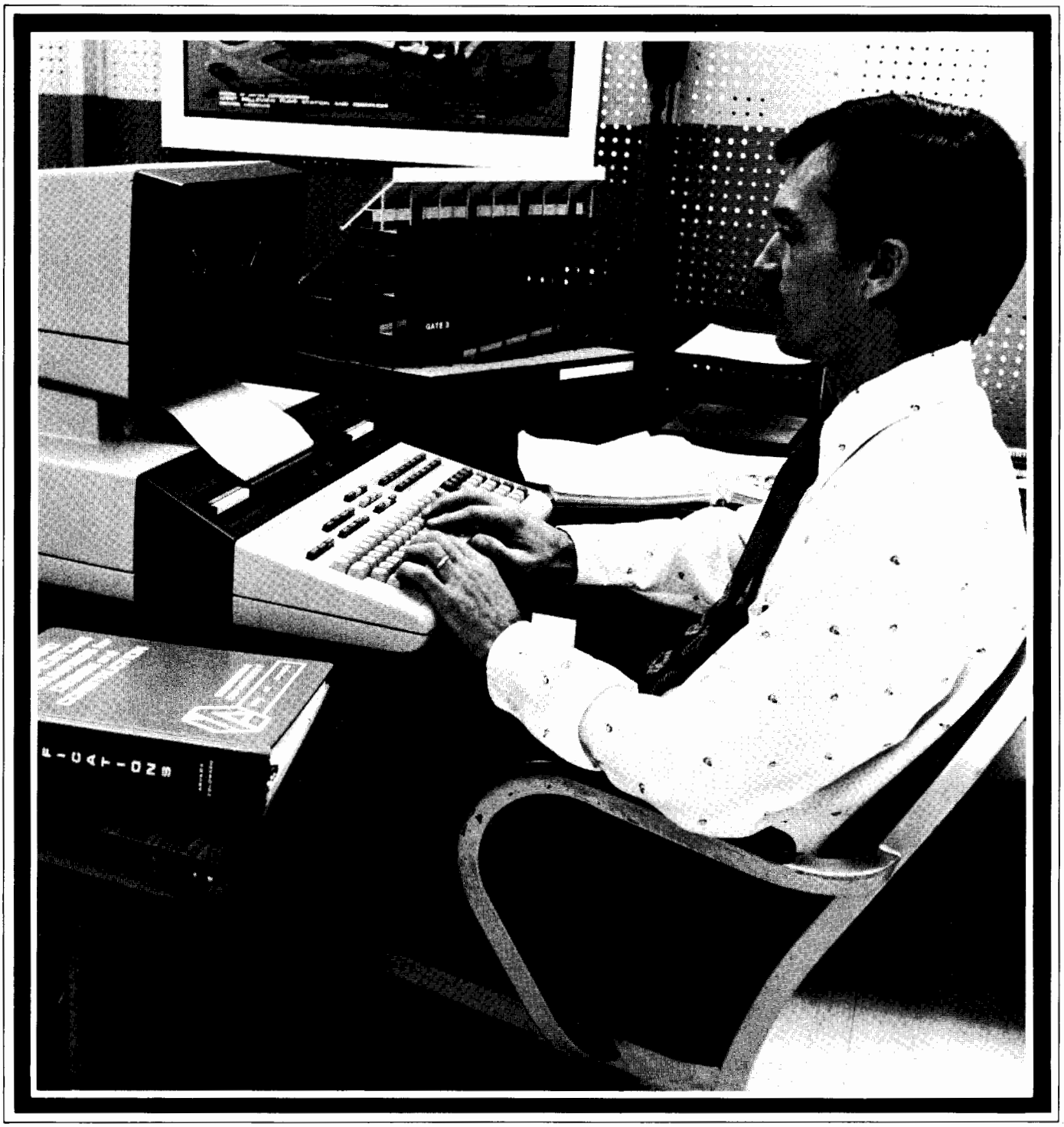
A Hewlett-Packard Software Summary
for the System 45B Desktop Computer

System 45B Structural Engineering Design & Analysis



Take the total solution approach to your structural engineering problems

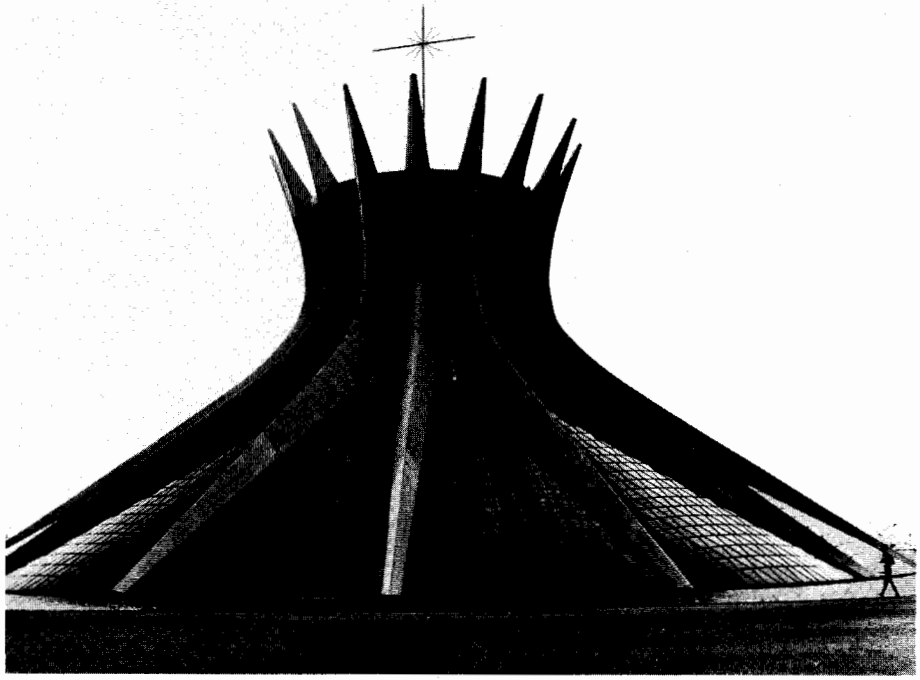
Work Through Complex Designs With Minimum Time and Effort

As a structural engineer, your continuing challenge is to create designs that are not only economical and practical, but provide the final specifications within the demanding time schedules you face everyday. To accomplish this, you need to work through complex design problems requiring many tedious and complicated mathematical computations. Because these problems must be solved quickly and accurately, in a way that minimizes costs, the tools you choose to help you can make a critical difference in giving you the competitive edge.

To answer your needs . . . Hewlett-Packard provides you with a powerful, yet easy-to-use total solution package. With HP's System 45B desktop computer and comprehensive structural engineering software library, after only a few hours experience you can competently tackle a wide variety of analysis and design problems from simple beams and planar trusses through three-dimensional space frames.

System 45B integrates keyboard, large memory, dual processors, mass storage, graphics CRT, and optional printer into one compact unit small enough to sit on your desk. The System 45B is at your command — to do what you want, when you want. You can virtually eliminate the slow response times and expensive charges of timeshared systems and service bureaus.

But hardware is only part of the solution. HP also offers an impressive selection of structural engineering software. This software, which includes an analysis series and design series, plus job cost accounting, was developed and tested by



structural design professionals who know the design problems and the best way to use computers to solve them. These programs address the problems most frequently encountered by the structural engineer. The approach used follows the typical analytical and code checking procedures familiar to practicing engineers. In addition, these programs are designed to interact with you to insure that your design expertise is used most effectively.

