Report 4601

AN UPDATED GUIDE TO THE USE OF GENERAL BENDING RESPONSE PROGRAM (GBRP)

NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER

Bethesda, Maryland 20034

AN UPDATED GUIDE TO THE USE OF GENERAL BENDING RESPONSE PROGRAM (GBRP)

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and

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COMPUTATION AND MATHEMATICS DEPARTMENT
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Naval Ship Research and Development Center

Bethesda, Md. 20034

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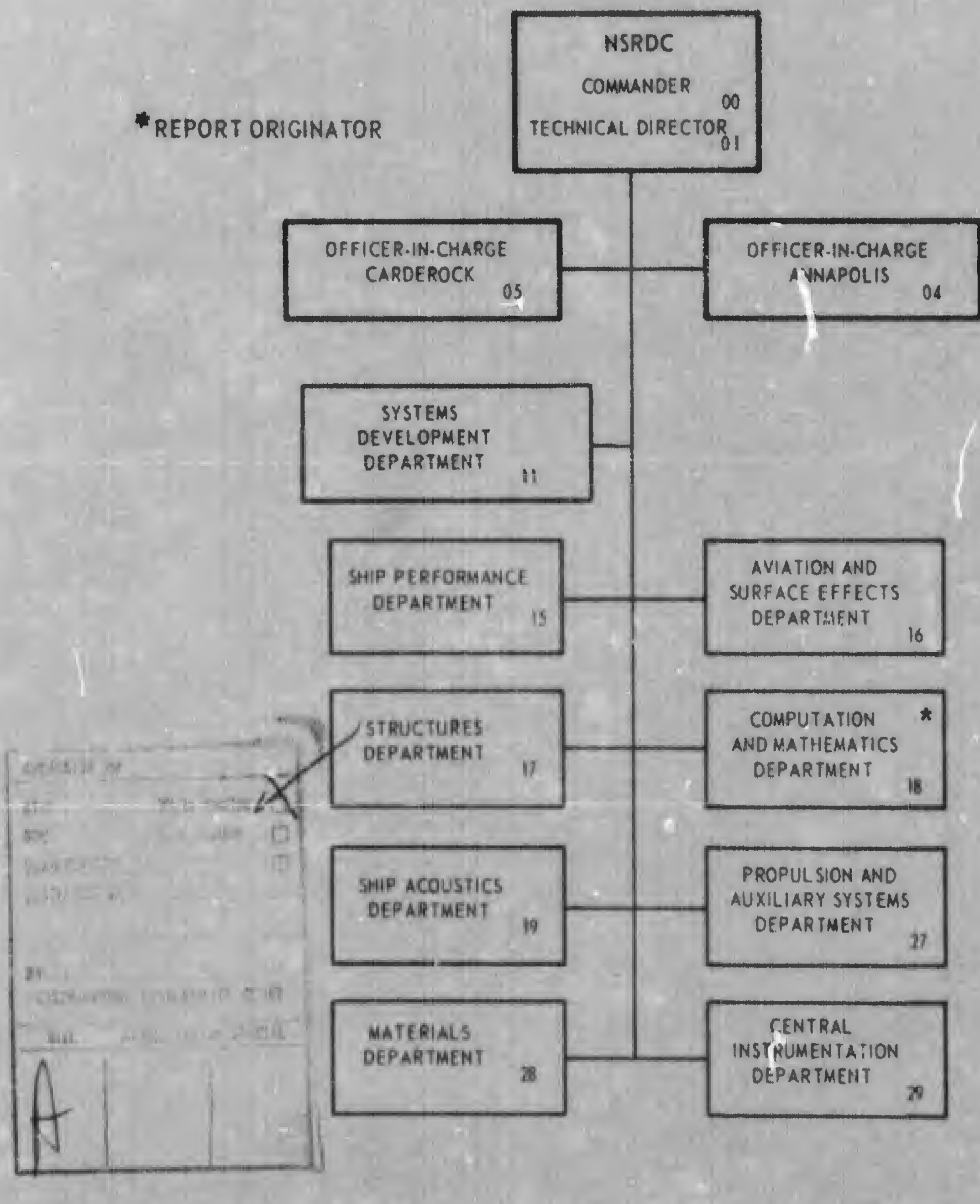

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A new version of General Bending Response Program, a computer program for ship vibration analysis, has been established on the Center's CDC computing system. This version differs from former versions primarily by permitting users to dynamically adjust computer core to fit the needs of any particular application.

The report documents the use of the program to: (1) calculate the vibratory forces in a propeller shaft; (2) check the → (over)

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accuracy of normal mode shapes computed with the program's natural frequency option; and (3) obtain SC-4020 plots of computed results. Sample problems demonstrate each of these applications.

1473 B

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I. INTRODUCTION

This report is primarily an update to the original documentation of General Bending Response Program (GBRP).[1] GBRP consists of the union of three programs: General Bending Response Code 1 (for lateral, longitudinal, and torsional vibrations), General Bending Response Code 2 (for vibration involving bending coupled with torsion), and General Bending Response Code 3 (for whirling vibrations of propeller shafts). The latter two codes resulted from an extended application of the mathematical method used in the first code. A complete description of the mathematical method, data input cards, data forms, options for selecting various capabilities, and sample calculations was given in the documentation for the individual codes.[2,3,4] Teng[1] summarized the data input information for a unified version (GBRP) of the capabilities of the three codes and illustrated with sample calculations how program options could be used to initiate GBRC1, GBRC2, and GBRC3 runs either individually or in combination for multi-application jobs.

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[1] Teng, E.C., "General Bending Response Program: GBRP," Naval Ship Research and Development Center Technical Note AML-35-67 (Jul 1967).

[2] Cuthill, E.H. and F.M. Henderson, "Description and Usage of General Bending Response Code 1 (GBRC1)," David Taylor Model Basin Report 1925 (Jul 1965).

[3] Henderson, F., "Description and Usage of General Bending Response Code 2 (GBRC2)," Naval Ship Research and Development Center Technical Note AML-59-66 (Aug 1966).

[4] Henderson, F., "Description and Usage of General Bending Response Code 3 (GBRC3)," Naval Ship Research and Development Center Technical Note AML-4-68 (Feb 1968).

Significant changes have been made to the original GBRP since it was first reported. These changes include 1) incorporation of a capability for general forced vibration response,[5] 2) addition of subroutines to check accuracy of computed results and to calculate vibratory forces, 3) modification of the original plotting subroutines,[2,3] and 4) introduction of a technique for dynamic allocation of computer core for storage of arrays. In order to incorporate the general forced vibration response, GBRP was completely restructured[5] into a series of program overlay segments, first, through use of the NASTRAN Linkage Editor,[6] and later through the facility of CDC program segmentation.[7]

The next section of this report describes the procedures for executing runs using the latest version of GBRP. Successive sections present update procedures relating to program options, capabilities, and data.

Descriptions for the complete set (including updates) of GBRP data cards are given in the Appendix. Also included in the appendix is the complete set of data input forms revised to include the additional cards and data discussed in this report.

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5 Henderson, F., "Forced Vibration Calculation Using General Bending Response Program (GBRP) and the Fast Fourier Transform," Naval Ship Research and Development Center Report 4481 (Aug 1974).

6 Martin, R.J., "A General Purpose Overlay Loader for CDC-6000 Series Computers; Modification of the NASTRAN Linkage Editor," Naval Ship Research and Development Center Report 4062 (Apr 1973).

7 "Control Data Cyber 70 Series Computer Systems, 6000 Series Computer Systems, 7600 Computer System Loader Reference Manual," Publication Number 60344200, Revision F, pp. 5-1 through 5-41, Control Data Corporation (Oct 1974).

II. USE OF GBRP WITH DYNAMIC CORE ALLOCATION

Two major modifications have been made to GBRP to reduce the machine core requirements which the program needs to execute. One of these involved the creation of a system of overlays for the program subroutines. The other involved the use of open core to optimize storage required for arrays in any particular application run.

The basic philosophy of GBRP's overlay structure as implemented with the NASTRAN linkage editor[5] has since been reworked through CDC program segmentation with the same philosophy. The subroutines of GBRP are divided into two program segments designated SEG1 and SEG2. SEG1 contains all the original subroutines of GBRP prior to the interfacing with fast Fourier transform. SEG2 contains the subroutines added for the general periodic vibration capability. Within these primary overlays is a secondary overlay structure of the constituent subroutines. Figure 1 shows how core is shared by the program segments.

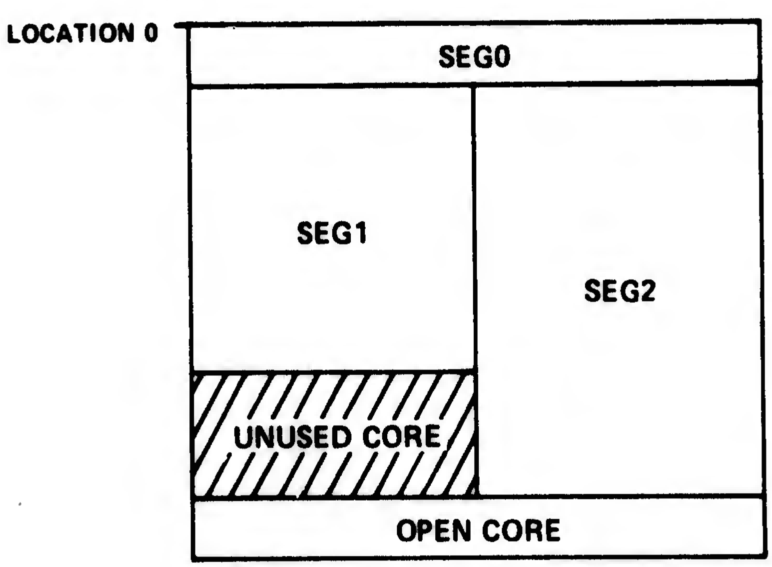


Figure 1. Core Configuration for GBRP

The rectangles SEG1 and SEG2 represent the core space necessary to accommodate the largest of the secondary overlays in SEG1 and SEG2. The rectangle SEG0 represents core space occupied by a control program that determines the sequence by which SEG1 and SEG2 access shared core during a run.

The rectangle OPEN CORE in Figure 1 represents the core space between the end of SEG2 and the end of core as determined by user request (CM parameter on the job card).

The introduction of overlay and open-core into the structuring of GBRP required new data for the control program, including information on whether a steady-state or general periodic vibration application is being run. The first card of GBRP data decks is therefore the "RUN SELECTION CARD" containing in column 1 the value of a new data option; NOPT=1 for steady-state or NOPT=2 for general periodic (nonharmonic) vibrations.

The next items of new data are the dimensions of the GBRP arrays (for computational and storage purposes) which occupy the bulk of open core. These dimensions are uniquely determined as functions of the type of vibration application involved (i.e. GBRC1, GBRC2, GBRC3), the amount of detail in the mathematical model of the ship structure, and the program options selected for editing computed results.

These dimensions are subsequently used in obtaining an optimization of open-core and hence of program core requirement. Since it is unnecessary to be concerned here with which dimensions belong to which arrays, we will simply designate them as D1, D2, etc. in the manner indicated on the data input forms. In the tabulation which follows, the dimension appears in the left column and the rule for obtaining its value is given (middle column) for the applications in the right column. Note that ALL appearing in the right column means ALL runs using GBRP. Data card types, indicated by " ", are the numbers always punched in columns 3 and 4 of the data input cards. All data card "types" and program options, designated OP, are described in the appendix.

DIMENSION	VALUE	APPLICATION SITUATION
D1	(Number of beam sections)x2	GBRC1 (lateral, longitudinal, and torsional vibrations)
	(Number of beam sections)x3	GBRC2 (coupled bending with torsion)
	(Number of beam sections)x4	GBRC3 (whirling vibrations of shafts)
D2	Number of beam sections	No "53" cards in data deck.
	Maximum of: Number of beam sections; Number of "53" cards	"53" cards present in data deck.
D3		GBRC1
	27	No "53" cards in data deck.
	57	"53" cards present in data deck.
	72	GBRC2
		GBRC3
	98	No "53" cards in data deck.
	105	"53" cards present in data deck.
D4		GBRC1
	4	No "53" cards in data deck.
	$2\|n-m\|_{max}+2$	"53" cards present in data deck: n,m are connected sections.

DIMENSION	VALUE	APPLICATION SITUATION
		GBRC2
	6	No "53" cards in data deck.
	$2\|n-m\|_{max}+4$	"53" cards present in data deck: n,m are connected sections.
		GBRC3
	8	No "53" cards in data deck.
	$4\|n-m\|_{max}+4$	"53" cards present in data deck: n,m are connected sections.
D5	5	All
D6	Maximum number of beam sections occurring among systems to be plotted	OP6 system plotting
D7	Total number of systems being plotted	OP6 system plotting
D8	Total number of frequency points (along x-axis) to be used for plotting. Number will be ≤ the number of frequencies for which response is computed.	OP7 plotting
D9	Twice the number of response curves (i.e., deflection, moment, etc.) being plotted	OP6 system plotting
D10	<u>One less</u> than the <u>maximum</u> number of sections to be used in plotting any system	OP6 system plotting

DIMENSION	VALUE	APPLICATION SITUATION
D11	Blank at present	
D12	(Total number of response variables computed) x number of sections selected via the "21" card	OP7 plotting
	3 x (number of response variables to be plotted) x number of systems selected for plotting. 3 corresponds to the real, imaginary, absolute values of the variable.	OP6 system plotting
	Maximum of the values for OP6 and OP7 above	OP6 and OP7 plotting
D13	= D8	OP7 plotting
	= D10	OP6 plotting
	Maximum of the values for OP6 and OP7 above	OP6 and OP7 plotting
D14	Total number of excitation forces acting on the structure	General periodic vibration
D15	Total number of "53" cards present in data deck	Vibratory force calculations
D16	The larger of: a. (number of sections) x 2 for GBRC1 x 3 for GBRC2 x 4 for GBRC3	General periodic vibration { one excitation force, single section model or one excitation force, multi-section model
	or	

DIMENSION	VALUE	APPLICATION SITUATION
	b. (maximum time at which response is desired)/(time interval at which response is required)	
	The larger of: a. as above b. as above or c. number of discrete Fourier coefficients specified for representing the excitation forces	More than one excitation force, multi-section model
D18		General periodic vibration
	The larger of: d. number of frequency response calculations by GBRP (=c. above) or e. (number of non-zero response variables) x number of sections Note that for longitudinal or pure torsional response, the variable, bending moment, is identically zero.	One excitation force, single section model or one excitation force, multi-section model
	The larger of: f. number of excitation forces d. as above or e. as above	More than one excitation force, multi-section model

DIMENSION	VALUE	APPLICATION SITUATION
D17	= D16	General periodic vibration
	or, if less core is desired,	Any of the combinations of excitation force(s) and number of sections above
	D16/K where K is an integer, ideally 64 or an integral multiple thereof	
D19		General periodic vibration
		Any of the combinations of excitation force(s) and number of sections stated above and:
	1	D17 = D16
	(c. above)xD17+1	D17 = D16/K

These rules for dimensions permit the core requirement for arrays used by GBRP to be calculated according to the four possible choices for steady-state vibration runs:

1) Plotting is not requested:

$$\text{Core}_1 = (D2 \times D3) + (D2 \times D5) + 2(D1 \times D4 + D1) + D14^* + 4\,(D15^*)$$

*D14 = 1 (default for steady-state applications)

*D15 = 1 (default when vibratory forces <u>are not</u> computed)

2) Option 7 plotting is requested:

$$\text{Core}_2 = \text{Core}_1 + D8 + (D12 \times D13)$$

3) Option 6 plotting is requested:

$$Core_3 = Core_1 + 1 + (D12 \times D13)$$
$$+ 2(D7 \times D9) + 2(D6 \times D7)$$
$$+ D6 + 5(D7) + D1$$

4) Option 6 and Option 7 plotting requested:

$$Core_4 = Core_2 + 2(D7 \times D9)$$
$$+ 2(D6 \times D7) + D6 + 5(D7) + D1$$

The core requirement for arrays used by the fast Fourier transform and interface subroutines is calculated as

5) $Core_5$ = maximum of $[2(D17 \times D18) + 2(D16) + D19]$ and $(8193 + 2 \times 16386)$

For general periodic vibrations the core requirement is then

6) $Core_6$ = maximum* of $Core_1$ and $Core_5$

* GBRP and the fast Fourier transform interface subroutines use shared open core (Figure 1).

The array dimensions, pgs. 5-9, are read into GBRP from two data cards. These cards do not have "type" numbers such as identify most GBRP data cards since they are not read by the program's data reading subroutine. They will be designated "DIMENSIONS FOR GBRP" and "DIMENSIONS FOR FAST FOURIER TRANSFORM INTERFACE." The formats for these cards are given in the appendix.

D1 and D4 are not specified as input since the program generates them automatically from the problem data. The default values for D14 and D15 are also generated from the data.

The following procedure is used for dynamic core allocation:

a. Determine from the application (1,2,3,4, or 6, pgs. 9-10) which dimensions are involved.

b. Determine dimension values using rules on pages 5-9. Dimensions are established only once per run. If several subsets of data are being run serially as one job (i.e., data deck contains several "90" or one or more "98" cards), that subset is used which will yield the largest dimension values. This data subset must also appear <u>first</u> in the deck.

c. Prepare the dimension card or cards according to the application.

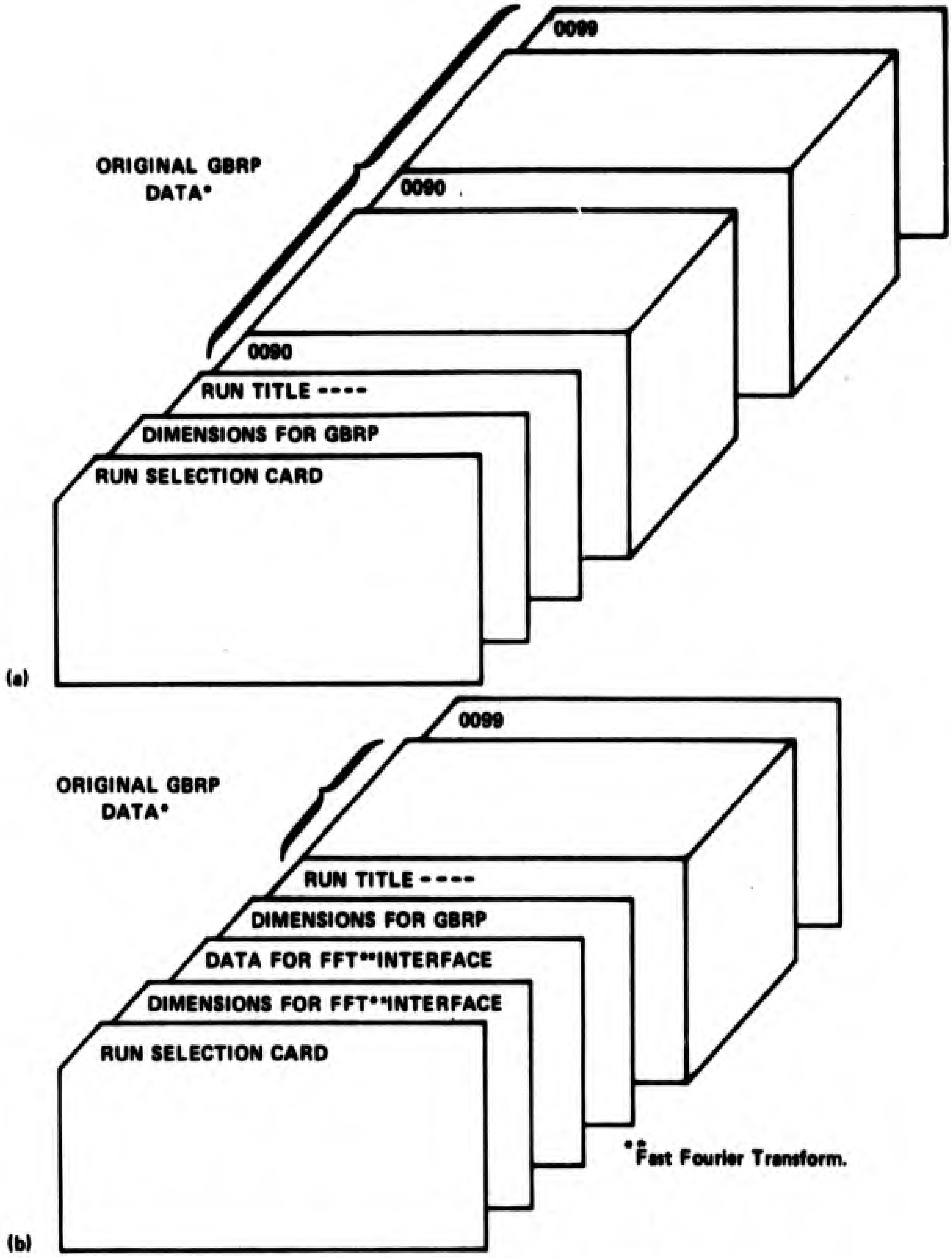
d. Calculate the length of core for arrays from the expressions ($Core_1$, $Core_2$, $Core_3$, $Core_4$, $Core_5$, $Core_6$, pgs. 9-10) for the desired applications.

e. Convert the number obtained in d to octal, round to the nearest 100_8, and add to 70000_8 to obtain the parameter CM for the job card.

Although dimensions must be supplied with all jobs using the latest version of GBRP, the calculation of CM (d and e) is optional. Its advantage is that it allows the user to choose the job priority based upon the amount of core actually needed.

The alternative to computing CM is to simply estimate an amount of core that the job would be unlikely to exceed. Whether or not the user calculates CM, the program will compute the minimum core required by the job, reduce CM if necessary, and execute in this space.

Figure 2 illustrates updated data deck configurations for the present version of GBRP.



*This will be the conventional data setup for GBRC1, GBRC2, or GBRC3 applications.

Figure 2. GBRP Data Deck Configurations. (a) For Steady-State Vibrations. (b) For General Periodic Vibration

The control card sequence for executing the program is

```
JOB CARD
CHARGE CARD
ATTACH, GBRPEX, ID=CAMH.
RFL, (CM from job card)
GBRPEX.
7/8/9
GBRP DATA DECK
6/7/8/9 (END OF FILE CARD)
```

III. VIBRATORY FORCE CALCULATIONS AND FREQUENCY DEPENDENT FORCING FUNCTIONS

In typical torsional vibration analyses of propulsion shafts the engineer is frequently interested in computing the vibratory forces occurring in the shaft. This calculation can be selected through a program option of GBRP.

This type of calculation can be demonstrated through the use of the idealized model of a propeller shaft shown in Figure 3. The shaft has been subdivided into nine sections of varying length connected by weightless rotational springs.

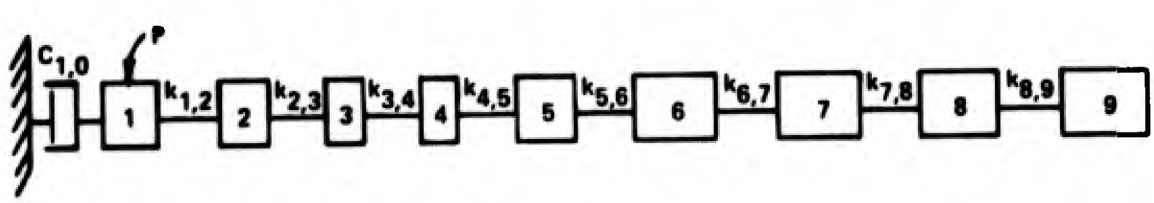


Figure 3. Concentrated Inertial-Elastic Representation of Propeller Shaft

The system has one reduction gear between sections 6 and 7 and two shafts with gears between sections 5 and 6. The shaft is excited by a simple harmonic torsional force at section 1. The procedure is to calculate the steady-state response and then the vibratory forces (torques) in the shaft. The standard GBRP forced response calculation yields the rotational angle θ_i (which may be complex-valued) at each section, i. Vibratory forces can then be computed from the expression

$$T_{n,m} = \frac{k_{n,m}(\theta_n - \theta_m)}{N_{n,m}\, G_{n,m}} \qquad (3.1)$$

where $T_{n,m}$ is the vibratory force (torque) in the shaft(s) between sections n,m

$k_{n,m}$ is the torsional compliance = $\left(\frac{\Delta x}{GJ_e}\right)_{n,m}$ with

- Δx the shaft length between sections n and m
- G the shear modulus
- J_e the effective area polar moment of inertia

$N_{n,m}$ is the number of shafts between sections n and m, and

$G_{n,m}$ is the reduction ratio between shaft n,m and reference shaft

For the sample calculation, the following values of N and G were used:

n	m	$N_{n,m}$	$G_{n,m}$
1	2	1	1
2	3	1	1
3	4	1	1
4	5	1	1
5	6	2	10.2
6	7	1	49.3

The pairs of $N_{n,m}$, $G_{n,m}$ are placed on respective continuation cards for the GBRP "53" type data cards as shown on pages

20 and 21.

The vibratory force calculation is selected by designating the number 2 for option 4 (OP4) on the option control (type "20") card. When this option is used, the program expects to find a continuation card following each type "53" card. If the vibratory force calculation is not required at a connection (i.e., no N and G are specified), the continuation card will be blank.

The data for this particular sample problem demonstrate, in addition to vibratory force calculations, a generalization of option 9 (OP9) for frequency proportional amplitudes of the forcing function, a facility frequently required in propeller shaft vibration analysis. In the original version of GBRP, selecting the number 1 for OP9 on the option control card signified to the program that the forcing function amplitude, P, was to be multiplied by the square of the angular frequency, ω. In the present version of the program, this option has been generalized to allow P to be multiplied by ω raised to any power. To use this feature, OP9 is assigned a value of 1 as before and the desired power of ω (assumed $\neq 0$, otherwise the option is redundant) is entered on the type "30" card.

The complete set of input data for the sample calculation is shown on GBRP data forms on the pages which follow.

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [| | |] ______ SHEET 1 OF 7

RUN SELECTION CARD ______

1
1

DIMENSIONS FOR FAST FOURIER TRANSFORM INTERFACE (NONHARMONIC VIBRATIONS ONLY) ______

D16	D17	D18	D19
1	4	7	10

DATA FOR FAST FOURIER TRANSFORM INTERFACE (NONHARMONIC VIBRATIONS ONLY) ______

1	6	11	17	23	27	31	35	43	51	59	61	63	65	67

DIMENSIONS FOR GBRP ______

D2	D3	D5	D14	D15	D6	D7	D8	D9	D10	D11	D12	D13
009	057	005		009								
1	4	7	10	13	16	19	22	25	28	31	34	37

Data Input Form (1)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [ ] ______ SHEET 2 OF 7

RUN TITLE CARD

ΔΔΔΔΔΔΔΔΔΔΔΔ TORSIONAL VIBRATION OF PROPELLER SHAFT (13)

DATA CONTROL CARD

NO TYPE NO TYPE etc.

