SETS

Structural Engineering Turnkey System
结构工程转鈕系统

Universal Structure Program
Input Guide

万能结构程序
输入指南

超强工能：一次输入一次输出，多种受力组合，任何结构（线性及非线性），便得全部正确答案。
地基土壤，为阵列仅单向可抗压力杆件，节省地基椿使用数量。
悬索桥力学分析，（可求得临界曲屈压力的）单向抗张力杆件。

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UNIVERSAL STRUCTURE DATA

A Universal Structure Program, mnemonic U S P has been developed. It is a powerful GENERAL purpose finite element program that covers entire field of A/E/C industry. It is Unit System independent. It accepts input data items with ALGEBRAIC EXPRESSION that contains VARIABLE, = ** * / + -. (Y=2**2+2.**3-2.*2.) Also, it incorporates MULtiplier, DIVisor, ADDer and SUBtracter to convert various data bases of different unit systems for mixed input/output in one single run. It is good WORLDWIDE for ANY system, British, Metric or mixed.

All input are in FREE FORMAT just plain English, abbreviated or complete word. The separator for any two input items can be BLANK SPACE/SPACES, COMMA or SLASH as the case may be.

COMMENT LINE & PORTION OF A LINE

```
        LEFT PORTION TO BE IGNORED        <$
  >$    PORTION IN-BETWEEN  TO BE IGNORED  <$
   $    RIGHT PORTION TO BE IGNORED, NAMELY WHOLE LINE
   3.45 7.8   $  RIGHT PORTION TO BE IGNORED
```

If a $ is preceded by only blank(s), the whole line is a COMMENT line. If a $ is a preceded by blank(s), the right portion, of the input line, which follows is treated as COMMENT. Still, an input line without a $ sign may have extra items in rear beyond they are normally needed. The PROGRAM will ignore these extra items with few or no exception. These extra input items may be useful for purpose other than the PROGRAM RUN.

Furthermore, any portion of input line stream can be DEACtivated. First, insert the command line, DEACtivate, just ahead of the 1ST line of interest; and then insert the command line, REACtivate, immediately following the LAST line of interest. A DEACtive command input must be followed by a REACtive command input. However, redundant DEACtive command inputs, before the 1st DEACtive command input is cancelled by a corresponding REACtive command input, may be present without any effect. Similarly, redundant REACtive command inputs that do not serve to cancel the preceding DEACtive command input may be present without any effect. Thus, great flexibility in input is facilitated.

In addition, the END DATA, which has been used for typographical :larity throughout the INPUT GUIDE as delimiter, may be REPLACED by a [carriage return]. The [carriage return] may be with or without BLANK space(s) ahead of it. (Try for your computer to see what the case is.)

The structure may be generated with a REAL TIME INTERACTIVE VIDEO SCREEN I/O PROGRAM, which also has a GENERAL GRAPHIC TEXT capability in both 3 dimension and 2 dimension.

ADVANCED DATA INPUT

1) ALGEBRAIC EXPRESSION INPUT DATA ITEM

1-1) AN INPUT DATA ITEM

An item of input data can be:

1-1-1) A simple numerical constant, which is conventionally accepted,
1-1-2) An ALGebraic expression that can contain variables, numerical constants and algebraic operators.
1-1-2-1) Algebraic Variables: X Y Z A B C ....
A single-letter from 26 alphabets, such as A B C .. X Y Z.
(Lower case is the same as upper case)
As many as needed that are defined currently or previously.
1-1-2-2) Algebraic Numerical Operators: = ** * / + -
6 operators: = ** * / + -
As many as needed with only ONE "=" as FIRST operator with top priority if any.
Others, namely ** * / + -, are according conventional algebraic convention.

Each item and every item of numeric data may be input as a form of ALGebraic expression in one contiguous item. For example, the numeric number 8. can be any one of them as shown below: (with (Y=2.))

```
8.   Y=2.**2+2.**3_2.*2.   Y*4.**3/4./Y**2   2.**4/2.
```

The operation priority for the expression Y=2.**2+2.**3_2.*2. is (Y=2.)**2+2.**3_2.*2.. However, in input the open parenthesis "(" and the close parenthesis ")" must be omitted.

Each item and every item must be contiguous including "+" and/or "-", which is used as sign of positive and/or negative numbers respectively.

Blanks are used as item separator along with commas "," as separator. It is highly advisable not to use commas "," due to third party compiler problem. This situation may be corrected in the future.

Use the under line "_" as subtraction operator, not minus "-", due to conflict in some input notations. The "-" is used for the sign of a negative number only. In time this situation will be corrected.

1-1-3) INPUT DATA SPACE LIMITATION

In an original input line, there are allocated 110 (or 80) total column spaces for input.

Each and every input data item, if needed, is converted to form a simple nominal data item. This way, a new input line is obtained.

The TABLE below shows their maximum allowable column spaces currently.

Input line that has converted data	
256	
Algebraic expression	
32	
Variable	Numerical constant
1	16

There are 6 ALGebraic operators in all to use and 26 single-letter variables that you can assign a numerical constant.

The 6 operators : = ** * / + -
The 26 variable : A B C D E ... X Y Z (lower case same as upper case)

1-2) PRIORITY OF OPERATION

The priority of algebraic operation is the same as that in conventional mathematics for ** * / + -. The Program adds the sign "=" as additional operator with top priority.

1-2-1) = An item can only have ONE equal sign in the form Y=xxx.xx Y, any one of 26 single-letter variables.

The "=" must be, if any, the FIRST algebraic operator. xxx.xx, which is assigned as value for Y, must be a numerical constant.
A variable is considered defined with this numerical constant and it continues to have the same value until it is redefined by another Y=yyy.yy in any OPERATION in the Articles 1-2), 2) and 3).

Y=xxx.xx** means (Y=xxx.xx)** in priority.
However, (Y=xxx.xx)** is INCORRECT input syntactically.

1-2-2) ** To raise to a power

1-2-3) * / The priority between * and / is according to input order.

.-2-4) + - The priority between + and - is according to input order.

Each numerical number associated with an algebraic operator must be in floating point except a number which is raised to the power of whole digit. (some computers may take fixed point for floating point.)

For example, all below are good.

```
X=2.54**2      better               (means (X=2.54)**2)
X=2.54**2.0    good
X=3600.**0.5   good and must be.
```

1-3) INVOCATION SYNTAX

1-3-1) ALGebraic 6 ...

```
ALG 6 :  The Program scans all 6 operators, namely = ** * / + _.
ALG 4 :  The Program scans only 4 operators, namely = ** * /.
         If there is + and/or -  in expression, Program will treat
         it as an input error and stops.
ALG 0 :  Defaults to ALG 4 (Otherwise it is meaningless.)
ALG ON:  The Program is to default currently to ALG 4.
ALG OFF: Program is disabled from such capability.
```

2) DATA CONVERT/MODIFY COMMAND: MUL, DIV, ADD & SUB

OPERATION PRIORITY			
1	2	3	4
MULtiplier	DIVisor	ADDer	SUBtracter

There are times when various data are mixed in use, when several sets of data with different reference points of datum are merged and/or when it is desired to output in different unit systems, then it can be highly advantageous to invoke the data converting/modifying commands, namely, MULtiplier, DIVisor, ADDer and SUBtracter.
For example, raw data base of different unit systems for section properties, material properties and so on are mixed in use.

2-1) MULtiplier

```
MULtiplier  6    xxxx  xxxx  xxxx xxxx xxxx xxxxx
MUL         6    xxxx  xxxx  xxxx xxxx xxxx xxxxx
MUL         4    xxxx  xxxx  xxxx xxxx xxxx xxxxx
MULtiplier  0    xxxx  xxxx  xxxx xxxx xxxx xxxxx
MULtiplier  ON   xxxx  xxxx  xxxx xxxx xxxx xxxxx
```

MULtiplier OFF : The capability is disabled.

```
MUL  N           xxxx  xxxx  xxxx xxxx xxxx xxxxx,
```

Where N is 6, 4, 0 or ON for enabling and OFF for disabling.

When N is 6, it is to scan 6 operators, = ** * / + _.
When N is 4, it is to scan 4 operators, = ** * /.
When N is 0, it is to scan 0 operator; namely all xxxx ....
must be simple numerical constants if any.
When N is ON, it is to default value for ON, currently 0.

Where xxxx xxxx .... are input data items as multipliers.
Number of multiplier items between 0 to 40.
If a multiplier item is NOT input, it will be filled with 0.
A non-zero input is retained as a simple numerical constant after ALGebraic operations and will NOT be wiped out after MUL OFF. They will be retained for future use under Article 3).
However, a subsequent MULtiplier Command that is ENABLING (not MUL OFF Command) will clear all existing numerical constants with 0. and start a new set of its own data items if any.
Each NONE ZERO (0.) multiplier as an item is to modify the corresponding item of the bulk data of input file respectively.