This system can also increase your computational accuracy, eliminating the need for approximations and tedious hand calculations. By freeing you from the computational routine, you can devote more time and effort to the creative aspects of your job.

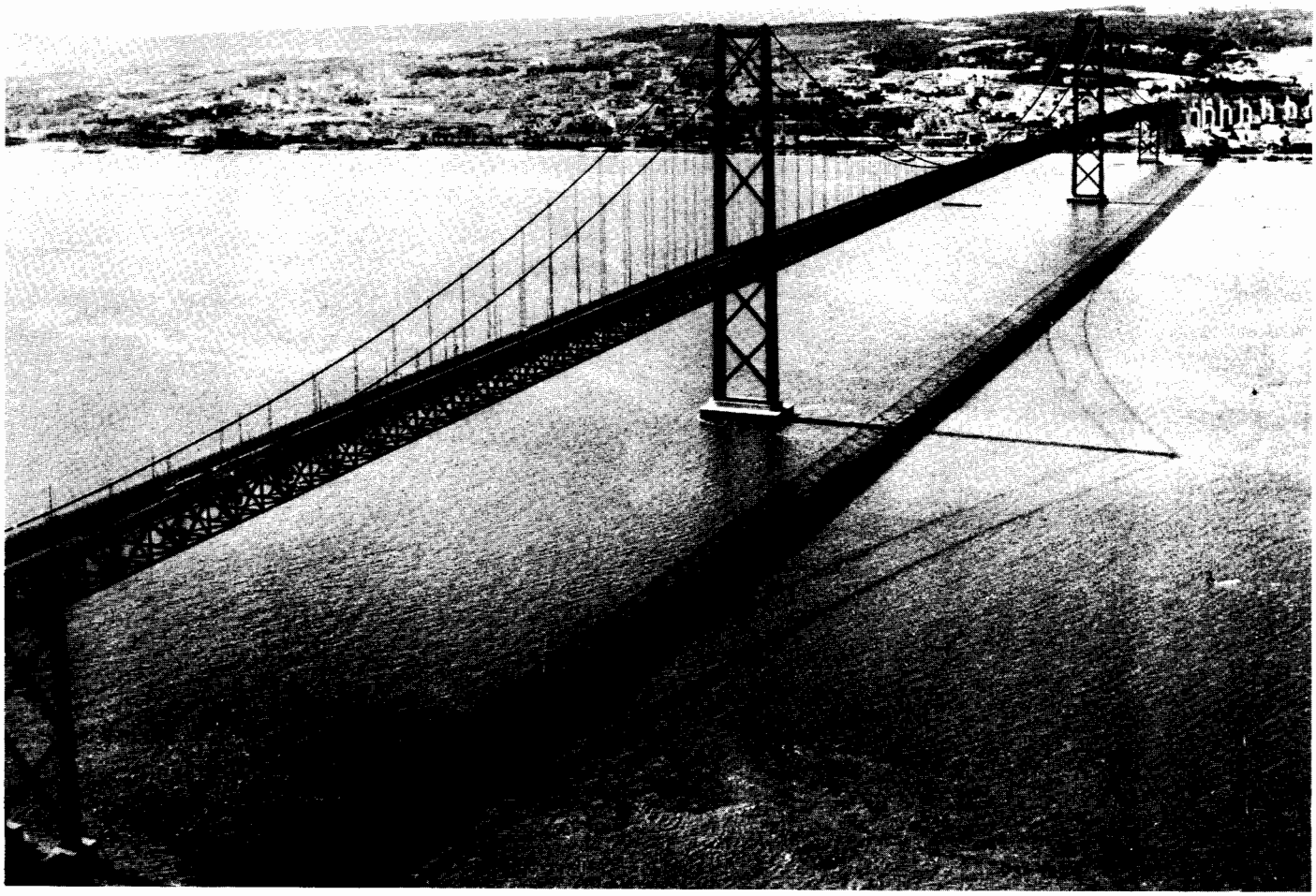
Integration Means Ease Of Use

Together the System 45B and structural engineering software make analyzing and designing—from input to results—fast and easy. All input data is displayed on CRT so you can spot data errors quickly. Conversational CRT user prompts guide you through the programs, so even if you've never used a computer before, you'll be solving complicated problems quickly and easily. Often entire computational routines are executed by a single keystroke. When designing, you can easily try several alternative designs to get your best solutions—a feature which helps you avoid costly overdesign. Then, for a hard copy record of your work, all the information and graphical displays can be quickly reproduced on System 45B's internal thermal line printer.

In addition, these programs have been designed to be complementary and interactive. Data file compatibility spares you unnecessary data reentry and has been built-in wherever time can be saved and accuracy improved.

Give Yourself The Competitive Edge

The program descriptions and examples that follow show you how the System 45B enables you to create high quality, cost-effective designs, giving you the competitive edge.



Speed Analysis, Increase Accuracy With System 45B's Graphics

Because your application needs can vary from job to job, HP has developed a complete series of structural analysis programs that address various levels of complexity ranging from analysis of continuous and simply supported beams all the way through complex three-dimensional structures.

Since most structural engineers do the majority of their work in two-dimensions, likewise the majority of these programs are two-dimensional analyses.

The software is available on ready-to-use tape cartridges. You insert the cartridge into the computer and simply respond to the conversational prompts on the CRT. The programs guide you through inputting your data, and should you make an error, easy-to-use data checking and editing routines help you correct it.

Once the data is entered, System 45B performs the analysis and automatically provides a printout listing of the results. If you want to modify your data, this can be done at various stages and the printout is logically organized to facilitate easy checking.

With System 45B's graphics option, the structure can quickly be displayed on the CRT to check the accuracy of your input data. You can also check the deformed geometry of the structure to be sure that the results look as you would expect.

HP's structural engineering analysis series also features:

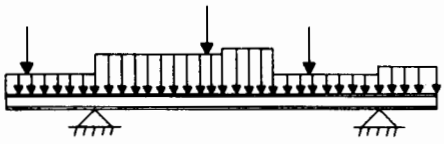
- —Choice of units. You can choose from popular U.S. or metric units or use any other set of internally consistent units of your choice.
- —Generate node and member data with numbering for positive identification. This is particularly useful by helping you to take advantage of the frequent symmetry of your structural designs.
- —Evaluation of multiple load cases and any important loading combinations.
- —Worst case tests. You can easily test critical supports for failure modes to improve the safety factors in your design.
- —Dynamic load analysis routines.
- —Calculate section properties of irregular shapes not included in handbooks.

Analysis Series Program Descriptions

Beam Span Analysis. Calculates shears, moments, and optionally deflections for a beam span including: (a) Simply-supported beam with or without cantilevers. Data may be obtained for cantilevers if any, as well as the main span. End moments may be input for the main span to simulate restraints of supports and/or continuity. (b) Spans of a continuous frame using data which has been output from the Continuous Frame Analysis program.

Both constant and variable sections can be considered. If the material is reinforced concrete, calculations can be based on effective moment of inertia.