0090	01	10	01	20	01	30	01	41	07	45	01	51	07	55
	5	7	9	11	13	15	17	19	21	23	25	27	29	31

33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71

CASE TITLE CARD

001000ΔΔΔΔΔΔ CALCULATION OF RESPONSE AND VIBRATORY FORCES (13)

OPTION CONTROL CARD

	OP1	OP2	OP3	OP4	OP5	OP6	OP7	OP8	OP9	OP10
00200000				0002					0001	
	9	13	17	21	25	29	33	37	41	45

EDIT CONTROL CARD

00210000					
	9	13	17	21	25	29

GENERAL DATA CARD

	NO SECTIONS	ω_1(CPS)	ω_2(CPS)	$\Delta\omega$(CPS)	h	Power of ω	NPLOTC
0030	0009	0.250	0.500	0.250		2.0	
	5	9	17	25	33	41	49 / 57

SYSTEMS DATA CARDS

	SYSTEMS	RADIUS	INITIAL J
0031			
0031			
	7	9	17

FORCING FUNCTION LOCATION CARD ______ (Used only if forces are nonharmonic) ______

0032 [columns 5 7 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78]

Data Input Form (2)

Bending, Longitudinal, Torsional

TITLE ____________ PROGRAMMER ____________ DATE ____________

PROBLEM NO. ____________ PHASE ______ LABEL ☐☐☐☐ ______ SHEET 3 OF 7

SECTION DATA CARDS

5	SECTION NO.	9 END CONDN.	13 SYSTEM	17 MASS	25 WATER INERTIA	33 $(\Delta X/EI)_n$	41 $(\Delta X)_{n,n+1}$	49 $(\Delta X/KAG)_{n,n+1}$	57 $(I_{\mu z}\Delta X)_{n,n+1}$	65 P_n	73
REAL PART OF SCALING FACTORS											
00410000		0000	0001	1.0						1.0	
00410000		0000									
00410000		0000									
IMAGINARY PART OF SCALING FACTORS											
00420000		0000									
00420000		0000									
00420000		0000									
PARAMETER VALUES - UNSCALED											
0043	0001		0001	99100.						10.1	
0043	0002		0001	10600.							
0043	0003		0001	15350.							
0043	0004		0001	6770.							
0043	0005		0001	87550.							
0043	0006		0001	250600.							
0043	0007		0001	1645000.							
0043	0008		0001	250600.							
0043	0009		0001	1645000.							
0043											
0043											
0043											
0043											
0043											
0043											

Data Input Form (3)

Bending, Longitudinal, Torsional

TITLE ______________________ PROGRAMMER ______________________ DATE ______________

PROBLEM NO. ______________________ PHASE ________ LABEL ☐☐☐☐ ________ SHEET 4 OF 7

1	5	9	13	17	25	33	41	49	57	65	73
SPECIAL CONNECTION CARDS											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$\Delta x_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I\mu_z \Delta X)_{n,m}$	$Q_{n,m}$	
REAL PART OF SCALING FACTORS											
0051	0000	0000	0001	▲▲▲1.0E6		1.0					
0051	0000	0000									
0051	0000	0000									
IMAGINARY PART OF SCALING FACTORS											
0052	0000	0000									
0052	0000	0000									
0052	0000	0000									
PARAMETER VALURS - UNSCALED											
0053											
0053											
0053											
0053											
0053											
0053											
0053											
0053											
0053											
0053											

Data Input Form (5)

Vibratory Force Data

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [| | |] ______ SHEET 5 OF 7

SPECIAL CONNECTIONS PARAMETER VALUES - UNSCALED

1	5	9	13	17	25	33	41	49	57	65	73
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053	0001	0002	0001	317.							
				$N_{n,m}$	$G_{n,m}$						
BLANK				1	1.0						
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053	0002	0003	0001	741.							
				$N_{n,m}$	$G_{n,m}$						
BLANK				1	1.0						
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053	0003	0004	0001	630.							
				$N_{n,m}$	$G_{n,m}$						
BLANK				1	1.0						
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053	0004	0005	0001	473.							
				$N_{n,m}$	$G_{n,m}$						
BLANK				1	1.0						
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053	0005	0006	0001	5360.							
				$N_{n,m}$	$G_{n,m}$						
BLANK				2	10.2						
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053	0005	0008	0001	5360.							
				$N_{n,m}$	$G_{n,m}$						
BLANK				0	0.						

Data Input Form (7)

Vibratory Force Data

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL ☐☐☐ ______ SHEET 6 OF 7

SPECIAL CONNECTIONS PARAMETER VALUES - UNSCALED

	5	9	13	17	25	33	41	49	57	65	73
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053	0006	0007	0001	15500.							
				$N_{n,m}$	$G_{n,m}$						
← BLANK →				1	49.3						
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053	0008	0009	0001	15500.							
				$N_{n,m}$	$G_{n,m}$						
← BLANK →				0	0.						
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053	0001	0000	0001			24800.					
				$N_{n,m}$	$G_{n,m}$						
← BLANK →				0	0.						
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053											
				$N_{n,m}$	$G_{n,m}$						
← BLANK →											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053											
				$N_{n,m}$	$G_{n,m}$						
← BLANK →											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053											
				$N_{n,m}$	$G_{n,m}$						
← BLANK →											

Data Input Form (7)

TITLE ____________ PROGRAMMER ____________ DATE ________

PROBLEM NO. ____________ PHASE ______ LABEL [| | |] ______ SHEET 7 OF 7

CHARACTRON PLOTTING CHARACTERS

006000	ΔΔΔΔΔΔΔΔΔΔ	+ΔΔΔΔΔΔΔΔΔ	0ΔΔΔΔΔΔΔΔΔ	XΔΔΔΔΔΔΔΔΔ	−ΔΔΔΔΔΔΔΔΔ	•ΔΔΔΔΔΔΔΔΔ
34	7	17	27	37	47	57

NATURAL FREQUENCY SELECTION CARD

00700000	[ ]	
34	9	11

SYSTEMS TO BE PLOTTED (USED ONLY WITH OPTION 6 PLOTTING)

1st	2nd	3rd	4th	5th	6th	
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	etc.
1	3	5	7	9	11	

START NEW DATA SET CARD

0098

34

END OF DATA CARD

✓ 0099

34

Δ indicates blank space

Data Input Form (16)

THERE ARE 011110(OCTAL) WORDS OF OPEN-CORE AVAILABLE FOR THIS PROBLEM

ELAPSED TIME AT ENTRY INTO GBRP = 1.712E+02 SECONDS

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TORSIONAL VIBRATION OF PROPELLER SHAFT

DATA CONTROL CARD

NO	TYPE
1	10
1	20
1	30
1	41
9	43
1	51
9	53

CASE TITLE-CALCULATION OF RESPONSE AND VIBRATORY FORCES

OPTION DATA
20 -0 -0 -0 2 -0 -0 -0 -0 1 -0

GENERAL DATA - NUMBER OF SECTIONS 9
FREQUENCY RANGE FROM .250 CPS TO .500 CPS
FREQUENCY INTERVAL .250 CPS
POWER OF FREQUENCY = 2.000

REAL PARTS OF SCALING FACTORS

SECTION-END CONON-SYSTEM	MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	IMZ*DX(N,N+1)	P(N)/Y
1	1.0000E+00	-0.	-0.	-0.	-0.	-0.	1.0000E+00

PARAMETER VALUES FOR EACH SECTION - UNSCALED

SECTION-END	CONON-SYSTEM		MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	IMZ*DX(N,N+1)	P(N)/Y
1	-0	1	9.9100E+04	-0.	-0.	-0.	-0.	-0.	1.0100E+01
2	-0	1	1.0600E+04	-0.	-0.	-0.	-0.	-0.	-0.
3	-0	1	1.5350E+04	-0.	-0.	-0.	-0.	-0.	-0.
4	-0	1	6.7700E+03	-0.	-0.	-0.	-0.	-0.	-0.
5	-0	1	8.7550E+04	-0.	-0.	-0.	-0.	-0.	-0.
6	-0	1	2.5060E+05	-0.	-0.	-0.	-0.	-0.	-0.
7	-0	1	1.6450E+06	-0.	-0.	-0.	-0.	-0.	-0.
8	-0	1	2.5060E+05	-0.	-0.	-0.	-0.	-0.	-0.
9	-0	1	1.6450E+06	-0.	-0.	-0.	-0.	-0.	-0.

REAL PARTS OF SCALING FACTORS

N	M	SYSTEM	K(N,M)	C(N,M)	C(N,M)/W	DX(N,M)	DX/KAG(N,M)	IMZ*DX(N,M)	Q(N,M)/Y
		1	1.0000E+06	-0.	1.0000E+00	-0.	-0.	-0.	-0.

PARAMETER VALUES FOR SPECIAL CONNECTIONS

N	M	SYSTEM	K(N,M)	C(N,M)	C(N,M)/W	DX(N,M)	DX/KAG(N,M)	IMZ*DX(N,M)	Q(N,M)/Y
1	2	1	3.1700E+02	-0.	-0.	-0.	-0.	-0.	-0.
2	3	1	7.4100E+02	-0.	-0.	-0.	-0.	-0.	-0.
3	4	1	6.3000E+02	-0.	-0.	-0.	-0.	-0.	-0.
4	5	1	4.7300E+02	-0.	-0.	-0.	-0.	-0.	-0.
5	6	1	5.3600E+03	-0.	-0.	-0.	-0.	-0.	-0.
5	8	1	5.3600E+03	-0.	-0.	-0.	-0.	-0.	-0.
6	7	1	1.5500E+04	-0.	-0.	-0.	-0.	-0.	-0.
8	9	1	1.5500E+04	-0.	-0.	-0.	-0.	-0.	-0.
1	-0	1	-0.	-0.	2.4000E+04	-0.	-0.	-0.	-0.

PARAMETER VALUES FOR VIBRATORY FORCE CALCULATION

N	M	N(N,M)	G(N,M)
1	2	1.0000E+00	1.0000E+00
2	3	1.0000E+00	1.0000E+00
3	4	1.0000E+00	1.0000E+00
4	5	1.0000E+00	1.0000E+00
5	6	2.0000E+00	1.0200E+01
6	7	1.0000E+00	4.9300E+01

THE MINIMUM AMOUNT OF OPEN CORE NEEDED FOR THE STEADY-STATE PORTION OF THIS PROBLEM IS 002026(OCTAL) WORDS

DIMENSIONS FOR ARRAYS

```
DIMENSION  1 =  10
DIMENSION  2 =   9
DIMENSION  3 =  57
DIMENSION  4 =   0
DIMENSION  5 =   5
DIMENSION  6 =  -0
DIMENSION  7 =  -0
DIMENSION  8 =  -0
DIMENSION  9 =  -0
DIMENSION 10 =  -0
DIMENSION 11 =  -0
DIMENSION 12 =  -0
DIMENSION 13 =  -0
DIMENSION 14 =   1
DIMENSION 15 =   9
```

CM REDUCED TO 071000 (OCTAL)

GBRP

TORSIONAL VIBRATION OF PROPELLER SHAFT

CALCULATION OF RESPONSE AND VIBRATORY FORCES

FREQUENCY .25 CPS

STATION	DEFLECTIONS				MOMENT			
	REAL PART	IMAG PART	ABS VALUE	PHASE ANGLE	REAL PART	IMAG PART	ABS VALUE	PHASE ANGLE
1	-2.3222E-06	-1.3242E-08	2.3223E-06	-1.7967E+02	0.	0.	0.	0.
2	-2.3991E-05	-1.3680E-08	2.3991E-06	-1.7967E+02	0.	0.	0.	0.
3	-2.4318E-06	-1.3867E-08	2.4319E-06	-1.7967E+02	0.	0.	0.	0.
4	-2.4702E-06	-1.4086E-08	2.4703E-06	-1.7967E+02	0.	0.	0.	0.
5	-2.5213E-05	-1.4377E-08	2.5214E-06	-1.7967E+02	0.	0.	0.	0.
6	-2.5235E-06	-1.4390E-08	2.5236E-06	-1.7967E+02	0.	0.	0.	0.
7	-2.5242E-06	-1.4394E-08	2.5242E-06	-1.7967E+02	0.	0.	0.	0.
8	-2.5235E-06	-1.4390E-08	2.5236E-06	-1.7967E+02	0.	0.	0.	0.
9	-2.5242E-06	-1.4394E-08	2.5242E-06	-1.7967E+02	0.	0.	0.	0.

GBRP

TORSIONAL VIBRATION OF PROPELLER SHAFT

CALCULATION OF RESPONSE AND VIBRATORY FORCES

FREQUENCY .50 CPS

STATION	DEFLECTIONS				MOMENT			
	REAL PART	IMAG PART	ABS VALUE	PHASE ANGLE	REAL PART	IMAG PART	ABS VALUE	PHASE ANGLE
1	-1.7291E-06	-7.3416E-09	1.7291E-06	-1.7976E+02	0.	0.	0.	0.
2	-2.0382E-05	-8.6540E-09	2.0383E-06	-1.7976E+02	0.	0.	0.	0.
3	-2.1702E-06	-9.2143E-09	2.1702E-06	-1.7976E+02	0.	0.	0.	0.
4	-2.3249E-06	-9.8710E-09	2.3249E-06	-1.7976E+02	0.	0.	0.	0.
5	-2.5306E-05	-1.0744E-08	2.5306E-06	-1.7976E+02	0.	0.	0.	0.
6	-2.5394E-06	-1.0782E-08	2.5395E-06	-1.7976E+02	0.	0.	0.	0.
7	-2.5421E-06	-1.0793E-08	2.5421E-06	-1.7976E+02	0.	0.	0.	0.
8	-2.5394E-06	-1.0782E-08	2.5395E-06	-1.7976E+02	0.	0.	0.	0.
9	-2.5421E-06	-1.0793E-08	2.5421E-06	-1.7976E+02	0.	0.	0.	0.

GBRP

TORSIONAL VIBRATION OF PROPELLER SHAFT

CALCULATION OF RESPONSE AND VIBRATORY FORCES

FREQUENCY CPS	FORCE	REAL PART	IMAG PART	ABS VALUE	PHASE ANGLE
.25					
	T(1, 2)	2.4352E+01	1.3886E-01	2.4353E+01	3.2671E-01
	T(2, 3)	2.4289E+01	1.3851E-01	2.4290E+01	3.2671E-01
	T(3, 4)	2.4197E+01	1.3799E-01	2.4198E+01	3.2671E-01
	T(4, 5)	2.4156E+01	1.3774E-01	2.4156E+01	3.2671E-01
	T(5, 6)	5.7871E-01	3.3000E-03	5.7872E-01	3.2671E-01
	T(6, 7)	2.0782E-01	1.1850E-03	2.0782E-01	3.2671E-01
.50					
	T(1, 2)	9.7990E+01	4.1685E-01	9.7991E+01	2.4327E-01
	T(2, 3)	9.7777E+01	4.1514E-01	9.7778E+01	2.4327E-01
	T(3, 4)	9.7449E+01	4.1375E-01	9.7449E+01	2.4327E-01
	T(4, 5)	9.7293E+01	4.1309E-01	9.7294E+01	2.4327E-01
	T(5, 6)	2.3310E+00	9.8972E-03	2.3311E+00	2.4327E-01
	T(6, 7)	8.3716E-01	3.5545E-03	8.3717E-01	2.4327E-01

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TORSIONAL VIBRATION OF PROPELLER SHAFT

DATA CONTROL CARD

NO TYPE

END GBRP RUN

ELAPSED TIME AT EXIT FROM GBRP = 1.718E+02 SECONDS

IV. ACCURACY CHECK ON COMPUTED MODE SHAPES

A standard option (OP10) of GBRP designates the calculation of the natural frequencies and mode shapes for a beam-spring-mass model of a mechanical system. If the application involves bending or torsion-bending of a single beam or coupled beam system in which the beam(s) has free ends, an additional option can be used to obtain a check on the accuracy of the computed mode shapes.

The mode checking facility is based on two of the six equations for free, undamped, torsion-bending motion of a moderately nonuniform slender beam[8]:

$$\frac{\partial V(x,t)}{\partial x} = -\mu(x)\frac{\partial^2 y(x,t)}{\partial t^2} + \mu(x)\bar{z}(x)\frac{\partial^2 \phi(x,t)}{\partial t^2} \qquad (4.1)$$

$$\frac{\partial T(x,t)}{\partial x} = \mu(x)\bar{z}(x)\frac{\partial^2 y(x,t)}{\partial t^2} - I_{\mu x}(x)\frac{\partial^2 \phi(x,t)}{\partial t^2} \qquad (4.2)$$

where V is the shearing force in the direction of flexural vibration (y-direction)

μ is the effective mass per unit length

y is the displacement normal to x in the plane (xy) of bending

$\bar{z}$ is the vertical distance from the x-axis to the center of mass (including allowance for added mass of water)

ϕ is the rotation of the cross section of a beam or hull with respect to its longitudinal axis (x)

x is the distance in the longitudinal direction measured from the origin of coordinates

---

8 McGoldrick, R.T., "Ship Vibration," David Taylor Model Basin Report 1451 (Dec 1960).

t is the time variable

T is the moment about the longitudinal axis of a hull due to all shearing stresses in the cross section

$I_{\mu x}$ is the mass moment of inertia per unit length with respect to the x-axis, including allowance for the inertial effect of the water

ω is the angular frequency of vibration

The time-independent equations of motion corresponding to Equations (4.1) and (4.2) are,

$$\frac{dV(x)}{dx} = \mu(x)\omega^2 y(x) - \mu(x)\bar{z}(x)\omega^2\phi(x) \tag{4.3}$$

$$\frac{dT(x)}{dx} = -\mu(x)\bar{z}(x)\omega^2 y(x) + I_{\mu x}(x)\omega^2\phi(x) \tag{4.4}$$

The finite-difference equations[3] approximating Equations (4.3) and (4.4) at each section of the subdivided beam

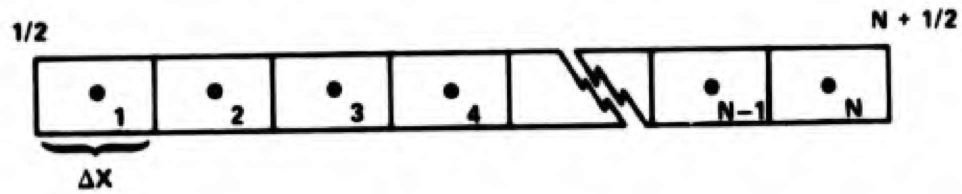

Figure 4. Subdivided Beam

are

$$V_{n+1/2} - V_{n-1/2} = (\mu\Delta x)_n\omega^2 y_n - (\mu\Delta x\bar{z})_n\omega^2\phi_n \tag{4.5}$$

$$T_{n+1/2} - T_{n-1/2} = -\omega^2(\mu\Delta x\bar{z})_n y_n + \omega^2(I_{\mu x}\Delta x)_n\phi_n \tag{4.6}$$

$$n = 1,2,3,\cdots,N$$

Summing the left- and right-hand sides of each of these expressions over all beam sections gives

$$\sum_{n=1}^{N} (V_{n+1/2} - V_{n-1/2}) = \sum_{n=1}^{N} [(\mu\Delta x)_n \omega^2 y_n - (\mu\Delta x\bar{z})_n \omega^2 \phi_n] \quad (4.7)$$

$$\sum_{n=1}^{N} (T_{n+1/2} - T_{n-1/2}) = \sum_{n=1}^{N} [-\omega^2 (\mu\Delta x\bar{z})_n y_n + \omega^2 (I_{\mu x}\Delta x)_n \phi_n] \quad (4.8)$$

Since the left sides of Equation (4.7) and Equation (4.8) yield respectively $V_{N+1/2} - V_{1/2}$ and $T_{N+1/2} - T_{1/2}$, and for free ends,

$$V_{1/2} = V_{N+1/2} = 0$$

$$T_{1/2} = T_{N+1/2} = 0$$

Equations (4.7) and (4.8) become

$$\sum_{n=1}^{N} [(\mu\Delta x)_n y_n - (\mu\Delta x\bar{z})_n \phi_n] = 0 \quad (4.9)$$

$$\sum_{n=1}^{N} [-(\mu\Delta x\bar{z})_n y_n + (I_{\mu x}\Delta x)_n \phi_n] = 0 \quad (4.10)$$

with ω^2 factored out since it is always >0.
For the case of bending without torsion, these expressions reduce to

$$\sum_{n=1}^{N} (\mu\Delta x)_n y_n = 0 \quad (4.11)$$

The expressions are valid for systems of elastically coupled beams as well as single beams, assuming that all beams in the system have free-free end conditions.

If option 8 (OP8) is designated as 4 in conjunction with a natural frequency calculation of the types referred to, GBRP will evaluate the left sides of Equations (4.9) and (4.10) and print the results with each mode computed. The magnitude of the results compared with zero affords an estimate of the accuracy of the modal displacements y and ϕ.

An example of the use of this option follows.

TITLE ____ PROGRAMMER ____ DATE ____

PROBLEM NO. ____ PHASE ____ LABEL ☐☐☐ ____ SHEET 1 OF 8

RUN SELECTION CARD ____

1
1

DIMENSIONS FOR FAST FOURIER TRANSFORM INTERFACE (NONHARMONIC VIBRATIONS ONLY) ____

D16	D17	D18	D19
1	4	7	10

DATA FOR FAST FOURIER TRANSFORM INTERFACE (NONHARMONIC VIBRATIONS ONLY) ____

1	6	11	17	23	27	31	35	43	51	59	61	63	65	67

DIMENSIONS FOR GBRP ____

D2	D3	D5	D14	D15	D6	D7	D8	D9	D10	D11	D12	D13
020	072	005										
1	4	7	10	13	16	19	22	25	28	31	34	37

Data Input Form (1)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [ ] ______ SHEET 2 OF 2

RUN TITLE CARD

ΔΔΔΔΔΔΔΔΔΔΔΔ COUPLED BENDING AND TORSION (col. 13)

DATA CONTROL CARD

NO TYPE NO TYPE etc.

0090	01	10	01	20	01	30	01	41	20	43	01	70
col.	5	7	9	11	13	15	17	19	21	23	25	27

Column numbers: 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71

CASE TITLE CARD

001000ΔΔΔΔΔΔ NATURAL FREQUENCY CALCULATION AND CHECK OF MODE ACCURACY (col. 13)

OPTION CONTROL CARD

	OP1	OP2	OP3	OP4	OP5	OP6	OP7	OP8	OP9	OP10
00200000		0001						0004		0001
col.	9	13	17	21	25	29	33	37	41	45

EDIT CONTROL CARD

00210000					
col.	9	13	17	21	25

Column: 29

GENERAL DATA CARD

	NO SECTIONS	ω_1(CPS)	ω_2(CPS)	$\Delta\omega$(CPS)	h	Power of ω	NPLOTC
0030	0020	1.0	10.0	1.0			
col.	5	9	17	25	33	41	49

Column: 57

SYSTEMS DATA CARDS

	SYSTEMS	RADIUS	INITIAL J
0031			
0031			
col.	7	9	17

FORCING FUNCTION LOCATION CARD ______ (Used only if forces are nonharmonic)

0032	

Column numbers: 5 7 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78

Data Input Form (2)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [| | |] ______ SHEET 3 OF 8

SECTION DATA CARDS

Column positions: 5, 9, 13, 17, 25, 33, 41, 49, 57, 65, 73

REAL PART OF SCALING FACTORS											
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0041	0000	0000	0001	1.0	1.0	▲1.0E-08	1.0	▲1.0E-06		•	
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
BLANK				1.0	▲▲▲1.0E5	1.0	▲▲1.0E-8				
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0041	0000	0000									
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
BLANK											
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0041	0000	0000									
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
BLANK											
IMAGINARY PART OF SCALING FACTORS											
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0042	0000	0000									
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
BLANK											
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0042	0000	0000									
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$.	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
BLANK											

Data Input Form (8)

Torsion-Bending

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO ______ PHASE ______ LABEL ☐☐☐☐ ______ SHEET 4 OF 8

SECTION PARAMETER VALUES - UNSCALED

	5	9	13	17	25	33	41	49	57	65	73
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I\mu_z\Delta X)_{n,n+1}$	P_n	
0043	0001	0001	0001	30.0	5.0	0.097	52.0	3.21			
				$(\mu\bar{z}\Delta X)_n$	$(I\mu_x\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →				1547.	0.76	9.25	0.138				
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I\mu_z\Delta X)_{n,n+1}$	P_n	
0043	0002		0001	59.0	16.0	0.036	52.0	1.87			
				$(\mu\bar{z}\Delta X)_n$	$(I\mu_x\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →				3705.	2.41	9.25	0.118				
	SECTION NO.	END CONDN	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I\mu_z\Delta X)_{n,n+1}$	P_n	
0043	0003		0001	80.	26.0	0.026	52.0	1.42			
				$(\mu\bar{z}\Delta X)_n$	$(I\mu_x\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →				5049.	2.96	8.00	0.097				
	SECTION NO.	END CONDN	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I\mu_z\Delta X)_{n,n+1}$	P_n	
0043	0004		0001	114.	31.0	0.019	52.0	1.25			
				$(\mu\bar{z}\Delta X)_n$	$(I\mu_x\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →				7375.	4.4	4.0	0.08				
	SECTION NO	END CONDN	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I\mu_z\Delta X)_{n,n+1}$	P_n	
0043	0005		0001	135.0	31.0	0.016	52.0	1.14			
				$(\mu\bar{z}\Delta X)_n$	$(I\mu_x\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →				8575.0	5.3	-0.25	0.07				

Data Input Form (9)

TITLE		PROGRAMMER		DATE	
PROBLEM NO.		PHASE	LABEL	SHEET 5	OF 8

SECTION PARAMETER VALUES - UNSCALED

	5	9	13	17	25	33	41	49	57	65	73
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043	0006		0001	141.0	32.0	0.014	52.	1.08			
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
BLANK				9070.0	5.64	-1.375	0.065				
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043	0007		0001	160.0	32.0	0.013	52.	1.04			
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
BLANK				10250.0	6.4	-1.0	0.062				
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043	0008		0001	170.0	32.0	0.013	52.	1.01			
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
BLANK				10940.0	6.87	-1.25	0.061				
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043	0009		0001	157.5	32.0	0.012	52.	1.0			
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
BLANK				10210.0	6.44	-1.25	0.061				
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043	0010		0001	151.0	31.0	0.012	52.	1.0			
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
BLANK				9785.0	6.91	-0.25	0.063				

Data Input Form (9)

Torsion-Bending

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO ______ PHASE ______ LABEL ☐☐☐☐ ______ SHEET 6 OF 8

SECTION PARAMETER VALUES - UNSCALED

	5	9	13	17	25	33	41	49	57	65	73
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043	0011		0001	155.0	30.0	0.013	52.	1.0			
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
BLANK				9895.0	6.17	0.625	0.067				
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043	0012		0001	148.5	29.0	0.013	52.	1.01			
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
BLANK				9262.0	5.66	-0.125	0.	0.072			
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043	0013		0001	136.0	28.0	0.015	52.	1.03			
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
BLANK				8300.0	4.91	-1.125	0.079				
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043	0014		0001	125.0	27.0	0.017	52.	1.07			
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
BLANK				7350.0	4.12	-0.625	0.091				
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043	0015		0001	134.0	26.0	0.021	52.	1.12			
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
BLANK				7519.0	4.0	1.375	0.114				

Data Input Form (9)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL ______ SHEET 7 OF 8

SECTION PARAMETER VALUES - UNSCALED

1	5	9	13	17	25	33	41	49	57	65	73
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043	0016		0001	145.0	26.0	0.027	52.	1.26			
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →				7869.0	4.05	5.0	0.153				
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043	0017		0001	118.0	25.0	0.036	52.	1.57			
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →				6337.0	3.15	8.25	0.217				
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043	0018		0001	81.0	20.0	0.054	52.	2.24			
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →				4400.0	2.19	9.25	0.355				
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043	0019		0001	67.0	12.0	0.097	52.	4.21			
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →				3068.0	1.28	9.25	0.674				
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043	0020	0001	0001	54.0	4.0	0.258	52.				
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →				2946.0	1.9						

Data Input Form (9)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [| | |] ______ SHEET 8 OF 8

CHARACTRON PLOTTING CHARACTERS ______

006000	ΔΔΔΔΔΔΔΔΔΔ	+ΔΔΔΔΔΔΔΔΔ	0ΔΔΔΔΔΔΔΔΔ	XΔΔΔΔΔΔΔΔΔ	–ΔΔΔΔΔΔΔΔΔ	•ΔΔΔΔΔΔΔΔΔ
34	7	17	27	37	47	57

NATURAL FREQUENCY SELECTION CARD ______

✓

00700000	01
34	9 – 11

SYSTEMS TO BE PLOTTED (USED ONLY WITH OPTION 6 PLOTTING) ______

1st	2nd	3rd	4th	5th	6th	
						etc.
1	3	5	7	9	11	

START NEW DATA SET CARD ______

0098

34

END OF DATA CARD ______

✓

0099

34

Δ indicates blank space

Data Input Form (16)

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THERE ARE 011110(OCTAL) WORDS OF OPEN-CORE AVAILABLE FOR THIS PROBLEM

ELAPSED TIME AT ENTRY INTO GBRP =     1.710E+02  SECONDS




 GBRP   NOV. 1974
 COUPLED BENDING AND TORSION

DATA CONTROL CARD

NO  TYPE

 1   10
 1   20
 1   30
 1   41
20   43
 1   70

CASE TITLE-NATURAL FREQUENCY CALCULATION AND CHECK OF MODE ACCURACY

OPTION DATA
 20      -0   1  -0  -0  -0  -0  -0   4  -0   1

GENERAL DATA -  NUMBER OF SECTIONS   20
                  FREQUENCY RANGE FROM      1.000 CPS  TO    10.000 CPS
                  FREQUENCY INTERVAL   1.000 CPS
                  POWER OF FREQUENCY = -0.000


REAL PARTS OF SCALING FACTORS

SECTION-END CONDN-SYSTEM    MASS     WATER INERTIA    DX/EI(N)       DX(N,N+1)  DX/KAG(N,N+1)  IMZ*DX(N,N+1)     P(N)/Y

                      1    1.0000E+00    1.0000E+00    1.0000E-08    1.0000E+00    1.0000E-06   -0.             -0.