Note: The above four commands are independent from one among another.

Each can only be applied to all original bulk data in input file but not to data of these four input lines themselves.

2-1-1) Taking from the SECT.DAT file for illustration, For example:

```
          ITEM          ITEM             ITEM      ITEM
          ----   -----------------   -----------   ----
           1             2                3          4
          ----   -----------------   -----------   ----
  MUL 6    0.    Y=2.**2+2.**3_2.*2. Y*4.**2/Y**2    1.
```

The line above shows 4 multiplier items.

2-1-1-1) The 1ST item is a 0., which indicates NOT to modify EACH and EVERY 1ST corresponding ITEM of the bulk data of the SECT.DAT File as shown below. In this case, the data item is NOT an input data of numerical number but of characters, namely, STELW36X230.

2-1-1-2) The 2ND item is Y=2.**2+2.**3_2.*2., which is an ALGebraic expression data item evaluated as (Y=2.)**2+2.**3_2.*2. to be 8.. As a multiplier to its corresponding 2ND item 67.6 is to give:

67.6 times 8 equaling 540.8.

2-1-1-3) The 3RD item is Y*4.**2/Y**2, which is an ALGebraic expression data item evaluated with Y predefined as 2. to be 8. too. As a multiplier to its corresponding 2ND item 9.4*10. is to give:

firstly, "ALG 6" operating on 9.4*10. to yield 940.,
secondly, 8. as multiplier to 940. resulting in 7520.

```
$ SECT.DAT FILE
$ SECTION PROPERTIES OF MEMBERS
$          ITEM      ITEM  ITEM    ITEM     ITEM  ITEM  ITEM
$       ---------  -----  -------  -------  -----  -----  ----
$           1        2       3        4       5      6      7
$       ---------  -----  -------  -------  -----  -----  ----
$
$         ID NAME  AREA     IY       IZ       J      DY    DZ
$
  MUL   6   0.      Y=2.**2+2.**3_2.*2.  Y*4.**2/Y**2   1.
  ALG   6
       STELW36X230  67.6  9.4*10. 15.*10.**3  28.6  35.9 16.47
  ...
  ...
  ALG OFF
  MUL OFF
  END DATA
```

2-2) DIVisor   The same logic as that of multiplier is applied.
2-3) ADDer   The same logic as that of multiplier is applied.
2-4) SUBtracter The same logic as that of multiplier is applied.

3) COMBINED MATHEMATICAL OPERATION for 1-3) and 2)

3-1) ALL MATh ON:

3-1-1) To enable all mathematical operations of Articles 1-3) and 2).

In Article 1-3), the LATEST ALGebraic Command that is enabling is to be invoked, namely ALG 6, or ALG 4 whichever is the case.
If none of ALG Command was enabled previously, default ALG Command is assumed, currently ALG 4.

Also all FOUR Commands in Article 2) are invoked with all NONE ZERO values that have been retained reactivated.

ALL MAT ON
MATh ALL ON: Another equivalent command syntax.
MAT ALL ON

3-1-2) To save time not to reinput the data that have been retained in Article 2).

3-2) ALL MATh OFF: To disable all the capabilities.

ALL MAT OFF is equivalent to :
MUL OFF, DIV OFF, ADD OFF and SUB OFF combined.

MATh ALL OFF

C O N T E N T S **PAGE**

C O N T E N T S **PAGE**

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```
COMMENT LINE & PORTION OF A LINE
     LEFT PORTION TO BE IGNORED          <$
 >$  PORTION IN-BETWEEN  TO BE IGNORED  <$
  $  RIGHT PORTION TO BE IGNORED, NAMELY WHOLE LINE
  3.45 7.8  $  RIGHT PORTION TO BE IGNORED
```

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Furthermore, any portion of input line stream can be DEACtivated. First, insert the command line, DEACtivate, just ahead of the 1ST line of interest; and then insert the command line, REACtivate, immediately following the LAST line of interest. A DEACtive command input must be followed by a REACtive command input. However, redundant DEACtive command inputs, before the 1st DEACtive command input is cancelled by a corresponding REACtive command input, may be present without any effect. Similarly, redundant REACtive command inputs that do not serve to cancel the preceding DEACtive command input may be present without any effect. Thus, great flexibility in input is facilitated.

In addition, the END DATA, which has been used for typographical clarity throughout the INPUT GUIDE as delimiter, may be REPLACED by a [carriage return]. The [carriage return] may be with or without BLANK space(s) ahead of it. (Try for your computer to see what the case is.)

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All input are in **FREE FORMAT** plain English. No open quote <'>, nor close quote <'> in any literal data is needed; just plain English, abbreviated or complete word. The separator for any two input items can be **BLANK SPACE/SPACES**, **COMMA** or **SLASH** as the case may be. Any line that has a **$** sign as its **FIRST NONE-BLANK** input is treated as a **COMMENT** line. Also if a **$** is a separated input character from preceding input item, then the rear portion, of the input line, which follows is treated as **COMMENT**. Still, an input line without a **$** sign may have extra items in rear beyond they are normally needed. The **PROGRAM** will ignore these extra items with few or no exception. These extra input items may be useful for purpose other than the **PROGRAM RUN**. Furthermore, any portion of input line stream can be **DEAC**tivated. First, insert the command line, **DEAC**tivate, just ahead of the first line of interest; and then insert the command line, **REAC**tivate, immediately following the last line of interest. A **DEAC**tive command input must be followed by a **REAC**tive command input. However, redundant **DEAC**tive command inputs, before the 1st **DEAC**tive command input is cancelled by a corresponding **REAC**tive command input, may be present without any effect. Similarly, redundant **REAC**tive command inputs that do not serve to cancel the preceding **DEAC**tive command input may be present without any effect. Thus, great flexibility in input is facilitated.

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I. INPUT

There are 4 files for the **U**niversal **S**tructure **P**rogram in input. They are all preconnected.
The Files are:

A) MODEL.DAT - File that contains Structure Geometry,
B) SECT.DAT - File that contains Section Properties,
C) MAT.DAT - File that contains Material Properties; and
D) LOAD.DAT - File that contains Load information.

The Unit system consistency is maintained as follows:

1) MAT.DAT FILE - A convenient unit system for Input/Output
2) SECT.DAT FILE - Same as **MAT.DAT** FILE
3) MODEL.DAT FILE - Same as **MAT.DAT** FILE except OPTIONALLY the length unit in **MODEL.DAT** corresponds to that length unit in **MAT.DAT** by a conversion factor. The value of length in **MODEL.DAT** times the conversion factor is to give the value of length in **MAT.DAT**.
For example, if the length unit in **MODEL.DAT** FILE is in foot and the length unit in **MAT.DAT** FILE is in inch, then the conversion factor is 12.
NON-OPTION: r/k in CRItical load case shall ALWAYS have length unit as in **SECT.DAT** FILE.
4) LOAD.DAT FILE - Same as **MAT.DAT** FILE except
Same as **MODEL.DAT** FILE for **LENGTH** unit, or as it is redefined by conversion factor.

A) MODEL.DAT FILE

1.1 Client Name and Return Address, etc

$ Input a dollars sign on first non-blank column to make it a comment line for as many lines as needed. Also input here a **STATEMENT** and an auction PRICE that have been determined/decided by you for various reasons and that you are willing to pay for THIS RUN in a fair fashion. **CAEinc** believes that to price the product service by auction at initial stage of uses by a customer is most efficient and economical for both vendor and users.

1.2 Length UNIt CONversion FACtor

```
UNIt CONversion FACtor 12.
UNIt CONversion 12.
UNI  CON  12.
UNIt CONversion FACtor 1.
UNIt CONversion FACtor 100.
```

1.3 JOINT COORDINATES

```
$       1          2          3          4          5  thru   11
$  ----------- --------- --------- --------- ----------------------
$   NODE NAME   X-VALUE   Y-VALUE   Z-VALUE   FIXITY INDICATOR

     ORIG         0.        0.         0.        S
     ORIG                                        S $ X=Y=Z = 0.
     ORIG                                        Support
     ORIG         0.        0.         0.        1
     1          100.        0.         0.        1

     FREE         5.        0.         0.        0
     FREE         5.                                 $ Y=Z=0.
     2           15.        5.
     PT3        200.      100.       300.        0
     U1         200.      200.       300.        6   0 0 0 0 0 0