BEAM SPAN ANALYSIS



INPUT

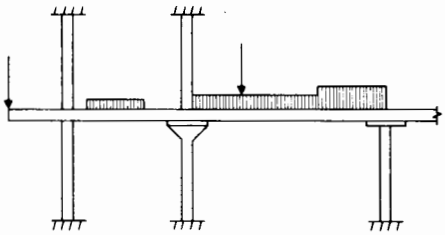
Spans (including cantilevers)
Loadings (uniform and concentrated)
End Moments (if desired)

OUTPUT

End Moments and Shears
Points of Inflection
Shear, Moment and Deflection (at specified points)

Continuous Frame Analysis. Solves for critical shears and moments in multiple-scan continuous frames or beams of a single level (not multi-story) with or without columns above and below the level under consideration. Equivalent column stiffness is used to account for torsional flexibility of span-to-column connections. Spans and columns may be prismatic or variable section. Cantilevered members and loads may be input at either or both ends. Loads may be concentrated, uniformly distributed (full or partial) and include live and dead leads. Up to 12 spans, including cantilevers, can be evaluated.

CONTINUOUS FRAME ANALYSIS



INPUT

Frame Geometry
Cantilevers (if any)
Stiffness Data for Spans and Columns
Loadings
Joint Moments

OUTPUT

End Moments (Beams & Column)
Inflection Points
Maximum Positive Moments
Shears (at specified points)

Multi-Story Frame Analysis. Determines critical moments on all members for a planar multi-story frame. The beam shears, the loads in the columns and the sway displacements are calculated for all levels. All members must be vertical or horizontal. The bottom of each column line may have a hinged or fixed support at the foundations. Prismatic or variable sections may be considered. Either or both ends of any member may be hinged. Beams may have uniformly distributed (full or partial length), and concentrated

GENERAL FRAME ANALYSIS

SAMPLE PROBLEM #1

JOINT COORDINATES

JOINT	X	Y
1	0	0
2	0	16
3	0	26
4	12	16
5	12	26
6	24	16
7	24	26
8	36	16
9	36	26
10	36	0

JOINT RESTRAINTS

1 FIXED
10 FIXED

OF EQUATIONS = 24

MEMBER IDENTIFICATION

MEMBER	JT.	JT.	TYPE	LENGTH	L(X)	L(Y)
1	3	5	H	12.00	12.00	+0.00
2	5	7	H	12.00	12.00	+0.00
3	7	9	H	12.00	12.00	+0.00
4	2	4	I	12.00	12.00	+0.00
5	4	6	J	12.00	12.00	+0.00
6	6	8	K	12.00	12.00	+0.00
7	3	4	E	15.62	12.00	-10.00
8	5	6	G	15.62	12.00	+10.00
9	4	5	F	10.00	0.00	+10.00
10	6	7	F	10.00	0.00	+10.00
11	2	3	B	10.00	0.00	+10.00
12	8	9	C	10.00	0.00	+10.00
13	1	2	A	16.00	0.00	+16.00
14	10	8	D	16.00	0.00	+16.00

MEMBER TYPE A

LENGTH = 16 L(X)= 0 L(Y)= 16
UNIFORM LOADS:

WL	Y1	Y2
.4	10	16

CONCENTRATED LOADS:

WL	Y
3	10

SECTION NO. 1 I = 273 A = 14.4

FIXED-END	MOMENTS		LOADS	
	LEFT	RIGHT	LEFT	RIGHT
WL	-5.51	11.14	1.22	4.19

MEMBER TYPE B

LENGTH = 10 L(X)= 0 L(Y)= 10
UNIFORM LOADS:

WL	Y1	Y2
.4	0	10

SECTION NO. 1 I = 273 A = 14.4

FIXED-END	MOMENTS		LOADS	
	LEFT	RIGHT	LEFT	RIGHT
WL	-3.33	3.33	2.00	2.00

DISPLACEMENTS

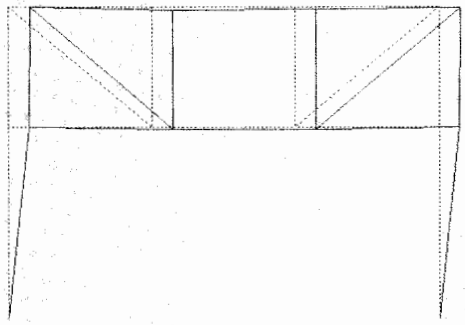
JOINT	X (-->)	Y (DOWN)	ROT.(CW)	LOAD COMBINATION 2
1	0.0000E+00	0.0000E+00	0.0000E+00	
2	4.3018E-02	5.3724E-04	1.4655E-03	
3	4.4052E-02	7.9302E-04	1.3077E-04	
4	4.2084E-02	5.4727E-03	1.0446E-04	
5	4.4542E-02	5.4798E-03	2.0358E-04	
6	4.3338E-02	5.0709E-03	-5.4788E-03	
7	4.4228E-02	5.1337E-03	-1.4485E-05	
8	4.3213E-02	8.6228E-04	1.5315E-03	
9	4.3959E-02	1.2065E-03	-6.0877E-04	
10	0.0000E+00	0.0000E+00	0.0000E+00	

MEMBER FORCES

MEMBER	LD.COMB.	JOINT	AXIAL	SHEAR	MOMENT
TYPE A					
13	1	1	-20.10	.08	-.33
		2	-20.10	.08	-.99
13	2	1	-14.26	6.35	-51.66
		2	-14.26	.95	-24.76
TYPE B					
11	1	2	-15.56	-.86	.99
		3	-15.56	-.86	7.65
11	2	2	-10.87	-2.13	24.76
		3	-10.87	-6.13	16.50
TYPE C					
12	1	8	-15.82	.86	-.99
		9	-15.82	.86	-7.81
12	2	8	-14.62	-2.60	24.95
		9	-14.62	-2.60	1.01
TYPE I					
4	1	2	.95	4.54	0.00
		4	.95	-5.86	3.11
		MAX.			12.89
4	2	2	3.88	3.40	0.00
		4	3.88	-9.30	2.42
		MAX.			9.62
TYPE J					
5	1	4	17.52	34.65	-128.18
		6	17.52	25.85	-238.86
5	2	4	11.78	27.75	-101.28
		6	11.78	20.55	-188.48
TYPE K					
6	1	6	.96	19.87	-180.81
		8	.96	10.27	0.00
6	2	6	-5.64	16.17	-150.79
		8	-5.64	8.97	0.00

REACTIONS

JOINT	X (<--)	Y (UP)	MOM. (+CCW)	LOAD COMBINATION 2
1	6.35	14.26	51.66	
10	3.65	18.14	23.84	

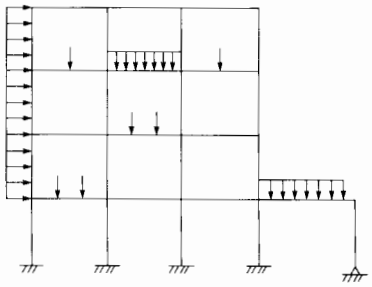


LOAD COMB. 2 MAX. DISPL.= 4.4852E-02

Figure 1. General Frame Analysis.

dead and/or live loads. Moments and vertical loads may be added to any of the joints in addition to those imposed by the beam loads. Lateral loads may be applied to any of the levels. Up to five load combinations can be created from the basic load cases. This program can evaluate up to 50 levels with 12 levels per bay.

