

Demonstration Problem Manual

For the

**MYSTRAN General Purpose Finite Element
Structural Analysis Computer Program**

(Feb 2009)

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Preface

This manual is not a complete reference for all types of MYSTRAN analyses but does contain example problems to demonstrate the use of MYSTRAN for solving unique kinds of problems. At the present time, only examples that use the unique Craig-Bampton model generation and synthesis capability are covered. Additional examples will be added as needed to explain how to use the program for solving problems not generally covered by the popular NASTRAN computer program known to most users of finite element analysis computer programs

1 Demo Problem 1 – Craig-Bampton model generation and synthesis into an overall structure model

1.1 Example Problem Definition

1.1.1 Introduction

This example demonstrates two different features in MYSTRAN:

- Generation of Craig-Bampton (CB) models from physical finite element model (FEM).
- Synthesis of CB models with optional physical FEM's to obtain system modes.

Figure 1.1 shows a model made up of a basic structure and 2 substructures. The model can certainly be analyzed as a physical FEM using SOL 3 to obtain the modes of the combined structure. It actually will be so analyzed as a comparison with the CB synthesis model results, but the main purpose of this example is to demonstrate how a structure like the one in Figure 1.1 can be modeled with substructures using the CB substructure technique. The CB reduction technique will be referred to as a modal synthesis or substructure technique to distinguish from the ordinary FEM technique wherein all degrees of freedom (DOF) are physical displacements and rotations at grid points

The simple structure in Figure 1.1 is small enough that using substructure techniques are not economical but is used to demonstrate the techniques that would be used on much larger structural models. The CB technique is a mathematical reduction of the ordinary FEM model having all physical DOF to an approximate model consisting of the physical DOF at the boundary of the substructure (where it connects to other substructures) plus some fixed boundary modal DOF. The technique is exactly equivalent to obtaining the modes (eigenvalues) from the ordinary FEM with all physical DOF if all of the boundary modes are included. However, the economy in using the CB approach is that the user can truncate the boundary modal DOF to some acceptably small fraction of all of the complete set without appreciable loss of accuracy. From a physical point of view, this statement is equivalent to saying that the substructure probably has many higher modes of vibration that are not of interest to the user and do not contribute significantly to the responses of interest to the user.

The first step in a modal synthesis is to break the complete structure into separate substructures. In many cases this is a process of convenience in that separate entities may be responsible for different parts of a structure and would have their own FEM's of their structure's designs. However, there are also modeling concerns, as listed below, in breaking the complete structure into separate substructures:

- It is more economical to separate the substructures at locations where there are a relatively few physical boundary DOF.
- In order to take advantage of modal truncation the separate substructures should be able to be adequately represented using only a small number of modal DOF.

In Figure 1.1 we have already taken into account the considerations above and have made the decision to separate the model into 3 parts:

- A basic structure consisting of the frame of CBAR's connected to the grids numbered in the range 111 to 222. This will be kept as a physical FEM in the analysis rather than reducing it to a CB model.
- Substructure 1, modeled as 1 CBAR from grids 3101 to 3102. This physical FEM will be reduced to a CB model containing only the boundary DOF's (6 components of motion at grid 3101) plus some modal DOF's.

- Substructure 2, modeled as a frame of CBAR's connecting grids 3201 through 3204. This physical FEM will be reduced to a CB model containing only the boundary DOF's (in this case the 3 translation components of motion at grids 3201, 3202, 3203) plus some modal DOF's

Sections 1.1.2 and 1.1.3 will explain the input/output data for the 2 CB models. Section 1.1.4 will explain the model to obtain the system modes using these 2 CB models and the physical FEM of the basic structure. Finally, section 1.1.5 will show that the CB synthesis results are the same as those from a completely physical FEM model.

1.1.2 Generation of Craig-Bampton model of substructure 1

Section 1.4 has the input data for the generation of a CB model of substructure 1. Note the following regarding the input data deck (see Figure 1.1 for a picture of this substructure):

- SOL 31 is for CB model generation
- OUTPUT4 calls for CB matrices KXX, MXX, RBM0 (NASTRAN matrices KRRGN, MRRGN, RBMCG) to be output to binary OUTPUT4 formatted files
- METHOD = 2 selects an EIGR with set ID = 2 to find the eigenvalues (so modes found will be fixed base relative to the boundary DOF's identified by the SUPORT Bulk Data entry)
- Model has 2 GRID's and 1 CBAR
- Coordinate system 19 is used for the global system for the 2 grids. This is only done to demonstrate the flexibility of MYSTRAN to deal with coordinate systems other than basic in CB analyses
- The only mass is a concentrated mass at grid 3102
- SUPORT identifies the boundary DOF for this substructure to be the 3 translation components of displacement at grid 3101
- PARAM CUSERIN requests MYSTRAN to print out equivalent CUSERIN Bulk Data entries for this substructure

The output is shown on the following pages in section 1.4. Note the following:

- Grid Point Weight Generator output shows the rigid body mass properties of substructure 1 relative to its basic coordinate system.
- *INFORMATION: message listed shows that matrices KXX, MXX, RBM0 have been written to binary file CB1d-SUBSTR-1-CB-MODEL.OP1 which will be used in the synthesis run (section 1.6)
- Based on Bulk data PARAM CUSERIN, the Bulk Data entries needed in the synthesis run for this CB substructure is listed. Some of the entries will have to be modified (e.g. CID0 must be defined) for the synthesis run in section 1.6
- Only 3 eigenvalues were found although 4 were requested. Since the model has only 3 mass DOF, there are only 3 finite eigenvalues. Normally we would not be asking for all modes in a CB analysis but are doing so here so that the system modes can be compared to a run in which a complete FEM model is used (section 1.7)

- Output of displacements was requested in Case Control and the output is shown next. Note that for CB analyses, “displacement” output is of the rows of the Displacement Output Transformation Matrix (Displ OTM) described in Appendix D to Reference 1

1.1.3 Generation of Craig-Bampton model of substructure 2

Section 1.5 has the input data for the generation of a CB model of substructure 2. Note the following regarding the input data deck (see Figure 1.1 for a picture of this substructure):

- SOL 31 is for CB model generation
- OUTPUT4 calls for CB matrices KXX, MXX, RBM0 (NASTRAN matrices KRRGN, MRRGN, RBMCG) to be output to binary OUTPUT4 formatted files
- METHOD = 2 selects an EIGR with set ID = 2 to find the eigenvalues (so modes found will be fixed base relative to the boundary DOF's identified by the SUPORT Bulk Data entry)
- Model has 4 GRID's and 6 CBAR's
- Coordinate systems 291 through 294 are used for the global system for the 4 grids. This is only done to demonstrate the flexibility of MYSTRAN to deal with coordinate systems other than basic in CB analyses
- The only mass is a concentrated mass at grid 3204
- SUPORT identifies the boundary DOF for this substructure which is to be the 3 translation components of displacement at grids 3201, 3202, 3203
- PARAM CUSERIN requests MYSTRAN to print out equivalent CUSERIN Bulk Data entries for this substructure