     SLAV       200.      100.       300.        6   -3 -3 -3 1 1 1
     HING       200.      100.       300.        6   -3 -3 1 1 1 0
     MOVE       100.      100.       200.        6   0 0 2 0 0 0
           0.05
     SUPT       0.        100.        0.         6   1 1 1 0 0 0
     SLNT       100.      100.        0.        -6   1 1 1 0 0 0
        0.5  0.86602  0.    -0.86602  0.5  0.        0. 0. 1.
     ....       ....      ....       ....        .
     ....       ....      ....       ....        .
```

END DATA

```
$      Information to be skipped by the  PROGRAM   may be placed here,
       before  ELEMent  line is invoked.
       SUPT      0.       100.        0.      6   1 1 1 0 0 0
       ....      ....     ....       ....     .
```

On first line of input, there may be an option to input a factor to convert the length unit for joint coordinates, member lengths and member loads to agree with that length unit in **MAT.DAT**. IF the first line is omitted, the Program will set a default value for you. Currently it is set to be 12. in U S A. (For input in feet, and output in inches, which is assumed to be the length unit for **MAT.DAT**) In Metric system country, it is set to 100. (For input in meter, and output in cm, which is assumed to be the length unit for **MAT.DAT**)

If you do not use length unit in this fashion, please, input proper UNIt CONversion FACtor in your first line input.

This input line to convert length unit may be input as many times as needed to phase in new length unit system and to phase out immediate previous length unit system. (Currently it can only be input in the input zone of joint coordinate to avoid ambiguity)

Node name is 4/6-column wide internally. (Thus, for some old computer systems, there must be at least 4/6 spaces with **BLANK** spaces inclusive before X-value can be input if **BLANK** spaces are used as separator.) However, for most of computer systems you do not have to be concerned about it.

BLANK OR NO INPUT may be used for default value of 0. for X, Y OR Z value provided ALL trailing values/value are also 0. In this case, the boundary condition must be **BLANK** or **NO INPUT** for a **FREE** joint and an S or Support (a word headed by S) for a **FIXED** joint. This is to facilitate 2-D structure analysis. In most cases, Z-value or Y value as well as Z value may be omitted in input. However, the Program is 3-D in nature and is transparent to your 2-D input.

Item 5 must be:

BLANK	Free joint for all 6 degree of direction.
0	Free joint for all 6 degree of direction.
S	Fixed joint for all 6 degree of direction.
1	Fixed joint for all 6 degree of direction.
6	Free, Fixed or Other case is input from items 6 thru 11; and
-6	The joint has freedom direction not in the direction of the **GLOBAL COORDINATE SYSTEM.** It has its own joint local coordinate system. The direction cosines of local x-, y- and z-axis must be input immediately, in **ORDER**, following this joint coordinate input. (9 VALUES in all)

Item 6 through 11 can be:

0 The direction is free.
1 The direction is fixed.
2 The direction is a known displacement.(translation or rotation) The VALUE of displacement must be input immediately, in ORDER, following, if any, input for local joint direction cosines or, if none, input for joint coordinate. (The known displacement can be either a support or NOT a support.) The rotational displacement must be in RADIAN. (NOT in degree. This way it avoids confusion of 360 degree for a circle or 400 degree for a circle.)
-1 The direction has a support with a gap. The VALUE of gap with sign must be input immediately, in ORDER, following, if any, input for local joint direction cosines or, if none, input for joint coordinate.
-2 The direction has a support with two types of gaps. The 1st gap is in **POSITIVE DIRECTION**; 2nd, **NEGATIVE DIRECTION.** The VALUES of gaps with sign must be input immediately, in ORDER, following this input or input, if any, for local joint direction cosines.
-3 The direction is slave (dependent) to a master (independent) degree of direction of freedom. (connection of a slave degree of freedom to the master degree of freedom is done by **ELEM**ent **RBAR** or **BBAR**)

END DATA must be input to end joint coordinate input.

Additional information beyond **END DATA** may be PRESENT, such as unused joint coordinates and others, to provide input flexibility.

1.4 ELEMENT LIBRARY

1.4.1 ELEMENT TRUSS

```
      1         2
   -------  --------
   1st line input
   ELEMent   TRUSs                    (pinned end axial member)

   2nd line input     (see NOTES 3 and NOTES 4)

$  12345678 12345678 12345678 12345678 12345678 12345678 12345678
   -------- -------- -------- -------- -------- -------- -------- -----
      1        2        3        4        5        6        7       8
   -------- -------- -------- -------- -------- -------- -------- -----
             ITEM     ITEM    VALUE    VALUE
                               for      for    NODE I   NODE J   NODE K
                              ITEM 2   ITEM 3
   -------- -------- -------- -------- -------- -------- -------- -----


     see NOTE 3 for 1st truss member option 1   U1       U2       J3RD
     see NOTE 3 for 1st truss member option 2   U1       U2

                      L-SF              0.05    U1       U2
      T                                         U1       U2
      T   U1  U2      plain tension-only member
      T       T-C     S-L      -1.56     0.05   U1       U2
      T       T-C     L-S      -1.56     0.05   U1       U2
      T       T-C     S-LA     -1.56     0.1    U1       U2
      T       T-C     AL-S     -1.56     0.1    U1       U2
      T       C-T     S-LF     -1.56     0.05   U1       U2
      T       C-T     L-SF     -1.56     0.05   U1       U2
      T       CRI     L-SF      1.21     0.05   U1       U2
      T       CRIT              1.21            U2       U3
      T       PRES    FL-S     -5.5      0.05   U1       U2
      T       PRE     L-SF      5.5      0.05   U1       U2
      T               S-LF               0.05   U1       U2
      T       T-C              -1.56            U1       U2

   last line input
   END DATA
             T   means that this member is a tension-only member.
                 (SEE NOTES  3   and  NOTES  4   for more explanation)
 ------------------------------------------------------------------------
```

1.4.2 ELEMENT ONE-WAY

```
   1         2
-------  --------
1st line input
ELEMent  ONE-way
```

2nd line input   (see NOTES 4)

```
$     12345678 12345678 12345678 12345678 12345678 12345678 12345678
      -------- -------- -------- -------- -------- -------- -------- -----
         1        2        3        4        5        6        7       8
      -------- -------- -------- -------- -------- -------- -------- -----
                ITEM     ITEM    VALUE    VALUE
                                  for      for    NODE I   NODE J   NODE K
                                 ITEM 2   ITEM 3
      -------- -------- -------- -------- -------- -------- -------- -----

         T                                          U1       U2
         T  U1  U2         plain tension-only member
         T                 S-LF              0.05   U1       U2
         T        T-C               -1.56           U1       U2
         T        T-C     S-L       -1.56    0.05   U1       U2
         T        T-C     L-S       -1.56    0.05   U1       U2
         T        T-C     L-SA      -1.56    0.1    U1       U2
         T        T-C     S-LA      -1.56    0.1    U1       U2
         T        C-T     S-LF      -1.56    0.05   U1       U2
         T        C-T     L-SF      -1.56    0.05   U1       U2
         T        CRI     L-SF       1.21    0.05   U1       U2
         T        CRI                1.21           U2       U3
         T        PRE     L-SF       5.5     0.05   U1       U2
         T        PRE     L-SF      -5.5     0.05   U1       U2

         C                                          U1       U2
         C  U1  U2        plain compression-only member
         C                S-LF               0.05   U1       U2
         C        T-C                1.56           U1       U2
         C        T-C     S-L        1.56    0.05   U1       U2
         C        T-C     L-S        1.56    0.05   U1       U2
         C        T-C     S-LA       1.56    0.1    U1       U2
         C        T-C     L-SA       1.56    0.1    U1       U2
         C        C-T     S-LF       1.56    0.05   U1       U2
         C        C-T     L-SF       1.56    0.05   U1       U2
         C        PRE     L-SF      -5.5     0.05   U1       U2
```

last line input
END DATA

T   means that this member is a tension-only member.
C   means that this member is a compression-only member.
    (SEE NOTES 4 for more explanation)

One-way element can be input with only two nodes. Unlike truss element, it has no option to input third node for its first element. However, it has compression-only capability for which truss element lacks.

1.4.3 ELEMENT BEAM

```
   1          2
-------   --------
1st line   input
ELEMent    BEAM                    (frame member)

   1          2         3
--------   --------  --------
 NODE I     NODE J    NODE K

2nd line input
  3           4         ORIG
 B1          B2         COM
 B1          B2
 ....        ....       ....
 ....        ....       ....

last line input
END DATA
```

1.4.4 ELEMENT Rigid BAR

```
    1          2
-------  --------
1st line input
ELEMent    RBAR                   1st line

2nd line input
  U11      B11                    Rigid BAR of 6 infinite stiff springs
  ....     ....                   with possible degree of freedom of
  ....     ....                   a joint dependent on the degree of
  ....     ....                   freedom of another joint

last line input
END DATA
```

1.4.5 ELEMENT Big BAR

```
    1          2
-------  --------
1st line input
ELEMent    BBAR                   1st line