MULTI-STORY FRAME ANALYSIS



INPUT

Frame Geometry
Member Properties
Loads (including gravity, wind, seismic)
Load Combinations
Support Conditions

OUTPUT

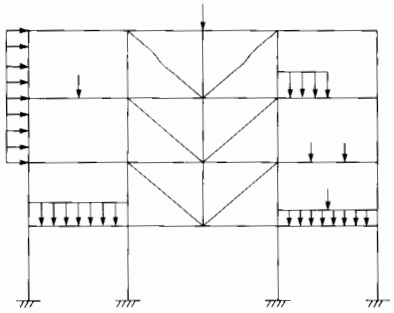
Undeformed Geometry and Lateral Deflections
End Moments
Maximum Positive Moments (Beams)
Shears (Beams)
Axial Loads (Columns)
Lateral Deflections

Data input routines take advantage of design symmetry. Graphical output displays the input geometry and level sway displacements on the CRT.

Output data can be accessed directly by the reinforced concrete beam and column, and steel column design programs.

General Frame Analysis. Determines critical moments, shears, axial loads, and the displacements at all joints for a planar frame of any configuration. Initial axial displacements are allowed to evaluate settlement, member shrinkage, or member temperature change. Members may be prismatic or variable section. Members may have uniformly distributed (full or partial length), and concentrated loads. (See Figure 1.) Frames with up to 340 joints and 640 members can be evaluated.

GENERAL FRAME ANALYSIS



INPUT

Frame Geometry
Member Properties
Support Conditions
Loads and Axial Displacements
Load Combinations

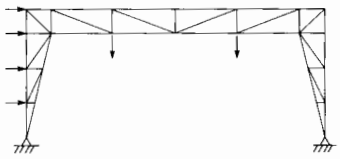
OUTPUT

Joint Displacements
Maximum Moments
Member Forces and Reactions
Deformed and Undeformed Geometry

Flexible input routines and graphical output of the initial geometry and the analysis results are included.

Truss Analysis. Analyzes statically determinate and indeterminate planar trusses of any configuration. The structure is assumed to consist of prismatic members which carry only axial forces connected at pinned joints with only concentrated loads applied at the joints. This program will analyze trusses with up to 400 joints and 800 members.

TRUSS ANALYSIS



INPUT

Joint Coordinates
Member Properties
Support Conditions

OUTPUT

Member Forces
Joint Displacements
Reactions
Deformed and Undeformed Geometry

CRT plots of input and deformed geometry are provided along with flexible data input and editing routines. Internal checks are provided for completeness of input data.

Space Frame Analysis. Determines member forces and moments for all members, reactions at all supports, and joint deformations at all joints for frames in 3-dimensional space. The program can also be used to analyze space trusses as well as planar frames, trusses and grids.

It is assumed that all members of the structure are prismatic and perfectly elastic. Members may have rotational and translational end releases in any direction on either end within certain stability restrictions.

Each solution may have from one to twelve load conditions, with loadings consisting of joint loads, support settlements and member loads namely concentrated, uniform, linear, or temperature change loadings. Self-weight of the members can also be considered.

Data defining the structure can be saved so that further load cases can be evaluated quickly and easily.

Included in this program is a graphics mode which displays perspective plots of the structure. The structure can then be rotated around any of the three axes so that portions of any frame can be easily seen.

INPUT

Joint Coordinates
Support Conditions and Releases
Member Data
Cross Sectional Area
Torsion Constant
Moments of Inertia
Elastic Moduli
Member Loads
Joint Loads

OUTPUT

Joint Displacements
Joint Rotations
Member Forces and Moments
Reactions at All Supports
Deformed and Undeformed Geometry

Dynamic Analysis. Determines natural frequencies of vibration, characteristic mode shapes, and modal participation factors for a multi-degree elastic system with up to 120 lumped masses (Frequency Analysis). A maximum of 120 degrees of freedom is permitted. The dynamic response of any portion of the system to a given acceleration spectrum may then be determined using the modal method of analysis (Modal Analysis).

INPUT

Accelerations (Gravity)
Masses (Lumped)
Number of Modes
Flexibility or Stiffness Matrix
Acceleration for Each Mode
Unit Load Value of Response

OUTPUT

Frequency Analysis for Each Mode and Circular Natural Frequency and Period
Modal Shape Values
Modal Participation Factor
General Forcing Factor
Response Component for Each Mode
Modal Responses (Vector and Absolute Sum)

Section Properties. Determines the properties of irregularly shaped sections—area elements, line elements and concrete and reinforced elements. Gross, uncracked transformed, and cracked section moments of inertia and the cracking moment for normal and lightweight concrete are calculated for reinforced concrete sections. Effective moments of inertia can also be obtained for an applied moment.

INPUT

Element Type (Line, Circular Arc or any General Shape)
Element Dimensions or Properties

OUTPUT

Area or Lengths
Moment of Inertia
Centroidal Location
Radius of Gyration
Section Modulus
Product of Inertia

DATA ECHO SPACE FRAME ANALYSIS PAGE # 1

SPACE FRAME EXAMPLE

JOINT CARTESIAN COORDINATES

UNITS = FEET

JOINT	-X-(FT)	-Y-(FT)	-Z-(FT)
1	0.0000	0.0000	0.0000
5	2.0000	2.0000	10.0000
9	4.0000	4.0000	20.0000
13	6.0000	6.0000	30.0000
2	20.0000	0.0000	0.0000
6	18.0000	2.0000	10.0000
10	16.0000	4.0000	20.0000
14	14.0000	6.0000	30.0000
3	20.0000	20.0000	0.0000
7	13.0000	18.0000	10.0000
11	16.0000	16.0000	20.0000
15	14.0000	14.0000	30.0000
4	0.0000	20.0000	0.0000
8	2.0000	18.0000	10.0000
12	4.0000	16.0000	20.0000
16	6.0000	14.0000	30.0000

JOINT SUPPORT DATA

SUPPORT RELEASES DO NOT OCCUR

NOTE: PX,PY---MZ RELEASE CODES >>---> 0=FIXED, 1=RELEASED

REF #	<----------RELEASES----------> PPPMMM XYZXYZ	ANGLES---UNITS=DEGREES ALPHA	BETA	GAMMA	<----------LISTING----------> OF JOINT SUPPORTS
1	000000	0	0	0	1-4

MEMBER DATA

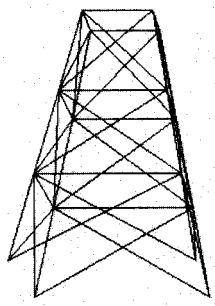
UNITS = FEET DEGREES
ALL MEMBER PROPERTIES ARE TYPE #1

MBR	NE#	PE#	TYPE	ALPHA	BETA	GAMMA	LENGTH	NE CODE	PE CODE
1	1	5	1	45.000	-74.207	0.000	10.392	000000	000000
17	5	9	1	45.000	-74.207	0.000	10.392	000000	000000
33	9	13	1	45.000	-74.207	0.000	10.392	000000	000000
2	2	6	1	135.000	-74.207	0.000	10.392	000000	000000
18	6	10	1	135.000	-74.207	0.000	10.392	000000	000000
34	10	14	1	135.000	-74.207	0.000	10.392	000000	000000
3	3	7	1	225.000	-74.207	0.000	10.392	000000	000000
19	7	11	1	225.000	-74.207	0.000	10.392	000000	000000
35	11	15	1	225.000	-74.207	0.000	10.392	000000	000000
4	4	8	1	315.000	-74.207	0.000	10.392	000000	000000
20	8	12	1	315.000	-74.207	0.000	10.392	000000	000000
36	12	16	1	315.000	-74.207	0.000	10.392	000000	000000
5	1	6	1	6.340	-28.906	0.000	20.688	000000	000000
21	5	10	1	8.130	-35.264	0.000	17.321	000000	000000