                          MZB*DX(N)     IMX*DX(N)     ZBB(N,N+1)   DX/GJE(N,N+1)     U(N)

                          1.0000E+00    1.0000E+05    1.0000E+00    1.0000E-08   -0.
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PARAMETER VALUES FOR EACH SECTION - UNSCALED

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SECTION-END CONDN-SYSTEM   MASS        WATER INERTIA   DX/EI(N)      DX(N,N+1)   DX/KAG(N,N+1)  IMZ*DX(N,N+1)   P(N)/Y
    1          1       1   3.0000E+01   5.0000E+00     9.7000E-02   5.2000E+01    3.2100E+00   -0.             -0.
                           MZB*DX(N)    IMX*DX(N)      ZBB(N,N+1)   DX/GJE(N,N+1)    U(N)
                           1.5470E+03   7.6000E-01     9.2500E+00   1.3000E-01   -0.

                           MASS        WATER INERTIA   DX/EI(N)      DX(N,N+1)   DX/KAG(N,N+1)  IMZ*DX(N,N+1)   P(N)/Y
    2         -0       1   5.9000E+01   1.6000E+01     3.6000E-02   5.2000E+01    1.0700E+00   -0.             -0.
                           MZB*DX(N)    IMX*DX(N)      ZBB(N,N+1)   DX/GJE(N,N+1)    U(N)
                           3.7050E+03   2.4100E+00     9.2500E+00   1.1000E-01   -0.

                           MASS        WATER INERTIA   DX/EI(N)      DX(N,N+1)   DX/KAG(N,N+1)  IMZ*DX(N,N+1)   P(N)/Y
    3         -0       1   8.0000E+01   2.6000E+01     2.6000E-02   5.2000E+01    1.4200E+00   -0.             -0.
                           MZB*DX(N)    IMX*DX(N)      ZBB(N,N+1)   DX/GJE(N,N+1)    U(N)

                           5.0490E+03   2.9600E+00     3.0000E+00   9.7000E-02   -0.

                           MASS        WATER INERTIA   DX/EI(N)      DX(N,N+1)   DX/KAG(N,N+1)  IMZ*DX(N,N+1)   P(N)/Y
    4         -0       1   1.1400E+02   3.1000E+01     1.9000E-02   5.2000E+01    1.2500E+00   -0.             -0.
                           MZB*DX(N)    IMX*DX(N)      ZBB(N,N+1)   DX/GJE(N,N+1)    U(N)
                           7.3730E+03   4.4000E+00     4.0000E+00   8.0000E-02   -0.

                           MASS        WATER INERTIA   DX/EI(N)      DX(N,N+1)   DX/KAG(N,N+1)  IMZ*DX(N,N+1)   P(N)/Y
    5         -0       1   1.3500E+02   3.1000E+01     1.6000E-02   5.2000E+01    1.1400E+00   -0.             -0.
                           MZB*DX(N)    IMX*DX(N)      ZBB(N,N+1)   DX/GJE(N,N+1)    U(N)
                           8.5750E+03   5.3000E+00    -2.5000E-01   7.0000E-02   -0.
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                 MASS        WATER INERTIA    DX/EI(N)      DX(N,N+1)   DX/KAG(N,N+1)  IMZ*DX(N,N+1)       P(N)/Y
 6    -0    1    1.4100E+02    3.2000E+01    1.4000E-02    5.2000E+01    1.0000E+00    -0.                 -0.
                 MZB*DX(N)     IMX*DX(N)     ZBB(N,N+1)    DX/GJE(N,N+1)     U(N)
                 9.0700E+03    5.6400E+00   -1.3750E+00    6.5000E-02   -0.

                 MASS        WATER INERTIA    DX/EI(N)      DX(N,N+1)   DX/KAG(N,N+1)  IMZ*DX(N,N+1)       P(N)/Y
 7    -0    1    1.6000E+02    3.2000E+01    1.3000E-02    5.2000E+01    1.0400E+00    -0.                 -0.
                 MZ9*DX(N)     IMX*DX(N)     ZBB(N,N+1)    DX/GJE(N,N+1)     U(N)
                 1.0250E+04    6.4000E+00   -1.0000E+00    6.2000E-02   -0.

                 MASS        WATER INERTIA    DX/EI(N)      DX(N,N+1)   DX/KAG(N,N+1)  IMZ*DX(N,N+1)       P(N)/Y
 8    -0    1    1.7000E+02    3.2000E+01    1.3000E-02    5.2000E+01    1.0100E+00    -0.                 -0.
                 MZB*DX(N)     IMX*DX(N)     ZBB(N,N+1)    DX/GJE(N,N+1)     U(N)
                 1.0940E+04    6.8700E+00   -1.2500E+00    6.1000E-02   -0.

                 MASS        WATER INERTIA    DX/EI(N)      DX(N,N+1)   DX/KAG(N,N+1)  IMZ*DX(N,N+1)       P(N)/Y
 9    -0    1    1.5750E+02    3.2000E+01    1.2000E-02    5.2000E+01    1.0000E+00    -0.                 -0.
                 MZB*DX(N)     IMX*DX(N)     ZBB(N,N+1)    DX/GJE(N,N+1)     U(N)
                 1.0210E+04    6.4400E+00   -1.2500E+00    6.1000E-02   -0.

                 MASS        WATER INERTIA    DX/EI(N)      DX(N,N+1)   DX/KAG(N,N+1)  IMZ*DX(N,N+1)       P(N)/Y
10    -0    1    1.5100E+02    3.1000E+01    1.2000E-02    5.2000E+01    1.0000E+00    -0.                 -0.
                 MZB*DX(N)     IMX*DX(N)     ZBB(N,N+1)    DX/GJE(N,N+1)     U(N)
                 9.7850E+03    6.9100E+00   -2.5000E-01    6.3000E-02   -0.
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			MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	IMZ*DX(N,N+1)	P(N)/Y
11	-0	1	1.5500E+02	3.0000E+01	1.3000E-02	5.2000E+01	1.0000E+00	-0.	-0.
			MZB*DX(N)	IMX*DX(N)	ZBB(N,N+1)	DX/GJE(N,N+1)	U(N)		
			9.0950E+03	6.1700E+00	6.2500E-01	6.7000E-02	-0.		
			MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	IMZ*DX(N,N+1)	P(N)/Y
12	-0	1	1.4050E+02	2.9000E+01	1.3000E-02	5.2000E+01	1.0100E+00	-0.	-0.
			MZB*DX(N)	IMX*DX(N)	ZBB(N,N+1)	DX/GJE(N,N+1)	U(N)		
			9.2620E+03	5.6600E+00	-1.2500E-01	7.2000E-02	-0.		
			MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	IMZ*DX(N,N+1)	P(N)/Y
13	-0	1	1.3600E+02	2.8000E+01	1.5000E-02	5.2000E+01	1.0300E+00	-0.	-0.
			MZB*DX(N)	IMX*DX(N)	ZBB(N,N+1)	DX/GJE(N,N+1)	U(N)		
			8.3000E+03	4.9190E+00	-1.1250E+00	7.9000E-02	-0.		
			MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	IMZ*DX(N,N+1)	P(N)/Y
14	-0	1	1.2500E+02	2.7000E+01	1.7000E-02	5.2000E+01	1.0700E+00	-0.	-0.
			MZB*DX(N)	IMX*DX(N)	ZBB(N,N+1)	DX/GJE(N,N+1)	U(N)		
			7.3500E+03	4.1200E+00	-6.2500E-01	9.1000E-02	-0.		
			MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	IMZ*DX(N,N+1)	P(N)/Y
15	-0	1	1.3400E+02	2.6000E+01	2.1000E-02	5.2000E+01	1.1200E+00	-0.	-0.
			MZB*DX(N)	IMX*DX(N)	ZBB(N,N+1)	DX/GJE(N,N+1)	U(N)		
			7.5190E+03	4.0000E+00	1.3750E+00	1.1400E-01	-0.		

```
                      MASS      WATER INERTIA     DX/EI(N)        DX(N,N+1)  DX/KAG(N,N+1)  IMZ*DX(N,N+1)      P(N)/Y
16      -0      1   1.4500E+02    2.6000E+01     2.7000E-02      5.2000E+01    1.2600E+0C     -0.              -0.
                    MZB*DX(N)     IMX*DX(N)      ZBB(N,N+1)    DX/GJE(N,N+1)      U(N)
                    7.0680E+03    4.0500E+00     5.0000E+00      1.5300E-01   -0.

                      MASS      WATER INERTIA     DX/EI(N)        DX(N,N+1)  DX/KAG(N,N+1)  IMZ*DX(N,N+1)      P(N)/Y
17      -0      1   1.1830E+02    2.5000E+01     3.6000E-02      5.2000E+01    1.5700E+00     -0.              -0.
                    MZB*DX(N)     IMX*DX(N)      ZBB(N,N+1)    DX/GJE(N,N+1)      U(N)
                    6.3370E:03    3.1500E+00     8.2500E+00      2.1700E-01   -0.

                      MASS      WATER INERTIA     DX/EI(N)        DX(N,N+1)  DX/KAG(N,N+1)  IMZ*DX(N,N+1)      P(N)/Y
18      -0      1   8.1000E+01    2.0000E+01     5.4000E-02      5.2000E+01    2.2400E+00     -0.              -0.

                    MZB*DX(N)     IMX*DX(N)      ZBB(N,N+1)    DX/GJE(N,N+1)      U(N)
                    4.4000E+03    2.1900E+00     9.2500E+00      3.5500E-01   -0.

                      MASS      WATER INERTIA     DX/EI(N)        DX(N,N+1)  DX/KAG(N,N+1)  IMZ*DX(N,N+1)      P:N)/Y
19      -0      1   6.7000E+01    1.2000E+01     9.7000E-02      5.2000E+01    4.2100E+00     -0.              -0.
                    MZB*DX(N)     IMX*DX(N)      ZBB(N,N+1)    DX/GJE(N,N+1)      U(N)
                    3.0680E+03    1.2000E+00     9.2500E+00      6.7400E-01   -0.

                      MASS      WATER INERTIA     DX/EI(N)        DX(N,N+1)  DX/KAG(N,N+1)  IMZ*DX(N,N+1)      P(N)/Y
20       1      1   5.4000E+01    4.0000E+00     2.5000E-01      5.2000E+01   -0.             -0.              -0.
                    MZB*DX(N)     IMX*DX(N)      ZBB(N,N+1)    DX/GJE(N,N+1)      U(N)
                    2.9450E+03    1.9000E+00    -0.             -0.            -0.
THE NUMBER OF NATURAL FREQUENCIES REQUESTED IS  1
```

```
THE MINIMUM AMOUNT OF OPEN CORE NEEDED FOR THE STEADY-STATE PORTION OF THIS PROBLEM IS 005366(OCTAL) WORDS

DIMENSIONS FOR ARRAYS

 DIMENSION  1 =  60
 DIMENSION  2 =  20
 DIMENSION  3 =  72
 DIMENSION  4 =   6
 DIMENSION  5 =   5
 DIMENSION  6 =  -0
 DIMENSION  7 =  -0
 DIMENSION  8 =  -0
 DIMENSION  9 =  -0
 DIMENSION 10 =  -0
 DIMENSION 11 =  -0
 DIMENSION 12 =  -0
 DIMENSION 13 =  -9
 DIMENSION 14 =   1
 DIMENSION 15 =   1

CM REDUCED TO 074300 (OCTAL)

 THE NUMBER OF NATURAL FREQUENCIES FOUND IS  1
```

GBRP

COUPLED BENDING AND TORSION

NATURAL FREQUENCY CALCULATION AND CHECK OF MODE ACCURACY

FREQUENCY 1.25 CPS

SECTION		REAL PART	IMAG PART	ABS VALUE	PHASE ANGLE
1	DEFLECTION	1.0000E+00	0.	1.0000E+00	0.
	MOMENT	-4.3173E-05	0.	4.3173E-05	0.
	TWIST	-5.7101E-03	0.	5.7101E-03	0.
2	DEFLECTION	7.6809E-01	0.	7.6809E-01	0.
	MOMENT	1.4001E+05	0.	1.4001E+05	0.
	TWIST	-5.5765E-03	0.	5.5765E-03	0.
3	DEFLECTION	5.3557E-01	0.	5.3557E-01	0.
	MOMENT	5.3001E+05	0.	5.3001E+05	0.
	TWIST	-5.2111E-03	0.	5.2111E-03	0.
4	DEFLECTION	3.0714E-01	0.	3.0714E-01	0.
	MOMENT	1.1854E+06	0.	1.1854E+06	0.
	TWIST	-4.6602E-03	0.	4.6602E-03	0.
5	DEFLECTION	8.4986E-02	0.	8.4986E-02	0.
	MOMENT	2.0934E+06	0.	2.0934E+06	0.
	TWIST	-4.0196E-03	0.	4.0196E-03	0.
6	DEFLECTION	-1.2410E-01	0.	1.2410E-01	0.
	MOMENT	3.1566E+06	0.	3.1566E+06	0.
	TWIST	-3.2590E-03	0.	3.2590E-03	0.
7	DEFLECTION	-3.1035E-01	0.	3.1035E-01	0.
	MOMENT	4.2457E+06	0.	4.2457E+06	0.
	TWIST	-2.5090E-03	0.	2.5090E-03	0.

8	DEFLECTION	-4.6452E-01	0.	4.6452E-01	0.
	MOMENT	5.2266E+06	0.	5.2266E+06	0.
	TWIST	-1.8597E-03	0.	1.8597E-03	0.
9	DEFLECTION	-5.7820E-01	0.	5.7820E-01	0.
	MOMENT	5.9727E+06	0.	5.9727E+06	0.
	TWIST	-1.3640E-03	0.	1.3640E-03	0.
10	DEFLECTION	-6.4836E-01	0.	6.4836E-01	0.
	MOMENT	6.4134E+06	0.	6.4134E+06	0.
	TWIST	-1.0611E-03	0.	1.0611E-03	0.
11	DEFLECTION	-6.7153E-01	0.	6.7153E-01	0.
	MOMENT	6.5103E+06	0.	6.5103E+06	0.
	TWIST	-9.7176E-04	0.	9.7176E-04	0.
12	DEFLECTION	-6.4372E-01	0.	6.4372E-01	0.
	MOMENT	6.2411E+06	0.	6.2411E+06	0.
	TWIST	-1.1237E-03	0.	1.1237E-03	0.
13	DEFLECTION	-5.6700E-01	0.	5.6700E-01	0.
	MOMENT	5.6402E+06	0.	5.6402E+06	0.
	TWIST	-1.5258E-03	0.	1.5258E-03	0.
14	DEFLECTION	-4.4046E-01	0.	4.4046E-01	0.
	MOMENT	4.7827E+06	0.	4.7827E+06	0.
	TWIST	-2.1727E-03	0.	2.1727E-03	0.
15	DEFLECTION	-2.6773E-01	0.	2.6773E-01	0.
	MOMENT	3.7623E+06	0.	3.7623E+06	0.
	TWIST	-3.0423E-03	0.	3.0429E-03	0.
16	DEFLECTION	-5.3617E-02	0.	5.3617E-02	0.
	MOMENT	2.6783E+06	0.	2.6783E+06	0.
	TWIST	-4.1422E-03	0.	4.1422E-03	0.

17	DEFLECTION	1.9445E-01	0.	1.9445E-01	0.
	MOMENT	1.6690E+06	0.	1.6690E+06	0.
	TWIST	-5.3950E-03	0.	5.3950E-03	0.
18	DEFLECTION	4.6920E-01	0.	4.6920E-01	0.
	MOMENT	8.5774E+05	0.	8.5774E+05	0.
	TWIST	-6.7123E-03	0.	6.7123E-03	0.
19	DEFLECTION	7.6504E-01	0.	7.6504E-01	0.
	MOMENT	2.9219E+05	0.	2.9219E+05	0.
	TWIST	-8.1964E-03	0.	8.1964E-03	0.
20	DEFLECTION	1.0725E+00	0.	1.0725E+00	0.
	MOMENT	-5.7682E-05	0.	5.7682E-05	0.
	TWIST	-9.9357E-03	0.	9.9357E-03	0.

ACCURACY CHECK ON COMPUTED MODE

SUMMATION OF (MU * DELTAX) * Y - (MU * DELTAX * ZBAR) * PHI OVER ALL SECTIONS

REAL PART = 1.5681E-06 IMAGINARY PART = 0.

SUMMATION OF (INUX * DELTAX) * PHI - (MU * DELTAX * ZBAR) * Y OVER ALL SECTIONS

REAL PART = -1.9179E-08 IMAGINARY PART = 0.

GBRP NOV. 1974
COUPLED BENDING AND TORSION

DATA CONTROL CARD

NO TYPE

END GBRP RUN

ELAPSED TIME AT EXIT FROM GBRP = 1.788E+02 SECONDS

V. SC-4020 PLOTTING OF OUTPUT

The original plotting capabilities of GBRP corresponded essentially to the two types of tabular edit provided for computed results: 1) a printout of the magnitude of the computed response versus frequency for one to five beam sections designated by the user, and 2) a printout of the real and imaginary parts, magnitude, and phase angle of response at each frequency for every beam section. That is, the plotting subroutines provided a pictorial representation of 1) and 2) on an xy coordinate system with linear scales.

The original subroutines have been modified to make use of the North American Aviation Company's SC-4020 software plotting programs available on the CDC-series computing facilities at the Center. At the time of this modification, changes were also introduced into GBRP's selected edit (item 1, above) plotting capability to meet needs arising in particular applications. One change involved the use of North American's capabilities to obtain the response vs. frequency plots on semi-logarithmic grids (logarithmic for response, linear for frequency). This type of plot is more advantageous for engineering use than the linear-linear plots formerly produced by GBRP.

More basic changes were involved in the GBRP strategy which governed the external storage (i.e., disk) of computed results for editing. Consider how the strategy functioned when computations were made for a basic data set followed by a series of cases specifying alterations in the basic set (Figure 5): computed results (displacements, moments, etc.) for any single case were retained in storage only while that case was being computed, and all editing of the results, tabular and graph, had to be completed before the next case began. One could obtain then for each case, k "selected edit"

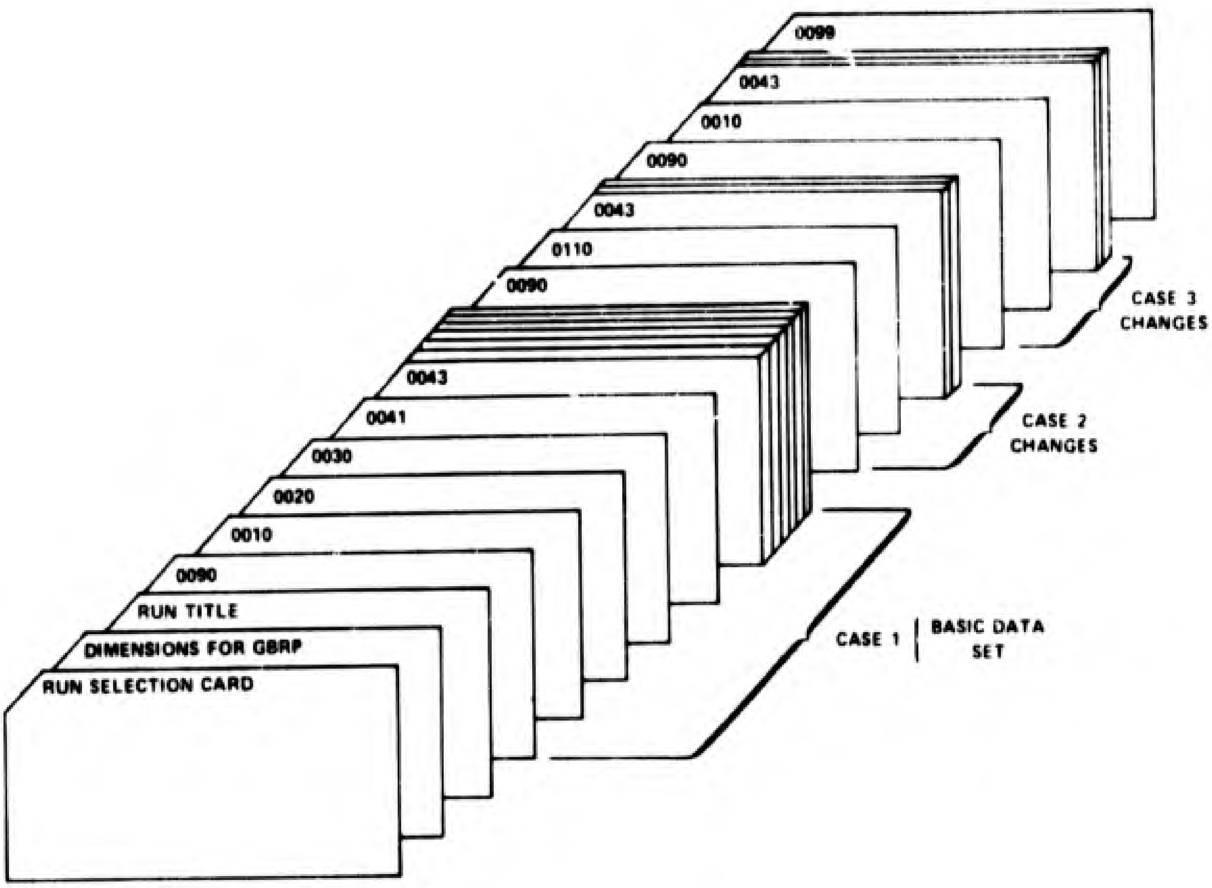

Figure 5. GBRP Data Deck Configuration for a Basic Data Set and Series of Data Change Sets

graphs, k depending upon the choice for option 7 (OP7), and k x m "detailed edit" (item 2, page 49) graphs where m is the total number of forced responses or natural frequencies computed.

The above strategy was modified to allow a more general application of the "selected edit" plotting. As part of this modification a new control variable NPLOTC is introduced on the "30" card and used in conjunction with option 4 (OP4), the "selected edit" graphing option (OP7) and option 8 (OP8) to designate the type of plot desired. The use of the augmented OP7 capability can be conveniently summarized by presenting the possible combinations of problem data deck with plotting selections. However, note that GBRP allows series of problem data decks to be stacked together through use of "98" (New Set of Data Indicator) cards, but that plotting selections hold only for the duration of the particular problem with which they are specified.

1. Problem data deck consists of a single case (i.e., contains one type "90" (Data Control Card))

   or

   Problem data deck consists of a series of cases (i.e., more than one "90" type card)

   and

   User requires the "selected edit" graph results to be performed on a case by case basis

   OPTION 4 = 1
   OPTION 7 = choice depending on variables to be plotted
   NPLOTC = 0

2. Problem data deck consists of a series of cases

   and

   a. User requires the "selected edit" graph results from all cases to be superimposed on a single frame

OPTION 4 = 1

NPLOTC = total number of type "90" cards +1

OPTION 8 = 0002

OPTION 7 = choice depending on variables to be plotted

or

b. User requires "selected edit" response results for each variable of interest to be graphed as a single curve over the frequency range encompassed by all cases

OPTION 4 = 0 for all cases up to but not including the last case to be plotted, for which it is 1*

OPTION 8 = 2

NPLOTC = 0

OPTION 7 = choice depending on variables to be plotted

* Two "20" cards are used to obtain this type of plot: the first, provided with the basic data set, has OP4=0 with OP8 and OP7 as given above; the last, appearing with the final case to be plotted, has OP4=1 with the original entries for OP8 and OP7 repeated.

Three sample calculations demonstrate "selected edit" plotting of a ship hull's response to a time harmonic excitation force over a range of frequencies of the force. The hull is idealized as a nonuniform beam which in turn is represented by a 20-section lumped mass-elastic model (Figure 6).

For the first calculation, which demonstrates case by case plotting of response, the sample data were set up to simulate a 2-case problem.

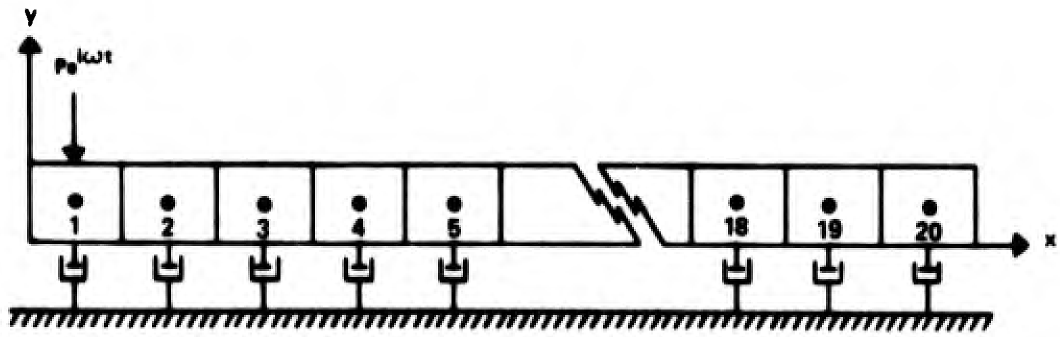

Figure 6. Nonuniform Beam Idealization of Ship Hull

The sections selected for response plots, numbers 5 and 15, are indicated on the type "21" (EDIT CONTROL) card. As many as five sections can be designated.