2nd line input
  B11      M11                    Big BAR of 6 big spring values
  ....     ....                   with possible degree of freedom of
  ....     ....                   a joint dependent on the degree of
  ....     ....                   freedom of another joint

last line input
END DATA
```

1.4.6 ELEMENT SHEAR WALL

See NOTE 8

1.4.7 ELEMENT GAP

See NOTE 4-9

1.4.8 ELEMENT LAP (OVER-LAP)

See NOTE 4-9

1.4.9 ELEMENT ONE-way SUPPORT

See NOTE 4-9

1.4.10 ELEMENT PIPE

See NOTE 8

```
=========================================================================
   END DATA                              to end  ALL  element input
=========================================================================
$       DATA not to be searched by the   PROGRAM   may be placed here.
     B1          B2         COM
     ....        ....       ....
=========================================================================
```

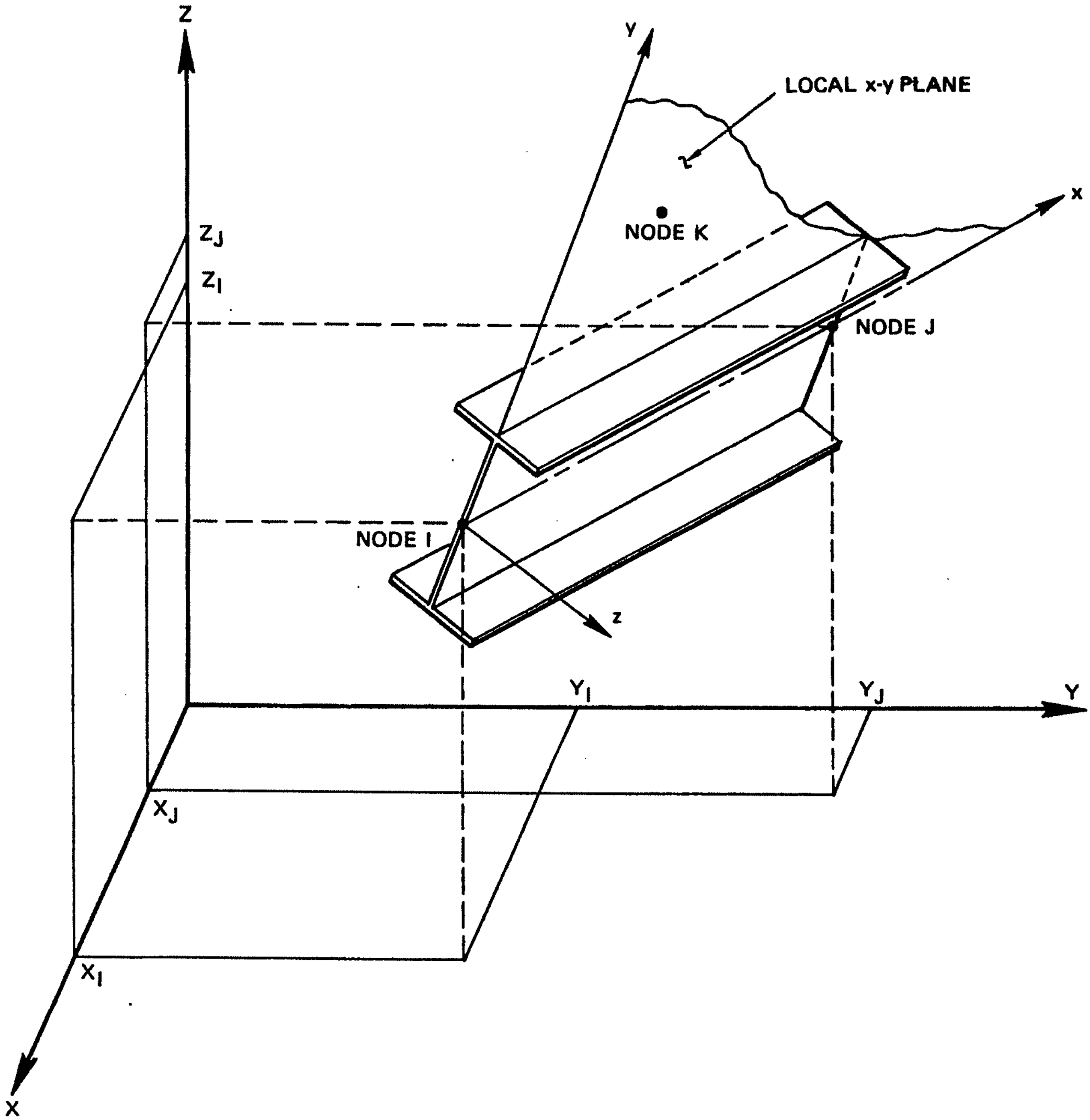
Node I and Node J connect the member. The member local x-axis is directed from Node I towards **Node J.**

The member z-axis is perpendicular to the plane formed by x-axis and line **I-K** in accordance with right-hand coordinate system. The ABSOLUTE VALUE of the angle formed by POSITIVE y-axis and I-K must be LESS than 90 degree. The x-axis and **I-K** must not be colinear.

If Node K is omitted for **ELEM**ents, the FIRST node in JOINT **COORDINATES** is used for that member. For **ELEM**ents **TRUS**s, **ONE**-way, RBAR and **BBAR,** only **NODE I** and **NODE J** are needed. The **NODE K** may be present and it will be ignored. However, FIRST node in **JOINT COORDINATES** is used internally for **ELEM**ents **TRUS**s and ONE-way to facilitate member local coordinate system. See NOTE 3 for more explanation. Also an option is available to select the **K NODE** of the IMMEDIATE PREVIOUS ELEMENT as the **K NODE** of the CURRENT ELEMENT if it is omitted. If the CURRENT ELEMENT is the FIRST element, the FIRST node in **JOINT COORDINATES** is used as **K NODE.** See File **KEYUSP.DAT** for option.

NO MEMBER NUMBERING is input. It is done internally according to input sequence. However, **ELEM**ents **RBAR** and **BBAR** are searched and numbered ahead of others by current default.

END DATA must be input to end member incidences.
END DATA must be input the 2ND TIME IMMEDIATELY to end **All ELEM**ents.



GLOBAL AND LOCAL MEMBER COORDINATES RELATIONSHIP

B) SECT.DAT FILE

2. SECTION PROPERTIES OF MEMBERS

```
$    SECT.DAT  file - a reusable  accumulative  data base
$                    AISC  Property table can be here
$
$        1         2       3       4       4       6       7       8       9
$     ---------  ------- ------  ------  ------  ------  ------  ------  ------
$     I D  NAME   AREA     IY      IZ      J       DY      DZ     AVY     AVZ
$
$
$
  STEELWTHETA00  21.5    70.6   1600.   3.02   21.24    8.295
  STEELWTHETA90  21.5    1600.   70.6   3.02   8.295    21.24

      DITTo
      DITTo   1
      DITTo   16
      DITTo   ALL
      REPEat
      REPEat 1
      REPEat 19
      REPEat ALL

     ALUMIMEM     10.2    92.5    34.5    1.02   5.14     12.5
     CONCRCOL    400.   13333.  13333.   22560.  20.      20.
$
$                 PIPE     PIPE    PIPE
$                 O  D      t      I  D
     STEELPIPE    8.       0.25    7.0     0.        0.      0.
  STEELSOLIDROD   4.       0.      0.      0.        0.      0.
$
$                PLATE
$                  t
    STEELPLATE     1.
      .....       ...     ....    .....   ....
      .....       ...     ....    .....   ....