MEMBER DATA

UNITS = FEET DEGREES
ALL MEMBER PROPERTIES ARE TYPE #1

MBR	NE#	PE#	TYPE	ALPHA	BETA	GAMMA	LENGTH	NE CODE	PE CODE
37	9	14	1	11.310	-44.438	0.000	14.283	000000	000000
6	2	5	1	173.660	-28.906	0.000	20.688	000000	000000
22	6	9	1	171.870	-35.264	0.000	17.321	000000	000000
38	10	13	1	168.690	-44.438	0.000	14.283	000000	000000
7	2	7	1	96.340	-28.906	0.000	20.688	000000	000000
23	6	11	1	98.130	-35.264	0.000	17.321	000000	000000
39	10	15	1	101.310	-44.438	0.000	14.283	000000	000000
8	3	6	1	263.660	-28.906	0.000	20.688	000000	000000
24	7	10	1	261.870	-35.264	0.000	17.321	000000	000000
40	11	14	1	258.690	-44.438	0.000	14.283	000000	000000
9	3	8	1	186.340	-28.906	0.000	20.688	000000	000000
25	7	12	1	188.130	-35.264	0.000	17.321	000000	000000
41	11	16	1	191.310	-44.438	0.000	14.283	000000	000000
10	4	7	1	353.660	-28.906	0.000	20.688	000000	000000
26	8	11	1	351.870	-35.264	0.000	17.321	000000	000000
42	12	15	1	348.690	-44.438	0.000	14.283	000000	000000
11	4	5	1	276.340	-28.906	0.000	20.688	000000	000000
27	8	9	1	278.130	-35.264	0.000	17.321	000000	000000
43	12	13	1	281.310	-44.438	0.000	14.283	000000	000000
12	1	8	1	83.660	-28.906	0.000	20.688	000000	000000
28	5	12	1	81.870	-35.264	0.000	17.321	000000	000000
44	9	16	1	78.690	-44.438	0.000	14.283	000000	000000
13	5	6	1	0.000	0.000	0.000	16.000	000000	000000
29	9	10	1	0.000	0.000	0.000	12.000	000000	000000
45	13	14	1	0.000	0.000	0.000	8.000	000000	000000
14	6	7	1	90.000	0.000	0.000	16.000	000000	000000
30	10	11	1	90.000	0.000	0.000	12.000	000000	000000
46	14	15	1	90.000	0.000	0.000	8.000	000000	000000
15	7	8	1	180.000	0.000	0.000	16.000	000000	000000
31	11	12	1	180.000	0.000	0.000	12.000	000000	000000
47	15	16	1	180.000	0.000	0.000	8.000	000000	000000
16	8	5	1	270.000	0.000	0.000	16.000	000000	000000
32	12	9	1	270.000	0.000	0.000	12.000	000000	000000
48	16	13	1	270.000	0.000	0.000	8.000	000000	000000



KEY CONT

SPACE FRAME EXAMPLE

MEMBER PROPERTY CATALOG

CONSTANTS: E = 29500 G = 12000
UNITS FEET KIPS

MEMB TYPE	AX (FT^2)	IX (FT^4)	IY (FT^4)	IZ (FT^4)	DESCRIPTION
1	.01	.001	.01	.01	TYPE 1

LOADINGS

LOAD UNITS FEET KIPS
TEMPERATURE UNITS = DEGREES FAHRENHEIT

LOAD CONDITION #1

JT&MBR LOAD SETTLEMENTS	DIM	PX DX	PY DY	PZ DZ	MX ΘX	MY ΘY	MZ ΘZ
JOINT LIST 5-16							
JOINT LOADS CON		2.000	2.000	-10.000	0.000	0.000	0.000

OUTPUT UNIT SPECIFICATIONS

MEMBER FORCES & MOMENTS = FEET KIPS
REACTIONS = FEET KIPS
DEFORMATIONS = INCHES DEGREES

SPACE FRAME EXAMPLE

DEFORMATIONS UNITS: INCHES DEGREES

JOINT	LC	DX	DY	DZ	ΘX	ΘY	ΘZ
1	1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
2	1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
3	1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
4	1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
5	1	4.6614E+00	4.6614E+00	-5.1191E+00	-3.1512E+00	3.1512E+00	-2.9694E-07
6	1	6.3237E+00	3.4807E+00	-1.0695E+01	-3.3254E+00	2.1372E+00	-7.1547E-01
7	1	7.5043E+00	7.5043E+00	-1.6272E+01	-1.9630E+00	1.9630E+00	2.1556E-07
8	1	3.4807E+00	6.3237E+00	-1.0695E+01	-2.1372E+00	3.3254E+00	7.1547E-01
9	1	1.2680E+01	1.2680E+01	-1.8926E+01	-3.7070E+00	3.7070E+00	-1.8356E-07
10	1	1.3419E+01	1.2195E+01	-1.7976E+01	-3.7019E+00	2.9201E+00	-4.8927E-01
11	1	1.3904E+01	1.3904E+01	-2.5026E+01	-2.0451E+00	2.8451E+00	7.3453E-08
12	1	1.2195E+01	1.3419E+01	-1.7976E+01	-2.9201E+00	3.7819E+00	4.8927E-01
13	1	2.0939E+01	2.0939E+01	-1.5696E+01	-3.4437E+00	3.4437E+00	9.5627E-08
14	1	2.0944E+01	2.0834E+01	-2.0932E+01	-3.3716E+00	3.3800E+00	-7.5299E-02
15	1	2.1049E+01	2.1049E+01	-2.6169E+01	-3.4522E+00	3.4522E+00	-1.9553E-07
16	1	2.0834E+01	2.0944E+01	-2.0932E+01	-3.3800E+00	3.3716E+00	7.5299E-02

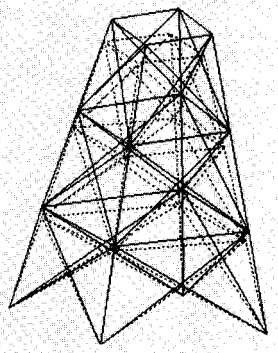
Joint numbers denoted with a '*' deform in the local system

MEMBER FORCES AND MOMENTS UNITS: FEET KIPS

MEMBER	LC	END	PX	PY	PZ	MX	MY	MZ
1	1	1	7.408	0.000	0.759	0.000	-6.150	0.000
		5	-7.408	-.000	-.759	-.000	-1.735	0.000
2	1	2	25.640	0.703	0.016	-.007	-.501	5.593
		6	-25.640	-.703	-.016	0.007	0.331	1.717
3	1	3	43.871	-.000	-.726	-.000	5.148	-.000
		7	-43.071	0.000	0.726	0.000	2.397	-.000
4	1	4	25.640	-.703	0.016	0.007	-.501	-5.593
		8	-25.640	0.703	-.016	-.007	0.931	-1.717
47	1	15	-.659	-.024	0.277	0.002	-1.159	-.144
		16	0.659	0.024	-.277	-.002	-1.055	-.047
48	1	16	-.017	-.024	0.277	0.002	-1.066	-.047
		13	0.017	0.024	-.277	-.002	-1.148	-.144

REACTIONS AT SUPPORTS UNITS: FEET KIPS

JOINT	LC	PX	PY	PZ	MX	MY	MZ
1	1	-.013	-.013	6.986	8.018	-8.018	0.000
2	1	-11.987	6.949	30.000	10.131	-1.844	4.355
3	1	-18.949	-18.949	53.014	-.269	0.269	0.000
4	1	6.949	-11.987	30.000	1.844	-10.131	-4.355



LOAD Comb 1 -- MAX. DISPL.= 3.9834E+01 Key CONT

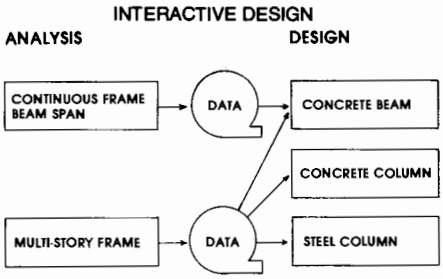
SPACE FRAME EXAMPLE

Figure 2. Space Frame Analysis

Let HP's Design Software Help With the Toughest Part of Your Job

System 45B's structural engineering software was developed to work the same way you do. By combining the analysis and design functions, you create the most reliable and economical design possible. And that's exactly how these programs are designed to work.