The plotting characters used to identify the response curves are read in as data from the type "60" (CHARACTRON PLOTTING CHARACTORS) card in the usual manner and can be any letters of the alphabet, any integer from 0 to 9 or any of the following symbols: = . - , ( ) + * $ / " Note that the charactor fields of the "60" card now have <u>10</u> places instead of 6 and that the plotting charactor is placed in the <u>first</u> instead of last space in the field.

For brevity, we present only the "selected edit" table output from GBRP, omitting the "detailed edit" of response at every section for each frequency.

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL ______ SHEET 1 OF 8

RUN SELECTION CARD ______

1
1

DIMENSIONS FOR FAST FOURIER TRANSFORM INTERFACE (NONHARMONIC VIBRATIONS ONLY) ______

D16	D17	D18	D19
1	4	7	10

DATA FOR FAST FOURIER TRANSFORM INTERFACE (NONHARMONIC VIBRATIONS ONLY) ______

1	6	11	17	23	27	31	35	43	51	59	61	63	65	67

DIMENSIONS FOR GBRP ______

D2	D3	D5	D14	D15	D6	D7	D8	D9	D10	D11	D12	D13
020	027	005					020				004	020
1	4	7	10	13	16	19	22	25	28	31	34	37

Data Input Form (1)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [ ] ______ SHEET 2 OF 2

RUN TITLE CARD

ΔΔΔΔΔΔΔΔΔΔΔΔ FORCED RESPONSE OF HULL (col. 13)

DATA CONTROL CARD

NO TYPE NO TYPE etc.

0090 | 01 | 10 | 01 | 20 | 01 | 21 | 01 | 30 | 01 | 41 | 20 | 43 | 01 | 60 |

CASE TITLE CARD

001000ΔΔΔΔΔΔ UNDAMPED RESPONSE (col. 13)

OPTION CONTROL CARD

	OP1	OP2	OP3	OP4	OP5	OP6	OP7	OP8	OP9	OP10
00200000				0001			0001			
(col.)	9	13	17	21	25	29	33	37	41	45

EDIT CONTROL CARD

00210000	0005	0015				
(col.)	9	13	17	21	25	29

GENERAL DATA CARD

	NO SECTIONS	ω_1(CPS)	ω_2(CPS)	$\Delta\omega$(CPS)	h	Power of ω	NPLOTC
0030	0020	1.0	20.0	1.0			
(col.)	5	9	17	25	33	41	49

SYSTEMS DATA CARDS

	SYSTEMS	RADIUS	INITIAL J
0031			
0031			
(col.)	7	9	17

FORCING FUNCTION LOCATION CARD ______ (Used only if forces are nonharmonic)

0032

Data Input Form (2)

Bending, Longitudinal, Torsional

TITLE ______________________ PROGRAMMER ______________________ DATE ______________

PROBLEM NO. ______________________ PHASE ________ LABEL [| | |] ________ SHEET 3 OF 8

SECTION DATA CARDS

5	9	13	17	25	33	41	49	57	65	73
SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I\mu_z \Delta X)_{n,n+1}$	P_n	
REAL PART OF SCALING FACTORS										
00410000	0000	0001	1.0		1.0E-09	1.0	1.0E-05		1.0	
00410000	0000									
00410000	0000									
IMAGINARY PART OF SCALING FACTORS										
00420000	0000									
00420000	0000									
00420000	0000									
PARAMETER VALUES - UNSCALED										
0043 0001	0001	0001	14.5		3.61	29.25	1.29		1.0	
0043 0002		0001	9.3		2.76	29.25	0.92			
0043 0003		0001	22.1		1.12	29.25	0.236			
0043 0004		0001	37.2		0.712	29.25	0.289			
0043 0005		0001	20.8		0.671	29.25	0.246			
0043 0006		0001	51.3		0.653	29.25	0.245			
0043 0007		0001	22.4		0.729	29.25	0.418			
0043 0008		0001	31.8		0.750	29.25	0.397			
0043 0009		0001	36.0		0.637	29.25	0.321			
0043 0010		0001	34.6		0.653	29.25	0.311			
0043 0011		0001	29.6		0.750	29.25	0.311			
0043 0012		0001	41.2		0.709	29.25	0.342			
0043 0013		0001	30.8		0.715	29.25	0.303			
0043 0014		0001	18.7		0.770	29.25	0.389			
0043 0015		0001	24.4		0.887	29.25	0.371			

Data Input Form (3)

Bending, Longitudinal, Torsional

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL ☐☐☐☐ ______ SHEET 4 OF 8

SECTION PARAMETER VALUES - UNSCALED

	5 SECTION NO.	9 END CONDN	13 SYSTEM	17 MASS	25 WATER INERTIA	33 $(\Delta X/EI)_n$	41 $(\Delta X)_{n,n+1}$	49 $(\Delta X/KAG)_{n,n+1}$	57 $(I_{\mu z}\Delta X)_{n,n+1}$	65 P_n	73
0043	0016		0001	22.2		1.17	29.25	0.420			
0043	0017		0001	25.6		1.61	29.25	0.488			
0043	0018		0001	20.2		2.17	29.25	0.616			
0043	0019		0001	17.6		2.53	29.25	0.849			
0043	0020	0001	0001	18.6		6.89					
0043											
0043											
0043											
0043											
0043											
0043											
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0043											
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0043											
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0043											
0043											
0043											
0043											
0043											

Data Input Form (4)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [| | |] ______ SHEET 5 OF 7

CHARACTRON PLOTTING CHARACTERS ______

✓ 006000 | ΔΔΔΔΔΔΔΔΔΔ | +ΔΔΔΔΔΔΔΔΔ | 0ΔΔΔΔΔΔΔΔΔ | XΔΔΔΔΔΔΔΔΔ | −ΔΔΔΔΔΔΔΔΔ | •ΔΔΔΔΔΔΔΔΔ |

34 7 17 27 37 47 57

NATURAL FREQUENCY SELECTION CARD ______

00700000 | |

34 9 11

SYSTEMS TO BE PLOTTED (USED ONLY WITH OPTION 6 PLOTTING) ______

1st 2nd 3rd 4th 5th 6th

| | | | | | | etc.

1 3 5 7 9 11

START NEW DATA SET CARD ______

0098

34

END OF DATA CARD ______

0099

34

Δ indicates blank space

Data Input Form (16)

TITLE ________ PROGRAMMER ________ DATE ________

PROBLEM NO ________ PHASE ________ LABEL [| | |] ________ SHEET 6 OF 8

RUN TITLE CARD

ΔΔΔΔΔΔΔΔΔΔΔΔ ________ (13)

DATA CONTROL CARD

NO TYPE NO TYPE etc

✓ 0090 | 01 | 10 | 01 | 42 | ...

5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71

CASE TITLE CARD

✓ 001000ΔΔΔΔΔΔ RESPONSE WITH DAMPING INCLUDED (13)

OPTION CONTROL CARD

	OP1	OP2	OP3	OP4	OP5	OP6	OP7	OP8	OP9	OP10
00200000										
	9	13	17	21	25	29	33	37	41	45

EDIT CONTROL CARD

00210000					
	9	13	17	21	25

(29)

GENERAL DATA CARD

	NO SECTIONS	ω_1 (CPS)	ω_2 (CPS)	$\Delta\omega$ (CPS)	h	Power of ω	NPLOTC
0030							
	5	9	17	25	33	41	49

(57)

SYSTEMS DATA CARDS

	SYSTEMS	RADIUS	INITIAL J
0031			
0031			
	7	9	17

FORCING FUNCTION LOCATION CARD ________ (Used only if forces are nonharmonic)

0032 | | | | ...

5 7 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78

Data Input Form (2)

Bending, Longitudinal, Torsional

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [| | |] ______ SHEET 7 OF 8

SECTION DATA CARDS

5	9	13	17	25	33	41	49	57	65	73
SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z} \Delta X)_{n,n+1}$	P_n	
REAL PART OF SCALING FACTORS										
00410000	0000									
00410000	0000									
00410000	0000									
IMAGINARY PART OF SCALING FACTORS										
✓ 00420000	0000	0001	0.3							
00420000	0000									
00420000	0000									
PARAMETER VALUES - UNSCALED										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										

Data Input Form (3)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [| | |] ______ SHEET 8 OF 8

CHARACTRON PLOTTING CHARACTERS

006000	ΔΔΔΔΔΔΔΔΔΔ	+ΔΔΔΔΔΔΔΔΔ	0ΔΔΔΔΔΔΔΔΔ	XΔΔΔΔΔΔΔΔΔ	–ΔΔΔΔΔΔΔΔΔ	•ΔΔΔΔΔΔΔΔΔ
34	7	17	27	37	47	57

NATURAL FREQUENCY SELECTION CARD

00700000	
34	9 11

SYSTEMS TO BE PLOTTED (USED ONLY WITH OPTION 6 PLOTTING)

1st	2nd	3rd	4th	5th	6th	
						etc.
1	3	5	7	9	11	

START NEW DATA SET CARD

0098
34

END OF DATA CARD

0099
34

Δ indicates blank space

Data Input Form (16)

```
THERE ARE 011110(OCTAL) WORDS OF OPEN-CORE AVAILABLE FOR THIS PROBLEM

ELAPSED TIME AT ENTRY INTO GBRP =     1.712E+02   SECONDS



 GBRP    NOV. 1974
 FORCED RESPONSE OF HULL

DATA CONTROL CARD

NO  TYPE

 1   10
 1   20
 1   21
 1   30
 1   41
20   43
 1   60

CASE TITLE-UNDAMPED RESPONSE

OPTION DATA
 20       -0  -0  -0   1  -0  -0   1  -0  -0  -0

OPTION DATA
 21        5  15  -0  -0  -0  -0  -0  -0  -0  -0

GENERAL DATA -  NUMBER OF SECTIONS    20
                 FREQUENCY RANGE FROM       1.000 CPS  TO     20.000 CPS
                 FREQUENCY INTERVAL    1.000 CPS
                 POWER OF FREQUENCY = -0.000


REAL PARTS OF SCALING FACTORS

SECTION-END CONDN-SYSTEM      MASS      WATER INERTIA     DX/EI(N)       DX(N,N+1)   DX/KAG(N,N+1)  IMZ*DX(N,N+1)       P(N)/Y

                     1    1.0000E+00     1.0000E+00     1.0000E-09     1.0000E+00     1.0000E-05   -0.                1.0000E+00
```

PARAMETER VALUES FOR EACH SECTION - UNSCALED

SECTION	END CONDN	SYSTEM	MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	IMZ*DX(N,N+1)	P(N)/Y
1	1	1	1.4500E+01	-0.	3.6100E+00	2.9250E+01	1.2300E+00	-0.	1.0000E+00
2	-0	1	9.3000E+00	-0.	2.7600E+00	2.9250E+01	9.2000E-01	-0.	-0.
3	-0	1	2.3100E+01	-0.	1.1200E+00	2.9250E+01	2.9600E-01	-0.	-0.
4	-0	1	3.7200E+01	-0.	7.1200E-01	2.9250E+01	2.8900E-01	-0.	-0.
5	-0	1	2.8800E+01	-0.	6.7100E-01	2.9250E+01	2.4500E-01	-0.	-0.
6	-0	1	5.1300E+01	-0.	6.5300E-01	2.9250E+01	2.4500E-01	-0.	-0.
7	-0	1	2.9400E+01	-0.	7.2900E-01	2.9250E+01	4.1800E-01	-0.	-0.
8	-0	1	3.1800E+01	-0.	7.5000E-01	2.9250E+01	3.9700E-01	-0.	-0.
9	-0	1	3.6000E+01	-0.	6.3700E-01	2.9250E+01	3.2100E-01	-0.	-0.
10	-0	1	3.4600E+01	-0.	6.5300E-01	2.9250E+01	3.1100E-01	-0.	-0.
11	-0	1	2.9600E+01	-0.	7.5000E-01	2.9250E+01	3.1100E-01	-0.	-0.
12	-0	1	4.1200E+01	-0.	7.0800E-01	2.9250E+01	2.4200E-01	-0.	-0.
13	-0	1	3.0800E+01	-0.	7.1500E-01	2.9250E+01	3.0300E-01	-0.	-0.
14	-0	1	1.8700E+01	-0.	7.9000E-01	2.9250E+01	3.8900E-01	-0.	-0.
15	-0	1	2.4400E+01	-0.	8.8700E-01	2.9250E+01	3.7100E-01	-0.	-0.
16	-0	1	2.2200E+01	-0.	1.1700E+00	2.9250E+01	4.2000E-01	-0.	-0.
17	-0	1	2.5600E+01	-0.	1.6100E+00	2.9250E+01	4.8800E-01	-0.	-0.
18	-0	1	2.0200E+01	-0.	2.1700E+00	2.9250E+01	6.1600E-01	-0.	-0.
19	-0	1	1.7600E+01	-0.	2.5300E+00	2.9250E+01	8.4900E-01	-0.	-0.
20	1	1	1.8600E+01	-0.	6.8900E+00	-0.	-0.	-0.	-0.

CHARACTRON PLOTTING CHARACTERS
CHAR(1) =
CHAR(2) =+
CHAR(3) =0
CHAR(4) =X
CHAR(5) =-
CHAR(6) =.

THE MINIMUM AMOUNT OF OPEN CORE NEEDED FOR THE STEADY-STATE PORTION OF THIS PROBLEM IS 002621(OCTAL) WORDS

```
DIMENSIONS FOR ARRAYS

 DIMENSION  1 =  40
 DIMENSION  2 =  20
 DIMENSION  3 =  27
 DIMENSION  4 =   4
 DIMENSION  5 =   5
 DIMENSION  6 =  -0
 DIMENSION  7 =  -0
 DIMENSION  8 =  20
 DIMENSION  9 =  -0
 DIMENSION 10 =  -0
 DIMENSION 11 =  -0
 DIMENSION 12 =   4
 DIMENSION 13 =  20
 DIMENSION 14 =   1
 DIMENSION 15 =   1

CM REDUCED TO 071600 (OCTAL)
```

GBRP

FORCED RESPONSE OF HULL

FREQUENCY CPS	DEFLECTION SECTION 5	MOMENT SECTION 5	DEFLECTION SECTION 15	MOMENT SECTION 15	DEFLECTION SECTION	MOMENT	DEFLECTION	MOMENT	DEFLECTION	MOMENT
1.00	1.313E-04	9.235E+01	2.982E-05	4.401E+01						
2.00	1.319E-05	2.676E+02	2.664E-05	3.164E+02						
3.00	3.339E-05	4.559E+01	1.991E-05	9.460E+01						
4.00	3.002E-05	1.463E+02	3.038E-05	1.272E+02						
5.00	5.794E-06	1.453E+02	4.373E-05	1.836E+02						
6.00	1.182E-05	3.263E+01	2.051E-05	8.938E+01						
7.00	3.378E-05	2.893E+02	4.042E-05	1.797E+02						
8.00	9.251E-07	3.853E+01	5.135E-06	2.067E+01						
9.00	2.551E-05	1.513E+02	2.785E-06	1.547E+01						
10.00	7.232E-06	7.311E+01	2.851E-06	2.384E+01						
11.00	3.978E-06	5.359E+01	6.755E-06	4.801E+01						
12.00	2.485E-06	2.163E+01	8.235E-06	5.497E+01						
13.00	2.551E-06	2.969E+01	5.195E-06	3.324E+01						
14.00	4.931E-07	2.544E+00	9.031E-06	5.564E+01						
15.00	1.229E-06	1.697E+01	1.612E-06	9.466E+00						
16.00	2.040E-06	2.632E+01	1.393E-06	7.398E+00						
17.00	1.053E-06	8.864E+00	9.412E-07	2.771E+00						
18.00	8.536E-07	1.309E+01	2.767E-07	3.310E+00						
19.00	5.831E-06	7.302E+01	8.305E-06	6.676E+01						
20.00	1.884E-06	2.604E+01	2.302E-06	1.678E+01						

GBRP NOV. 1974
FORCED RESPONSE OF HULL

DATA CONTROL CARD

NO	TYPE
1	10
1	42

CASE TITLE-RESPONSE WITH DAMPING INCLUDED

IMAGINARY PARTS OF SCALING FACTORS

SECTION-END CONDN-SYSTEM	MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	IMZ*DX(N,N+1)	P(N)/Y
1	3.0000E-01	-0.	-0.	-0.	-0.	-0.	-0.

GBRP

FORCED RESPONSE OF HULL

FREQUENCY CPS	DEFLECTION SECTION 5	MOMENT	DEFLECTION SECTION 15	MOMENT	DEFLECTION SECTION	MOMENT	DEFLECTION	MOMENT	DEFLECTION	MOMENT
1.00	1.261E-04	9.217E+01	2.079E-05	4.386E+01						
2.00	4.090E-05	1.466E+02	1.984E-05	1.590E+02						
3.00	3.010E-05	5.974E+01	1.722E-05	7.795E+01						
4.00	2.274E-05	1.150E+02	2.069E-05	8.490E+01						
5.00	1.100E-05	8.722E+01	1.745E-05	7.283E+01						
6.00	9.896E-06	6.423E+01	1.062E-05	4.672E+01						
7.00	7.958E-06	7.142E+01	6.262E-06	2.910E+01						
8.00	4.919E-06	5.003E+01	2.854E-06	1.427E+01						
9.00	4.827E-06	4.879E+01	1.784E-06	1.089E+01						
10.00	3.707E-06	4.258E+01	1.507E-06	1.027E+01						
11.00	2.612E-06	3.293E+01	1.425E-06	9.609E+00						
12.00	1.959E-06	2.567E+01	1.157E-06	7.543E+00						
13.00	1.544E-06	2.105E+01	8.241E-07	5.203E+00						
14.00	1.246E-06	1.763E+01	5.286E-07	3.279E+00						
15.00	1.077E-06	1.551E+01	3.230E-07	2.014E+00						
16.00	9.634E-07	1.389E+01	2.073E-07	1.323E+00						
17.00	8.672E-07	1.240E+01	1.428E-07	9.502E-01						
18.00	8.178E-07	1.140E+01	1.093E-07	7.476E-01						
19.00	7.977E-07	1.062E+01	8.820E-08	5.976E-01						
20.00	7.651E-07	9.540E+00	6.580E-08	4.541E-01						

```
GBRP   NOV. 1974
FORCED RESPONSE OF HULL

DATA CONTROL CARD

NO  TYPE

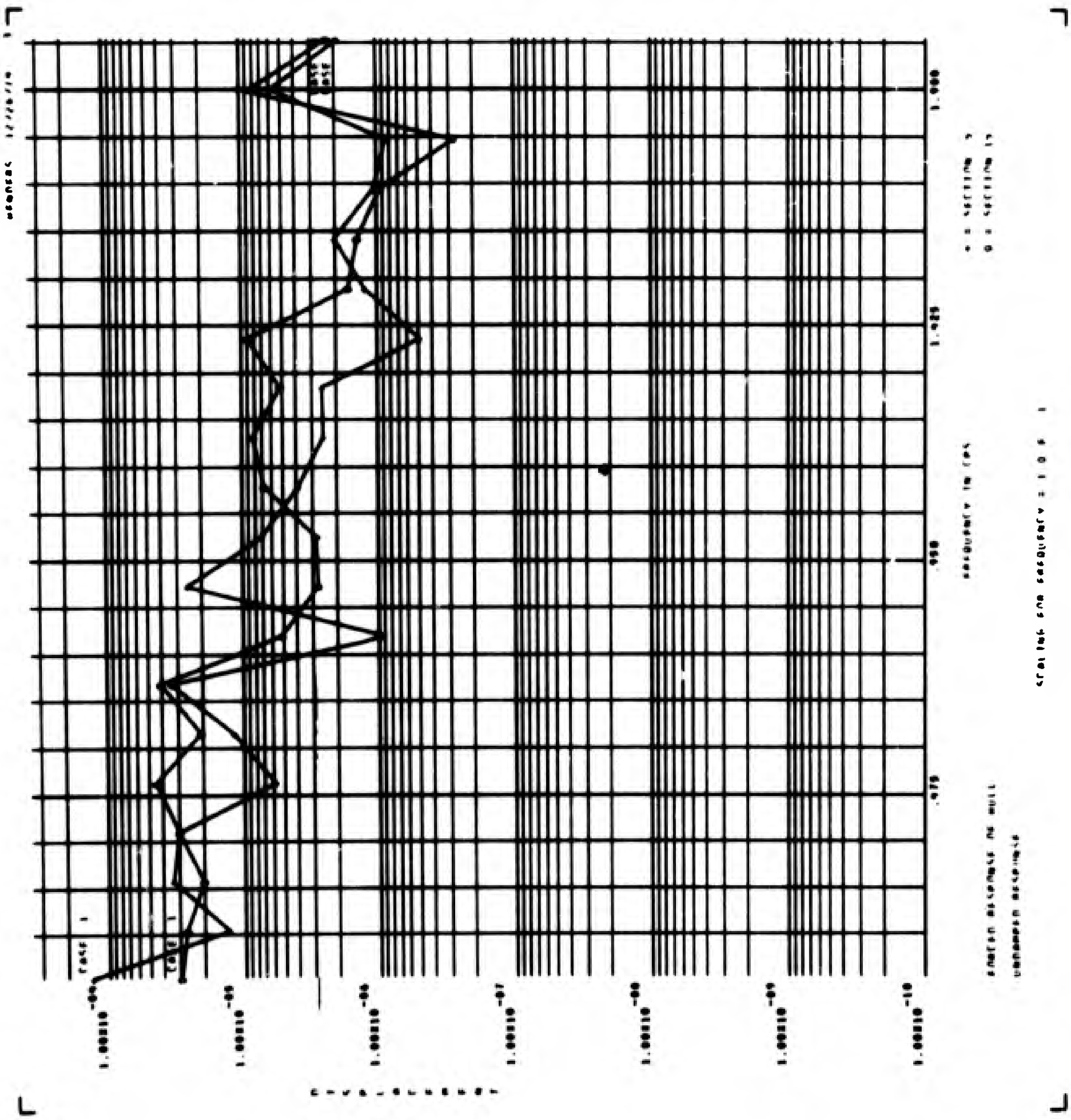


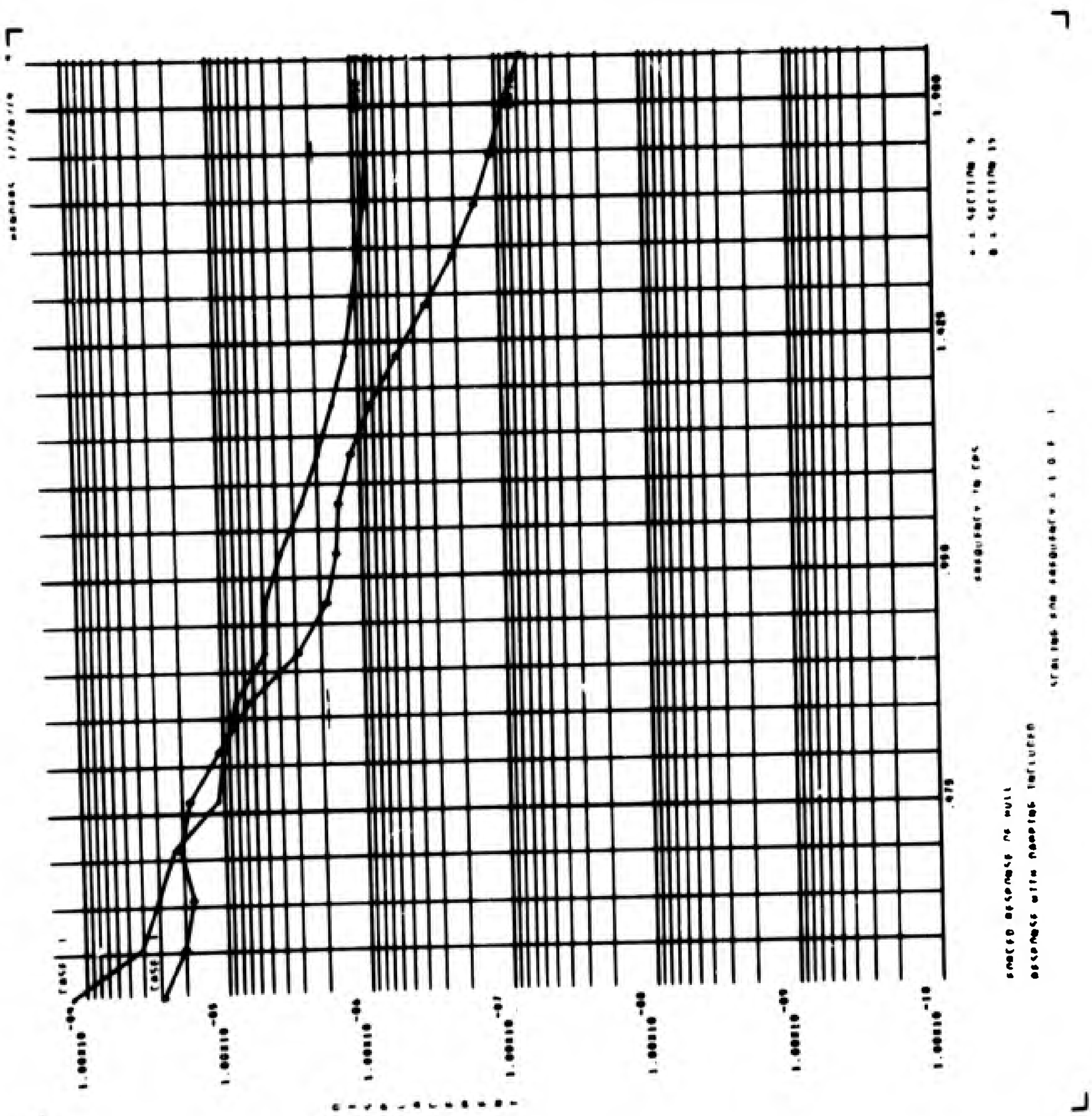
END GBRP  RUN



 THE NUMBER OF SC 4020 FRAMES IN THIS FILE IS        6

ELAPSED TIME AT EXIT FROM GBRP =    1.034E+02  SECONDS
```





The second sample calculation illustrates how the comparison of response curves from several cases can be facilitated by superimposing them on a single frame (2a., pg. 51). This type of plotting assumes that the response is calculated over the same frequency range and with the same increment of frequency, $\Delta\omega$, for each case to be superimposed.

This calculation uses the input data from the first calculation (pgs. 54-61) changing only the type "20" and "30" cards in the first case (undamped response) and the "10" card for the second case as indicated on page 71.

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [| | |] ______ SHEET ____ OF ____

RUN TITLE CARD ______

ΔΔΔΔΔΔΔΔΔΔΔΔ ______ (13)

DATA CONTROL CARD ______

NO TYPE NO TYPE etc.