     END DATA
  -----------------------------------------------------------------------
$     Inactive section properties can be placed after   END DATA.
      STEELWS    21.5    1600.   70.6    3.02   8.295   21.24
      .....       ...     ....    .....   ....
  =======================================================================
```

I D Name   is the designated name/symbol/number for the section. It has a input width of 12 columns. (Thus for some old systems, the next item input, AREA, must be at least 12

columns away all inclusive from the beginning of the 1st input item.)
Columns 1-4 identify the material of the element and columns 5-12 identify the section property of the element. Sections that are of the same material may be assigned the same **I D** Name from columns 1-4. The section property **I D** (columns 5-12) is used exclusively by Preprocesors, such as **USPPLOT, USPMESH** and **USPGEN;** to interactivly select section property from premade data base. **CAEINC** supplies this kind of data base. You may use your own data base if you so prefer.

AREA	section area.
IY	area moment of inertia about local y-axis.
IZ	area moment of inertia about local z-axis.
J	torsional constant of the member.
DY	dimension in y-axis direction for temperature load use.
DZ	dimension in z-axis direction for temperature load use.
AVY	effective shear area for member y-direction shear force.
AVZ	effective shear area for member z-direction shear force.
DITTo	input for the I D NAME for the section properties just ahead are used. In this case no input of items 2-9 is required. (If input, they will be ignored.)
DITTo N	input for the I D NAME for the section properties just ahead are used. It is to be repeated for the next N times. N = 1, 2, 3 ..... 99999.
DITTo ALL	input for the I D NAME for the section properties just ahead are used. It is to be repeated for all.
REPEat	Same as DITTo
REPEat N	Same as DITTo N
REPEat ALL	Same as DITTo ALL
PIPE O D	Outside diameter of a pipe
PIPE t	Thickness of a pipe wall
PIPE I D	Inside diameter of a pipe
PLATE t	Thickness of a plate element

The section properties are in sequential order corresponding to that for the input of **MEMBER INCIDENCES.** However, NO input for **RBAR ELEMent** or **BBAR ELEMent** is permitted.

For ELEMent **TRUS**s or **ELEM**ent ONE-way, only AREA is needed for input. Any of others may be present and will be ignored.

Item 9 may be omitted if no AVZ is to be considered for analysis.

Items 8 and 9 may be omitted if no shear effect is to be considered for analysis.

ALTERNATIVELY, item 8 and/or 9 may be input as 0. if no shear effect is to be considered for analysis.

Items 7, 8 and 9 may be omitted if the effect of all these items is to be ignored, namely no shear effect nor **TEM**perature load in member

z-direction (thermal bending about member y-axis).
Items 6, 7, 8 and 9 may be omitted if no thermal bending load is present nor shear effect is to be considered.

If AVY and/or AVZ are included, the Program will be able to analyze SHEAR WALLS of various configuration in combination of all other elements for a complex structure.

For a pipe element, the inside diameter is ignored and the wall thickness is used. However, when it is input as 0., then the inside diameter is used. If both input are 0., the pipe is considered as a solid rod. The properties of the pipe,such as AREA, IY, IZ, J, DY, DZ are computed from these input.

END DATA may be input optionally.

C) MAT.DAT FILE

3. MATERIAL OF MEMBERS

```
$     MAT.DAT   file - a reusable  accumulative  data base
$
$        1          2          3           4          5
$     ---------  ------   -------   ----------- --------
$     I D  NAME     E          G          ALPHA      RHO

       STEELWS    29000.    11200.    0.0000065 0.000283565
       ALUMINUM   10000.     3750.    0.0000128 0.000095486
       CONCRETE    3300.     1240.    0.0000055 0.000086806
$   HALF  strain-vs-stress  curve input
       NMT1       10000.      3750.   0.0000128 0.000095486
       NONL       0.01 100.   0.02 130.   0.04 150.
       NONL       0.1  160.   0.2  165.
$   HALF  strain-vs-stress  curve input  with  ORIGIN  input
       NMT2       10000.      3750.   0.0000128 0.000095486
       NONL       0.0  0.0   0.01 100.   0.02 130.   0.04 150.
       NONL       0.1  160.   0.2  165.
$   WHOLE  strain-vs-stress  curve input with/without symmetry
       NMT3       10000.      3750.   0.0000128 0.000095486
       NONL      -0.2  -145.  -0.04 -135.  -0.01 -100.
       NONL       0.0  0.0   0.01 100.   0.02 130.   0.04 150.
       NONL       0.1  160.   0.2  165.
       ....       ....       ....     ....       ....
       ....       ....       ....     ....       ....

     END DATA
   ------------------------------------------------------------------------
$     Material properties not to be searched by the  Program   can be here.
       TESTMAT    10000.      3750.   0.0000128 0.000095486
       NONL       0.01 100.   0.02 130.   0.04 150.
       ....       ....       ....     ....       ....
   ========================================================================
```

I D NAME must correspond to that for **SECTION PROPERTIES of MEMBERS.**
E Young's modulus of elasticity
G Shear modulus of elasticity
ALPHA Coefficient of thermal expansion
RHO Weight per unit volume

IF the material has a **NONL**inear property for analysis, NONLinear must be input immediately following the regular properties input.

A poly-linear curve is assumed for the non-linear property.

As many pairs of strain-vs-stress values as needed must be input to define the shape of the poly-linear curve in a **MONOTONOUS** increasing fashion. The strain is in x-axis direction; and stress, y-axis direction.

The input may be continued beyond 2nd line as long as **NONL** is input for every line.

If the material is **SYMMETRICAL** between tension and compression, there are 3 ways to define the poly-linear curve. Input HALF curve to represent WHOLE curve or input whole curve. The half curve input must be **ALL NON-NEGATIVE VALUES.**

If the material is NOT symmetrical, input WHOLE curve.

In all cases, the FIRST point must be LEFTEST point. Also if there are more than ONE slopes along either direction of the curve the Young's modulus of elasticity must agree with the 1st slope of the curve from the origin to next adjacent point. This rule must be applied separately for the slope both above and below origin. For instance, there are three slopes above origin and two slopes below origin. Then at the region near origin both above and below must have a common slope that agrees with Young's modulus of elasticity. If there is only ONE slope the slope must either agree with Young's modulus of elasticity or be zero.

Currently the non-linear capability is only for axial direction. It can be for any elements, **TRUSS**, **ONE-WAY**, **BEAM** and others.

IF there is NO generation of load using RHO, RHO may be omitted or may be input any value.

IF there is NO generation of load using RHO, and NO temperature load is present, RHO and ALPHA may be input any values or omitted.

Material properties which are not used may be present.
There must be NO input for **ELEM**ent **RBAR** or **BBAR.**
Currently 20 differnt materials are provided by the Program.

END DATA must be input.

D) LOAD.DAT FILE

$ LOAD.DAT file

4.0 Length UNIt CONversion FACtor

```
UNIt CONversion FACtor 12.
UNIt CONversion 12.
UNI  CON  12.
UNIt CONversion FACtor 1.
UNIt CONversion FACtor 100.
```

The Length Unit Conversion Factor is carried from **MODEL.DAT** FILE and may be redefined at **LOAD.DAT** FILE. On a line and preferably at the start of a set of load input, there may be an option to input a factor to convert the length unit for joint loads and member loads to agree with that length unit in **MAT.DAT**.

This input line to convert length unit may be input as many times as needed to phase in new length unit system and to phase out immediate previous length unit system.

4.1 Command for BIG Displacement non-linear analysis if any

$ Syn-tax	NO. of CYCLE	E X P L A N A T I O N
BIGD	20	the integer for number of cycles for iteration. It must be >= 2 (SEE NOTES 7) This line shall be omitted if NO non-linear analysis is to be done.
BIGD	2	for P-DELTA analysis
PDEL		for P-DELTA analysis

4.2 JOINT LOAD

4.2.1 JOInt LOAd Commnad to invoke loads

4.2.2 Joint Load Input as follows:

$ 1	2	3	4	5	6	7
$ NODE NAME	DIRECTION	VALUE				
2	FY	14.5				
3	MZ	30.8				
4	5.5	7.5	3.0	18.	0.	0.

```
U2            3        4.
```

END DATA

The DIRECTION in **GLOBAL COORDINATE SYSTEM** can be:

FX	FY	FZ	MX	MY	MZ
X	Y	Z	MX	MY	MZ
1	2	3	4	5	6

Another method is to input all 6 values from items 2 thru 7.

All loads are **ACCUMULATIVE**, if they are input MORE than ONCE.

END DATA must be input to end the **JOINT LOAD.**

4.3 MEMBER LOAD (FRAME BEAM MEMBER, TRUSS MEMBER or ONE-WAY ELEMENT)

4.3.1 AUTO LOAD GENERATION for every member and all members

1	2	3	4	5	
NATURE		COOR-SYS	DIRECTION	MULTIPLI LICATION FACTOR	
SELf	**LOA**d		Z	-1.	Default to GLOBAL direction
SELf	**LOA**d		X	1.	
SELf	**LOA**d		1	1.	
SELf	**LOA**d	GLO	Z	-1.	
SELf	**LOA**d	LOC	Z	-1.	
SELf	**LOA**d		Y	0.1	
SELf	**LOA**d		2	0.5	
SELf	**LOA**d		Z	-1.	
SELf	**LOA**d		3	-1.	

END DATA

GEN	**LOA**d		Z	1.	Default to GLOBAL direction
GEN	**LOA**d	GLO	Z	-1.	see NOTES 5.
GEN	**LOA**d	LOC	Y	0.2	

END DATA

4.3.2 AUTO TEMPERATURE LOAD GENERATION for every member and all members

1	2	3	4	5	
NATURE		COOR-SYS	DIRECTION	TEMPE-RATURE CHANGE	
GEN	**TEMp**	LOC	X	-60.	
GEN	**TEMp**	GLO	Y	30.	
GEN	**TEMp**		X	20.	Default to GLObal direction The Unit shall be in agreement with that in **MAT.DAT**

END DATA

4.3.3 Individual Member Loads

4.3.3.1 MEMber LOAd **Command to invoke loads**

4.3.3.2 Load Input for individual MEMBER as follows:

1st line input for individual member