The output is shown on the following pages in section 1.5. Note the following:

- Grid Point Weight Generator output shows the rigid body mass properties of substructure 2 relative to its basic coordinate system.
- *INFORMATION: message listed shows that matrices KXX, MXX, RBM0 have been written to binary file CB1d-SUBSTR-2-CB-MODEL.OP1 which will be used in the synthesis run (section 1.6)
- Based on Bulk data PARAM CUSERIN, the Bulk Data entries needed in the synthesis run for this CB substructure is listed. Some of the entries will have to be modified (e.g. CID0 must be defined) for the synthesis run in section 1.6
- Only 3 eigenvalues were found although 4 were requested. Since the model has only 3 mass DOF, there are only 3 finite eigenvalues. Normally we would not be asking for all modes in a CB analysis but are doing so here so that the system modes can be compared to a run in which a complete FEM model is used (section 1.7)
- Output of displacements was requested in Case Control and the output is shown next. Note that for CB analyses, “displacement” output is of the rows of the Displacement Output Transformation Matrix (Displ OTM) described in Appendix D to Reference 1

1.1.4 System modes using the 2 CB models and the basic structure FEM

Section 1.6 has the input data for the system modes model. In this run we will use the CB model data generated in the runs described in the 2 previous sections along with a physical model FEM of the basic structure. Note the following about the input data:

- IN4 statements in Exec Control define the files that contain the stiffness and mass data generated in the 2 CB runs described in the last 2 sections. There must be one of these IN4 statements for every CB model included in the synthesis run
- SOL 3 requests an eigenvalue run with METHOD = 2 selecting Bulk data EIGRL entry with set ID 2
- The 1st portion of the Bulk Data is a standard FEM model of the basic structure containing 8 grids and 12 CBAR's and concentrated masses at all 8 grids
- The 2nd portion of the input data is the CB model definition for substructure 1. It uses the CUSERIN, PUSERIN, etc data written to the F06 file in section 1.4 to describe the substructure 1 CB model connection and "property" data (more on this below)
- The 3rd portion of the input data is the CB model definition for substructure 2. It uses the CUSERIN, PUSERIN, etc data written to the F06 file in section 1.5 to describe the substructure 2 CB model connection and "property" data (more on this below)
- Each CB model must have its basic coordinate system defined relative to the basic coordinate system of the overall system model. All other CB unique coordinate systems must be defined relative to this CB basic coordinate system.
- In this example, RBE2 rigid elements are used to connect CB boundary grids to the basic structure grids. This is not at all necessary, only a preference of the author. The CUSERIN connection data for each substructure could have alternately referred to grids from the basic structure where the CB model attached. For example, CUSERIN 100 would have referred to grid 112 instead of 3101 and then the RBE2 1001 and GRID 3101 would have been omitted from the substructure 1 CB model definition. Note that this would also have required that GRID 112 have the coordinate system 19 that was used in CB model 1 as the global coordinate system.

Since some of the input data for the CB models is not standard NASTRAN type of input, the description below is given to help explain that input data.

The CUSERIN Bulk Data connection parent entry specifies:

- Field 1: CUSERIN
- Field 2: element ID
- Field 3: property ID
- Field 4: number of boundary grids (the number that are in the R-set when the CB model was generated)
- Field 6: number of SPOINT's (1 for each modal DOF in the CB model)

- Field 6: ID of the coordinate system which defines the basic system used when the CB model was generated. It must define this coordinate system relative to the basic coordinate system of the overall system model

Subsequent CUSERIN continuation entries define

- grids/components that define the support (boundary) DOF for this substructure
- ID's of SPOINT's for MYSTRAN to use as the DOF identifiers for the modal DOF (these must begin on a new continuation entry; i.e. they can not be on the same continuation entry as the grid/component definition)

The PUSERIN “property” entry does not define physical properties (as is the case with other finite elements); rather it specifies information about the files that contain the KRRGN and MRRGN matrices for the CB element. It also specifies the names of these matrices as they were written to the OUTPUT4 file when the CB model was generated. There is one more matrix defined; RBM0, which is a 6x6 rigid body mass matrix relative to the basic coordinate system origin for the CB model (RBM0 generated in the run that creates the CB model). If the RBM0 matrix is not present the synthesis of the substructures will still yield the correct results for everything except the overall mass properties (6x6 rigid mass matrix) reported from the “Grid Point Weight Generator” subroutine.

Specifically, the PUSERIN Bulk Data entry specifies:

- Field 1: PUSERIN
- Field 2: property ID referenced in field 3 of the CUSERIN entry
- Field 3: ID of a IN4 Executive Control Deck entry which has the name of the file containing the KXX, MXX, RBM0 (NASTRAN KRRGN, MRRGN and RBMCG) matrices
- Field 4: Name of the KRRGN matrix (can be up to 8 characters long)
- Field 5: Name of the MRRGN matrix (can be up to 8 characters long)
- Field 6: Name of the RBM0 matrix (can be up to 8 characters long) if there is one

The KXX, MXX, RBM0 (NASTRAN KRRGN, MRRGN, RBMCG) matrices are read into MYSTRAN in NASTRAN INPUTT4 format. The command statements to do this are part of the Executive Control Deck, the format of which is shown in the listing in section 1.6. The commands to read in the matrices are: IN4 i = *filename*, where i is the file ID in field 3 of the PUSERIN property entry for the CUSERIN element and *filename* is the name of the file in which the matrices were written when the CB model was generated

The output for this modal synthesis run is the standard type of output one would expect from a SOL 3 modal analysis. Note the following:

- The Grid Point Weight Generator gives the rigid body mass properties of the complete model. Unless the CB matrices RBM0 had been input (IN4 Exec Control command), the overall model mass properties would not have been correct and would not match those shown in the next section in which a completely physical FEM model is run
- The eigenvalues are system values and will be directly comparable to those in section 1.7. They will, in fact, be exactly the same since we have used all of the finite modes for each substructure (not a normal circumstance, only done here for demonstration purposes)

- The eigenvectors show the “mode shapes” for the CB synthesis DOF’s, which, in this model, uses physical grids for the basic structure and CB boundary DOF’s plus modal DOF’s for the fixed base modes of each substructure. The meaning of an eigenvector like this for the CB fixed base modes is the following. The magnitudes shown in system eigenvector i for the CB DOF’s (scalar points 10001,2,3 and 20001,2,3) are the relative magnitudes of the substructure CB eigenvectors in their contribution to system eigenvector i .