0090 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71

(second case) CASE TITLE CARD ______

001000ΔΔΔΔΔΔ COMPARISON OF DAMPED, UNDAMPED RESPONSE (13)

OPTION CONTROL CARD ______

(first case)

	OP1	OP2	OP3	OP4	OP5	OP6	OP7	OP8	OP9	OP10
00200000				0001			0001	0002		
	9	13	17	21	25	29	33	37	41	45

EDIT CONTROL CARD

00210000					
	9	13	17	21	25 29

GENERAL DATA CARD

(first case)

	NO SECTIONS	ω_1 (CPS)	ω_2 (CPS)	$\Delta\omega$ (CPS)	h	Power of ω	NPLOTC
0030	0020	1.0	20.0	1.0			ΔΔΔΔΔΔΔ3
	5	9	17	25	33	41	49 57

SYSTEMS DATA CARDS ______

	SYSTEMS	RADIUS	INITIAL J
0031			
0031			
	7	9	17

FORCING FUNCTION LOCATION CARD ______ (Used only if forces are nonharmonic) ______

0032 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

5 7 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78

Data Input Form (2)

```
THERE ARE 011110(OCTAL) WORDS OF OPEN-CORE AVAILABLE FOR THIS PROBLEM

ELAPSED TIME AT ENTRY INTO GBRP =    1.720E+02  SECONDS



 GBRP   NOV. 1974
 FORCED RESPONSE OF HULL

DATA CONTROL CARD

NO  TYPE

 1   10
 1   20
 1   21
 1   30
 1   41
20   43
 1   60

CASE TITLE-UNDAMPED RESPONSE

OPTION DATA
 20      -0  -0  -0   1  -0  -0   1   2  -0  -0

OPTION DATA
 21       5  15  -0  -0  -0  -0  -0  -0  -0  -0

GENERAL DATA -  NUMBER OF SECTIONS   20
                  FREQUENCY RANGE FROM      1.000 CPS  TO     20.000 CPS
                  FREQUENCY INTERVAL   1.000 CPS
                  POWER OF FREQUENCY = -0.000


REAL PARTS OF SCALING FACTORS

SECTION-END CONDN-SYSTEM    MASS     WATER INERTIA    DX/EI(N)      DX(N,N+1)  DX/KAG(N,N+1)  IMZ*DX(N,N+1)     P(N)/Y

                    1    1.0000E+00    1.0000E+00    1.0000E-09    1.0000E+00    1.0000E-05   -0.             1.0000E+00
```

PARAMETER VALUES FOR EACH SECTION - UNSCALED

SECTION-END CONDN-SYSTEM			MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	IMZ*DX(N,N+1)	P(N)/Y
1	1	1	1.4500E+01	-0.	3.6100E+00	2.9250E+01	1.2300E+00	-0.	1.0000E+00
2	-0	1	9.3000E+00	-0.	2.7600E+00	2.9250E+01	9.2000E-01	-0.	-0.
3	-0	1	2.3100E+01	-0.	1.1200E+00	2.9250E+01	2.9600E-01	-0.	-0.
4	-0	1	3.7200E+01	-0.	7.1200E-01	2.9250E+01	2.8900E-01	-0.	-0.
5	-0	1	2.0000E+01	-0.	6.7100E-01	2.9250E+01	2.4500E-01	-0.	-0.
6	-0	1	5.1300E+01	-0.	6.5300E-01	2.9250E+01	2.4500E-01	-0.	-0.
7	-0	1	2.9400E+01	-0.	7.2900E-01	2.9250E+01	4.1000E-01	-0.	-0.
8	-0	1	3.1800E+01	-0.	7.5000E-01	2.9250E+01	3.9700E-01	-0.	-0.
9	-0	1	3.6000E+01	-0.	6.3700E-01	2.9250E+01	3.2100E-01	-0.	-0.
10	-0	1	3.4600E+01	-0.	6.5300E-01	2.9250E+01	3.1100E-01	-0.	-0.
11	-0	1	2.9600E+01	-0.	7.5000E-01	2.9250E+01	3.1100E-01	-0.	-0.
12	-0	1	4.1200E+01	-0.	7.0800E-01	2.9250E+01	2.4200E-01	-0.	-0.
13	-0	1	3.0000E+01	-0.	7.1500E-01	2.9250E+01	3.0300E-01	-0.	-0.
14	-0	1	1.8700E+01	-0.	7.9000E-01	2.9250E+01	3.8900E-01	-0.	-0.
15	-0	1	2.4400E+01	-0.	8.8700E-01	2.9250E+01	3.7100E-01	-0.	-0.
16	-0	1	2.2200E+01	-0.	1.1700E+00	2.9250E+01	4.2000E-01	-0.	-0.
17	-0	1	2.5600E+01	-0.	1.6100E+00	2.9250E+01	4.8800E-01	-0.	-0.
18	-0	1	2.0200E+01	-0.	2.1700E+00	2.9250E+01	6.1600E-01	-0.	-0.
19	-0	1	1.7600E+01	-0.	2.5300E+00	2.9250E+01	8.4900E-01	-0.	-0.
20	1	1	1.8600E+01	-0.	5.8900E+00	-0.	-0.	-0.	-0.

CHARACTRON PLOTTING CHARACTERS
CHAR(1)=
CHAR(2)=+
CHAR(3)=0
CHAR(4)=X
CHAR(5)=-
CHAR(6)=.

THE MINIMUM AMOUNT OF OPEN CORE NEEDED FOR THE STEADY-STATE PORTION OF THIS PROBLEM IS 002621(OCTAL) WORDS

DIMENSIONS FOR ARRAYS

```
DIMENSION  1 =  40
DIMENSION  2 =  20
DIMENSION  3 =  27
DIMENSION  4 =   4
DIMENSION  5 =   5
DIMENSION  6 =  -0
DIMENSION  7 =  -0
DIMENSION  8 =  20
DIMENSION  9 =  -0
DIMENSION 10 =  -0
DIMENSION 11 =  -0
DIMENSION 12 =   4
DIMENSION 13 =  20
DIMENSION 14 =   1
DIMENSION 15 =   1
```

CM REDUCED TO 071600 (OCTAL)

GBRP

FORCED RESPONSE OF HULL

FREQUENCY CPS	DEFLECTION SECTION 5	MOMENT	DEFLECTION SECTION 15	MOMENT	DEFLECTION SECTION	MOMENT	DEFLECTION	MOMENT	DEFLECTION	MOMENT
1.00	1.313E-04	9.235E+01	2.902E-05	4.401E+01						
2.00	1.319E-05	2.676E+02	2.654E-05	3.164E+02						
3.00	3.339E-05	4.559E+01	1.931E-05	9.460E+01						
4.00	3.002E-05	1.463E+02	3.038E-05	1.272E+02						
5.00	5.794E-06	1.453E+02	4.373E-05	1.836E+02						
6.00	1.192E-05	3.263E+01	2.051E-05	8.930E+01						
7.00	3.378E-05	2.093E+02	4.042E-05	1.797E+02						
8.00	9.251E-07	3.853E+01	5.135E-06	2.067E+01						
9.00	2.551E-05	1.513E+02	2.785E-06	1.547E+01						
10.00	7.232E-06	7.311E+01	2.451E-06	2.384E+01						
11.00	3.878E-06	5.359E+01	6.755E-06	4.801E+01						
12.00	2.485E-06	2.163E+01	8.235E-06	5.497E+01						
13.00	2.551E-05	2.969E+01	5.195E-06	3.324E+01						
14.00	4.931E-07	2.544E+03	9.031E-06	5.564E+01						
15.00	1.229E-06	1.697E+01	1.612E-06	9.466E+00						
16.00	2.040E-05	2.632E+01	1.393E-06	7.388E+00						
17.00	1.053E-06	8.864E+00	9.412E-07	2.771E+00						
18.00	8.536E-07	1.303E+01	2.767E-07	3.310E+00						
19.00	5.831E-06	7.302E+01	8.305E-06	6.676E+01						
20.00	1.884E-06	2.604E+01	2.302E-06	1.678E+01						

GBRP NOV. 1974
FORCED RESPONSE OF HULL

DATA CONTROL CARD

NO	TYPE
1	10
1	42

CASE TITLE-COMPARISON OF DAMPED,UNDAMPED RESPONSE

IMAGINARY PARTS OF SCALING FACTORS

SECTION-END CONDN-SYSTEM	MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	IMZ*DX(N,N+1)	P(N)/Y
1	3.0000E-01	-0.	-0.	-0.	-0.	-0.	-0.

GBRP

FORCED RESPONSE OF HULL

FREQUENCY CPS	DEFLECTION	MOMENT	DEFLECTION	MOMENT	DEFLECTION	MOMENT	DEFLECTION	MOMENT	DEFLECTION	MOMENT
	SECTION 5		SECTION 15		SECTION					
1.00	1.251E-04	9.217E+01	2.879E-05	4.386E+01						
2.00	4.000E-05	1.466E+02	1.904E-05	1.590E+02						
3.00	3.010E-05	5.974E+01	1.722E-05	7.795E+01						
4.00	2.274E-05	1.150E+02	2.069E-05	8.490E+01						
5.00	1.100E-05	8.722E+01	1.745E-05	7.283E+01						
6.00	9.896E-06	6.423E+01	1.062E-05	4.672E+01						
7.00	7.950E-06	7.142E+01	6.262E-06	2.910E+01						
8.00	4.919E-06	5.003E+01	2.054E-06	1.427E+01						
9.00	4.027E-06	4.079E+01	1.704E-06	1.009E+01						
10.00	3.707E-06	4.259E+01	1.507E-06	1.027E+01						
11.00	2.612E-06	3.293E+01	1.425E-06	9.600E+00						
12.00	1.959E-06	2.567E+01	1.157E-06	7.543E+00						
13.00	1.544E-06	2.105E+01	8.241E-07	5.203E+00						
14.00	1.246E-06	1.763E+01	5.286E-07	3.279E+00						
15.00	1.077E-06	1.551E+01	3.239E-07	2.014E+00						
16.00	9.634E-07	1.309E+01	2.073E-07	1.323E+00						
17.00	8.672E-07	1.240E+01	1.420E-07	9.502E-01						
18.00	8.170E-07	1.140E+01	1.099E-07	7.476E-01						
19.00	7.977E-07	1.062E+01	8.820E-08	5.976E-01						
20.00	7.651E-07	9.548E+00	6.598E-08	4.541E-01						

```
GBRP   NOV. 1974
FORCED RESPONSE OF HULL

DATA CONTROL CARD

NO  TYPE

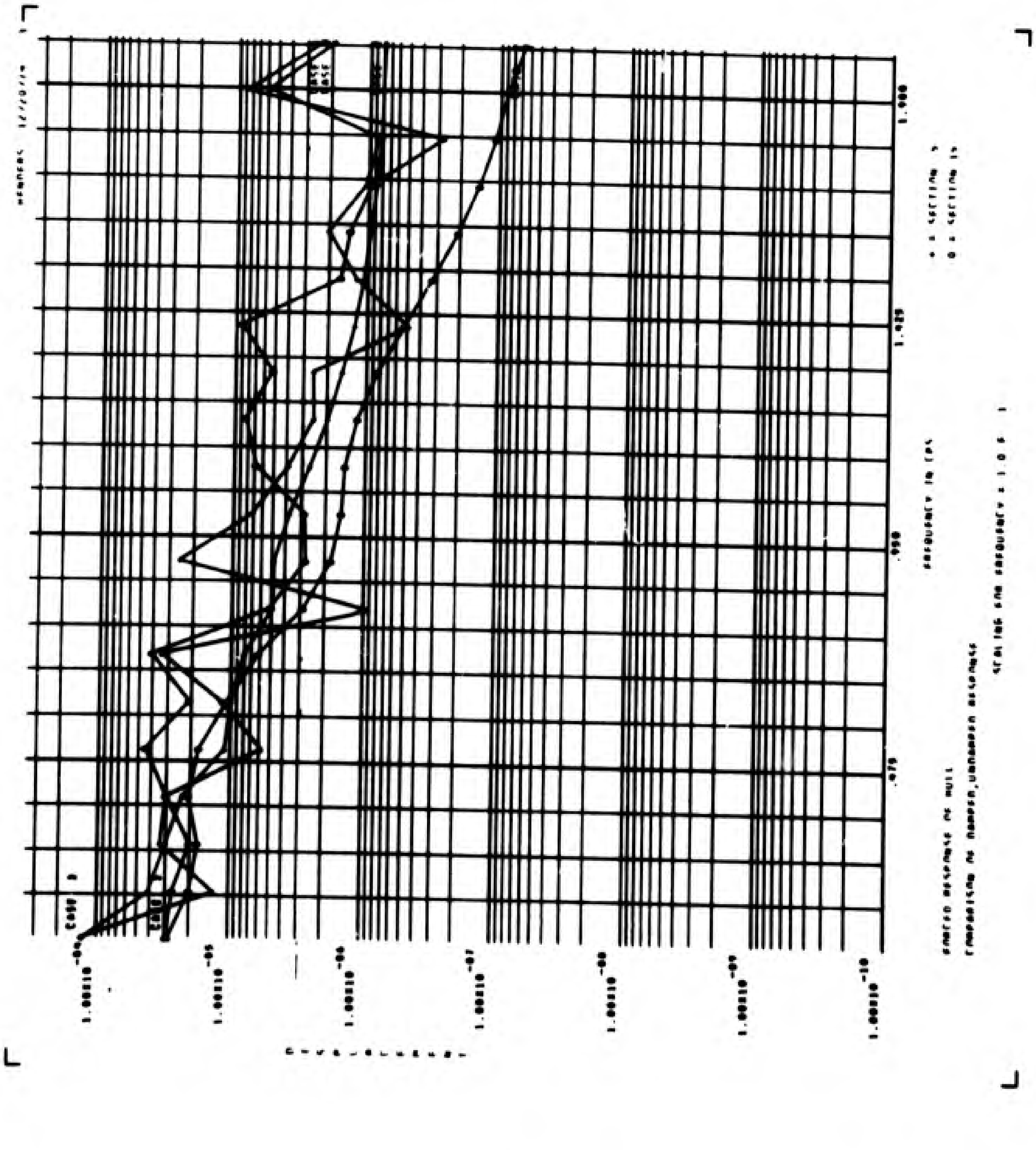


END GBRP  RUN



THE NUMBER OF SC 4020 FRAMES IN THIS FILE IS        3

ELAPSED TIME AT EXIT FROM GBRP =    1.030E+02  SECONDS
```



The third sample calculation demonstrates the procedure for obtaining a single plotted response curve from results calculated over several cases (2b., pg. 52). This type of plotting was designed for applications which require parameter changes in the hull model in subintervals of the frequency range over which plots are desired.

The input data for the first example, case 1 (undamped response), were used as a base for this calculation also. The frequency range, 0.5 CPS to 19.5 CPS, was subdivided into three subintervals in each of which a different value of hull damping was introduced, thus forming three cases for plotting.

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL ☐☐☐☐ ______ SHEET 1 OF 9

RUN SELECTION CARD

1
1

DIMENSIONS FOR FAST FOURIER TRANSFORM INTERFACE (NONHARMONIC VIBRATIONS ONLY)

D16	D17	D18	D19
1	4	7	10

DATA FOR FAST FOURIER TRANSFORM INTERFACE (NONHARMONIC VIBRATIONS ONLY)

1	6	11	17	23	27	31	35	43	51	59	61	63	65	67

DIMENSIONS FOR GBRP

D2	D3	D5	D14	D15	D6	D7	D8	D9	D10	D11	D12	D13
020	027	005					020				004	020
1	4	7	10	13	16	19	22	25	28	31	34	37

Data Input Form (1)

TITLE ____ PROGRAMMER ____ DATE ____

PROBLEM NO ____ PHASE ____ LABEL ____ SHEET 2 OF 9

RUN TITLE CARD

ΔΔΔΔΔΔΔΔΔΔΔΔ FORCED RESPONSE OF HULL (13)

DATA CONTROL CARD

NO TYPE NO TYPE etc.

0090	01	10	01	20	01	21	01	30	01	41	01	42	20	43	01	60	
	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71

CASE TITLE CARD

001000ΔΔΔΔΔΔ VARIATION OF DAMPING OVER THREE SUBINTERVALS (13)

OPTION CONTROL CARD

	OP1	OP2	OP3	OP4	OP5	OP6	OP7	OP8	OP9	OP10
00200000							0001	0002		
	9	13	17	21	25	29	33	37	41	45

EDIT CONTROL CARD

00210000	0005	0015				
	9	13	17	21	25	29

GENERAL DATA CARD

	NO SECTIONS	ω_1(CPS)	ω_2(CPS)	$\Delta\omega$(CPS)	h	Power of ω	NPLOTC
0030	0020	0.5	4.5	1.0			
	5	9	17	25	33	41	49 57

SYSTEMS DATA CARDS

	SYSTEMS	RADIUS	INITIAL J
0031			
0031			
	7	9	17

FORCING FUNCTION LOCATION CARD ____ (Used only if forces are nonharmonic) ____

0032

5 7 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78

Data Input Form (2)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL ______ SHEET 3 OF 9

SECTION DATA CARDS

	SECTION NO. (5)	END CONDN. (9)	SYSTEM (13)	MASS (17)	WATER INERTIA (25)	$(\Delta X/EI)_n$ (33)	$(\Delta X)_{n,n+1}$ (41)	$(\Delta X/KAG)_{n,n+1}$ (49)	$(I_{\mu z}\Delta X)_{n,n+1}$ (57)	P_n (65)	(73)
REAL PART OF SCALING FACTORS											
0041	0000	0000	0001	1.0		▲1.0 E-09	1.0	▲1.0 E-05		1.0	
0041	0000	0000									
0041	0000	0000									
IMAGINARY PART OF SCALING FACTORS											
0042	0000	0000	0001	0.1							
0042	0000	0000									
0042	0000	0000									
PARAMETER VALUES - UNSCALED											
0043	0001	0001	0001	14.5		3.61	29.25	1.33		1.0	
0043	0002		0001	9.3		2.76	29.25	0.92			
0043	0003		0001	23.1		1.12	29.25	0.296			
0043	0004		0001	37.2		0.712	29.25	0.289			
0043	0005		0001	20.8		0.671	29.25	0.245			
⋮	⋮		⋮	⋮		⋮	⋮				
0043	0013		0001	30.8		0.715	29.25	0.303			
0043	0014		0001	19.7		0.790	29.25	0.389			
0043	0015		0001	24.4		0.887	29.25	0.371			
0043	0016		0001	22.2		1.17	29.25	0.420			
0043	0017		0001	25.6		1.61	29.25	0.488			
0043	0018		0001	20.2		2.17	29.25	0.616			
0043	0019		0001	17.6		2.53	29.25	0.849			
0043	0020	0001	0001	18.6		6.89					

Data Input Form (3)

TITLE ____ PROGRAMMER ____ DATE ____

PROBLEM NO. ____ PHASE ____ LABEL [| | |] ____ SHEET 4 OF 9

CHARACTRON PLOTTING CHARACTERS

006000	ΔΔΔΔΔΔΔΔΔΔ	+ΔΔΔΔΔΔΔΔΔ	0ΔΔΔΔΔΔΔΔΔ	XΔΔΔΔΔΔΔΔΔ	–ΔΔΔΔΔΔΔΔΔ	•ΔΔΔΔΔΔΔΔΔ
34	7	17	27	37	47	57

NATURAL FREQUENCY SELECTION CARD

00700000		
34	9	11

SYSTEMS TO BE PLOTTED (USED ONLY WITH OPTION 6 PLOTTING)

1st	2nd	3rd	4th	5th	6th	
						etc.
1	3	5	7	9	11	

START NEW DATA SET CARD

0098

34

END OF DATA CARD

0099

34

Δ indicates blank space

Data Input Form (16)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL ______ SHEET 5 OF 9

RUN TITLE CARD

ΔΔΔΔΔΔΔΔΔΔΔΔ ______ (13)

DATA CONTROL CARD

	NO	TYPE	NO	TYPE	etc.	
0090	01	10	01	30	01	42

Columns: 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71

CASE TITLE CARD

001000ΔΔΔΔΔΔ VARIATION OF DAMPING OVER THREE SUBINTERVALS (13)

OPTION CONTROL CARD

	OP1	OP2	OP3	OP4	OP5	OP6	OP7	OP8	OP9	OP10
00200000										
	9	13	17	21	25	29	33	37	41	45

EDIT CONTROL CARD

00210000					
	9	13	17	21	25 / 29

GENERAL DATA CARD

	NO SECTIONS	ω_1(CPS)	ω_2(CPS)	$\Delta\omega$(CPS)	h	Power of ω	NPLOTC
0030	0020	5.5	9.5	1.0			
	5	9	17	25	33	41	49 / 57

SYSTEMS DATA CARDS

	SYSTEMS	RADIUS	INITIAL J
0031			
0031			
	7	9	17

FORCING FUNCTION LOCATION CARD ______ (Used only if forces are nonharmonic)

0032	

Columns: 5 7 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78

Data Input Form (2)

Bending, Longitudinal, Torsional

TITLE ______________________ PROGRAMMER ______________________ DATE __________

PROBLEM NO. ______________________ PHASE ________ LABEL [| | |] ________ SHEET 6 OF 9

SECTION DATA CARDS

5 / SECTION NO.	9 / END CONDN.	13 / SYSTEM	17 / MASS	25 / WATER INERTIA	33 / $(\Delta X/EI)_n$	41 / $(\Delta X)_{n,n+1}$	49 / $(\Delta X/KAG)_{n,n+1}$	57 / $(I_{\mu z}\Delta X)_{n,n+1}$	65 / P_n	73
REAL PART OF SCALING FACTORS										
00410000	0000									
00410000	0000									
00410000	0000									
IMAGINARY PART OF SCALING FACTORS										
✓ 00420000	0000	0001	0.2							
00420000	0000									
00420000	0000									
PARAMETER VALUES - UNSCALED										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										

Data Input Form (3)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL ______ SHEET 7 OF 9

RUN TITLE CARD

ΔΔΔΔΔΔΔΔΔΔΔΔ (13)

DATA CONTROL CARD

NO TYPE NO TYPE etc.

✓ 0090 | 01 | 10 | 01 | 20 | 01 | 30 | 01 | 42 |

(columns 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71)

CASE TITLE CARD

✓ 001000ΔΔΔΔΔΔ VARIATION OF DAMPING OVER THREE SUBINTERVALS (13)

OPTION CONTROL CARD

	OP1	OP2	OP3	OP4	OP5	OP6	OP7	OP8	OP9	OP10
✓ 00200000				0001			0001	0002		
	9	13	17	21	25	29	33	37	41	45

EDIT CONTROL CARD

00210000						
	9	13	17	21	25	29

GENERAL DATA CARD

	NO SECTIONS	ω_1(CPS)	ω_2(CPS)	$\Delta\omega$(C/S)	h	Power of ω	NPLOTC
✓ 0030	0020	10.5	19.5	1.0			
	5	9	17	25	33	41	49 57

SYSTEMS DATA CARDS

	SYSTEMS	RADIUS	INITIAL J
0031			
0031			
	7	9	17

FORCING FUNCTION LOCATION CARD ______ (Used only if forces are nonharmonic)

0032 (columns 5 7 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78)

Data Input Form (2)

Bending, Longitudinal, Torsional

TITLE ______________________ PROGRAMMER ______________ DATE ______________

PROBLEM NO. ______________________ PHASE ________ LABEL ☐☐☐☐ ________ SHEET 8 OF 9

SECTION DATA CARDS

5 SECTION NO.	9 END CONDN.	13 SYSTEM	17 MASS	25 WATER INERTIA	33 $(\Delta X/EI)_n$	41 $(\Delta X)_{n,n+1}$	49 $(\Delta X/KAG)_{n,n+1}$	57 $(I_{\mu z}\Delta X)_{n,n+1}$	65 P_n	73
REAL PART OF SCALING FACTORS										
00410000	0000									
00410000	0000									
00410000	0000									
IMAGINARY PART OF SCALING FACTORS										
✓ 00420000	0000	0001	0,3							
00420000	0000									
00420000	0000									
PARAMETER VALUES - UNSCALED										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										
0043										

Data Input Form (3)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL ☐☐☐☐ ______ SHEET 9 OF 9

CHARACTRON PLOTTING CHARACTERS

006000 | ΔΔΔΔΔΔΔΔΔΔ | +ΔΔΔΔΔΔΔΔΔ | 0ΔΔΔΔΔΔΔΔΔ | XΔΔΔΔΔΔΔΔΔ | –ΔΔΔΔΔΔΔΔΔ | •ΔΔΔΔΔΔΔΔΔ

34 7 17 27 37 47 57

NATURAL FREQUENCY SELECTION CARD

00700000 | ☐

34 9 11

SYSTEMS TO BE PLOTTED (USED ONLY WITH OPTION 6 PLOTTING)

1st 2nd 3rd 4th 5th 6th

☐ ☐ ☐ ☐ ☐ ☐ etc.

1 3 5 7 9 11

START NEW DATA SET CARD

0098

34

END OF DATA CARD

✓ 0099

34

Δ indicates blank space

Data Input Form (16)

```
THERE ARE 0111100(OCTAL) WORDS OF OPEN-CORE AVAILABLE FOR THIS PROBLEM

ELAPSED TIME AT ENTRY INTO GBRP =    1.732E+02  SECONDS


GBRP  NOV. 1974
FORCED RESPONSE OF HULL

DATA CONTROL CARD

NO  TYPE

 1   10
 1   20
 1   21
 1   30
 1   41
 1   42
20   43
 1   60

CASE TITLE-VARIATION OF DAMPING OVER THREE SUBINTERVALS

OPTION DATA
 20      -0  -0  -0  -0  -0  -0   1   2  -0  -0

OPTION DATA
 21       5  15  -0  -0  -0  -0  -0  -0  -0  -0

GENERAL DATA -  NUMBER OF SECTIONS   20
                  FREQUENCY RANGE FROM       .500 CPS  TO      4.500 CPS
                  FREQUENCY INTERVAL   1.000 CPS
                  POWER OF FREQUENCY = -0.000


REAL PARTS OF SCALING FACTORS
```

SECTION-END	CONDN-SYSTEM	MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	IMZ*DX(N,N+1)	P(N)/Y
	1	1.0000E+00		1.0000E-09	1.0000E+03	1.0000E-05	-0.	1.0000E+00

IMAGINARY PARTS OF SCALING FACTORS

SECTION-END	CONDN-SYSTEM		MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	IMZ*DX(N,N+1)	P(N)/Y
		1	1.0000E-01	-0.	-0.	-0.	-0.	-0.	-0.