```
  1         2
------    ------
NODE I    NODE J
NODE 1    NODE 2
------    ------
 T1        T2                    1st and 2nd NODES
 B3        B4     COM            3rd NODE may be present.
-----------------------------------------------------------
```

2nd line input

```
  1       2         3
------ -------- ---------
NATURE COOR-SYS DIRECTION
------ -------- ---------
 CONc    GLO       FZ       for CONcentrated point load
 CONc    LOC       MX
 CONc              Z        default to GLObal coordinate system
 UNIf              3        for UNIformly spread load
 DISt              FX       for DIStributed load varying linearly
 DISt    GLO       FX       for GLObal coordinate system
 TEMp              Z        for TEMperature load (SEE NOTES 1)
 TEMp              X        default to GLObal coordinate system
 TEMp    LOC       Y
 FENd              MY       for Fixed ENd load (SEE NOTES 2)
 FENd              FX       (NO permission for 4th line for FENd)
                            (NO 2nd item input for FENd)
```

The DIRECTION in GLOBAL COORDINATE SYSTEM or
in MEMBER LOCAL COORDINATE SYSTEM can be:

```
FX   FY   FZ   MX   MY   MZ
 X    Y    Z   MX   MY   MZ
 1    2    3    4    5    6
```

3rd line input

1 ----- VALUE -----	2 ----- VALUE -----	
40.		for **CON**centrated load at a point
3.		for **UNI**form distributed load with 1st item of 2nd line input as **UNIf** If 2nd value is input, it will be ignored.
		TEMp load must have TWO input ITEMS for this line as any line BELOW may be good.
U-F	2.5	for **U**niform-**F**ull span load and
F-U	-60.	Uniform-Full span **TEM**perature change
F-U	2.5	NO permission to input **4**th LINE
UNF	2.5	for **U**niform a**N**d **F**ull span load
FNU	2.5	NO permission to input **4**th LINE
UFUl	2.5	for **U**niform-**FU**ll span load
FULu	2.5	NO permission to input **4**th LINE
UANf	2.5	NO permission to input **4**th LINE
FANu	2.5	NO permission to input **4**th LINE
UAF	2.5	for **U**niform **A**nd **F**ull span load
FAU	2.5	NO permission to input **4**th LINE
1.5	3.5	for **DIS**tributed load varying linearly
3.0	3.0	for **DIS**tributed load varying linearly
-4.0	0.0	**TEM**p load must have TWO input ITEMS for this line as any line ABOVE may be good.

4th line input

for **UNI**form load with one input item on 3rd line input, **DIS**tributed and **TEM**perature load with input on 3rd line NOT Unifrom-Full span

1	2	3
	DISTANCE FROM 1ST NODE	
ACTUAL or **FR**ACTION	for LOAd Starting POINT	for LOAD Ending POINT
FR	0.	1.
FR	0.25	0.75
ACt	0.	100.
AC	25.	75.
	0.	100.
	25.	75.

FR for FRaction of a member length
AC or (NO input) for default to ACtual distance along member local axis direction.

4th line input for **CON**centrated load

1 FROM 1st or 2nd NODE	2 ACTUAL or FRACTION	3 DISTANCE
1	FR	0.5
2	AC	50.
1		50.

END DATA to end ONE member loads

END DATA to end ONE loading condition

TO REPEAT LOADING CONDITION:

4.1 Command for BIG Displacement non-linear analysis if any

4.2 JOINT LOAD

```
      $ Begin here to  REPEAT the LOADING CONDITION  for multi-loading
$  cases.  Start with 4.2 JOInt LOAd as another loading pattern.  This
$  loading pattern can be repeated as many times as needed.
-----------------------------------------------------------------------
   JOInt LOAd
   .....
   .....
   END DATA
-----------------------------------------------------------------------
```

4.3 MEMBER LOAd (FRAME BEAM MEMBER, TRUSS MEMBER or ONE-WAY ELEMENT)

```
-----------------------------------------------------------------------
   MEMber LOAd
   .....
   .....
   END DATA
-----------------------------------------------------------------------
```

4.4 LOAd COMbination