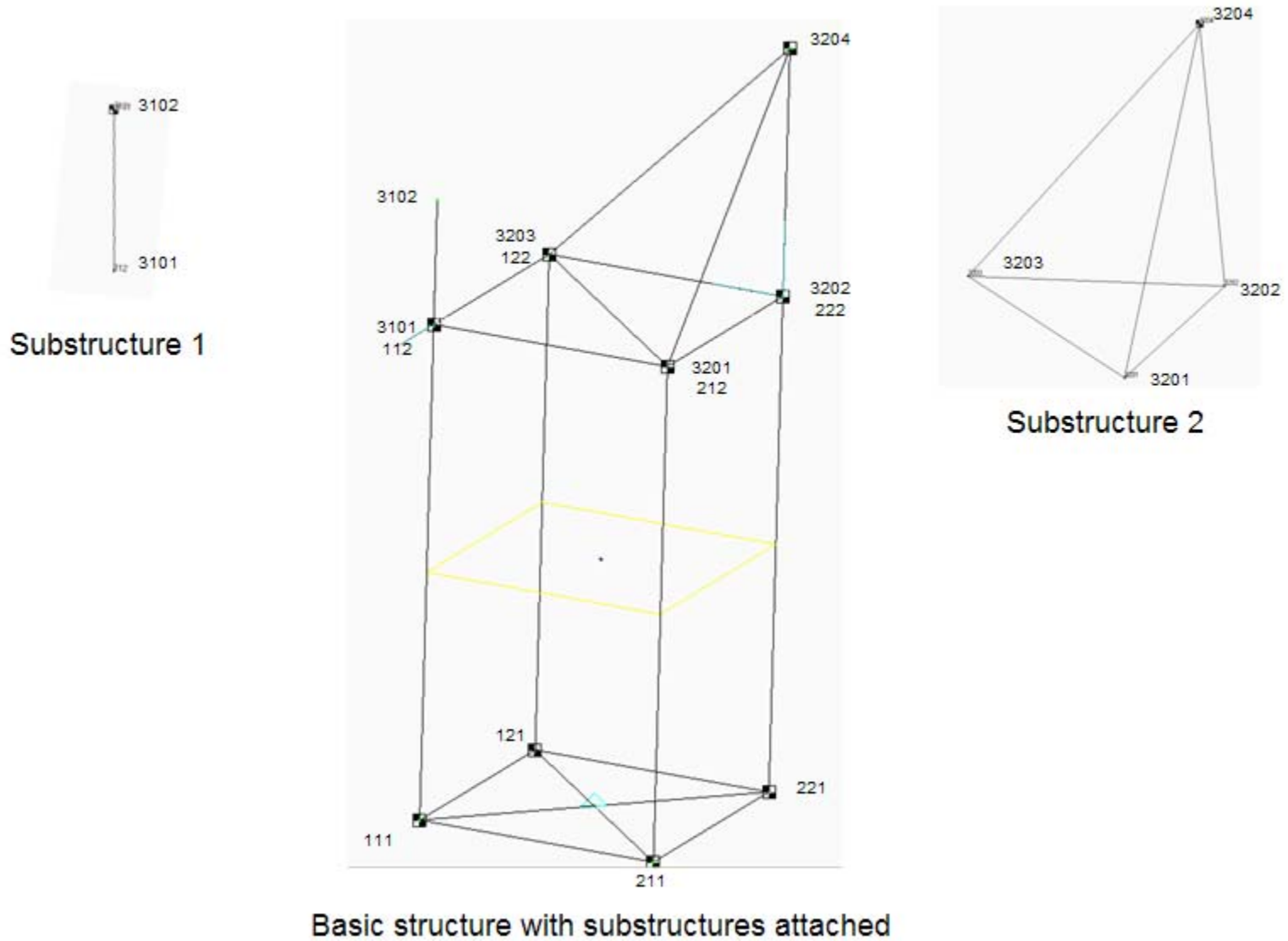
1.1.5 System modes using complete structure FEM

In order to demonstrate that the CB substructure techniques used in the last section can yield the same eigenvalues as would be used if it were analyzed as a full FEM model, section 1.7 is included. It shows the results of a run using a complete physical FEM of the basic structure with the 2 substructures run as one complete model. The input shown is that used in a standard analysis of a FEM with SOL 3 and requesting 10 eigenvalues. The output shows the rigid body mass properties of the complete model, the 10 eigenvalues and 1 of the eigenvectors. The eigenvalue data in section 1.7 is to be compared with those in section 1.6 (using CB models for the 2 substructures). The eigenvector data will, however, be different as the system DOF’s for the two runs are not the same. In the case of the complete FEM, the DOF’s are all 6 component displacement components at physical grids. For the CB synthesis run the DOF’s are physical grids for the basic structure but the DOF’s for the substructures have physical grids for the boundary DOF’s and modal DOF’s for the remainder of the CB model. Analysts familiar with modal synthesis will be aware of this distinction.

1.2 Summary

The eigenvalues in section 1.7, which is a complete FEM model, form the baseline for comparison with the eigenvalues in section 1.6, which uses CB models for substructures 1 and 2. Since all of the finite mass modes were included in generating the substructure CB models, it should be expected that the eigenvalues in section 1.6 should be the same as those in section 1.7. As shown in these two sections the 10 eigenvalues found for the combined structure are identical. In a practical CB synthesis, only some of the modes of each CB model would be used and then the CB synthesis eigenvalues would not be identical to those from the completely physical FEM model. However, if the analyst is careful in modeling the problem at hand the important eigenvalues in the CB synthesis should be a very good approximation to the ones that would have been obtained from a run using a completely physical FEM.