PARAMETER VALUES FOR EACH SECTION - UNSCALED

SECTION-END	CONDN-SYSTEM		MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	IMZ*DX(N,N+1)	P(N)/Y
1	1	1	1.4500E+01	-0.	3.6100E+00	2.9250E+01	1.2300E+00	-0.	1.0000E+00
2	-0	1	9.3000E+00	-0.	2.7600E+00	2.9250E+01	9.2000E-01	-0.	-0.
3	-0	1	2.3100E+01	-0.	1.1200E+00	2.9250E+01	2.9600E-01	-0.	-0.
4	-0	1	3.7200E+01	-0.	7.1200E-01	2.9250E+01	2.8900E-01	-0.	-0.
5	-0	1	2.0800E+01	-0.	6.7100E-01	2.9250E+01	2.4500E-01	-0.	-0.
6	-0	1	5.1300E+01	-0.	6.5300E-01	2.9250E+01	2.4500E-01	-0.	-0.
7	-0	1	2.9400E+01	-0.	7.2900E-01	2.9250E+01	4.1800E-01	-0.	-0.
8	-0	1	3.1800E+01	-0.	7.5000E-01	2.9250E+01	3.9700E-01	-0.	-0.
9	-0	1	3.6000E+01	-0.	6.3700E-01	2.9250E+01	3.2100E-01	-0.	-0.
10	-0	1	3.4600E+01	-0.	6.5300E-01	2.9250E+01	3.1100E-01	-0.	-0.
11	-0	1	2.9600E+01	-0.	7.5000E-01	2.9250E+01	3.1100E-01	-0.	-0.
12	-0	1	4.1200E+01	-0.	7.0000E-01	2.9250E+01	2.4200E-01	-0.	-0.
13	-0	1	3.0900E+01	-0.	7.1500E-01	2.9250E+01	3.0300E-01	-0.	-0.
14	-0	1	1.0700E+01	-0.	7.9000E-01	2.9250E+01	3.8900E-01	-0.	-0.
15	-0	1	2.4400E+01	-0.	8.8700E-01	2.9250E+01	3.7100E-01	-0.	-0.
16	-0	1	2.2200E+01	-0.	1.1700E+00	2.9250E+01	4.2000E-01	-0.	-0.
17	-0	1	2.5600E+01	-0.	1.6100E+00	2.9250E+01	4.8800E-01	-0.	-0.
18	-0	1	2.0200E+01	-0.	2.1700E+00	2.9250E+01	6.1600E-01	-0.	-0.
19	-0	1	1.7600E+01	-0.	2.5300E+00	2.9250E+01	8.4900E-01	-0.	-0.
20	1	1	1.0600E+01	-0.	6.8900E+00	-0.	-0.	-0.	-0.

CHARACTRON PLOTTING CHARACTERS
CHAR(1)=
CHAR(2)=+
CHAR(3)=0
CHAR(4)=X
CHAR(5)=-
CHAR(6)=.

THE MINIMUM AMOUNT OF OPEN CORE NEEDED FOR THE STEADY-STATE PORTION OF THIS PROBLEM IS 002621(OCTAL) WORDS

DIMENSIONS FOR ARRAYS

```
DIMENSION  1 =  40
DIMENSION  2 =  20
DIMENSION  3 =  27
DIMENSION  4 =   4
DIMENSION  5 =   5
DIMENSION  6 =  -0
DIMENSION  7 =  -0
DIMENSION  8 =  20
DIMENSION  9 =  -0
DIMENSION 10 =  -0
DIMENSION 11 =  -0
DIMENSION 12 =   4
DIMENSION 13 =  20
DIMENSION 14 =   1
DIMENSION 15 =   1
```

CM REDUCED TO 071600 (OCTAL)

GBRP

FORCED RESPONSE OF HULL

FREQUENCY CPS	DEFLECTION SECTION 5	MOMENT SECTION 5	DEFLECTION SECTION 15	MOMENT SECTION 15	DEFLECTION SECTION	MOMENT	DEFLECTION	MOMENT	DEFLECTION	MOMENT
.50	5.354E-04	8.421E+01	1.275E-04	3.405E+01						
1.50	5.144E-05	1.140E+02	8.500E-06	7.494E+01						
2.50	5.180E-05	3.715E+01	2.935E-05	1.712E+02						
3.50	2.760E-05	8.279E+01	1.995E-05	8.627E+01						
4.50	3.980E-05	3.165E+02	6.766E-05	2.810E+02						

GBRP NOV. 1974
FORCED RESPONSE OF HULL

DATA CONTROL CARD

NO	TYPE
1	10
1	30
1	42

CASE TITLE-VARIATION OF DAMPING OVER THREE SUBINTERVALS

GENERAL DATA - NUMBER OF SECTIONS 20
FREQUENCY RANGE FROM 5.500 CPS TO 9.500 CPS
FREQUENCY INTERVAL 1.000 CPS
POWER OF FREQUENCY = -0.000

IMAGINARY PARTS OF SCALING FACTORS

SECTION-END	CONDN-SYSTEM	MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	IMZ*DX(N,N+1)	P(N)/Y
	1	2.0000E-01	-0.	-0.	-0.	-0.	-0.	-0.

GBRP

FORCED RESPONSE OF HULL

FREQUENCY CPS	DEFLECTION SECTION 3	MOMENT	DEFLECTION SECTION 15	MOMENT	DEFLECTION SECTION	MOMENT	DEFLECTION	MOMENT	DEFLECTION	MOMENT
5.50	8.650E-06	5.405E+01	1.600E-05	7.215E+01						
6.50	1.323E-05	9.082E+01	1.410E-05	6.303E+01						
7.50	6.331E-06	6.662E+01	5.956E-06	2.729E+01						
8.50	5.193E-06	4.710E+01	2.771E-06	1.369E+01						
9.50	5.909E-06	5.814E+01	2.070E-06	1.447E+01						

GBRP NOV. 1974
FORCED RESPONSE OF HULL

DATA CONTROL CARD

NO	TYPE
1	10
1	20
1	30
1	42

CASE TITLE-VARIATION OF DAMPING OVER THREE SUBINTERVALS

OPTION DATA
20 -0 -0 -0 1 -0 -0 1 2 -0 -0

GENERAL DATA - NUMBER OF SECTIONS 20
FREQUENCY RANGE FROM 10.500 CPS TO 19.500 CPS
FREQUENCY INTERVAL 1.000 CPS
POWER OF FREQUENCY = -0.000

IMAGINARY PARTS OF SCALING FACTORS

SECTION-END CONDN-SYSTEM	MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	IMZ*DX(N,N+1)	P(N)/V
1	3.0000E-01	-0.	-0.	-0.	-0.	-0.	-0.

GBRP

FORCED RESPONSE OF HULL

FREQUENCY CPS	DEFLECTION SECTION 5	MOMENT	DEFLECTION SECTION 15	MOMENT	DEFLECTION SECTION	MOMENT	DEFLECTION	MOMENT	DEFLECTION	MOMENT
10.50	3.096E-06	3.761E+01	1.473E-06	1.005E+01						
11.50	2.242E-06	2.888E+01	1.316E-06	8.731E+00						
12.50	1.735E-06	2.316E+01	9.877E-07	6.328E+00						
13.50	1.379E-06	1.918E+01	6.689E-07	4.176E+00						
14.50	1.148E-06	1.643E+01	4.129E-07	2.557E+00						
15.50	1.018E-06	1.469E+01	2.572E-07	1.616E+00						
16.50	9.111E-07	1.310E+01	1.700E-07	1.107E+00						
17.50	8.364E-07	1.194E+01	1.237E-07	8.359E-01						
18.50	8.068E-07	1.102E+01	9.872E-08	6.710E-01						
19.50	7.854E-07	1.014E+01	7.730E-08	5.250E-01						

```
GBRP   NOV. 1974
FORCED RESPONSE OF HULL

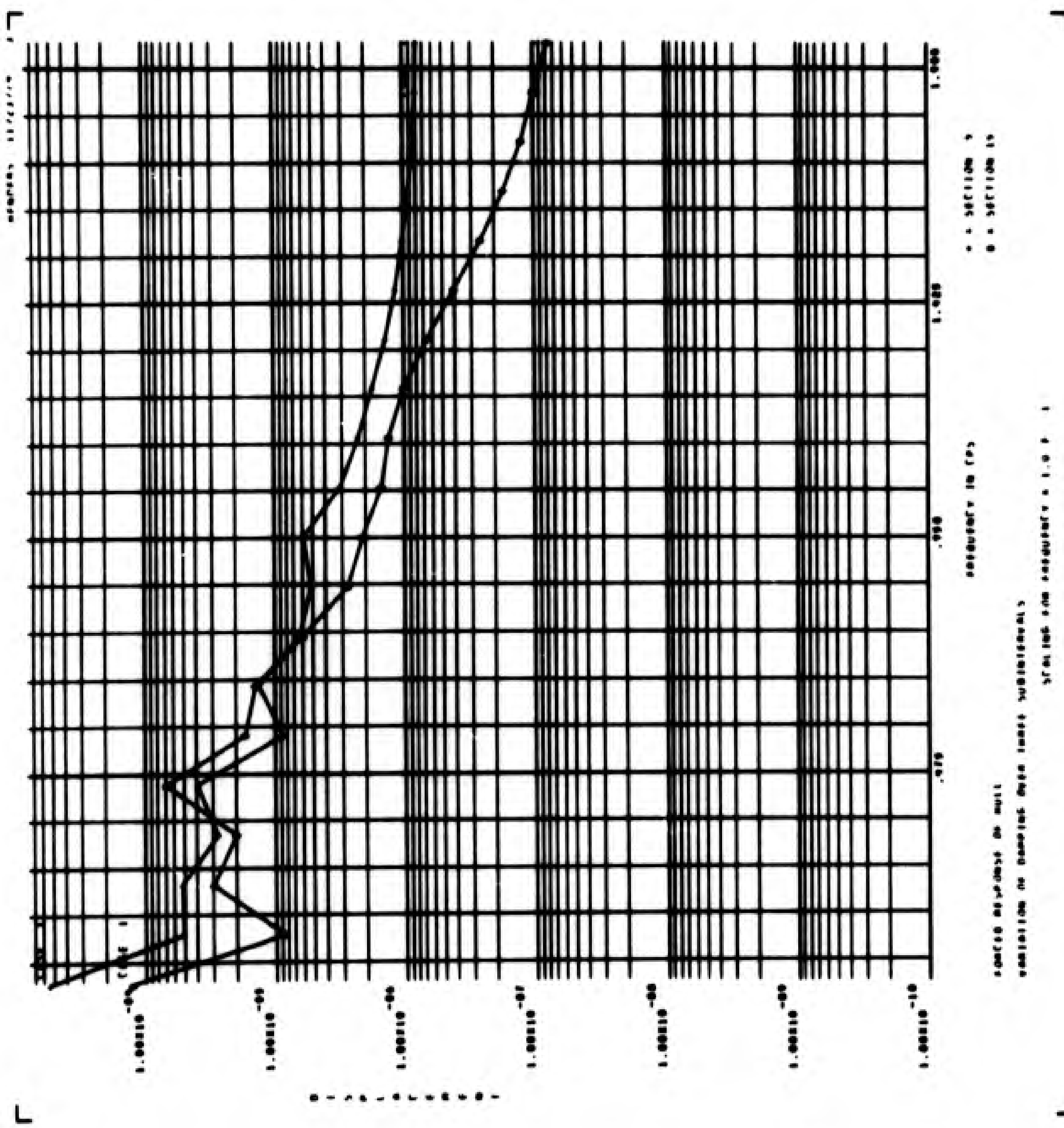
DATA CONTROL CARD

NO  TYPE


END GBRP  RUN

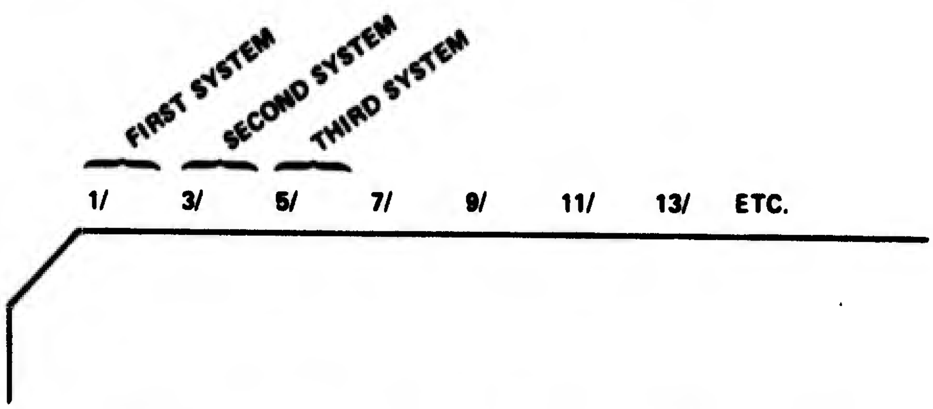

THE NUMBER OF SC 4020 FRAMES IN THIS FILE IS        3

ELAPSED TIME AT EXIT FROM GBRP =    1.004E+02  SECONDS
```



In applications involving either superposed curves from a series of cases or single curves as shown in the last example, information for the second line of the graph title (lower left-hand margin of plot) must appear on the "10" (Case Title) card belonging to the final case to be computed. The reason for this is that in such applications, the calculations are done for all cases before plotting begins and, as each case is computed, its case title data overlays and replaces that from the previous case. Thus, when the plotting subroutine is called, only the title data from the final case is stored in memory. It therefore should function more as a subtitle for the overall graph than for just the final case.

The GBRP option 6 (OP6) "detailed edit" plotting is performed according to designated "systems" of the beam-spring model. This capability has essentially the features it originally had when introduced in the second program module[3] of GBRP but with the following modification: particular systems can now be plotted as specified on a data card rather than plotting every system as was previously done when multisystem plotting was called for. The format for the required data card ("SYSTEMS TO BE PLOTTED") is:



with two card columns for each system number. First, second, third, as used here, indicate the order for plotting, and not system numbers themselves. When system plotting is used (i.e., OP6≠0), this card will appear as the final data card of each case involved.

A sample application of OP6 uses a coupled beam model acted upon by a forcing function as shown in Figure 7.

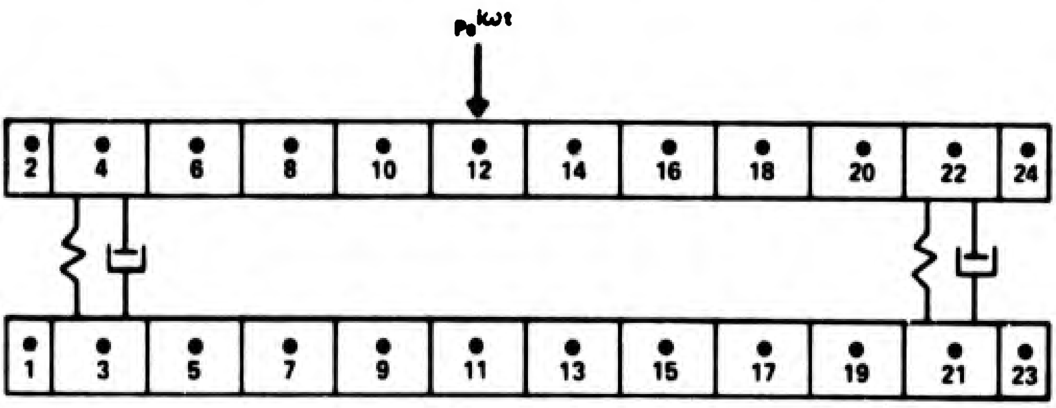


Figure 7. Coupled Uniform Beams

In the data setup for this example the lower beam is designated "system" 1 and the upper "system" 2. OP6 specifies the detailed edit and the "SYSTEMS TO BE PLOTTED" card, page 105, indicates that both systems are to be plotted.

The sample plots for OP6 and OP7 demonstrate the use of DIMENSION parameters to specify the number of points used to define a particular curve (see Section I, page 6). For the OP7 runs we arbitrarily chose to plot just 20 frequency-response pairs from among those calculated and therefore selected the dimension D8 as 20. Similarly, for the OP6 run we arbitrarily chose to plot the results for a maximum of six sections in each system and thus selected the dimension D10 as 6-1=5.

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [| |] ______ SHEET 1 OF 1

RUN SELECTION CARD ______

1
1

DIMENSIONS FOR FAST FOURIER TRANSFORM INTERFACE (NONHARMONIC VIBRATIONS ONLY) ______

D16	D17	D18	D19
1	4	7	10

DATA FOR FAST FOURIER TRANSFORM INTERFACE (NONHARMONIC VIBRATIONS ONLY) ______

1	6	11	17	23	27	31	35	43	51	59	61	63	65	67

DIMENSIONS FOR GBRP ______

D2	D3	D5	D14	D15	D6	D7	D8	D9	D10	D11	D12	D13
024	057	005			012	002		002	005		006	006
1	4	7	10	13	16	19	22	25	28	31	34	37

Data Input Form (1)

TITLE ________ PROGRAMMER ________ DATE ________

PROBLEM NO. ________ PHASE ______ LABEL [| |] ______ SHEET 2 OF 8

RUN TITLE CARD

ΔΔΔΔΔΔΔΔΔΔΔΔ COUPLED BEAM SYSTEM (13)

DATA CONTROL CARD

NO TYPE NO TYPE etc.

	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35
0090	01	10	01	20	01	30	02	41	24	43	02	51	24	53	01	60

Columns 37–71 blank.

CASE TITLE CARD

001000ΔΔΔΔΔΔ SYSTEM PLOTTING WITH OPTION 6 (13)

OPTION CONTROL CARD

	OP1 (9)	OP2 (13)	OP3 (17)	OP4 (21)	OP5 (25)	OP6 (29)	OP7 (33)	OP8 (37)	OP9 (41)	OP10 (45)
00200000				0001		0001				

EDIT CONTROL CARD

	9	13	17	21	25	29
00210000						

GENERAL DATA CARD

	NO SECTIONS (5)	ω_1(CPS) (9)	ω_2(CPS) (17)	$\Delta\omega$(CPS) (25)	h (33)	Power of ω (41)	NPLOTC (49)	(57)
0030	0024	1.0	1.0	1.0				

SYSTEMS DATA CARDS

	SYSTEMS (7)	RADIUS (9)	INITIAL J (17)
0031			
0031			

FORCING FUNCTION LOCATION CARD ______ (Used only if forces are nonharmonic)

	5	7	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78
0032																																					

Data Input Form (2)

Bending, Longitudinal, Torsional

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL ☐☐☐ ______ SHEET 3 OF 8

SECTION DATA CARDS

(5)	SECTION NO. (9)	END CONDN. (13)	SYSTEM (17)	MASS (25)	WATER INERTIA (33)	$(\Delta X/EI)_n$ (41)	$(\Delta X)_{n,n+1}$ (49)	$(\Delta X/KAG)_{n,n+1}$ (57)	$(I_{\mu z}\Delta X)_{n,n+1}$ (65)	P_n (73)	
REAL PART OF SCALING FACTORS											
00410000		0000	0001	▲▲1.0E-2		▲1.0E-11	1.0				
00410000		0000	0002	▲▲1.0E-2		▲1.0E-11	1.0				
00410000		0000								1.0	
IMAGINARY PART OF SCALING FACTORS											
00420000		0000									
00420000		0000									
00420000		0000									
PARAMETER VALUES - UNSCALED											
0043	0001	0001	0001	8.888980		.4134543					
0043	0003		0001	851.0852		37.60872					
0043	0005		0001	851.0852		37.60872					
0043	0007		0001	851.0852		37.60872					
0043	0009		0001	851.0852		37.60872					
0043	0011		0001	851.0852		37.60872					
0043	0013		0001	851.0852		37.60872					
0043	0015		0001	851.0852		37.60872					
0043	0017		0001	851.0852		37.60872					
0043	0019		0001	851.0852		37.60872					
0043	0021		0001	851.0852		37.60872					
0043	0023	0001	0001	8.888980		.4134543					
0043	0002	0001	0002	8.888980		.4134543					
0043	0004		0002	851.0852		37.60872					
0043	0006		0002	851.0852		37.60872					

Data Input Form (3)

Bending, Longitudinal, Torsional

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [| | |] ______ SHEET 4 OF 8

SECTION PARAMETER VALUES - UNSCALED

	5	9	13	17	25	33	41	49	57	65	73
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I\mu_z \Delta X)_{n,n+1}$	P_n	
0043	0008		0002	851.0852		39.60892					
0043	0010		0002	851.0852		39.60892					
0043	0012		0002	851.0852		39.60892				1.0	
0043	0014		0002	851.0852		39.60892					
0043	0016		0002	851.0852		39.60892					
0043	0018		0002	851.0852		39.60892					
0043	0020		0002	851.0852		39.60892					
0043	0022		0002	851.0852		39.60892					
0043	0024	0001	0002	8.888780		.4134543					
0043											
0043											
0043											
0043											
0043											
0043											
0043											
0043											
0043											
0043											
0043											
0043											
0043											
0043											
0043											

Data Input Form (4)

Bending, Longitudinal, Torsional

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL ☐☐☐☐ ______ SHEET 5 OF 8

	5	9	13	17	25	33	41	49	57	65	73
SPECIAL CONNECTION CARDS											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$\Delta x_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I\mu_z\Delta X)_{n,m}$	$Q_{n,m}$	
REAL PART OF SCALING FACTORS											
0051	0000	0000	0001				1,0				
0051	0000	0000	0002	1.0	1.0						
0051	0000	0000									
IMAGINARY PART OF SCALING FACTORS											
0052	0000	0000									
0052	0000	0000									
0052	0000	0000									
PARAMETER VALURS - UNSCALED											
0053	0001	0003	0001				36.3				
0053	0003	0005	0001				71.85				
0053	0005	0007	0001				71.85				
0053	0007	0009	0001				71.85				
0053	0009	0011	0001				71.85				
0053	0011	0013	0001				71.85				
0053	0013	0015	0001				71.85				
0053	0015	0017	0001				71.85				
0053	0017	0019	0001				71.85				
0053	0019	0021	0001				71.85				

Data Input Form (5)

Bending, Longitudinal, Torsional

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [| | |] ______ SHEET 6 OF 8

Column markers: 5, 9, 13, 17, 25, 33, 41, 49, 57, 65, 73

SPECIAL CONNECTION CARDS	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$\Delta x_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
REAL PART OF SCALING FACTORS											
0051	0000	0000									
0051	0000	0000									
0051	0000	0000									
IMAGINARY PART OF SCALING FACTORS											
0052	0000	0000									
0052	0000	0000									
0052	0000	0000									
PARAMETER VALURS - UNSCALED											
0053	0021	0023	0001				36.3				
0053	0002	0004	0001				36.3				
0053	0004	0006	0001				71.85				
0053	0006	0008	0001				71.85				
0053	0008	0010	0001				71.85				
0053	0010	0012	0001				71.85				
0053	0012	0014	0001				71.85				
0053	0014	0016	0001				71.85				
0053	0016	0018	0001				71.85				
0053	0018	0020	0001				71.85				

Data Input Form (5)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [| |] ______ SHEET 7 OF 8

	5	9	13	17	25	33	41	49	57	65	73
SPECIAL CONNECTION CARDS											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$\Delta x_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
REAL PART OF SCALING FACTORS											
0051	0000	0000									
0051	0000	0000									
0051	0000	0000									
IMAGINARY PART OF SCALING FACTORS											
0052	0000	0000									
0052	0000	0000									
0052	0000	0000									
PARAMETER VALURS - UNSCALED											
0053	0020	0022	0001				71.85				
0053	0022	0024	0001				36.3				
0053	0003	0004	0002	10000.	100.						
0053	0021	0022	0002	10000.	100.						
0053											
0053											
0053											
0053											
0053											
0053											

Data Input Form (5)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [| | |] ______ SHEET 8 OF 8

CHARACTRON PLOTTING CHARACTERS

006000	ΔΔΔΔΔΔΔΔΔΔ	+ΔΔΔΔΔΔΔΔΔ	0ΔΔΔΔΔΔΔΔΔ	XΔΔΔΔΔΔΔΔΔ	–ΔΔΔΔΔΔΔΔΔ	•ΔΔΔΔΔΔΔΔΔ
34	7	17	27	37	47	57

NATURAL FREQUENCY SELECTION CARD

00700000	
34	9 11

SYSTEMS TO BE PLOTTED (USED ONLY WITH OPTION 6 PLOTTING)

1st	2nd	3rd	4th	5th	6th	
01	02					etc.
1	3	5	7	9	11	

START NEW DATA SET CARD

0098

34

END OF DATA CARD

0099

34

Δ indicates blank space

Data Input Form (16)

THERE ARE 011110(OCTAL) WORDS OF OPEN-CORE AVAILABLE FOR THIS PROBLEM

ELAPSED TIME AT ENTRY INTO GBRP = 1.712E+02 SECONDS

GBRP NOV. 1974
COUPLED BEAM SYSTEM

DATA CONTROL CARD

NO	TYPE
1	10
1	20
1	30
2	41
24	43
2	51
24	53
1	60

CASE TITLE-SYSTEM PLOTTING WITH OPTION 6

OPTION DATA
20 -0 -0 -0 1 -0 1 -0 -0 -0 -0

GENERAL DATA - NUMBER OF SECTIONS 24
FREQUENCY RANGE FROM 1.000 CPS TO 1.000 CPS
FREQUENCY INTERVAL 1.000 CPS
POWER OF FREQUENCY = -0.000

REAL PARTS OF SCALING FACTORS

SECTION-END CONDN-SYSTEM	MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	INZ*DX(N,N+1)	P(N)/Y
1	1.0000E-02	-0.	1.0000E-11	1.0000E+00	-0.	-0.	-0.
2	1.0000E-02	-0.	1.0000E-11	1.0000E+00	-0.	-0.	1.0000E+00

PARAMETER VALUES FOR EACH SECTION - UNSCALED

SECTION-END	CONDN	SYSTEM	MASS	WATER INERTIA	DX/EI(N)	DX(N,N+1)	DX/KAG(N,N+1)	IMZ*DX(N,N+1)	P(N)/V
1	1	1	8.8890E+00	-0.	4.1345E-01	-0.	-0.	-0.	-0.
3	-0	1	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
5	-0	1	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
7	-0	1	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
9	-0	1	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
11	-0	1	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
13	-0	1	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
15	-0	1	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
17	-0	1	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
19	-0	1	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
21	-0	1	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
23	1	1	8.8890E+00	-0.	4.1345E-01	-0.	-0.	-0.	-0.
2	1	2	8.8890E+00	-0.	4.1345E-01	-0.	-0.	-0.	-0.
4	-0	2	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
6	-0	2	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
8	-0	2	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
10	-0	2	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
12	-0	2	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	1.0000E+00
14	-0	2	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
16	-0	2	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
18	-0	2	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
20	-0	2	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
22	-0	2	8.5109E+02	-0.	3.9609E+01	-0.	-0.	-0.	-0.
24	1	2	8.8898E+00	-0.	4.1345E-01	-0.	-0.	-0.	-0.

REAL PARTS OF SCALING FACTORS

N	M	SYSTEM	K(N,M)	C(N,M)	C(N,M)/W	DX(N,M)	DX/KAG(N,M)	IMZ*DX(N,M)	Q(N,M)/V
		2	1.0000E+00	1.0000E+00	-0.	-0.	-0.	-0.	-0.
		1	-0.	-0.	-0.	1.0000E+00	-0.	-0.	-0.