```
-----------------------------------------------------------------------
   LOAd COMbination         $ Commnad to invoke load combination
$
$  LOAD MULTI-  LOAD MULTI-  LOAD MULTI-  LOAD MULTI- LOAD MULTI-
$       PLYING       PLYING       PLYING       PLYING      PLYING
$  CASE FACTOR  CASE FACTOR  CASE FACTOR  CASE FACTOR CASE FACTOR
$
    1    1.2     2    0.8     5    0.3     4     0.2  ....  ....
$  up to  40  load combinations in  ONE line of input as shown above:
$  currently input width is 80 columns.
   END DATA
-----------------------------------------------------------------------
=======================================================================
   .....
   .....
   END DATA                          to end  ANOTHER  loading condition
=======================================================================
=======================================================================
   END DATA                          to end all LOADING CONDITIONS
=======================================================================
$     Inactive  DATA can be placed here after this 3rd  END DATA   is
      invoked.
=======================================================================
```

END DATA must be input to end **ONE** load for the next load.
END DATA must be input the **SECOND TIME** immediately to end **ALL LOADS.**
END DATA must be input the **THIRD TIME** immediately to end **All LOADING CONDITIONS.**

This means **TWO** consective **END DATA** to terminate a loading condition and **THREE** consecutive **END DATA** to exit entirely the loading condition(s).

A **COMMAND** may be invoked in any order as long as it is ended properly by **END DATA.** However, the **BIGD** Command, if it is needed, shall preferably be at first of each loading condition.

If there are MORE than ONE Loading Conditions, another loading condition can be repeated. It can be repeated as many times as needed.

Within a **LOADING CONDITION** after invoking **MEM**ber **LOA**d **C**ommand, the load pattern may be REPEATED for 4.3.3) as follows:

1) Line 2 thru line 4 as a SET,
2) line 1 thru END DATA as a SET, or
3) MEM LOA thru END DATA as a SET.

All loads are **ACCUMULATIVE** if they are input more than ONCE. This applies to all situations, namely 4.2) and ALL cases in 4.3). (However, NO reinput of 4.4) load combination is allowed.)

Also each and every member in input files (**MODEL.DAT** and **LOAD.DAT**) shall be consistent in its node ORDER at each and every occasion.

The length **UNI**t **CON**version **FAC**tor as it is explained for the **MODEL.DAT** file can be applied here at beginning of each load set.

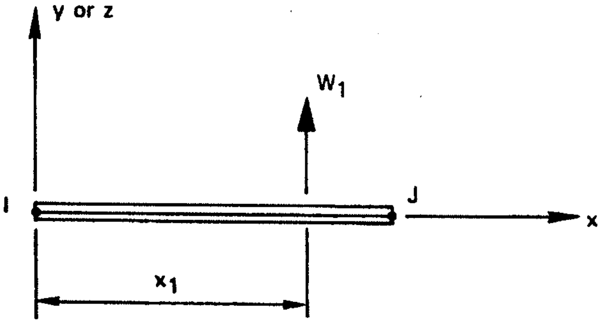
For 4.4) load combination, the effect of **LOAD MATRIX** due to previous loading conditions are combined linearly to give final solution. The solution may give linear or non-linear effect depending on the structure configuration. This is another powerful capability of the Program for non-linear analysis.

The 4.4) load combination MUST be input **ONLY ONCE FIRST** in a new loading condition and shall preferably be a stand alone loading condition without any other loads that add to it.

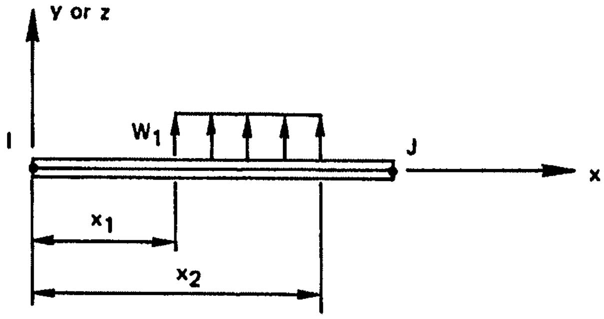
The **BIG D**isplacement and small displacement analysis shall not be mixed with each other in multi-loading condition analysis input run.

The former includes Article 4.1, Article 4.2 for **JOINT LOAD,** Article 4.3 for **MEMBER LOAD** and Article 4.4 for **LOAD COMBINATION.** For the next loading condition, the previous input for Article 4.1 is used if it is not input. The latter does not include Article 4.1.

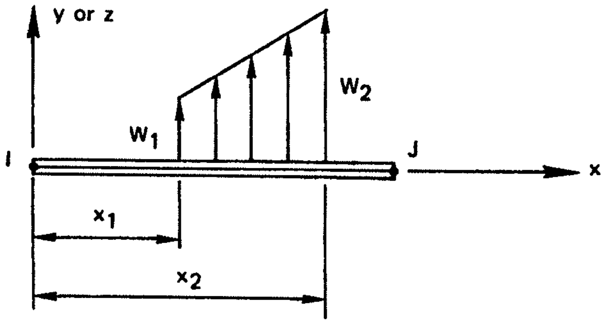
NOTE: A joint load is applied in joint coordinate system, which in general agree with global coordinate system. However, the two systems may be different when a joint has its own local coordinate system.



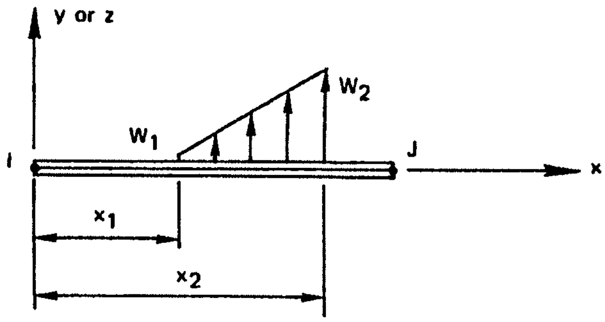
CONCentrated force



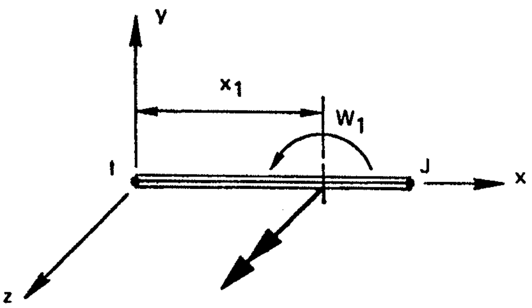
DISTributed or UNIForm load



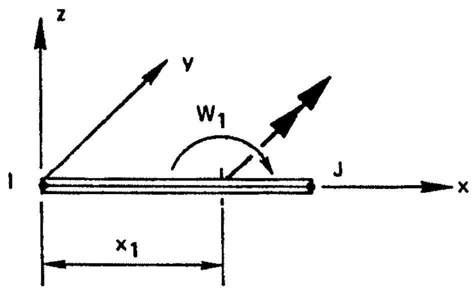
DISTributed load



DISTributed load



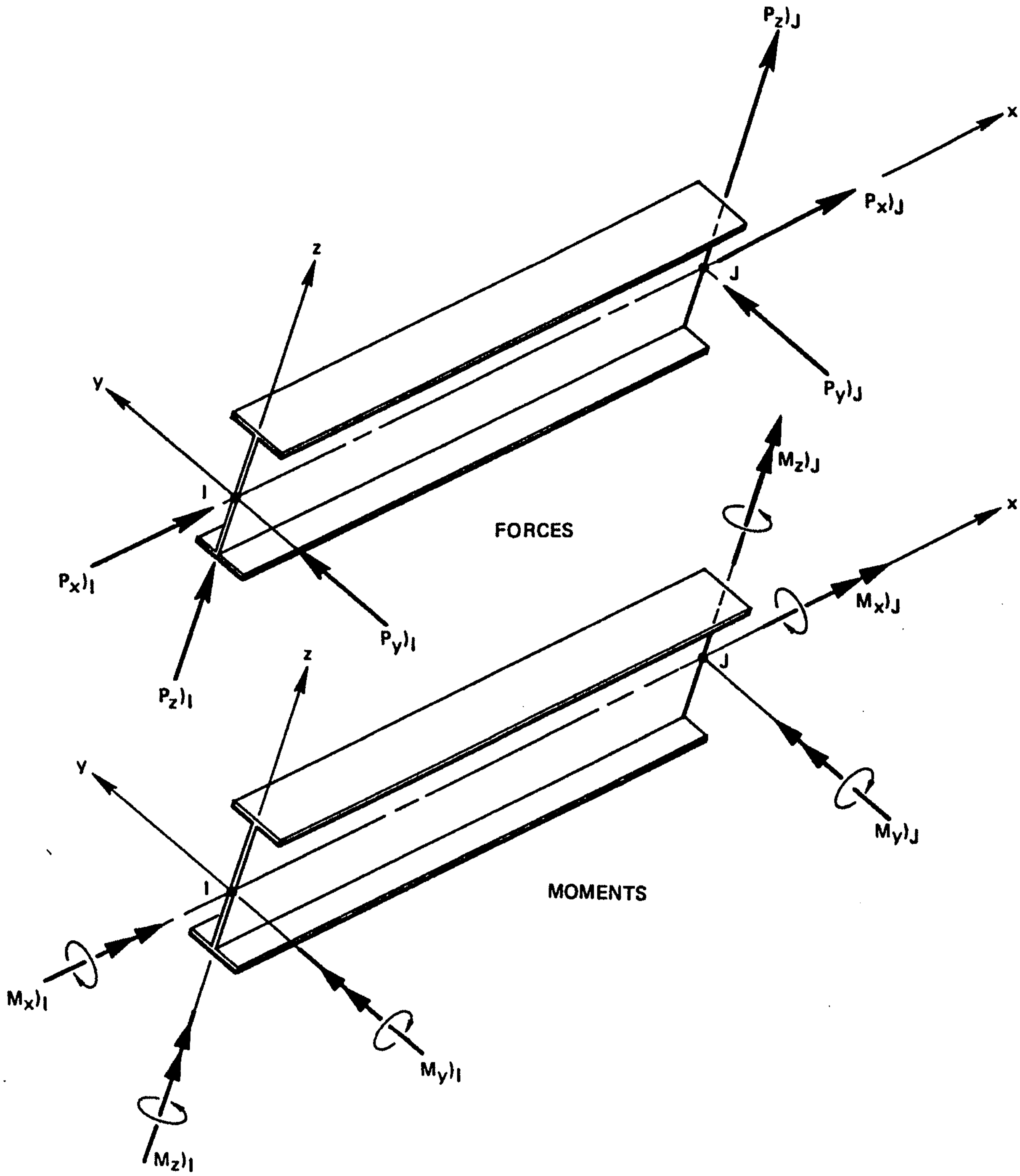
Positive Z



Positive Y

CONCentrated load, moment

MEMBER LOAD PATTERN



POSITIVE DIRECTION FOR FORCE AND MOMENT

II. O U T P U T

1) Member forces and joint displacements in all six directions. Member forces may be output in **MEMBER LOCAL COORDINATE SYSTEM** and/or **JOINT COORDINATE SYSTEM.**
2) Loading conditions on joints and boundary condition.
3) Final joint coordinates for non-linear **BIG** displacement analysis.
4) Flow path output to help input error diagnostics for correction.
5) Input data I/O sequence to help input error diagnostics.

The OUTPUT FILES are:

1-a) **RESULT** (joint/member coordinate system for OUTPUT)
1-b) **RESULTL** (member coordinate system if both systems are requested)
2) **LBCON** (LOAD MATRIX and BOUNDARY CONDITION)
3) **JOINTC** (Final JOINT coordinate for BIGD analysis only)
4) **IOCHECK**
5) **IOFLO**

The unit system for all output files is in agreement with that in **MAT.DAT.**

NOTES 1: Temperature Load

1-1) For local (member axial) x-direction, the value/values is the difference between actual temperature and stress free temperature of neutral axis as it is varying along the span.

1-2) For local y/z direction, the value is the difference in temperature between positive face and negative face of y/z axis of the beam as it is varying along the x-axial span. POSITIVE face is at a positive distance ALONG the local coordinate AXIS from the origin, namely the neutral axis of the member, and vice versa for negative face.

1-3) The local y-direction temperature load tends to cause bending stress and/or strain about local z-axis, and vice versa.

1-4) If no temperature load is input, ALPHA, RHO, DY and DZ may be input any number as place holder, such as 0., 0.01 and so on. If condition permits, they may be omitted.
(see SECTION PROPERTIES OF MEMBERS)
(also see MATERIAL OF MEMBERS)

1-5) The powerful **GEN**erate **TEM**perature command can be used for structure subjected to general change of temperature.
The LOCal direction can be used effectively for axial direction. Change of member lengths of guyed tower belongs to this case.
The **GLO**bal direction can be used for **BENDING** condition as well as semi-axial direction effectively. Change of room temperature as compared with adjacent room belongs to this case.
However, the Program capability is **GENERAL.** As long as correct modeling technique is used, it will be good for any **DIRECTION.**

NOTES 2: Fixed END Load

2-1) Fixed End load comes usually in pairs, thus the 3rd line shall be input accordingly. The value for item 1 is for 1st member **NODE;** and the value for item 2, 2nd NODE.
(4TH line input is NOT permitted)

2-2) Fixed End load may be due to:
Support displacement (translational or rotational)
Loads in-between two joints along a beam
Temperature load

2-3) However, the BEST way to input loads is to input by using OTHER proper commands. This command can be used for fall back situation.

NOTES 3: ELEMent TRUSs

3-1) All truss member are two-node members. The 3rd node may be present in input line without being processed by the Program. It is assumed in accordance with a parameter in File **KEYUSP.DAT.** However, there is an exception for the 1st truss element. There are two options for it to facilitate element local coordinate system.

3-1-1) Three-node input option, namely Nodes I, J and K.
3-1-2) Two-node input option, namely Nodes I and J.
Refer File **KEYUSP.DAT** to select the option.

3-2) For a truss member, if this 3rd NODE causes colinear problem, the Program has by-passing capability built-in to resolve the problem. The answer shall be good as long as the truss member load is specified for the member of problem in:

3-1-1) **GLOBAL** coordinate system; or
3-1-2) **LOCAL** coordinate system for x- (axial) direction.

3-3) A member load may be applied at truss members. The Program will properly compute joint load automatically and proceed as though the loads are at pinned joints.
However, the truss member will be treated as a pinned simply-supported beam without a necessary condition that forces between two ends must be **CO-LINEAR.** This will give a quick clue for **SECONDARY** stress potential. To be in equilibrium, load/loads along member span must be accounted.

3-4) NO rotational member load (MX, MY or MZ) is permitted.

3-5) Each ITEM from ITEMS 1 through 5 MUST be OMITTED in input if it does not apply to that member. Among Items 1 through 3, each Item is **INTERCHANGEABLE** as long as corresponding Item 4 or Item 5 also changes accordingly.

3-6) See NOTES 4 for further explanation.

NOTES 4: ONE-way element can be used to model linear spring with Tension-only or Compression-only member.

4-1) The program will pick a **THIRD** node properly to bypass the colinear problem. If member load is input like a truss member the answer shall be good too.

4-2) S-L, L-S means the member is either too Short or too Long.

4-3) S-LA, AL-S, AS-L or L-SA is in term of Actual value.

4-4) S-LF, L-SF, FS-L or FL-S is in term of Fractional value as compared with the member length.

4-5) S-L is in default value, currently to Actual value.(S-LA)

4-6) T-C or C-T means that this member is capable of taking small amount of compression for Tension-only member, and vice versa for Compression member.

4-7) The Value in item 5 shall agree in length unit as in this **MODEL.DAT** if the Actual length is used.

4-8) The VALUE is Positive for Tension, Negative for compression; Positive for too Long and Negative for too Short.

4-9) The Compression-only member can be used to model member with opening GAP as too Short, while Tension-only member, as **OVER-LAP** or **SLACK** as too Long. Also a ONE-way support may be simulated by modeling this support direction as a **FREE** direction that is connected by a big ONE-way element to a fixed node that occupies a different location. However, it shall not be used if normal mode analysis is contemplated.

4-9-1) Support with Gap
Currently, the PC version is not supported as in 1.3 to save space. However, it is supported as above along with use of **ELEM**ent **GAP**.

4-10) CRI means that the tension-only member is capable of (Pcri) CRItical buckling load based on Euler Buckling Equation for **ECONOMICAL** design. The computer Program will perform such computation for an optimum design analysis.
The Value in Items 4 shall be r/k.
where r = ruling radius of gyration (Unit shall be as that in **MAT.DAT**. This is an exception)
k = factor for effective length
The Euler Buckling Equation is as follows:

Pcri = 3.141592*3.141592 E A (r/k)(r/k)/(L*L)

where E= Young's modulus of elasticity,
A= Area
L= Length

4-11) PRE means that the final force for the member is **PRE**scribed. (Known before hand under a given loading condition. For example, **INITIAL** guy tension of a guyed tower; known **ZERO** value of force of **GAP** element, of **OVERLAP/SLACK** element when it is not in action)

4-12) EACH ITEM for ITEMS 2 through 5 MUST be OMITTED if it does not apply to the member.

4-13) The Tension-only member can be used to model a structure with cable-networks system, such as cable-stayed girder, cable-truss roof,transmission tower,oil-drilling platform tower,micro-wave tower, guyed tower,suspension bridge and so on. It is a very powerful tool for such analysis.

NOTES 5: SELf LOAd Z 0.2 command to generate applied loads
GEN LOAd Z 1. command to generate applied loads

5-1) On 1st line input, self-weight load due to the structure for every and each member may be generated as uniform full span load along member axis. The direction shall be in **GLOBAL COORDINATE** system. The multiplication factor other than 1. or -1. may be specified in input. This capability is powerful for lateral load earth-quake analysis, structure dead load analysis and wind load analysis.

5-2) The Load is obtained by volume times unit weight times multiplication factor. By adjustment of the multiplication factor, any proper live load can be obtained. To facilitate wind load, the unit weight also can be adjusted.

5-3) NO input is allowed for 2nd, 3rd or 4th line. However, **END DATA** must be **INPUT** since it is treated as one set of member load.

NOTES 6: ELEMent RBAR and ELEMent BBAR

6-1) **RBAR** or **BBAR** may be either translational or rotational.

6-2) NO member load is allowed. However, Joint load is allowed.

6-3) **RBAR** or **BBAR** may be used to model structure that has hinge(s), roller(s), or member release(s).

6-4) To do so, extra coordinate joint(s) with same coordinate values is input.
For the connected direction, **EACH DEGREE** of **FREEDOM** for ONE of the joints is specified as a SLAVE (dependent) degree of freedom in **JOINT COORDINATE** input.

6-5) Make sure that each connected direction of a pair of joints or a set of joints shall be in same direction for the selected coordinate system(s). If needed, the **JOINT LOCAL** coordinate system(s) shall be used for such orientation.

6-6) A **SLAVE** (dependent) degree of freedom can only be dependent on **ONE MASTER** (independent) degree of freedom. However, a **MASTER** degree of freedom can have several **SLAVE** degree of freedom.

NOTES 7: BIG displacement for non-linear and/or P-DELTA analysis

7-1) If there is Big Displacement non-linear analysis, then the FIRST line of input in **LOAD.DAT** file must be 4.1).