1.3 Fig 1.1 – Simple example problem: Basic structure and 2 substructures



1.4 Substructure 1 – Generate CB model
(input deck CB1d-SUBSTR-1-CB-MODEL.DAT)

```

ID CB1, RUN (b)
SOL 31
$
OUTPUT4   KXX      , MXX      ,RBM0      ,      ,      // -1/21 $
$
CEND
TITLE = CB PROBLEM - SUBSTR 1, GENERATE CB MODEL
SUBTI = SUBSTR GLOBAL IS COORD SYSTEM 19
LABEL = V VEC FOR BAR IS X19 DIR WHICH IS OA MODEL BASIC X0
ECHO = UNSORT
METHOD = 2
DISP = ALL
BEGIN BULK
$
EIGR      2          MGIV          1          4          +E1
+E1      MASS
$
GRID      3101          0.          0.          0.          19
GRID      3102          25.         0.          0.          19
CORD2R    19          0.          0.          0.          1.          0.          0.          +C19
+C19      0.          0.          1.
CBAR      3101      3101      3101      3102      1.          0.          0.
PBAR      3101      301       1.          20.         20.         40.
MAT1      301       30.+6          .3
$
CONM2     3102      3102          400.
$
SUPORT    3101      123456
$
PARAM     CUSERIN    100          190          10001      100
PARAM     GRDPNT     0
PARAM     GRIDSEQ    GRID
PARAM     WTMASS     .002591
PARAM     PRTDOF     2
PARAM     PRTSET     1
PARAM     PRTMXX     1
$
ENDDATA

```

OUTPUT FROM GRID POINT WEIGHT GENERATOR
 REFERENCE POINT IS BASIC COORD SYSTEM ORIGIN

TOTAL MASS = 4.000000E+02

X Y Z
 C.G. location : 2.500000E+01 0.000000E+00 0.000000E+00
 (relative to reference point in basic coordinate system)

6x6 Rigid body mass matrix - about reference point in basic coordinate system

```

***
* 4.000000E+02 0.000000E+00 0.000000E+00 * 0.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 4.000000E+02 0.000000E+00 * 0.000000E+00 0.000000E+00 1.000000E+04 *
* 0.000000E+00 0.000000E+00 4.000000E+02 * 0.000000E+00 -1.000000E+04 0.000000E+00 *
* ***** ***** ***** * ***** ***** ***** *
* 0.000000E+00 0.000000E+00 0.000000E+00 * 0.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 0.000000E+00 * 0.000000E+00 2.500000E+05 0.000000E+00 *
* 0.000000E+00 0.000000E+00 0.000000E+00 * 0.000000E+00 0.000000E+00 2.500000E+05 *
***
  
```

M.O.I. matrix - about reference point in basic coordinate system

```

***
* 0.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 2.500000E+05 0.000000E+00 *
* 0.000000E+00 0.000000E+00 2.500000E+05 *
***
  
```

M.O.I. matrix - about c.g. in basic coordinate system

```

***
* 0.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 0.000000E+00 *
***
  
```

M.O.I. matrix - about c.g. in principal directions

```

***
* 0.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 0.000000E+00 *
***
  
```

Transformation from basic coordinates to principal directions

```

***
* 1.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 1.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 1.000000E+00 *
***
  
```

*INFORMATION: THE FOLLOWING 3 MATRICES WILL BE WRITTEN TO 1 OUTPUT4 FILES IN THE ORDER LISTED BELOW:

OUTPUT4 file on unit 21 has been created as: CB1d-SUBSTR-1-CB-MODEL.OP1 and will contain the matrices:

(1) KXX : 9 rows and 9 cols
(2) MXX : 9 rows and 9 cols
(3) RBM0 : 6 rows and 6 cols

```
*****
$ B.D. entries for USERIN element      100 for use in a system model
$ KXX and MXX matrices are in file: CB1d-SUBSTR-1-CB-MODEL.OP1
$
$--1---|---2---|---3---|---4---|---5---|---6---|---7---|---8---|---9---|--10---|
GRID   3101  "CID0"  0.00  0.00  0.00  19
$
CORD2R  19   "CID0"  0.    0.    0.    1.00  0.00  0.00
      0.00  0.00  1.00
$
SPOINT 10001 THRU 10003
$
CUSERIN 100   190   1     3     "CID0"
      3101  123456
      10001 THRU 10003
$
PUSERIN 190   100   KXX     MXX
$
$ "CID0" is to be replaced with the coord sys ID that is used to define the
$ basic coord sys of this USERIN elem rel to the system model basic coord sys.
$ If the above grid entries is used, RBE2's should be included to connect
$ them to the corresponding grids in the system model
$
*****
```


OUTPUT FOR CRAIG-BAMPTON DOF 1 OF 15 (boundary acceleration for grid 3101 component 1)
 CB PROBLEM - SUBSTR 1, GENERATE CB MODEL
 SUBSTR GLOBAL IS COORD SYSTEM 19
 V VEC FOR BAR IS X19 DIR WHICH IS OA MODEL BASIC X0

C B D I S P L A C E M E N T O T M (in global coordinate system at each grid)							
GRID	COORD	T1	T2	T3	R1	R2	R3
SYS							
3101	19	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
3102	19	-8.996528E-06	0.000000E+00	0.000000E+00	0.000000E+00	-5.397917E-07	0.000000E+00

OUTPUT FOR CRAIG-BAMPTON DOF 2 OF 15 (boundary acceleration for grid 3101 component 2)
 CB PROBLEM - SUBSTR 1, GENERATE CB MODEL
 SUBSTR GLOBAL IS COORD SYSTEM 19
 V VEC FOR BAR IS X19 DIR WHICH IS OA MODEL BASIC X0

C B D I S P L A C E M E N T O T M (in global coordinate system at each grid)							
GRID	COORD	T1	T2	T3	R1	R2	R3
SYS							
3101	19	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
3102	19	0.000000E+00	-8.996528E-06	0.000000E+00	5.397917E-07	0.000000E+00	0.000000E+00

OUTPUT FOR CRAIG-BAMPTON DOF 3 OF 15 (boundary acceleration for grid 3101 component 3)
 CB PROBLEM - SUBSTR 1, GENERATE CB MODEL
 SUBSTR GLOBAL IS COORD SYSTEM 19
 V VEC FOR BAR IS X19 DIR WHICH IS OA MODEL BASIC X0

C B D I S P L A C E M E N T O T M (in global coordinate system at each grid)							
GRID	COORD	T1	T2	T3	R1	R2	R3
SYS							
3101	19	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
3102	19	0.000000E+00	0.000000E+00	-8.636667E-07	0.000000E+00	0.000000E+00	0.000000E+00

.
 .
 .
 .

