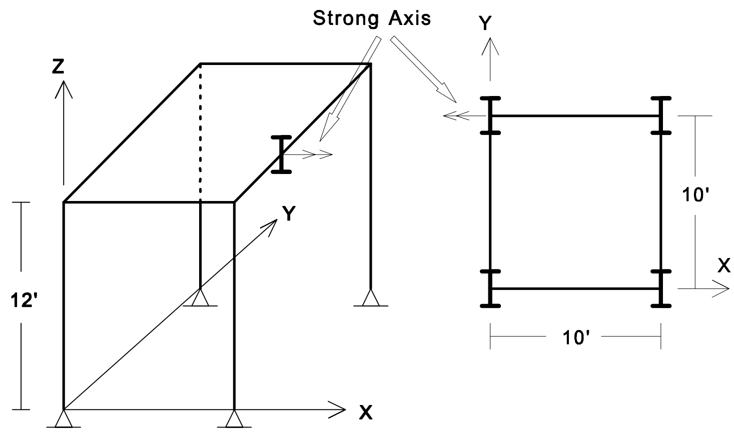
Sstan Three Dimensional Frame Example

Objectives:

1) Analyze a 3-D frame structure
2) Use the K-node beam orientation method

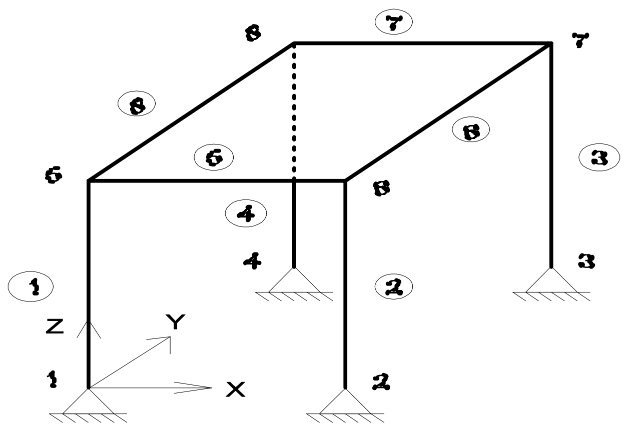
The final example of SSTAN is a three dimensional structure. The structure is a square single story frame. The load on the structure will be a uniform load on the roof of 0.8 K/ft^2. It is assumed that the roof load can be converted into a line load on each beam. Each beam will take one quarter of the total roof load. While the use of a line load is not completely accurate, it will be sufficient for demonstration purposes. The structure to be analyzed is:



3-D Example 6.4

The properties of the members are:	columns	Ix = 650 in^4
		Iy = 54 in^4
		A = 4 in^2
		J = 60 in^4
	beams	Ix = 450 in^4
		Iy = 32 in^4
		A = 3.2 in^2
		J = 43 in^4

For all beams, the strong axis lies along the X or Y axis. This means that the roof load will cause bending about the strong or 2 local axis. The first step is to number the nodes and members. The following scheme is used:



Node and Element Numbering

The resulting input file is:

```
3-D structure
8,1,1 : 8 nodes, beams only, one load case
:
COORDINATE
1 X=0 Y=0 Z=0
2 X=10*12
3 Y=10*12
4 X=0
5 Y=0 Z=12*12
6 X=10*12
7 Y=10*12
8 X=0
:
BOUNDARY
1,4 F=F,F,F,R,R,R
5,8 F=R,R,R,R,R,R
:
BEAMS
8,2
C-----PROPERTIES
1 A=4 E=29000 I=650,54 J=60
2 A=3.2 E=29000 I=450,32 J=43
C-----COLUMNS -----
1 1,5,4 M=1
2 2,6,3
3 3,7,2
4 4,8,1
C-----BEAMS -----
5 5,6,1 M=2 L=-2/12 : 2 K/FT = 1/4 TOTAL LOAD
6 6,7,2
7 7,8,3
8 8,5,4
:
```

Notice how the third node is used to specify the strong direction of the columns and beams is used. For the beams, a node in the vertical plane is chosen (just the base node under the I node). The columns strong axis is defined following the given diagram. In this case, a node from another column is chosen. Notice any node can be used to define the K node for a beam. It doesn't matter whether the node is part of the structure or an extra node with no active DOF. Nodes can be included for the purpose of defining a beams K node (as was done in Continuous Beam Example) and then given NO released DOF.

Portions of the output file are given below. Again, watch the output force sign convention since it is dependent on the choice of the third node for axis definition. Here notice that forces exist in both planes for the beam members.