To facilitate this interactive design process, data files are compatible on several of the programs so the results of your structural analysis can be directly accessed by the design programs. The following chart shows where the analysis and design programs link together.



Hewlett-Packard's design series programs also feature:

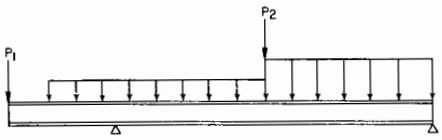
- —Flexibility to select economical and readily available materials for designs.
- —An extensive library of standard sections—eliminates tedious handbook look-up.
- —Comprehensive, stand-alone, Prestressed Concrete Beam and Flat Slab Analysis and Design programs.

These design programs do not lock you into a specific solution, but allow you to communicate with the System 45B; you make the choices to get the best designs of concrete and steel structures. These programs help you select the best design members which meet the latest AISC and ACI codes and specifications—as well as check the alternatives.

Design Series Program Descriptions

Steel Beam Design. Used to design or check steel W, S, and channel sections subjected to transverse loads and end moments. The program selects the lightest sections for any specified section depth. A check routine allows the designer an opportunity to check a lighter section than specified by the programs and the amount of overstress is determined. The ratio of the actual working load maximum shear stress to the AISC allowable shear stress is also calculated. Solutions do not cover biaxial bending problems, nor do the internally calculated moments and shears include the section weight.

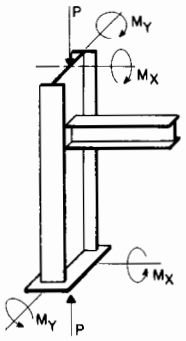
STEEL BEAM DESIGN



INPUT
Loads
End Moments
Material Properties
Bracing Points
Section Type
Nominal Depth

OUTPUT
Lightest Section
Moment Capacity and Shear Stress Ratio
End Reactions
Maximum Moments
Centerline and Cantilever Deflections

Steel Column Design. Used to design or check W steel sections subjected to axial loads with or without bending moments applied about the X and Y axes of the column. The moments can be applied to either or both ends of the column. The program selects the lightest sections for any specified depth section. "Pin-ended column" base plates can also be designed. Base plate dimensions can be established for special "built-up" column shapes.



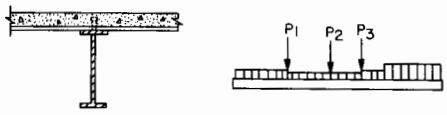
STEEL COLUMN DESIGN

INPUT
Material Properties
Bracing Conditions
Moments
Axial Loads
Nominal Depth

OUTPUT
Lightest Section
Equation Results (AISC)
Base Details (if requested)

Composite Steel Beam. Used to design or check simple span beams of composite steel and concrete construction. A non-composite steel beam may also be designed provided the beam is assumed to have continuous lateral support. Loads may include concentrated as well as uniform (partial or full-length) loads. No provision is made for continuity or end moments.

COMPOSITE STEEL BEAM



```
                    REINFORCED CONCRETE BEAM DESIGN

MATERIAL PROPERTIES--- F'c = 3.5 KSI
                       Fy = 60 KSI

     DESIGN BY THE STRENGTH (ULTIMATE STRENGTH) METHOD

     INPUT LOADS ARE NOT FACTORED TO ULTIMATE LEVEL


                  SPAN LENGTH = 20 Ft

LOADS: (KIP AND Ft UNITS)
          UNIFORM
                        DL        LL        X1        X2
                        1         1         0         7
                        1.8       1         7         20
          CONCENTRATED
                        DL        LL        X
                        10        12        7

     END MOMENTS ( - = TOP TENSION)
                              LEFT       RIGHT
     DEAD LOAD ONLY           -30        -90
     DL + LIVE LOAD           -65        -200
     DL(ADJ)+ %LL             -70        -170
     DL+%LL(ADJ)              -40        -120
     DL + %LL(LEFT)           -75        -190
     DL+ %LL(RIGHT)           -50        -220


BOTTOM REINFORCEMENT DESIGN

DESIGN MOMENT=  167.4 Ft-Kips

       As=  2.92 SQ.IN.      REINF. % =  .540

            SECTION (In.)

     DEPTHS---
       EFFECTIVE=  13.5      TOTAL= 16     FLANGE=  5

     WIDTHS---
       AT COMP. FACE=  40      AT TENSILE FACE=  12


               --LEFT--                          --RIGHT--
     SIZE MIN % BARS    LOCATION WHERE    MIN % BARS    LOCATION WHERE
          INTO SUPPORT    REST ARE CUT    INTO SUPPORT    REST ARE CUT
     # 7       25           1.8              25           4.7
     # 8       36           1.8              32           4.7
     # 9       52           1.8              47           4.7
     #10       70           1.8              63           4.7
     #11       90           1.8              80           4.7

     INFLECTION POINTS AT 1.8 AND 4.7

       NO. OF BARS >  1.3 FOR INT.,> 2.3 FOR EXT. EXPOSURE

TOP REINFORCEMENT DESIGN

     LEFT  END

        AT 4 INCHES, DESIGN MOMENT= -102.2 Ft-Kips

        As=  1.91 SQ.IN.      REINF. % = 1.179

            SECTION (In.)

     DEPTHS---
       EFFECTIVE=  13.5      TOTAL= 16     RECESS=  11

     WIDTHS---
       AT COMP. FACE=  12      AT TENSILE FACE=  40

     BAR CUTOFF LOCATIONS FROM CENTER OF SUPPORT (Ft.)
       2/3 MAY BE CUT AT---
           3.0  FOR # 6 OR SMALLER BARS
           3.2  FOR # 7
           4.1  FOR # 8
           5.1  FOR # 9
           6.3  FOR # 10
           7.7  FOR # 11
       1/3 MUST BE EXTENDED TO---
           4.2  FOR # 6 OR SMALLER BARS
           4.6  FOR # 7
           5.5  FOR # 8
           6.5  FOR # 9
           7.8  FOR # 10
           9.1  FOR # 11
     INFLECTION POINT AT 2.9 Ft.
       NO. OF BARS > 2.6 FOR INT.,> 4.6 FOR EXT. EXPOSURE


     RIGHT  END

        AT 6 INCHES,
        AT 6 INCHES, DESIGN MOMENT= -314.3 Ft-Kips

        As=  3.62 SQ.IN.      REINF. % = 1.480

            SECTION (In.)

     DEPTHS---
       EFFECTIVE=  21.5      TOTAL= 24     RECESS=  19

     WIDTHS---
       AT COMP. FACE=  12      AT TENSILE FACE=  40

     BAR CUTOFF LOCATIONS FROM CENTER OF SUPPORT (Ft.)
       2/3 MAY BE CUT AT---
           6.8  FOR # 10 OR SMALLER BARS
           7.9  FOR # 11
       1/3 MUST BE EXTENDED TO---
           8.6  FOR # 9 OR SMALLER BARS
           9.7  FOR # 10
           11.1 FOR # 11
     INFLECTION POINT AT 6.7 Ft.
       NO. OF BARS > 2.6 FOR INT.,> 4.6 FOR EXT. EXPOSURE


STIRRUPS

     MIDSPAN CROSS-SECTION ENDS AT 14 Ft.

     SUPPORT SIDE:

     CRIT. SHEAR = 45.45 KIPS AT 1.62 Ft. FROM CENTER OF SUPPORT

        B(W) = 12 In.    D = 13.5 In. v = 330.1 PSI

     SINGLE LOOP STIRRUPS
     16  -# 3 : 1 AT 2 , 7 AT 5 , 8 AT 6.5

     SUPPORT SIDE:

     CRIT. SHEAR = 41.09 KIPS AT 6 Ft. FROM CENTER OF SUPPORT

        B(W) = 12 In.    D = 13.5 In. v = 298.4 PSI

     SINGLE LOOP STIRRUPS
      24  -# 3 : 1 AT 3 , 23 AT 6
```