1.5 Substructure 2 – Generate CB model
(input deck CB1d-SUBSTR-2-CB-MODEL.DAT)

```

ID CB1, RUN (c)
SOL 31
$
OUTPUT4   KXX      , MXX      ,RBM0      ,      ,      // -1/21 $
$
TIME 7
CEND
TITLE = CB PROBLEM - SUBSTR 2, GENERATE CB MODEL
SUBTI = SUBSTR GLOBAL IS COORD SYSTEM 29
LABEL = BARS 3201-3 V IS OA MODEL BASIC Z0, BARS 3204-6 V IS OA MODEL BASIC Y0
ECHO = UNSORT
METHOD = 2
DISP = ALL
BEGIN BULK
$
EIGR      2      MGIV      1      4      +E1
+E1      MASS
$
GRID      3201      50.      0.      0.      291
GRID      3202      0.      0.      0.      292
GRID      3203      0.      0.      50.      293
GRID      3204      0.      50.      0.      294
$
CORD2R    291      0.      0.      0.      1.      0.      0.      +C29
+C29      0.      1.      0.
$
CORD2R    292      0.      0.      0.      0.      1.      0.      +C29
+C29      0.      0.      1.
$
CORD2R    293      0.      0.      0.      0.      0.      1.      +C29
+C29      1.      0.      0.
$
CORD2R    294      0.      0.      0.      0.      0.      1.      +C29
+C29      1.      0.      0.
$
CBAR      3201      3201      3201      3202      1.      0.      0.
CBAR      3202      3201      3202      3203      0.      0.      1.
CBAR      3203      3201      3203      3201      0.      1.      0.
$
CBAR      3204      3201      3201      3204      0.      0.      1.
CBAR      3205      3201      3202      3204      0.      1.      0.
CBAR      3206      3201      3203      3204      1.      0.      0.
$
PBAR      3201      302      1.      20.      20.      40.
MAT1      302      30.+6      .3
$
CONM2     3201      3204      600.
$
SUPORT    3201      123      3202      123      3203      123
$
PARAM     CUSERIN  200      290      20001      200
PARAM     GRDPNT   0

```

```
PARAM  GRIDSEQ  GRID
PARAM  WTMASS   .002591
PARAM  PRTDOF   2
PARAM  PRTSET   1
PARAM  PRTMXX   1
$
ENDDATA
```

OUTPUT FROM GRID POINT WEIGHT GENERATOR
 REFERENCE POINT IS BASIC COORD SYSTEM ORIGIN

TOTAL MASS = 6.000000E+02

X Y Z
 C.G. location : 0.000000E+00 5.000000E+01 0.000000E+00
 (relative to reference point in basic coordinate system)

6x6 Rigid body mass matrix - about reference point in basic coordinate system

```

***
* 6.000000E+02 0.000000E+00 0.000000E+00 * 0.000000E+00 0.000000E+00 -3.000000E+04 *
* 0.000000E+00 6.000000E+02 0.000000E+00 * 0.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 6.000000E+02 * 3.000000E+04 0.000000E+00 0.000000E+00 *
* ***** ***** ***** * ***** ***** ***** *
* 0.000000E+00 0.000000E+00 0.000000E+00 * 1.500000E+06 0.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 0.000000E+00 * 0.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 0.000000E+00 * 0.000000E+00 0.000000E+00 1.500000E+06 *
***
  
```

M.O.I. matrix - about reference point in basic coordinate system

```

***
* 1.500000E+06 0.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 1.500000E+06 *
***
  
```

M.O.I. matrix - about c.g. in basic coordinate system

```

***
* 0.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 0.000000E+00 *
***
  
```

M.O.I. matrix - about c.g. in principal directions

```

***
* 0.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 0.000000E+00 *
***
  
```

Transformation from basic coordinates to principal directions

```

***
* 1.000000E+00 0.000000E+00 0.000000E+00 *
* 0.000000E+00 1.000000E+00 0.000000E+00 *
* 0.000000E+00 0.000000E+00 1.000000E+00 *
***
  
```

*INFORMATION: THE FOLLOWING 3 MATRICES WILL BE WRITTEN TO 1 OUTPUT4 FILES IN THE ORDER LISTED BELOW:

OUTPUT4 file on unit 21 has been created as: CB1d-SUBSTR-2-CB-MODEL.OP1 and will contain the matrices:

(1) KXX : 12 rows and 12 cols
(2) MXX : 12 rows and 12 cols
(3) RBM0 : 6 rows and 6 cols

\$ B.D. entries for USERIN element 200 for use in a system model
\$ KXX and MXX matrices are in file: CB1d-SUBSTR-2-CB-MODEL.OP1

\$
\$--1---|---2---|---3---|---4---|---5---|---6---|---7---|---8---|---9---|--10---|

GRID	3201	"CID0"	50.0	0.00	0.00	291			
GRID	3202	"CID0"	0.00	0.00	0.00	292			
GRID	3203	"CID0"	0.00	0.00	50.0	293			

\$
CORD2R 291 "CID0" 0. 0. 0. 0.00 1.00 0.00
0.00 0.00 1.00
CORD2R 292 "CID0" 0. 0. 0. 1.00 0.00 0.00
0.00 1.00 0.00
CORD2R 293 "CID0" 0. 0. 0. 0.00 0.00 1.00
1.00 0.00 0.00

\$
SPOINT 20001 THRU 20003
\$

CUSERIN	200	290	3	3	"CID0"				
	3201	123	3202	123	3203	123			
	20001	THRU	20003						

\$
PUSERIN 290 200 KXX MX

\$
\$ "CID0" is to be replaced with the coord sys ID that is used to define the
\$ basic coord sys of this USERIN elem rel to the system model basic coord sys.
\$ If the above grid entries is used, RBE2's should be included to connect
\$ them to the corresponding grids in the system model
\$

OUTPUT FOR CRAIG-BAMPTON DOF 1 OF 21 (boundary acceleration for grid 3201 component 1)
 CB PROBLEM - SUBSTR 2, GENERATE CB MODEL
 SUBSTR GLOBAL IS COORD SYSTEM 29
 BARS 3201-3 V IS OA MODEL BASIC Z0, BARS 3204-6 V IS OA MODEL BASIC Y0

C B D I S P L A C E M E N T O T M
 (in global coordinate system at each grid)

GRID	COORD	T1	T2	T3	R1	R2	R3
	SYS						
3201	291	0.000000E+00	0.000000E+00	0.000000E+00	3.863993E-10	-6.960263E-09	4.572454E-08
3202	292	0.000000E+00	0.000000E+00	0.000000E+00	-8.427715E-08	1.606673E-08	2.200350E-10
3203	293	0.000000E+00	0.000000E+00	0.000000E+00	2.034509E-08	-8.242526E-09	-9.579740E-08
3204	294	8.954192E-06	2.284642E-06	2.155154E-06	5.610407E-08	-1.791753E-08	-1.976135E-07

OUTPUT FOR CRAIG-BAMPTON DOF 2 OF 21 (boundary acceleration for grid 3201 component 2)
 CB PROBLEM - SUBSTR 2, GENERATE CB MODEL
 SUBSTR GLOBAL IS COORD SYSTEM 29
 BARS 3201-3 V IS OA MODEL BASIC Z0, BARS 3204-6 V IS OA MODEL BASIC Y0

C B D I S P L A C E M E N T O T M
 (in global coordinate system at each grid)