PARAMETER VALUES FOR SPECIAL CONNECTIONS

N	M	SYSTEM	K(N,M)	C(N,M)	C(N,M)/W	DX(N,M)	DX/KAG(N,M)	IMZ*DX(N,M)	Q(N,M)/T
1	3	1	-0.	-0.	-0.	3.6300E+01	-0.	-0.	-0.
3	5	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
5	7	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
7	9	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
9	11	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
11	13	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
13	15	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
15	17	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
17	19	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
19	21	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
21	23	1	-0.	-0.	-0.	3.6300E+01	-0.	-0.	-0.
2	4	1	-0.	-0.	-0.	3.6300E+01	-0.	-0.	-0.
4	6	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
6	8	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
8	10	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
10	12	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
12	14	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
14	16	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
16	18	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
18	20	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
20	22	1	-0.	-0.	-0.	7.1850E+01	-0.	-0.	-0.
22	24	1	-0.	-0.	-0.	3.6300E+01	-0.	-0.	-0.
3	4	2	1.0000E+04	1.0000E+02	-0.	-0.	-0.	-0.	-0.
21	22	2	1.0000E+04	1.0000E+02	-0.	-0.	-0.	-0.	-0.

CHARACTRON PLOTTING CHARACTERS
CHAR(1) =
CHAR(2) =+
CHAR(3) =0
CHAR(4) =X
CHAR(5) =-
CHAR(6) =.

THE MINIMUM AMOUNT OF OPEN CORE NEEDED FOR THE STEADY-STATE PORTION OF THIS PROELEM IS 005150(OCTAL) WORDS

```
DIMENSIONS FOR ARRAYS

 DIMENSION  1 =  48
 DIMENSION  2 =  24
 DIMENSION  3 =  57
 DIMENSION  4 =   6
 DIMENSION  5 =   5
 DIMENSION  6 =  12
 DIMENSION  7 =   2
 DIMENSION  8 =   1
 DIMENSION  9 =   2
 DIMENSION 10 =   5
 DIMENSION 11 =  -0
 DIMENSION 12 =   6
 DIMENSION 13 =   6
 DIMENSION 14 =   1
 DIMENSION 15 =   1

CM REDUCED TO 074100 (OCTAL)
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GBRP

COUPLED BEAM SYSTEM

SYSTEM PLOTTING WITH OPTION 6

FREQUENCY 1.00 CPS

STATION	DEFLECTIONS REAL PART	DEFLECTIONS IMAG PART	DEFLECTIONS ABS VALUE	DEFLECTIONS PHASE ANGLE	MOMENT REAL PART	MOMENT IMAG PART	MOMENT ABS VALUE	MOMENT PHASE ANGLE
1	-2.1149E-04	1.0889E-06	2.1149E-04	1.7971E+02	7.8848E-07	1.1096E-10	7.8848E-07	8.0629E-03
2	-1.8529E-04	-1.0889E-06	1.8530E-04	-1.7966E+02	2.3353E-06	-1.1096E-10	2.3353E-06	-2.7223E-03
3	-2.0862E-04	1.0893E-06	2.0863E-04	1.7970E+02	-2.6939E-02	1.3871E-04	2.6940E-02	1.7970E+02
4	-1.7681E-04	-1.0893E-06	1.7682E-04	-1.7965E+02	-2.3601E-02	-1.3871E-04	2.3602E-02	-1.7966E+02
5	-2.0296E-04	1.0901E-06	2.0296E-04	1.7969E+02	1.7836E+01	-1.0261E-01	1.7836E+01	-3.2963E-01
6	-1.6004E-04	-1.0901E-06	1.6004E-04	-1.7961E+02	-2.7292E+01	1.0261E-01	2.7292E+01	1.7978E+02
7	-1.9679E-04	1.0880E-06	1.9679E-04	1.7968E+02	3.0799E+01	-1.7905E-01	3.0800E+01	-3.3308E-01
8	-1.4404E-04	-1.0880E-06	1.4404E-04	-1.7957E+02	-5.8423E+01	1.7905E-01	5.8423E+01	1.7982E+02
9	-1.8974E-04	1.0808E-06	1.8974E-04	1.7967E+02	3.9012E+01	-2.2922E-01	3.9013E+01	-3.3664E-01
10	-1.2970E-04	-1.0808E-06	1.2970E-04	-1.7952E+02	-9.3032E+01	2.2922E-01	9.3032E+01	1.7986E+02
11	-1.8158E-04	1.0670E-06	1.8158E-04	1.7966E+02	4.2644E+01	-2.5330E-01	4.2645E+01	-3.4032E-01
12	-1.1800E-04	-1.0670E-06	1.1801E-04	-1.7948E+02	-1.3077E+02	2.5330E-01	1.3077E+02	1.7989E+02
13	-1.7221E-04	1.0461E-06	1.7221E-04	1.7965E+02	4.1892E+01	-2.5162E-01	4.1893E+01	-3.4413E-01
14	-1.1004E-04	-1.0461E-06	1.1004E-04	-1.7946E+02	-9.9510E+01	2.5162E-01	9.9510E+01	1.7986E+02
15	-1.6164E-04	1.0180E-06	1.6165E-04	1.7964E+02	3.6984E+01	-2.2469E-01	3.6984E+01	-3.4809E-01
16	-1.0490E-04	-1.0180E-06	1.0490E-04	-1.7944E+02	-7.0904E+01	2.2469E-01	7.0905E+01	1.7982E+02
17	-1.5003E-04	9.8346E-07	1.5003E-04	1.7962E+02	2.8173E+01	-1.7318E-01	2.8173E+01	-3.5219E-01
18	-1.0178E-04	-9.8346E-07	1.0178E-04	-1.7945E+02	-4.4832E+01	1.7318E-01	4.4832E+01	1.7978E+02
19	-1.3761E-04	9.4403E-07	1.3761E-04	1.7961E+02	1.5740E+01	-9.7928E-02	1.5740E+01	-3.5647E-01
20	-9.9933E-05	-9.4403E-07	9.9938E-05	-1.7946E+02	-2.1216E+01	9.7928E-02	2.1216E+01	1.7974E+02
21	-1.2474E-04	9.0181E-07	1.2474E-04	1.7959E+02	-1.5064E-02	1.1217E-04	1.5064E-02	1.7957E+02
22	-9.8693E-05	-9.0181E-07	9.8697E-05	-1.7948E+02	-1.2492E-02	-1.1217E-04	1.2493E-02	-1.7949E+02
23	-1.1824E-04	8.8049E-07	1.1824E-04	1.7957E+02	-1.7907E-06	5.8753E-09	1.7907E-06	1.7981E+02
24	-9.8066E-05	-8.8049E-07	9.8070E-05	-1.7949E+02	-1.7257E-07	-5.8753E-09	1.7267E-07	-1.7805E+02