Figure 3. Reinforced Concrete Beam Design.

INPUT

Concrete Strength, Modular Ratio
Total and Deck Thicknesses
Beam Spacing
Shored or Unshored Conditions
Material Properties
Span Length
Loadings
Nominal Depth
Shear Connector Capacity

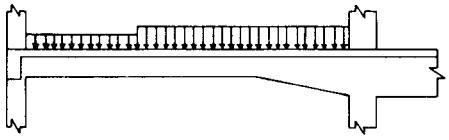
OUTPUT

Reactions
Maximum Moment and Location
Selected Section
Stresses (Bending and Web Shear)
Midspan Deflection
Shear Connector Details

Each of the steel design programs include data files for W6 through W36 sections listed in the AISC Steel Construction Manual. Any steel strength can be considered. All designs and checks are made in accordance with the latest AISC Specifications.

Reinforced Concrete Beam. Designs reinforced concrete beams by either the strength (ultimate strength) or alternate (working stress) method of ACI 317-77 for vertical loads. Flexural reinforcement requirements are given for rectangular, tee, or ledger beam sections. Cutoff locations are given for the various bar sizes that the designer may choose to use. The end sections and midspan sections may be of different size. (See Figure 2.)

REINFORCED CONCRETE BEAM



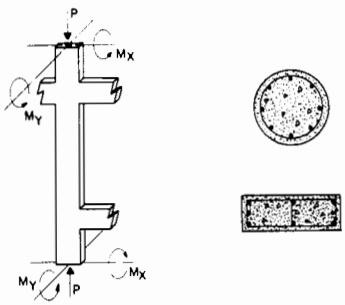
INPUT

Material Properties
Design Method
Dimensions (Cross-Section)
Stirrup Size and Spacing
Span Loading
Critical Shear and Moment Location

OUTPUT
Reinforcement Details
Bar Cutoff Data
Stirrup Design
Design Moments
Inflection Points
Critical Shear Force Details

Reinforced Concrete Column. For design or capacity-checking of reinforced concrete columns in accordance with ACI 318-77 with bending in either or both directions. Slenderness effects are evaluated according to the approximate ("moment magnification") method in accordance with ACI 318-77, of Section 10.11 of the ACI code, with slenderness ratio limited to 100 or less. Cross-sections include rectangular (tied), round (spiral or tied) and square with circular bar arrangement (spiral or tied). No provision has been made for lateral loads applied between ends.

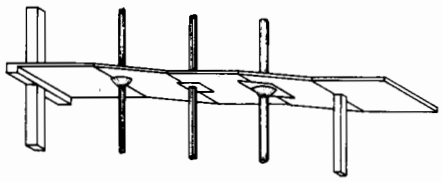
REINFORCED CONCRETE COLUMN



INPUT
Material Properties
Design Method
Loads (Axial, Moment)
Length (Unsupported)
Section (Shape and Dimensions)
Slenderness Effects
OUTPUT
Reinforcement Details
Ultimate Load and Moment
Moment Magnification Factors
Spiral Size and Pitch
Eccentricities

Flat Slab Analysis and Design. For the analysis and design of flat slab or waffle slab floors in accordance with ACI 318-77 "Building Code Requirements for Reinforced Concrete" of Section 13.7 of the ACI code. Flat slabs may have drop panels at columns. Columns may have capitals. Either the ultimate-strength method or the alternate (working stress) method may be chosen. Analysis and design are for a one-bay-wide strip using the equivalent frame analysis method. The strip may have up to 20 spans and may have cantilevers at the ends. No beams parallel to the direction of moments are permitted.

FLAT SLAB ANALYSIS AND DESIGN

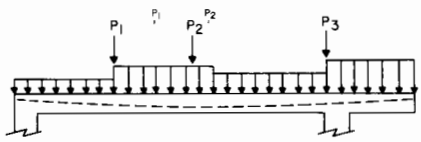


INPUT
Design Method
Spans and Bay Widths
Material Properties
Loads
Slab Thickness
Dimensions (Column, Spandrel Beam, Drop Panels)
OUTPUT
Joint Moments and Shears
Shear Stresses
Reinforcement Details
Material Quantities
Design Forces (Reactions and Moments)

Prestressed Concrete Beam Analysis and Design. For the design and analysis of pre-tensioned, simply-supported flexural concrete beams with or without cantilevers at either or both ends in accordance with ACI 318-77. The section is assumed to be constant along the length and may be non-composite or composite (unshored). Up to two depression ("harp") points are permitted. Strands may be shielded (sleeved or "slipped") for a portion of their length. Loss of prestress for the given stranding is calculated unless losses are input.

If allowable fiber stresses are exceeded at release, the required auxiliary mild steel reinforcement is calculated or the release strength revised. Loads may include uniformly-distributed (partial or full) and concentrated superimposed dead or live loads. If no live load is input, the maximum allowable (working) uniform live load as limited by fiber stresses and ultimate moment is determined by the program. If live loads are considered, an estimate of the required prestressing strands is displayed based on the approximate location of the strand centroid. Based on the given prestress, flexural stresses, ultimate moment capacity, shear, and deflections are checked. Shear is checked for the main span only. If desired, required area of web reinforcement and composite ties are calculated. Deflections are found for various conditions, including release, full dead load (short and long time), and live load increment (short and long time).

PRESTRESSED CONCRETE BEAM



INPUT
Material Properties
Section Properties
Span and Loading
Prestressing Details
Reinforcement (if any)
OUTPUT
Reactions and Moments
Stresses
Loss of Prestress
Reinforcing Details
Deflections
Ultimate Moments (Critical Section)

Footing Design (Biaxial Bending). Designs or checks an isolated column footing for proper dimension, steel requirements and quantities. Factors are included for wind or earthquake load conditions. Also included is a check (and design of horizontal keys, if necessary) of the horizontal forces acting to resist sliding. Horizontal slabs for retaining walls may be designed by using appropriate loads and dimensions.