GRID	COORD	T1	T2	T3	R1	R2	R3
	SYS						
3201	291	0.000000E+00	0.000000E+00	0.000000E+00	-2.270768E-11	7.125241E-11	-3.715046E-10
3202	292	0.000000E+00	0.000000E+00	0.000000E+00	2.636055E-10	-2.636055E-10	0.000000E+00
3203	293	0.000000E+00	0.000000E+00	0.000000E+00	-7.125241E-11	2.270768E-11	3.715046E-10
3204	294	-2.916436E-08	-1.191538E-08	-2.916436E-08	-6.656870E-10	0.000000E+00	6.656870E-10

OUTPUT FOR CRAIG-BAMPTON DOF 3 OF 21 (boundary acceleration for grid 3201 component 3)
 CB PROBLEM - SUBSTR 2, GENERATE CB MODEL
 SUBSTR GLOBAL IS COORD SYSTEM 29
 BARS 3201-3 V IS OA MODEL BASIC Z0, BARS 3204-6 V IS OA MODEL BASIC Y0

C B D I S P L A C E M E N T O T M
 (in global coordinate system at each grid)

GRID	COORD	T1	T2	T3	R1	R2	R3
	SYS						
3201	291	0.000000E+00	0.000000E+00	0.000000E+00	-2.109567E-10	5.870611E-09	-4.005508E-08
3202	292	0.000000E+00	0.000000E+00	0.000000E+00	7.696471E-08	-1.315541E-08	-2.058377E-10
3203	293	0.000000E+00	0.000000E+00	0.000000E+00	-1.839181E-08	7.560184E-09	8.689709E-08
3204	294	-8.163419E-06	-2.027860E-06	-1.803074E-06	-4.751698E-08	1.676144E-08	1.798959E-07

1.6 *FEM basic structure and CUSERIN substructures*
(input deck CB1d-BASIC-STR-W-CUSERIN-SUBSTRS.DAT)

```

ID CB1,RUN (d)
SOL 3
$
IN4 100 = CB1d-SUBSTR-1-CB-MODEL.OP1 $ INPUTT4 form for matrices for substr 1
IN4 200 = CB1d-SUBSTR-2-CB-MODEL.OP1 $ INPUTT4 form for matrices for substr 2
$
CEND
TITLE = CB PROBLEM - BASIC STR AND 2 SUBSTR'S
SUBTI = SUBSTR'S LOCATED IN SEPARATE COORD SYSTEMS. SUBSTR GLOBAL ARE SEVERAL SYS DEFINED IN EACH SUBSTR DECK
ECHO = UNSORT
SPC = 1
METHOD = 2
DISP = ALL
BEGIN BULK
$
EIGRL 2 10 MASS
$*****
$ Basic str
$ -----
GRID 100 0. 0. -50.
$
GRID 111 -25. -25. -50.
GRID 211 25. -25. -50.
GRID 221 25. 25. -50.
GRID 121 -25. 25. -50.
$
GRID 112 -25. -25. 50.
GRID 212 25. -25. 50.
GRID 222 25. 25. 50.
GRID 122 -25. 25. 50.
$
CBAR 1001 1101 111 211 0. 0. 1.
CBAR 1002 1101 211 221 0. 0. 1.
CBAR 1003 1101 221 121 0. 0. 1.
CBAR 1004 1101 121 111 0. 0. 1.
$
CBAR 1005 1102 112 212 0. 0. 1.
CBAR 1006 1102 212 222 0. 0. 1.
CBAR 1007 1102 222 122 0. 0. 1.
CBAR 1008 1102 122 112 0. 0. 1.
$
CBAR 1009 1103 111 112 1. 0. 0.
CBAR 1010 1103 211 212 1. 0. 0.
CBAR 1011 1103 221 222 1. 0. 0.
CBAR 1012 1103 121 122 1. 0. 0.
$
PBAR 1101 100 1. 80. 80. 80.
PBAR 1102 100 1. 80. 80. 80.
PBAR 1103 100 1. 80. 80. 80.
$
MAT1 100 10.+06 .3
$

```

```

RBE2  1000  100  123456  111  211  221  121
$
CONM2  1001  111  500.
CONM2  1002  211  500.
CONM2  1003  221  500.
CONM2  1004  121  500.
CONM2  1005  112  500.
CONM2  1006  212  500.
CONM2  1007  222  500.
CONM2  1008  122  500.
$
SPC1   1      123456  100
$
$*****
$ Substr #1
$ -----
$ CORD2R 10 defines the basic system for substr 1 relative to OA model basic
$
CORD2R  10      -25.  -25.  50.  -20.  -25.  50.  +C10
+C10    -25.  -25.  60.
$
CORD2R  19      10      0.  0.  0.  1.  0.  0.  +C19
+C19    0.  0.  1.
$
GRID    3101    10      0.  0.  0.  19
$
SPOINT  10001  THRU  10003
$
CUSERIN 100     190     1      3      10
        3101    123456
        10001  THRU  10003
$
PUSERIN 190     100     KXX     MXX     RBM0
$
RBE2    1001    112     123456  3101
$
$*****
$ Substr #2
$ -----
$ CORD2R 20 defines the basic system for substr 2 relative to OA model basic
$ CORD2R 291, 292, 293, 294 are global systems for substr 2
$
CORD2R  20      25.  25.  50.  20.  25.  50.  +C20
+C20    25.  20.  50.
$
CORD2R  291     20      0.  0.  0.  1.  0.  0.  +C29
+C29    0.  1.  0.
$
CORD2R  292     20      0.  0.  0.  0.  1.  0.  +C29
+C29    0.  0.  1.
$
CORD2R  293     20      0.  0.  0.  0.  0.  1.  +C29

```

```

+C29    1.    0.    0.
$
GRID    3201   20    50.   0.    0.    291
GRID    3202   20     0.   0.    0.    292
GRID    3203   20     0.   0.   50.    293
$
SPOINT  20001  THRU  20003
$
CUSERIN 200    290    3      3      20
        3201   123   3202   123   3203   123
        20001  THRU  20003
$
PUSERIN 290    200    KXX    MXX    RBM0
$
RBE2    2001   212   123   3201
RBE2    2002   222   123   3202
RBE2    2003   122   123   3203
$
$*****
PARAM   GRDPNT   0
PARAM   WTMASS   .002591
PARAM   PRTDOF   2
PARAM   PRTSET   1
$
ENDDATA

```

OUTPUT FROM GRID POINT WEIGHT GENERATOR
(reference point is basic coord system origin)

Total mass = 5.000000E+03

X Y Z
C.G. location : 1.000000E+00 1.000000E+00 1.800000E+01
(relative to reference point in basic coordinate system)