```
      1st item    2nd item
7-2)  BIGD           20

      BIGD  ------ 1st item must be  BIGD.
      20    ------ 2nd item for number of iterations requested.
```

7-3) On converging or end of requested iteration cycle whichever comes first, the Program will exit. The output will have a file **JOINTC** (Joint coordinate of final position) also.

7-4) This is a powerful tool for hanging cable system, including but not limited to, non-linear guyed tower, non-linear suspension cable system bridge tower and so on.

7-5) For faster conversion, it is preferable that the sagging cable shall not have infinity of force component initially. In considering the equilibrium of a joint, for instance, a **HORIZONTAL** cable with **VERTICAL** loads is the case. The cable shall be made with SOME dipping with **NEGATIVE L-S** (too short) **VALUE** initially.

7-6) For **P-DELTA** analysis, the 2nd item in 7-2) must be 2 as number of iteratons requested. Also it is advisable that loads that are affected by the displacement of nodes be input in **GLO**bal direction. Among them are member distrtibuted loads and member concentrated loads.

NOTES 8: ELEMENT SHEAR WALL and PIPE

8-1) ELEMENT SHEAR WALL

- 8-1-1) Use **ELEM**ent **BEAM** with AVY and AVZ additionally.
- 8-1-2) See **SECT.DAT** File for AVY and AVZ definition.
- 8-1-3) Frequently, a shear wall with openings has to be modeled as many beams that occupy same location and have different section properties. In real shear wall, these beams are likely to be separate and parallel.
- 8-1-4) The Program will take beams with identical member incidences to handle above situation.

8-2) ELEMENT PIPE

- 8-2-1) **ELEMENT PIPE** is handled by **USPPIPE** or **USPSAP**.
- 8-2-2) **USPPIPE** also includes boundary element.
- 8-2-3) All Programs are free format input with **USPPLOT** as their preprocessor.

NOTES 9: INTERACTIVE video screen GRAPHIC-TEXT input/output capability

9-1) This **POWERFUL** capability is disk based data base management. The information created can be saved and be ready for **USP, USPPIPE, USPSAP** or other programs for additional process.

9-2) The Program is essentially **MENU** driven and can mostly be understood by following the instruction on the **SCREEN.**

9-3) However, a **User Guide** is available. See **USPPLOTGUIDE** for more details.

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