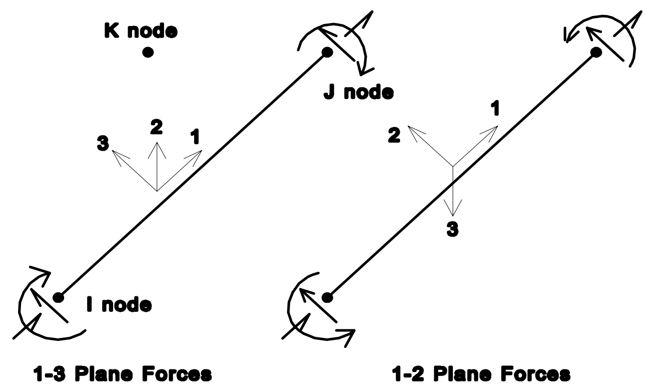
```
MEMB  CONNECTIVITY  MATERIAL                END ECCENTRICITES
 NUM. K=0 FOR Z-AXIS   SET  *****    I-END    ****   ****    J-END    *****  PIN
       I    J    K         X-VALUE Y-VALUE Z-VALUE X-VALUE Y-VALUE Z-VALUE  OPT

    1    1    5    4    1      .00     .00     .00     .00     .00     .00   0
 UNIFORM LOAD =    .000
    2    2    6    3    1      .00     .00     .00     .00     .00     .00   0
 UNIFORM LOAD =    .000
    3    3    7    2    1      .00     .00     .00     .00     .00     .00   0
 UNIFORM LOAD =    .000
    4    4    8    1    1      .00     .00     .00     .00     .00     .00   0
 UNIFORM LOAD =    .000
    5    5    6    1    2      .00     .00     .00     .00     .00     .00   0
 UNIFORM LOAD =   -.167
    6    6    7    2    2      .00     .00     .00     .00     .00     .00   0
 UNIFORM LOAD =   -.167
    7    7    8    3    2      .00     .00     .00     .00     .00     .00   0
 UNIFORM LOAD =   -.167
    8    8    5    4    2      .00     .00     .00     .00     .00     .00   0
 UNIFORM LOAD =   -.167
```

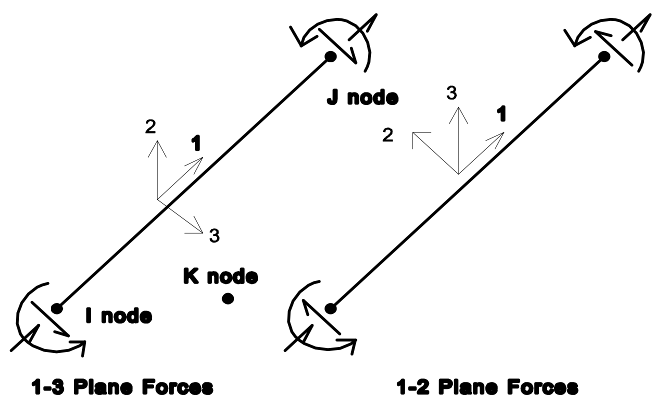
```
 ---------------------- FRAME MEMBER RESULTS ----------------
  MEM LOAD NODE          1-2 PLANE               1-3 PLANE      AXIAL FORCE
    #    #    #      MOMENT       SHEAR      MOMENT       SHEAR
    1    1    1 -.53256E-15  .18100E+00  .16660E-13  .88996E+00  .20000E+02
              5  .26064E+02 -.18100E+00 -.12815E+03 -.88996E+00 -.20000E+02
                                               AXIAL TORQUE =   .00000E+00
    2    1    2  .35735E-15 -.18100E+00  .11935E-13  .88996E+00  .20000E+02
              6 -.26064E+02  .18100E+00 -.12815E+03 -.88996E+00 -.20000E+02
                                               AXIAL TORQUE =   .00000E+00
    3    1    3  .83961E-15  .18100E+00  .89789E-14  .88996E+00  .20000E+02
              7  .26064E+02 -.18100E+00 -.12815E+03 -.88996E+00 -.20000E+02
                                               AXIAL TORQUE =   .00000E+00
    4    1    4 -.60889E-15 -.18100E+00  .16667E-13  .88996E+00  .20000E+02
              8 -.26064E+02  .18100E+00 -.12815E+03 -.88996E+00 -.20000E+02
                                               AXIAL TORQUE =   .00000E+00
    5    1    5  .11819E-15  .55870E-17  .26064E+02 -.10000E+02  .18100E+00
              6  .55226E-15 -.55870E-17 -.26064E+02 -.10000E+02 -.18100E+00
                                               AXIAL TORQUE =  -.43336E-15
 ** MAXIMUM MIDSPAN MOMENT =  -.326E+03 AT DISTANCE    60.00 FROM NODE     5
    6    1    6 -.73785E-17 -.26832E-17  .12815E+03 -.10000E+02  .88996E+00
              7 -.31460E-15  .26832E-17 -.12815E+03 -.10000E+02 -.88996E+00
                                               AXIAL TORQUE =   .00000E+00
 ** MAXIMUM MIDSPAN MOMENT =  -.428E+03 AT DISTANCE    60.00 FROM NODE     6
    7    1    7  .64439E-15  .16618E-16  .26064E+02 -.10000E+02  .18100E+00
              8  .13499E-14 -.16618E-16 -.26064E+02 -.10000E+02 -.18100E+00
                                               AXIAL TORQUE =  -.21673E-15
 ** MAXIMUM MIDSPAN MOMENT =  -.326E+03 AT DISTANCE    60.00 FROM NODE     7
```

```
   8    1    8  .64658E-15  .38404E-17  .12815E+03 -.10000E+02  .88996E+00
             5 -.18574E-15 -.38404E-17 -.12815E+03 -.10000E+02 -.88996E+00
                                                  AXIAL TORQUE =   .86671E-15
 ** MAXIMUM MIDSPAN MOMENT =  -.428E+03 AT DISTANCE    60.00 FROM NODE     8
```

The beam member in SSTAN is a three dimensional bending member. Therefore, it has six force results at each end. The coordinate system for these results is dictated by the **K node** location. The following figures show the two possible results. Note that SSTAN gives the results in terms of **local coordinate planes**.



Positive Beam Forces, K Node Left



Positive Beam Forces, K Node Right