6x6 Rigid body mass matrix - about reference point in basic coordinate system

```

***
* 5.000000E+03 0.000000E+00 0.000000E+00 * 0.000000E+00 9.000000E+04 -5.000000E+03 *
* 0.000000E+00 5.000000E+03 0.000000E+00 * -9.000000E+04 0.000000E+00 5.000000E+03 *
* 0.000000E+00 0.000000E+00 5.000000E+03 * 5.000000E+03 -5.000000E+03 0.000000E+00 *
* ***** ***** ***** * ***** ***** ***** *
* 0.000000E+00 0.000000E+00 0.000000E+00 * 2.137500E+07 -6.250000E+05 -7.500000E+05 *
* 0.000000E+00 0.000000E+00 0.000000E+00 * -6.250000E+05 2.137500E+07 -7.500000E+05 *
* 0.000000E+00 0.000000E+00 0.000000E+00 * -7.500000E+05 -7.500000E+05 6.250000E+06 *
***

```

M.O.I. matrix - about reference point in basic coordinate system

```

***
* 2.137500E+07 -6.250000E+05 -7.500000E+05 *
* -6.250000E+05 2.137500E+07 -7.500000E+05 *
* -7.500000E+05 -7.500000E+05 6.250000E+06 *
***

```

M.O.I. matrix - about c.g. in basic coordinate system

```

***
* 1.975000E+07 -6.200000E+05 -6.600000E+05 *
* -6.200000E+05 1.975000E+07 -6.600000E+05 *
* -6.600000E+05 -6.600000E+05 6.240000E+06 *
***

```

M.O.I. matrix - about c.g. in principal directions

```

***
* 6.172763E+06 -2.328306E-10 -1.449802E-10 *
* -4.656613E-10 1.919724E+07 1.118346E-09 *
* -1.325357E-10 1.142523E-09 2.037000E+07 *
***

```

Transformation from basic coordinates to principal directions

```

***
* 5.080514E-02 5.080514E-02 9.974155E-01 *
* 7.052793E-01 7.052793E-01 -7.184932E-02 *
* -7.071068E-01 7.071068E-01 5.220893E-16 *
***

```


1.7 *FEM basic structure and FEM substructures*

(input deck CB1d-BASIC-STR-W-FEM-SUBSTRS.DAT)

```

ID CB1,RUN (a)
SOL 3
CEND
TITLE = CB PROBLEM - PHYSICAL FEM MODELS FOR BASIC STR AND SUBSTR'S
SUBTI = SUBSTR'S LOCATED IN SEPARATE COORD SYSTEMS. SUBSTR GLOBAL IS ONE SYS DEFINED IN EACH SUBSTR DECK
ECHO = UNSORT
SPC = 1
METHOD = 2
DISP = ALL
BEGIN BULK
$
EIGRL 2 10 MASS
$*****
$ Basic str
$ -----
GRID 100 0. 0. -50.
$
GRID 111 -25. -25. -50.
GRID 211 25. -25. -50.
GRID 221 25. 25. -50.
GRID 121 -25. 25. -50.
$
GRID 112 -25. -25. 50.
GRID 212 25. -25. 50.
GRID 222 25. 25. 50.
GRID 122 -25. 25. 50.
$
CBAR 1001 1101 111 211 0. 0. 1.
CBAR 1002 1101 211 221 0. 0. 1.
CBAR 1003 1101 221 121 0. 0. 1.
CBAR 1004 1101 121 111 0. 0. 1.
$
CBAR 1005 1102 112 212 0. 0. 1.
CBAR 1006 1102 212 222 0. 0. 1.
CBAR 1007 1102 222 122 0. 0. 1.
CBAR 1008 1102 122 112 0. 0. 1.
$
CBAR 1009 1103 111 112 1. 0. 0.
CBAR 1010 1103 211 212 1. 0. 0.
CBAR 1011 1103 221 222 1. 0. 0.
CBAR 1012 1103 121 122 1. 0. 0.
$
PBAR 1101 100 1. 80. 80. 80.
PBAR 1102 100 1. 80. 80. 80.
PBAR 1103 100 1. 80. 80. 80.
$
MAT1 100 10.+06 .3
$
RBE2 1000 100 123456 111 211 221 121
$
CONM2 1001 111 500.
CONM2 1002 211 500.

```

```

CONM2 1003 221 500.
CONM2 1004 121 500.
CONM2 1005 112 500.
CONM2 1006 212 500.
CONM2 1007 222 500.
CONM2 1008 122 500.
$
SPC1 1 123456 100
$
$*****
$ Substr #1
$ -----
$ CORD2R 10 defines the basic system for substr 1 relative to OA model basic
$
CORD2R 10 -25. -25. 50. -20. -25. 50. +C10
+C10 -25. -25. 60.
$
CORD2R 19 10 0. 0. 0. 1. 0. 0. +C19
+C19 0. 0. 1.
$ GRID 3101 10 0. 0. 0. 19
GRID 3102 10 25. 0. 0. 19
CBAR 3101 3101 3101 3102 0. 0. 1.
PBAR 3101 301 1. 20. 20. 40.
MAT1 301 30.+6 .3
$
RBE2 1001 112 123456 3101
$
CONM2 3102 3102 400.
$
$*****
$ Substr #2
$ -----
$ CORD2R 20 defines the basic system for substr 2 relative to OA model basic
$ CORD2R 291, 292, 293, 294 are global systems for substr 2
$
CORD2R 20 25. 25. 50. 20. 25. 50. +C20
+C20 25. 20. 50.
$
CORD2R 291 20 0. 0. 0. 1. 0. 0. +C29
+C29 0. 1. 0.
$
CORD2R 292 20 0. 0. 0. 0. 1. 0. +C29
+C29 0. 0. 1.
$
CORD2R 293 20 0. 0. 0. 0. 0. 1. +C29
+C29 1. 0. 0.
$
CORD2R 294 20 0. 0. 0. 0. 0. 1. +C29
+C29 1. 0. 0.
$
GRID 3201 20 50. 0. 0. 291
GRID 3202 20 0. 0. 0. 292

```

```

GRID  3203  20      0.    0.    50.   293
GRID  3204  20      0.   50.    0.   294
$
CBAR  3201  3201  3201  3202  1.    0.    0.
CBAR  3202  3201  3202  3203  0.    0.    1.
CBAR  3203  3201  3203  3201  0.    1.    0.
$
CBAR  3204  3201  3201  3204  0.    0.    1.
CBAR  3205  3201  3202  3204  0.    1.    0.
CBAR  3206  3201  3203  3204  1.    0.    0.
$
PBAR  3201  302    1.    20.   20.   40.
MAT1  302    30.+6   .3
  *INFORMATION: MAT1 ENTRY      302 HAD FIELD FOR G BLANK. MYSTRAN CALCULATED G = 1.153846E+07
$
RBE2  2001  212    123   3201
RBE2  2002  222    123   3202
RBE2  2003  122    123   3203
$
CONM2 3201  3204          600.
$
$*****
PARAM  GRDPNT  0
PARAM  GRIDSEQ GRID
PARAM  WTMASS  .002591
PARAM  PRTDOF  2
PARAM  PRTSET  1
$
ENDDATA