INPUT
Loads (Column, Horizontal, Moments)
Column Dimension
Material Properties
Allowable Soil Pressures
Initial Footing Dimensions
Surcharge Loads (if any)
Column Offsets (if any)
OUTPUT
Footing Dimensions
Shear Stresses
Reinforcing Details
Material Quantities
Design Moments
Horizontal Key Details (if necessary)

System 45B Helps With Administrative Tasks Too

System 45B not only helps you through your technical problems, but it also handles your most important administrative job—keeping track of project costs.

The job cost program allows you flexibility in keeping up-to-date with the fixed and variable expenses associated with the variety of jobs which you are continually trying to manage.

Job Cost Accounting. Provides both periodic and job summary reports for all labor, direct expenses, adjustments and billings applied to each job. The program is job-numbered based. Jobs can be segmented into phases and time and costs can be applied against specific segments. Billable time is calculated for each job as time is accumulated. Time can be billed as a flat rate per hour, by employee or by an hourly rate times a pre-set billing factor. Up to 85 employees can be accommodated.

More Time Savers

If you want to put your System 45B to use in other administrative areas of your business, Hewlett-Packard has developed a comprehensive selection of easy-to-use programs for business and financial management. Text Management, Payroll, Project Management, and Statistics are just a few more of the many programs available from HP. With this software and the System 45B desktop computer, you can free yourself from the tedious, time-consuming tasks and return to the more challenging, creative aspects of your job.

PROJECT 79011
05/01/79
PERIODIC SUMMARY

PROJECT NAME: BROWN DEER BANK

CLIENT: BANKING DEVELOPMENT
52

FEE: $10000

PROJECT MGR: FUNK G.
STARTING DATE: 03/01/79 REQD. COMPLETION DATE: 07/15/79

OVERHEAD FACTORS: REG. TIME = 1.1
OVERTIME = 1.3
BILLING FACTORS: REG. TIME = 2.75
OVERTIME = 3

PAYROLL DATA	HOURS		PAYROLL	
	REG. TIME	OVERTIME	REG. TIME	OVERTIME
ENGINEER				
BAKER, B.	5.5	0.0	$ 57.75	$ 0.00
DRAFTING				
MILLER C.	10.5	0.0	$ 68.25	$ 0.00
BALMA M.	14.5	2.0	$ 126.88	$ 26.25
TOTAL	30.5	2.0	$ 252.88	$ 26.25

*DIRECT COST DATA *	ITEM	COST	MARKUP
	PRINTING	$ 12.50	$ 0.00
	TOTAL	$ 12.50	$ 0.00

TOTAL PAYROLL COST = $ 279.13
OVERHEAD ON PAYROLL = $ 312.29
TOTAL DIRECT COSTS = $ 12.50
TOTAL COSTS = $ 603.91

TOTAL BILLABLE= $ 786.67

PROJECT 79011
05/01/79
JOB SUMMARY

PROJECT NAME: BROWN DEER BANK

CLIENT: BANKING DEVELOPMENT
52

FEE: $10000

PROJECT MGR: FUNK G.
STARTING DATE: 03/01/79 REQD. COMPLETION DATE: 07/15/79
INVOICED TO DATE: $4,000.00 DATE OF LAST INVOICE: 05/1/79
RECEIVED TO DATE: $ 0.00
NET AMOUNT DUE: $ 4,000.00

OVERHEAD FACTORS: REG. TIME = 1.1
OVERTIME = 1.3
BILLING FACTORS: REG. TIME = 2.75
OVERTIME = 3

PAYROLL DATA	HOURS		PAYROLL	
	REG. TIME	OVERTIME	REG. TIME	OVERTIME
PRINCIPAL				
FUNK G.	22.5	0.0	$ 281.25	$ 0.00
ENGINEER				
BAKER, B.	44.0	3.0	$ 462.00	$ 47.25
DRAFTING				
BALMA M.	72.5	6.5	$ 634.38	$ 85.31
ERICS	12.0	0.0	$ 120.00	$ 0.00
MILLER C.	10.5	0.0	$ 68.25	$ 0.00
TOTAL	161.5	9.5	$ 1,565.88	$ 132.56

*DIRECT COST DATA *	ITEM	COST	MARKUP
	PRINTING	$ 131.02	$ 0.00
	COMPUTER	$ 150.00	$ 0.00
	CONSULTANT	$ 550.00	$ 50.00
	TOTAL	$ 831.02	$ 50.00

TOTAL PAYROLL COST = $ 1,698.44
OVERHEAD ON PAYROLL = $ 1,894.79
TOTAL DIRECT COSTS = $ 831.02
TOTAL COSTS = $ 4,424.25

TOTAL BILLABLE= $ 5,584.87

Figure 4. Both periodic and job summary reports are provided.

Benefit From The User's Club

Another way many owners get even more value from their equipment is through our free-membership BASIC User's Club. The BASIC User's Club is a service provided by Hewlett-Packard for people who own HP desktop computers and want to share programming ideas. You'll discover creative solutions to many problems while using your desktop computer. At the same time, many other users are working on their problems using similar machines. So why not exchange programs?

The club maintains a library of user-contributed BASIC language programs covering a wide range of applications. You can submit as many programs as you like, and for each program you contribute, you can choose three others from the library. The club catalog, which you receive free when you join, lists all available software. You can also get additional programs through the information exchange service and exchange ideas at area meetings.

Hardware Configuration

To use HP's Structural Software, you'll need the Hewlett-Packard 9845B Desktop Computer with the Thermal Line Printer (Opt. 560). Several programs require additional options (graphics, memory, second tape drive) as specified under ordering information.

A 9885M Flexible Disk is required for use with the Space Frame Analysis program.

Ordering Information

Order the appropriate part number to receive any or all of Hewlett-Packard's Structural Engineering programs. Each package includes:

- Program cartridge
- User's instruction manual

Package	Graphics (Opt. 700, 311)	Memory (Opt. 204)	Second Tape Drive Opt. 600)	Part Number
Analysis Series				
Continuous Frame Analysis			*	09845-12750
Beam Span Analysis				09845-12760
Multi-Story Frame Analysis	*	*	*	09845-12770
General Frame Analysis	*	*	*	09845-12780
Truss Analysis	*	*	*	09845-12790
Space Frame Analysis	*	*	*	09845-12800
Dynamic Load Analysis		*		09845-12880
Section Properties				09845-12900
Design Series*				
Steel Beam Design				09845-12840
Steel Column Design				09845-12850
Composite Steel Beam Design				09845-12860
Reinforced Concrete Beam Design		*		09845-12810
Reinforced Concrete Column Design				09845-12820
Flat Slab Analysis and Design		*		09845-12830
Prestressed Concrete Beam Analysis and Design		*		09845-12870
Footing Design		*		09845-12890
Job Cost Accounting		*	*	09845-12910

*For U.S. codes only

Recommended Options

Other options are also available to increase the power and flexibility of your System 45T:

- Any system compatible printer; e.g., 9871 Character Impact Printer, 2631 Dot Matrix Impact Printer, 2631G Graphics Printer, 7245 Printer/Plotter
- Any system compatible mass storage device; e.g., 9885 Flexible Disk Drive, 7906 Disc Drive (20M byte)
- Additional Read/Write memory, 318 026 bytes (Opt. 205), 448 906 bytes (Opt. 206)

HEWLETT hp PACKARD

3404 E. Harmony Road, Fort Collins, Colorado 80525

For assistance call: Washington (301) 948-6370, Chicago (312) 255-9800, Atlanta (404) 955-1500, Los Angeles (213) 877-1282. Ask for an HP Desktop Computer representative.

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