```
GBRP   NOV. 1974
COUPLED BEAM SYSTEM

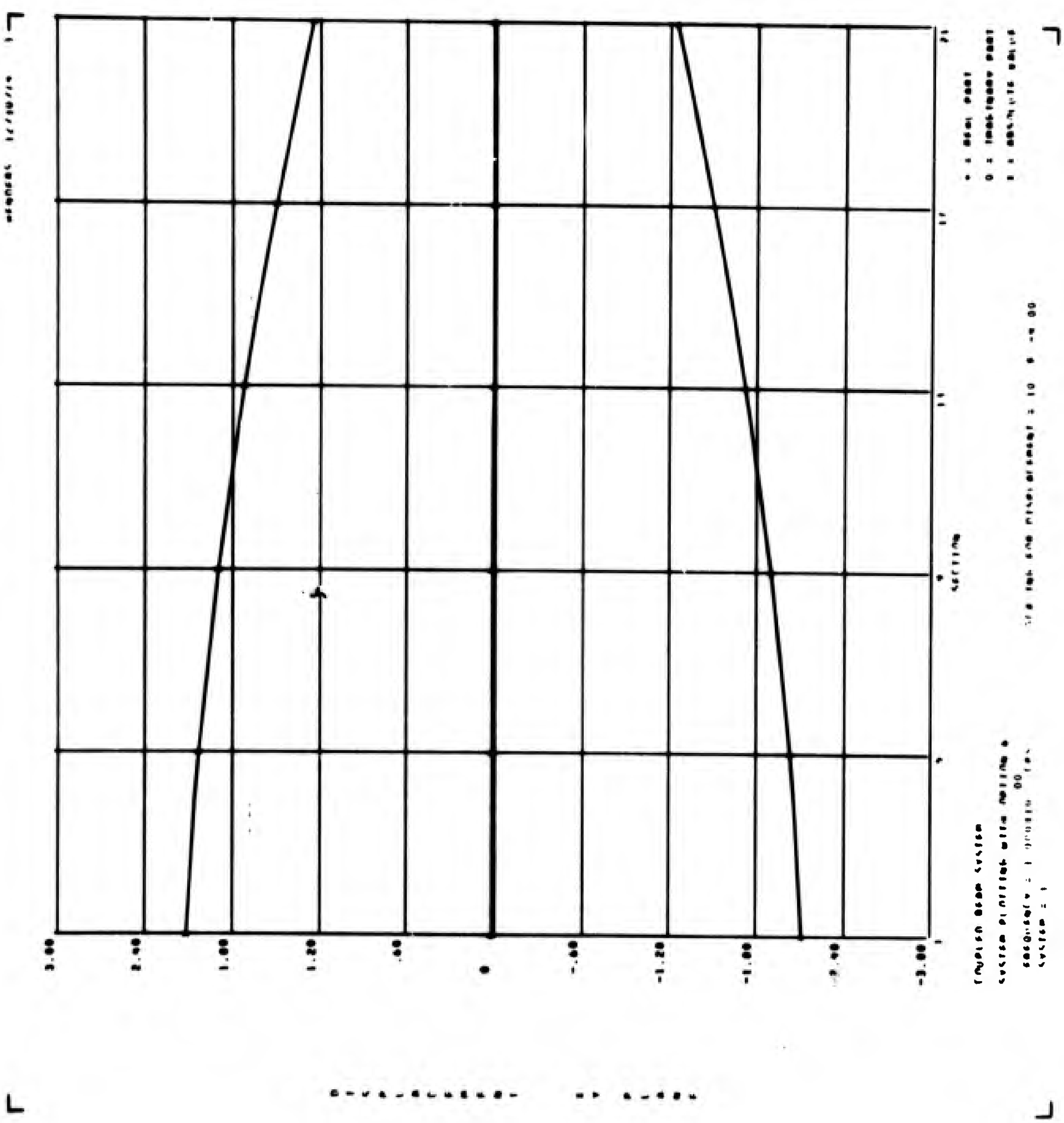
DATA CONTROL CARD

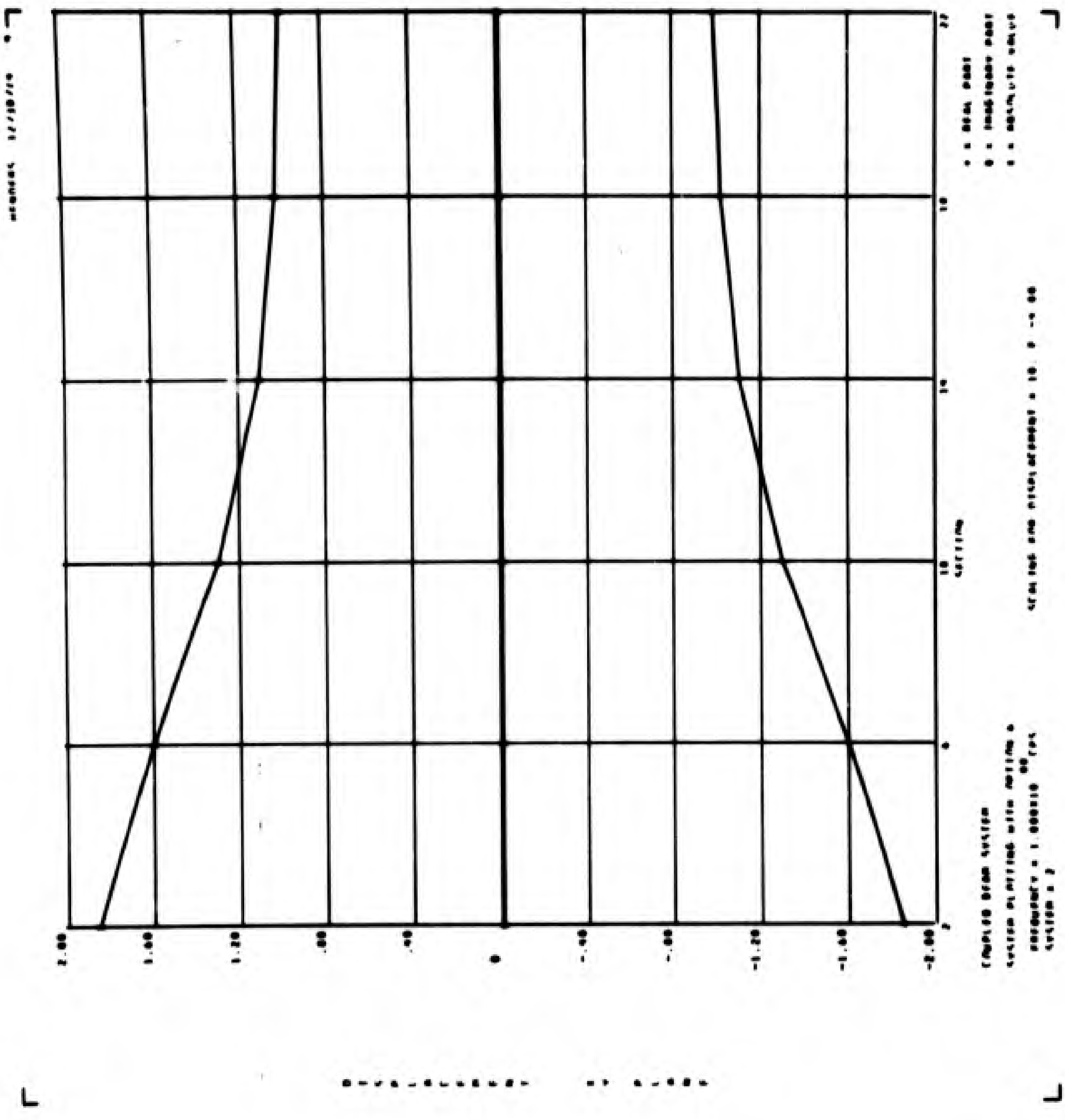
NO  TYPE


END GBRP  RUN


THE NUMBER OF SC 4020 FRAMES IN THIS FILE IS        6

ELAPSED TIME AT EXIT FROM GBRP =    1.742E+02  SECONDS
```





ACKNOWLEDGMENTS

The authors wish to express their indebtedness to the following persons: Mr. Alexander Mark (Naval Ship Engineering Center, Philadelphia Division, Code 6733D) for suggesting the vibratory force option and supplying the formulation used; Mr. William P. Foster and Mr. Brian J. Corbin (NSRDC, Code 1962) for suggesting the new forms of selected edit plotting; and Mr. Richard Taddeo (Naval Ship Engineering Center, Hyattsville, Code 6144) and Mr. Corbin for providing the background information for Section III.

APPENDIX - DESCRIPTION OF GBRP INPUT DATA AND DATA FORMS

- RUN SELECTION CARD*

Columns	Contents
1	1 Steady-state vibration applications
	2 General forced (nonharmonic) vibration applications

- DIMENSIONS FOR FAST FOURIER TRANSFORM INTERFACE (nonharmonic vibrations)

1-3	D16
4-6	D17
7-9	D18
10-12	D19

- DIMENSIONS FOR GBRP (all applications)

1-3	D2
4-6	D3
7-9	D5
10-12	D14
13-15	D15
16-18	D6
19-21	D7
22-24	D8
25-27	D9
28-30	D10
31-33	D11
34-36	D12
37-39	D13

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* Referred to as Data Card 1 in NSRDC Report 4481.[5]

● DATA FOR FAST FOURIER TRANSFORM INTERFACE*

Columns	Contents
1-5	Number of sampled time points describing one period of the nonharmonic forcing function(s). Each forcing function acting on the structure is assumed represented by this number of points. The number must be an integer power of 2 $\leq$ 16384.
6-10	Number of sampled time points to be printed for each forcing function; used in verifying input data.
11-16	Number of blocks of sampled time data input. Each block originates from a forcing function acting at a particular beam section.
17-22	Number of discrete Fourier coefficients to be used in the second stage[5] (complex frequency response calculation) of a non-harmonic response application.
23-26	Total number of beam sections.
27-30	An integer, L, indicating that every L^{th} input time point or time response coefficient (from the second stage complex frequency amplitude calculation[5]) is to be printed for verification purposes.
31-34	An integer, K, indicating that every K^{th} discrete Fourier coefficient of the time data transform is to be printed for verification purposes.
35-42	An approximate time interval, δt (in seconds), for editing the time response of the structure.[5]

* Referred to as Data Card 2 in NSRDC Report 4481.[5]

Columns	Contents
43-50	Maximum time ≤ T (period in seconds of the nonharmonic excitation force(s)) for which time response is to be edited for printing.
51-58	Period, T, in seconds, of nonharmonic forcing function(s).
59-60	01 Sampled data points for forcing function(s) are to be read in binary form from tape.
	02 Sampled data points are to be generated internally by the program.
61-62	01 Sampled data points for forcing function(s) and time response coefficients (complex frequency response amplitudes) are not to be printed.
	02 The data points and time response coefficients are to be printed.
63-64	01 Discrete Fourier coefficients of the forcing function transform(s) are not to be printed.
	02 The coefficients are to be printed.
65-66	Maximum number of response variables (deflection, moment, twist, etc.) that may be present in the steady-state solution vector at any beam section for a particular application.
67-68	The number of these variables that are not identically zero at every beam section (see page 8, e).

- RUN TITLE CARD

1-12	Blank
13-72	Title associated with the run.

● DATA CONTROL CARD

Columns	Contents
3-4 (Type of data)	90
5-6, 7-8	Columns 5 and 6 specify the number of data cards of the type specified in columns 7 and 8.
9-10, 11-12	Similar to previous four columns for next type of data card; groups repeated until all typed cards for an application have been accounted for.
etc.	

● CASE TITLE CARD

Columns	Contents
3-4	10
5-12	Blank
13-72	Title for particular case within a run.

● OPTION CONTROL CARD*

Columns	Contents	Description
3-4	20	
9-12		OP1: Selector for added mass.
	0000	Added mass is directly specified with input.
	0001	"J-factor" analysis for automatic adjustment of added mass as a function of mode shape.
13-16		OP2: Selector for A-matrix and P-vector setup.
	0000	Bending, longitudinal, torsional vibration (GBRC1)
	0001	Coupled torsion-bending vibration (GBRC2)
	0002	Whirling shaft vibration (GBRC3)
17-20		OP3: Selector for edit routine to be used at each frequency.

* Must appear before "30" card in data deck.

Columns	Contents	Description
21-24		OP4
	0000	Used when application does not involve plotting, vibratory force calculation, or non-harmonic vibration.
	0001	Plotting is involved.
	0002	Vibratory forces are to be calculated.
	0003	Nonharmonic vibration applications (see reference 5).
25-28		OP5: Selector for printing A-matrix and P-vector
	0000	A-matrix and P-vector are not to be printed.
	0001	A-matrix and P-vector are to be printed.
29-32		OP6: ≠0 "Detailed edit" plotting of response (displacement, moment, twist) versus section for each frequency for selected systems.
	0000	No plot.
	0001	Displacements only.
	0002	Moments only.
	0003	Displacements and moments.
	0004	Twist only.
	0005	Displacement, moment, and twist.
33-36		OP7*: ≠0 Plotting of magnitude of response versus frequency for selected sections.
	0000 0001 0002 0003 0004 0005	Same as description for columns 29-32.

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* See Section V, pgs. 51-52.

Columns	Contents	Description
37-40		OP8
	0000	Plotting either not involved or designated OP7* ≠ 0 with a request for case by case graphs.
	0002	Plotting with OP7 and a request for either superimposed curves from a number of cases or continous curves spanning calculated results from a number of cases.
	0003	Program deletes the tabular detailed edit (response versus section for all sections at each frequency of forced or free response computed).
	0004	Program performs accuracy check* on computed normal modes of free vibration.
41-44		OP9: Selects forcing function to be multiplied by a power of frequency, ω, in radians.
	0000	Force not multiplied.
	0001	Force is multiplied.
45-48		OP10: Selector for natural frequency search.
	0000	Forced response is obtained over a specified range of frequencies.
	0001	Program will search for natural frequencies within a specified frequency range and compute mode shapes for any frequencies found. Frequencies are undamped.

● EDIT CONTROL CARD

Columns	Contents	Description
3-4	21	
9-12 13-16 17-20 21-24 25-28		Section numbers for those sections whose displacement, moment, and twist are to be tabulated versus frequency.

* See Section IV.

● GENERAL DATA CARD

Columns	Contents	Description
3-4	30	
5-8	Number of sections; the maximum number of sections is dependent on the amount of computer core available.	
9-16	Starting frequency, ω_1 or Ω_1, in cps.	
17-24	Upper limit, ω_2 or Ω_2, for frequency in cps.	
25-32	Frequency increment, $\Delta\omega$ or $\Delta\Omega$, in cps. Note: For natural frequency calculation, ω_1 and ω_2 define the frequency range of interest. $\Delta\omega$ defines the search interval. The method of search assumes that no more than one natural frequency occurs within the interval. Similarly for Ω with whirling shaft applications. For nonharmonic vibration applications, the complex frequency response is performed for integral multiples, m=0,1,2,...,MN, of the fundamental frequency 1/T where T is the period of vibration.[5] In this case one chooses ω_1 = a small number such as 10^{-6} (since GBRP requires non-zero frequencies); ω_2 = MN · 1/T; and $\Delta\omega$ = 1/T.	
33-40	h(=ω/Ω) Ratio of spinning velocity to whirling frequency of shaft (whirling calculations only).	
41-48	Power of frequency, ω. Any real number. Must be specified when OP9 ≠ 0.	
49-56	NPLOTC: Used with OP7 plotting when curves from more than one case are to appear on a single grid. This integer equals the total number of "90" cards +1.	

- **SYSTEM DATA CARDS FOR ADDED MASS CALCULATION**

Columns	Contents	Description
3-4	31	
7-8	System number. The hull sections, shafting sections, etc., can be distinguished from each other by assigning a system number, an integer, to each one. This number can have values ranging from 1 to the total number of sections.	
9-16	Radius associated with system in the units in which the unscaled distances between adjacent sections midcenters are given.	
17-24	Initial J-value for use with this system.	

- **FORCING FUNCTION LOCATION CARD (Used only if excitation forces are non-harmonic)**

3-4	32	
7-9	Total number of beam sections.	
10-11 12-13 14-15 ⋮ 78-79	Section numbers of those sections where nonharmonic forcing functions act. Section numbers can be continued, if necessary, on additional cards beginning in column 1.	

- **SECTION PARAMETER CARDS**

3-4	43	
5-8	Section number, n	
12		Section end condition designator.
	0	Section is not an end.
	1	Free end: $V(n)=M(n)=0$ GBRC1 and GBRC2 $V_y(n)=V_z(n)=0$, $M_y(n)=M_z(n)=0$ GBRC3 V is internal shearing force M is bending moment

Columns	Contents	Description
	2	Fixed end: $\gamma(n)=y(n)=0$ GBRC1 $\left.\begin{array}{l}\alpha(n)=\beta(n)=0\\ y(n)=z(n)=0\end{array}\right\}$ GBRC3 y is deflection, normal to beam axis x, in the xy-plane z is deflection, normal to beam axis x, in the xz-plane γ,β are rotations in the xy-plane α is rotation in the xz-plane Note: For GBRC1 applications, a hinged end condition can be obtained by taking a free end condition in combination with the specification of a very stiff spring to ground at the particular condition giving $M(n)=y(n)=0$
15-16	System number	
17-24	Section mass	
25-32	Section water inertia	
33-40	$(\Delta x/EI)_n$	Integral over section of the reciprocal of bending rigidity per unit length.
41-48	$(\Delta x)_{n,n+1}$	Distance from midpoint of section n to midpoint of section n+1
49-56	$(\Delta x/KAG)_{n,n+1}$	Integral from midpoint of section n to midpoint of section n+1 of reciprocal of shear rigidity per unit length.
57-64	$(I_{\mu z}\Delta x)_{n,n+1}$	For GBRC1: Integral of the effective rotary inertia per unit length from midpoint of section n to midpoint of section n+1.

Columns	Contents	Description
	$(\tau_d \Delta x)_{n,n+1}$	For GBRC3: Integral of the diametrical mass moment of inertia per unit length from midpoint of section n to midpoint of section n+1. Program notation*, TAUD*DX(N,N+1)
65-72	P_n	For GBRC1, GBRC2: Integral of the external forcing function per unit length acting normal to the beam axis, x, in the plane of vibration.
	$(P_n)_y$	For GBRC3: Integral of the component of the external forcing function per unit length acting normal to the beam axis, x, in the y-direction.

● CONTINUATION "43" CARD FOR TORSION-BENDING PARAMETERS

Columns	Contents	Description
1-16	Blank	
17-24	$(\mu\bar{z}\Delta x)_n$	Integral over a section of $\mu\bar{z}$ per unit length. μ is mass per unit length of the section. $\bar{z}$ is the distance of the center of mass of the section from the beam axis x. Program notation, MZB*DX(N)
25-32	$(I_{\mu x}\Delta x)_n$	Integral over a section of the mass polar moment of inertia per unit length with respect to the x-axis. Program notation, IMX*DX(N)
33-40	$(\bar{\bar{z}})_{n,n+1}$	Average distance of the shear center from the x-axis taken from the midpoint of section n to the midpoint of section n+1. Program notation, ZBB(N,N+1)

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* Symbol for the parameter in the printout of input data.

Columns	Contents	Description
41-48	$(\Delta x/GJ_e)_{n,n+1}$	Integral from midpoint of section n to the midpoint of section n+1 of the reciprocal of the torsion rigidity per unit length. Program notation, DX/GJE(N,N+1)
49-56	U_n	Integral over a section of the externally acting torque per unit length.

- CONTINUATION "43" CARD FOR WHIRLING SHAFT PARAMETERS

Columns	Contents	Description
1-16	Blank	
17-24	$(\tau \cdot \Delta x)_{n,n+1}$	Integral of rotary mass moment of inertia per unit length of the shaft from the midpoint of section n to the midpoint of section n+1. Program notation, TAU*DX(N,N+1)
25-32	$(k_\alpha \cdot \Delta x)_{n,n+1}$	Integral of rotary spring constant per unit length of the shaft in the xz-plane from the midpoint of section n to the midpoint of section n+1. Program notation, KA*DX(N,N+1)
33-40	$(k_\beta \cdot \Delta x)_{n,n+1}$	Quantity analogous to integral of the rotary spring constant but in the xy-plane. Program notation, KB*DX(N,N+1)
41-48	$(P_n)_z$	Integral of the component of the external forcing function per unit length acting normal to the beam axis, x, in the z-direction.

- SCALING FACTOR CARDS FOR SECTION PARAMETERS

Columns	Contents	Description
3-4	<u>41</u>	Card indicates <u>real parts</u> of the scaling factors.

Columns	Contents	Description
	42	Card indicates imaginary parts of the scaling factors.
15-16	Number of the system to which scaling factors on this card apply.	
17-72	Scaling factors for the parameters in the corresponding field locations on the section parameter cards (type "43").	

- CONTINUATION "41" CARDS FOR GBRC2 AND GBRC3

1-16	Blank
17-56	Scaling factors for the parameters in the corresponding field locations on the "43" continuation cards.

- CONTINUATION "42" CARDS FOR GBRC2 AND GBRC3

1-16	Blank
17-56	Scaling factors for the parameters in the corresponding field locations on the "43" continuation cards.

- SPECIAL CONNECTION* PARAMETER CARDS

3-4	53
5-8 } 9-12 }	Section numbers for the connection n† to m; if m=0, this represents a connection from n to a rigid ground. The absolute value of (m-n) must be ≤15 when neither m or n is 0.

---

* Since connections are considered here to be either spring-type or rigid moment arm-type, the mechanical data for connections will be specified in columns 17-40 or 41-72.

† n should not be 0.

Columns	Contents	Description
15-16	System number assigned to the connection for purpose of scaling. These system numbers are completely independent of those assigned to sections on the "43" cards and therefore may have the same values.	
17-24		For GBRC1 and GBRC2:
	$k_{n,m}$	Spring constant for the connection in the direction of vibration.
		For GBRC3:
	$(k_{n,m})_y$	Component of spring constant for the connection in the y-direction.
25-32		For GBRC1 and GBRC2:
	$c_{n,m}$	Viscous damping coefficient for the connection in the direction of vibration.
		For GBRC3:
	$(c_{n,m})_y$	Component of a viscous damping coefficient for the connection in the y-direction.
33-40		For GBRC1 and GBRC2:
	$c_{n,m/\omega}$	Frequency dependent viscous damping coefficient for the connection in the direction of vibration.
		For GBRC3:
	$(c_{n,m/\Omega})_y$	Component of a frequency dependent viscous damping coefficient for the connection in the y-direction.
		For GBRC1 and GBRC2:
41-48	$(\Delta x)_{n,m}$	
49-56	$(\Delta x/KAG)_{n,m}$	
57-64	$(I_{\mu z}\Delta x)_{n,m}$	
		For GBRC3:
	$(\tau_d \Delta x)_{n,m}$	

Columns	Contents	Description
65-72	$Q_{n,m}$	For GBRC1 and GBRC2: Integral of the external forcing moment per unit length from the midpoint of section n to the midpoint of section m. The moment acts in the plane of vibration.
	$(Q_{n,m})_y$	For GBRC3: Same as above integral with y indicating the component in the xz-plane associated with rotation about an axis parallel to y.

- CONTINUATION "53" CARDS FOR GBRC2

1-16	Blank
17-24	$(\bar{\bar{z}})_{n,m}$
25-32	$(\Delta x/GJ_e)_{n,m}$

- CONTINUATION "53" CARDS FOR GBRC3

1-16	Blank
17-24	$(\tau\Delta x)_{n,m}$
25-32	$(k_\alpha \Delta x)_{n,m}$
33-40	$(k_\beta \Delta x)_{n,m}$
41-48	$(k_{n,m})_z$
49-56	$(c_{n,m})_z$
57-64	$(c_{n,m/\Omega})_z$
65-72	$(Q_{n,m})_z$

- CONTINUATION "53" CARDS
FOR VIBRATORY FORCE CALCULATION*

Columns	Contents	Description
1-16	Blank	
17-24	$N_{n,m}$	Number of shafts between sections n and m.
25-32	$G_{n,m}$	Reduction ratio between shaft n,m and the reference shaft.

- SCALING FACTOR CARDS FOR
SPECIAL CONNECTION PARAMETERS

3-4	<u>51</u>	Card indicates <u>real parts</u> of the scaling factors.
	<u>52</u>	Card indicates <u>imaginary parts</u> of the scaling factors.
13-16	Number of the system to which scaling factors on this card apply.	
17-72	Scaling factors for the parameters in the corresponding field locations on the special connection parameter cards (type "53")	

- CONTINUATION "51" CARDS
FOR GBRC2 AND GBRC3

1-16	Blank
17-72	Scaling factors for the parameters in the corresponding field locations on the "53" continuation cards.

- CONTINUATION "52" CARDS
FOR GBRC2 AND GBRC3

1-16	Blank
17-72	Scaling factors for the parameters in the corresponding field locations on the "53" continuation cards.

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* See Section III.

- **CHARACTRON PLOTTING CHARACTERS**

Columns	Contents	Description
3-4	<u>60</u>	
7-16	Blank	
17-26	+ΔΔΔΔΔΔΔΔΔ	
27-36	0ΔΔΔΔΔΔΔΔΔ	
37-46	XΔΔΔΔΔΔΔΔΔ	
47-56	-ΔΔΔΔΔΔΔΔΔ	
57-66	·ΔΔΔΔΔΔΔΔΔ	

- **NATURAL FREQUENCY CARD**

3-4	<u>70</u>	
9-10	Number of natural frequencies requested.	

- **SYSTEMS TO BE PLOTTED*** (Used only with OP6 plotting)

1-2, 3-4, 5-6, etc.	System numbers of those systems for which OP6 plotting is desired.

- **COMPLETE NEW SET OF DATA CARDS**

3-4	<u>98</u>	(This card precedes each such set when a series of GBRP jobs are stacked into a single run.)

- **END OF DATA CARD**

3-4	<u>99</u>

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* See Section V, pg. 96.

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [| | |] ______ SHEET ____ OF ____

RUN SELECTION CARD ______

1

DIMENSIONS FOR FAST FOURIER TRANSFORM INTERFACE (NONHARMONIC VIBRATIONS ONLY) ______

D16 D17 D18 D19

1 4 7 10

DATA FOR FAST FOURIER TRANSFORM INTERFACE (NONHARMONIC VIBRATIONS ONLY) ______

1 6 11 17 23 27 31 35 43 51 59 61 63 65 67

DIMENSIONS FOR GBRP ______

D2 D3 D5 D14 D15 D6 D7 D8 D9 D10 D11 D12 D13

1 4 7 10 13 16 19 22 25 28 31 34 37

Data Input Form (1)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL ______ SHEET ____ OF ____

RUN TITLE CARD ______

ΔΔΔΔΔΔΔΔΔΔΔΔ ______ 13

DATA CONTROL CARD ______

NO TYPE NO TYPE etc.

0090

5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71

CASE TITLE CARD ______

001000ΔΔΔΔΔΔ ______ 13

OPTION CONTROL CARD ______

	OP1	OP2	OP3	OP4	OP5	OP6	OP7	OP8	OP9	OP10
00200000	9	13	17	21	25	29	33	37	41	45

EDIT CONTROL CARD ______

00210000 ______ 9 13 17 21 25 29

GENERAL DATA CARD

	NO SECTIONS	ω_1(CPS)	ω_2(CPS)	$\Delta\omega$(CPS)	h	Power of ω	NPLOTC	
0030	5	9	17	25	33	41	49	57

SYSTEMS DATA CARDS ______

	SYSTEMS	RADIUS	INITIAL J
0031			
0031	7	9	17

FORCING FUNCTION LOCATION CARD ______ (Used only if forces are nonharmonic) ______

0032

5 7 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78

Data Input Form (2)

Bending, Longitudinal, Torsional

TITLE ______________________ PROGRAMMER ______________ DATE __________

PROBLEM NO. ______________________ PHASE ________ LABEL ☐☐☐☐ ________ SHEET ____ OF ____

SECTION DATA CARDS

5		9	13	17	25	33	41	49	57	65	73
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
REAL PART OF SCALING FACTORS											
00410000		0000									
00410000		0000									
00410000		0000									
IMAGINARY PART OF SCALING FACTORS											
00420000		0000									
00420000		0000									
00420000		0000									
PARAMETER VALUES - UNSCALED											
0043											
0043											
0043											
0043											
0043											
0043											
0043											
0043											
0043											
0043											
0043											
0043											
0043											
0043											
0043											

Data Input Form (3)

Bending. Longitudinal. Torsional

TITLE ______________________ PROGRAMMER ______________ DATE ________

PROBLEM NO. ______________________ PHASE ________ LABEL [| | |] ________ SHEET ____ OF ____

SECTION PARAMETER VALUES - UNSCALED

	5 SECTION NO.	9 END CONDN	13 SYSTEM	17 MASS	25 WATER INERTIA	33 $(\Delta x/EI)_n$	41 $(\Delta x)_{n,n+1}$	49 $(\Delta x/KAG)_{n,n+1}$	57 $(I_{\mu z}\Delta x)_{n,n+1}$	65 P_n	73
0043											
0043											
0043											
0043											
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Data Input Form (4)

Bending, Longitudinal, Torsional

TITLE ______________________ PROGRAMMER ______________ DATE ________

PROBLEM NO. ______________________ PHASE ________ LABEL [| | |] ________ SHEET ____ OF ____

5	9	13	17	25	33	41	49	57	65	73	
SPECIAL CONNECTION CARDS											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$\Delta X_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I\mu_z\Delta X)_{n,m}$	$Q_{n,m}$	
REAL PART OF SCALING FACTORS											
0051	0000	0000									
0051	0000	0000									
0051	0000	0000									
IMAGINARY PART OF SCALING FACTORS											
0052	0000	0000									
0052	0000	0000									
0052	0000	0000									
PARAMETER VALURS - UNSCALED											
0053											
0053											
0053											
0053											
0053											
0053											
0053											
0053											
0053											
0053											

Data Input Form (5)

Bending, Longitudinal, Torsional

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [| | |] ______ SHEET ____ OF ____

SPECIAL CONNECTIONS - PARAMETER VALUES - UNSCALED

	5	9	13	17	25	33	41	49	57	65	73
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I\mu_z\Delta X)_{n,m}$	$Q_{n,m}$	
0053											
0053											
0053											
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Data Input Form (6)

Vibratory Force Data

TITLE ____________________ PROGRAMMER ____________________ DATE __________

PROBLEM NO. ____________________ PHASE __________ LABEL [| | |] __________ SHEET ____ OF ____

SPECIAL CONNECTIONS PARAMETER VALUES - UNSCALED

	5	9	13	17	25	33	41	49	57	65	73
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053											
				$N_{n,m}$	$G_{n,m}$						
BLANK											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053											
				$N_{n,m}$	$G_{n,m}$						
BLANK											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053											
				$N_{n,m}$	$G_{n,m}$						
BLANK											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053											
				$N_{n,m}$	$G_{n,m}$						
BLANK											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053											
				$N_{n,m}$	$G_{n,m}$						
BLANK											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053											
				$N_{n,m}$	$G_{n,m}$						
BLANK											

Data Input Form (7)

Torsion-Bending

TITLE ______________________ PROGRAMMER ______________________ DATE __________

PROBLEM NO. ______________________ PHASE ________ LABEL [| | |] ________ SHEET ____ OF ____

SECTION DATA CARDS

	5	9	13	17	25	33	41	49	57	65	73
REAL PART OF SCALING FACTORS											
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0041	0000	0000									
(hatched)				$(\mu \bar{z} \Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →											
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0041	0000	0000									
(hatched)				$(\mu \bar{z} \Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →											
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0041	0000	0000									
(hatched)				$(\mu \bar{z} \Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →											
IMAGINARY PART OF SCALING FACTORS											
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0042	0000	0000									
(hatched)				$(\mu \bar{z} \Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →											
	SECTION NO.	END CONDN	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0042	0000	0000									
(hatched)				$(\mu \bar{z} \Delta X)_n$	$(I_{\mu x}\Delta X)_n$.	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →											

Data Input Form (8)

Torsion-Bending

TITLE ______________________ PROGRAMMER ______________________ DATE ________

PROBLEM NO. ______________________ PHASE ________ LABEL ☐☐☐☐ ________ SHEET ____ OF ____

SECTION PARAMETER VALUES - UNSCALED

	5	9	13	17	25	33	41	49	57	65	73
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043											
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →											
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043											
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →											
	SECTION NO.	END CONDN	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043											
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →											
	SECTION NO.	END CONDN	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043											
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →											
	SECTION NO.	END CONDN	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(I_{\mu z}\Delta X)_{n,n+1}$	P_n	
0043											
				$(\mu\bar{z}\Delta X)_n$	$(I_{\mu x}\Delta X)_n$	$(\bar{z})_{n,n+1}$	$(\Delta X/GJ_e)_{n,n+1}$	U_n			
← BLANK →											

Data Input Form (9)

Torsion-Bending

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [| | |] ______ SHEET ______ OF ______

SPECIAL CONNECTION CARDS

	5	9	13	17	25	33	41	49	57	65	73
REAL PART OF SCALING FACTORS											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0051											
//////	//////	//////	//////	$(\bar{z})_{n,m}$	$(\Delta X/GJ_e)_{n,m}$						
← BLANK →											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0051											
//////	//////	//////	//////	$(\bar{z})_{n,m}$	$(\Delta X/GJ_e)_{n,m}$						
← BLANK →											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0051											
//////	//////	//////	//////	$(\bar{z})_{n,m}$	$(\Delta X/GJ_e)_{n,m}$						
← BLANK →											
IMAGINARY PART OF SCALING FACTORS											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0052											
//////	//////	//////	//////	$(\bar{z})_{n,m}$	$(\Delta X/GJ_e)_{n,m}$						
← BLANK →											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0052											
//////	//////	//////	//////	$(\bar{z})_{n,m}$	$(\Delta X/GJ_e)_{n,m}$						
← BLANK →											

Data Input Form (10)

Torsion-Bending

TITLE ______________________ PROGRAMMER ______________ DATE ________

PROBLEM NO. ______________________ PHASE ______ LABEL [| | |] ________ SHEET ____ OF ____

SPECIAL CONNECTIONS PARAMETER VALUES - UNSCALED

	5	9	13	17	25	33	41	49	57	65	73
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053											
				$(\bar{z})_{n,m}$	$(\Delta X/GJ_e)_{n,m}$						
← BLANK →											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053											
				$(\bar{z})_{n,m}$	$(\Delta X/GJ_e)_{n,m}$						
← BLANK →											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053											
				$(\bar{z})_{n,m}$	$(\Delta X/GJ_e)_{n,m}$						
← BLANK →											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053											
				$(\bar{z})_{n,m}$	$(\Delta X/GJ_e)_{n,m}$						
← BLANK →											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053											
				$(\bar{z})_{n,m}$	$(\Delta X/GJ_e)_{n,m}$						
← BLANK →											
	n	m	SYSTEM	$K_{n,m}$	$C_{n,m}$	$C_{n,m}/\omega$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(I_{\mu z}\Delta X)_{n,m}$	$Q_{n,m}$	
0053											
				$(\bar{z})_{n,m}$	$(\Delta X/GJ_e)_{n,m}$						
← BLANK →											

Data Input Form (11)

TITLE ______________________ PROGRAMMER ______________ DATE ________

PROBLEM NO. ______________________ PHASE ______ LABEL [| | |] ______ SHEET ____ OF ____

SECTION DATA CARDS

	5	9	13	17	25	33	41	49	57	65	73
REAL PART OF SCALING FACTORS											
	SECTION NO	END CONDN	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(\tau_d\, \Delta X)_{n,n+1}$	$(P_n)_y$	
0041	0000	0000									
				$(\tau \cdot \Delta X)_{n,n+1}$	$(k_\alpha\, \Delta X)_{n,n+1}$	$(k_\beta\, \Delta X)_{n,n+1}$	$(P_n)_z$				
← BLANK →											
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(\tau_d \cdot \Delta X)_{n,n+1}$	$(P_n)_y$	
0041	0000	0000									
				$(\tau \cdot \Delta X)_{n,n+1}$	$(k_\alpha\, \Delta X)_{n,n+1}$	$(k_\beta \cdot \Delta X)_{n,n+1}$	$(P_n)_z$				
← BLANK →											
	SECTION NO	END CONDN	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(\tau_d \cdot \Delta X)_{n,n+1}$	$(P_n)_y$	
0041	0000	0000									
				$(\tau \cdot \Delta X)_{n,n+1}$	$(k_\alpha\, \Delta X)_{n,n+1}$	$(k_\beta \cdot \Delta X)_{n,n+1}$	$(P_n)_z$				
← BLANK →											
IMAGINARY PART OF SCALING FACTORS											
	SECTION NO.	END CONDN	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(\tau_d \cdot \Delta X)_{n,n+1}$	$(P_n)_y$	
0042	0000	0000									
				$(\tau \cdot \Delta X)_{n,n+1}$	$(k_\alpha\, \Delta X)_{n,n+1}$	$(k_\beta \cdot \Delta X)_{n,n+1}$	$(P_n)_z$				
← BLANK →											
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(\tau_d \cdot \Delta X)_{n,n+1}$	$(P_n)_y$	
0042	0000	0000									
				$(\tau\, \Delta X)_{n,n+1}$	$(k_\alpha\, \Delta X)_{n,n+1}$	$(k_\beta\, \Delta X)_{n,n+1}$	$(P_n)_z$				
← BLANK →											

Data Input Form (12)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL ☐☐☐☐ ______ SHEET ____ OF ____

SECTION PARAMETER VALUES - UNSCALED

1	5	9	13	17	25	33	41	49	57	65	73
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(\tau_d \cdot \Delta X)_{n,n+1}$	$(P_n)_y$	
0043											
				$(\tau \cdot \Delta X)_{n,n+1}$	$(k_\alpha \cdot \Delta X)_{n,n+1}$	$(k_\beta \cdot \Delta X)_{n,n+1}$	$(P_n)_z$				
← BLANK →											
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(\tau_d \cdot \Delta X)_{n,n+1}$	$(P_n)_y$	
0043											
				$(\tau \cdot \Delta X)_{n,n+1}$	$(k_\alpha \cdot \Delta X)_{n,n+1}$	$(k_\beta \cdot \Delta X)_{n,n+1}$	$(P_n)_z$				
← BLANK →											
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(\tau_d \cdot \Delta X)_{n,n+1}$	$(P_n)_y$	
0043											
				$(\tau \cdot \Delta X)_{n,n+1}$	$(k_\alpha \cdot \Delta X)_{n,n+1}$	$(k_\beta \cdot \Delta X)_{n,n+1}$	$(P_n)_z$				
← BLANK →											
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(\tau_d \cdot \Delta X)_{n,n+1}$	$(P_n)_y$	
0043											
				$(\tau \cdot \Delta X)_{n,n+1}$	$(k_\alpha \cdot \Delta X)_{n,n+1}$	$(k_\beta \cdot \Delta X)_{n,n+1}$	$(P_n)_z$				
← BLANK →											
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(\tau_d \cdot \Delta X)_{n,n+1}$	$(P_n)_y$	
0043											
				$(\tau \cdot \Delta X)_{n,n+1}$	$(k_\alpha \cdot \Delta X)_{n,n+1}$	$(k_\beta \cdot \Delta X)_{n,n+1}$	$(P_n)_z$				
← BLANK →											
	SECTION NO.	END CONDN.	SYSTEM	MASS	WATER INERTIA	$(\Delta X/EI)_n$	$(\Delta X)_{n,n+1}$	$(\Delta X/KAG)_{n,n+1}$	$(\tau_d \cdot \Delta X)_{n,n+1}$	$(P_n)_y$	
0043											
				$(\tau \cdot \Delta X)_{n,n+1}$	$(k_\alpha \cdot \Delta X)_{n,n+1}$	$(k_\beta \cdot \Delta X)_{n,n+1}$	$(P_n)_z$				
← BLANK →											

Data Input Form (13)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL ☐☐☐☐ ______ SHEET ____ OF ____

	5	9	13	17	25	33	41	49	57	65	73
REAL PART OF SCALING FACTORS											
	n	m	SYSTEM	$(K_{n,m})_y$	$(C_{n,m})_y$	$(C_{n,m}/\Omega)_y$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(\tau_d \cdot \Delta X)_{n,m}$	$(Q_{n,m})_y$	
0051											
				$(\tau \cdot \Delta X)_{n,m}$	$(k_\alpha \cdot \Delta X)_{n,m}$	$(k_\beta \cdot \Delta X)_{n,m}$	$(K_{n,m})_z$	$(C_{n,m})_z$	$(C_{n,m}/\Omega)_z$	$(Q_{n,m})_z$	
← BLANK →											
	n	m	SYSTEM	$(K_{n,m})_y$	$(C_{n,m})_y$	$(C_{n,m}/\Omega)_y$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(\tau_d \cdot \Delta X)_{n,m}$	$(Q_{n,m})_y$	
0051											
				$(\tau \cdot \Delta X)_{n,m}$	$(k_\alpha \cdot \Delta X)_{n,m}$	$(k_\beta \cdot \Delta X)_{n,m}$	$(K_{n,m})_z$	$(C_{n,m})_z$	$(C_{n,m}/\Omega)_z$	$(Q_{n,m})_z$	
← BLANK →											
	n	m	SYSTEM	$(K_{n,m})_y$	$(C_{n,m})_y$	$(C_{n,m}/\Omega)_y$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(\tau_d \cdot \Delta X)_{n,m}$	$(Q_{n,m})_y$	
0051											
				$(\tau \cdot \Delta X)_{n,m}$	$(k_\alpha \cdot \Delta X)_{n,m}$	$(k_\beta \cdot \Delta X)_{n,m}$	$(K_{n,m})_z$	$(C_{n,m})_z$	$(C_{n,m}/\Omega)_z$	$(Q_{n,m})_z$	
← BLANK →											
IMAGINARY PART OF SCALING FACTORS											
	n	m	SYSTEM	$(K_{n,m})_y$	$(C_{n,m})_y$	$(C_{n,m}/\Omega)_y$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(\tau_d \cdot \Delta X)_{n,m}$	$(Q_{n,m})_y$	
0052											
				$(\tau \cdot \Delta X)_{n,m}$	$(k_\alpha \cdot \Delta X)_{n,m}$	$(k_\beta \cdot \Delta X)_{n,m}$	$(K_{n,m})_z$	$(C_{n,m})_z$	$(C_{n,m}/\Omega)_z$	$(Q_{n,m})_z$	
← BLANK →											
	n	m	SYSTEM	$(K_{n,m})_y$	$(C_{n,m})_y$	$(C_{n,m}/\Omega)_y$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(\tau_d \cdot \Delta X)_{n,m}$	$(Q_{n,m})_y$	
0052											
				$(\tau \cdot \Delta X)_{n,m}$	$(k_\alpha \cdot \Delta X)_{n,m}$	$(k_\beta \cdot \Delta X)_{n,m}$	$(K_{n,m})_z$	$(C_{n,m})_z$	$(C_{n,m}/\Omega)_z$	$(Q_{n,m})_z$	
← BLANK →											

Data Input Form (14)

Whirling

TITLE ______________________ PROGRAMMER ______________ DATE ________

PROBLEM NO. ______________________ PHASE ____ LABEL ☐☐☐☐ ______ SHEET ____ OF ____

SPECIAL CONNECTIONS PARAMETER VALUES - UNSCALED

1	5	9	13	17	25	33	41	49	57	[illegible]	73
	n	m	SYSTEM	$(K_{n,m})_y$	$(C_{n,m})_y$	$(C_{n,m}/\Omega)_y$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(\tau_d \cdot \Delta X)_{n,m}$	$(Q_{n,m})_y$	
0053											
				$(\tau \cdot \Delta X)_{n,m}$	$(k_\alpha \cdot \Delta X)_{n,m}$	$(k_\beta \cdot \Delta X)_{n,m}$	$(K_{n,m})_z$	$(C_{n,m})_z$	$(C_{n,m}/\Omega)_z$	$(Q_{n,m})_z$	
← BLANK →											
	n	m	SYSTEM	$(K_{n,m})_y$	$(C_{n,m})_y$	$(C_{n,m}/\Omega)_y$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(\tau_d \cdot \Delta X)_{n,m}$	$(Q_{n,m})_y$	
0053											
				$(\tau \cdot \Delta X)_{n,m}$	$(k_\alpha \cdot \Delta X)_{n,m}$	$(k_\beta \cdot \Delta X)_{n,m}$	$(K_{n,m})_z$	$(C_{n,m})_z$	$(C_{n,m}/\Omega)_z$	$(Q_{n,m})_z$	
← BLANK →											
	n	m	SYSTEM	$(K_{n,m})_y$	$(C_{n,m})_y$	$(C_{n,m}/\Omega)_y$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(\tau_d \cdot \Delta X)_{n,m}$	$(Q_{n,m})_y$	
0053											
				$(\tau \cdot \Delta X)_{n,m}$	$(k_\alpha \cdot \Delta X)_{n,m}$	$(k_\beta \cdot \Delta X)_{n,m}$	$(K_{n,m})_z$	$(C_{n,m})_z$	$(C_{n,m}/\Omega)_z$	$(Q_{n,m})_z$	
← BLANK →											
	n	m	SYSTEM	$(K_{n,m})_y$	$(C_{n,m})_y$	$(C_{n,m}/\Omega)_y$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(\tau_d \cdot \Delta X)_{n,m}$	$(Q_{n,m})_y$	
0053											
				$(\tau \cdot \Delta X)_{n,m}$	$(k_\alpha \cdot \Delta X)_{n,m}$	$(k_\beta \cdot \Delta X)_{n,m}$	$(K_{n,m})_z$	$(C_{n,m})_z$	$(C_{n,m}/\Omega)_z$	$(Q_{n,m})_z$	
← BLANK →											
	n	m	SYSTEM	$(X_{n,m})_y$	$(C_{n,m})_y$	$(C_{n,m}/\Omega)_y$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(\tau_d \cdot \Delta X)_{n,m}$	$(Q_{n,m})_y$	
0053											
				$(\tau \cdot \Delta X)_{n,m}$	$(k_\alpha \cdot \Delta X)_{n,m}$	$(k_\beta \cdot \Delta X)_{n,m}$	$(K_{n,m})_z$	$(C_{n,m})_z$	$(C_{n,m}/\Omega)_z$	$(Q_{n,m})_z$	
← BLANK →											
	n	m	SYSTEM	$(K_{n,m})_y$	$(C_{n,m})_y$	$(C_{n,m}/\Omega)_y$	$(\Delta X)_{n,m}$	$(\Delta X/KAG)_{n,m}$	$(\tau_d \cdot \Delta X)_{n,m}$	$(Q_{n,m})_y$	
0053											
				$(\tau \cdot \Delta X)_{n,m}$	$(k_\alpha \cdot \Delta X)_{n,m}$	$(k_\beta \cdot \Delta X)_{n,m}$	$(K_{n,m})_z$	$(C_{n,m})_z$	$(C_{n,m}/\Omega)_z$	$(Q_{n,m})_z$	
← BLANK →											

Data Input Form (15)

TITLE ______ PROGRAMMER ______ DATE ______

PROBLEM NO. ______ PHASE ______ LABEL [| | |] ______ SHEET ____ OF ____

CHARACTRON PLOTTING CHARACTERS ______

006000	ΔΔΔΔΔΔΔΔΔΔ	+ΔΔΔΔΔΔΔΔΔ	0ΔΔΔΔΔΔΔΔΔ	XΔΔΔΔΔΔΔΔΔ	−ΔΔΔΔΔΔΔΔΔ	•ΔΔΔΔΔΔΔΔΔ
34	7	17	27	37	47	57

NATURAL FREQUENCY SELECTION CARD ______

00700000		
34	9	11

SYSTEMS TO BE PLOTTED (USED ONLY WITH OPTION 6 PLOTTING) ______

1st	2nd	3rd	4th	5th	6th	
						etc.
1	3	5	7	9	11	

START NEW DATA SET CARD ______

0098

34

END OF DATA CARD ______

0099

34

Δ indicates blank space

Data Input Form (16)

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