```

OUTPUT FROM GRID POINT WEIGHT GENERATOR
 REFERENCE POINT IS BASIC COORD SYSTEM ORIGIN

TOTAL MASS = 5.000000E+03

X Y Z
 C.G. location : 1.000000E+00 1.000000E+00 1.800000E+01
 (relative to reference point in basic coordinate system)

6x6 Rigid body mass matrix - about reference point in basic coordinate system

```

***
* 5.000000E+03 0.000000E+00 0.000000E+00 * 0.000000E+00 9.000000E+04 -5.000000E+03 *
* 0.000000E+00 5.000000E+03 0.000000E+00 * -9.000000E+04 0.000000E+00 5.000000E+03 *
* 0.000000E+00 0.000000E+00 5.000000E+03 * 5.000000E+03 -5.000000E+03 0.000000E+00 *
* ***** ***** ***** * ***** ***** ***** *
* 0.000000E+00 0.000000E+00 0.000000E+00 * 2.137500E+07 -6.250000E+05 -7.500000E+05 *
* 0.000000E+00 0.000000E+00 0.000000E+00 * -6.250000E+05 2.137500E+07 -7.500000E+05 *
* 0.000000E+00 0.000000E+00 0.000000E+00 * -7.500000E+05 -7.500000E+05 6.250000E+06 *
***
  
```

M.O.I. matrix - about reference point in basic coordinate system

```

***
* 2.137500E+07 -6.250000E+05 -7.500000E+05 *
* -6.250000E+05 2.137500E+07 -7.500000E+05 *
* -7.500000E+05 -7.500000E+05 6.250000E+06 *
***
  
```

M.O.I. matrix - about c.g. in basic coordinate system

```

***
* 1.975000E+07 -6.200000E+05 -6.600000E+05 *
* -6.200000E+05 1.975000E+07 -6.600000E+05 *
* -6.600000E+05 -6.600000E+05 6.240000E+06 *
***
  
```

M.O.I. matrix - about c.g. in principal directions

```

***
* 6.172763E+06 0.000000E+00 -6.017513E-13 *
* 1.164153E-10 1.919724E+07 3.742019E-09 *
* -2.910383E-11 3.725290E-09 2.037000E+07 *
***
  
```

Transformation from basic coordinates to principal directions

```

***
* -5.080514E-02 -5.080514E-02 -9.974155E-01 *
* 7.052793E-01 7.052793E-01 -7.184932E-02 *
* 7.071068E-01 -7.071068E-01 0.000000E+00 *
***
  
```

E I G E N V A L U E A N A L Y S I S S U M M A R Y (LANCZOS Mode 2 DPB Shift eigen = 0.00E+00)

NUMBER OF EIGENVALUES EXTRACTED 10
 LARGEST OFF-DIAGONAL GENERALIZED MASS TERM -3.8E-11 (Vecs renormed to 1.0 for gen masses)
 3
 MODE PAIR 1
 1
 NUMBER OF OFF DIAGONAL GENERALIZED MASS
 TERMS FAILING CRITERION OF 1.0E-04. 0

MODE NUMBER	EXTRACTION ORDER	EIGENVALUE	R E A L E I G E N V A L U E S		GENERALIZED MASS	GENERALIZED STIFFNESS
			RADIANS	CYCLES		
1	1	2.682498E+03	5.179284E+01	8.243086E+00	1.000000E+00	2.682498E+03
2	2	2.726318E+03	5.221415E+01	8.310141E+00	1.000000E+00	2.726318E+03
3	3	5.121950E+03	7.156780E+01	1.139037E+01	1.000000E+00	5.121950E+03
4	4	2.254593E+04	1.501530E+02	2.389760E+01	1.000000E+00	2.254593E+04
5	5	4.873465E+04	2.207593E+02	3.513493E+01	1.000000E+00	4.873465E+04
6	6	5.145711E+04	2.268416E+02	3.610296E+01	1.000000E+00	5.145711E+04
7	7	5.822092E+04	2.412901E+02	3.840251E+01	1.000000E+00	5.822092E+04
8	8	8.792938E+04	2.965289E+02	4.719404E+01	1.000000E+00	8.792938E+04
9	9	1.045087E+05	3.232780E+02	5.145130E+01	1.000000E+00	1.045087E+05
10	10	2.864546E+05	5.352146E+02	8.518204E+01	1.000000E+00	2.864546E+05

OUTPUT FOR EIGENVECTOR 1
 CB PROBLEM - PHYSICAL FEM MODELS FOR BASIC STR AND SUBSTR'S
 SUBSTR'S LOCATED IN SEPARATE COORD SYSTEMS. SUBSTR GLOBAL IS ONE SYS DEFINED IN EACH SUBSTR DECK

E I G E N V E C T O R							
(in global coordinate system at each grid)							
GRID	COORD SYS	T1	T2	T3	R1	R2	R3
100	0	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
111	0	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
112	0	2.257796E-01	2.257796E-01	5.556862E-02	-1.831903E-03	1.831903E-03	4.998794E-16
121	0	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
122	0	2.253124E-01	2.244884E-01	5.061107E-03	-1.544883E-03	1.930698E-03	1.247654E-05
211	0	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
212	0	2.244884E-01	2.253124E-01	5.061107E-03	-1.930698E-03	1.544883E-03	-1.247654E-05
221	0	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
222	0	2.248731E-01	2.248731E-01	-6.717091E-02	-1.902515E-03	1.902515E-03	5.179320E-16
3101	19	2.257796E-01	2.257796E-01	5.556862E-02	-1.831903E-03	1.831903E-03	4.998794E-16
3102	19	2.782932E-01	2.782932E-01	5.569766E-02	-2.234869E-03	2.234869E-03	5.000330E-16
3201	291	5.061107E-03	-2.244884E-01	-2.253124E-01	-1.633467E-05	1.467460E-03	-1.573769E-03
3202	292	-2.248731E-01	-2.248731E-01	-6.717091E-02	1.535535E-03	-1.535535E-03	5.193797E-16
3203	293	-2.244884E-01	5.061107E-03	-2.253124E-01	-1.467460E-03	1.633467E-05	1.573769E-03
3204	294	-3.070889E-01	-7.139002E-02	-3.070889E-01	-1.671972E-03	5.420716E-16	1.671972E-0