BEAM3 Inputs and Coordinate System

Figure 3.1 BEAM3 Geometry

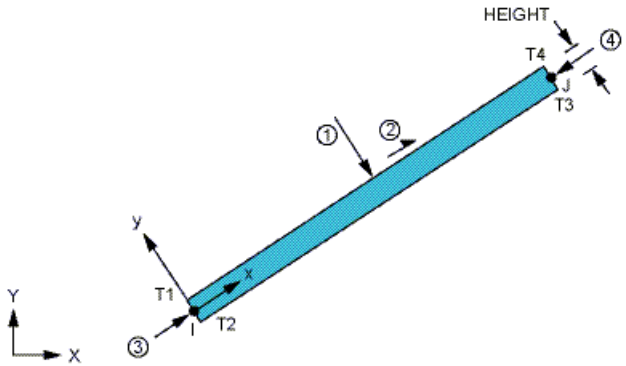
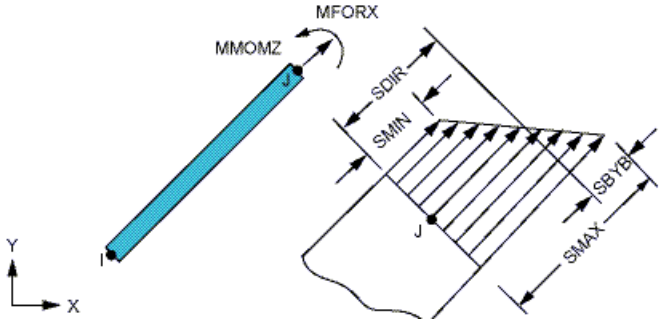


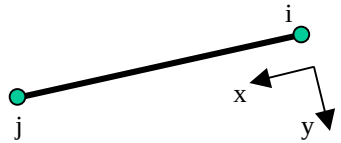
Figure 3.2 BEAM3 Stress Output



BEAM3 Input Data

Degrees of Freedom
UX, UY, ROTZ
Real Constants
AREA - Cross-sectional area
IZZ - Area moment of inertia
HEIGHT - Total beam height
SHEARZ - Shear deflection constant
ISTRN - Initial strain
ADDMAS - Added mass per unit length
Note
SHEARZ goes with the IZZ. If SHEARZ = 0, there is no shear deflection in the element Y direction.
Surface Loads
Pressure --
face 1 (I-J) (-Y normal direction)
face 2 (I-J) (+X tangential direction)
face 3 (I) (+X axial direction)
face 4 (J) (-X axial direction)

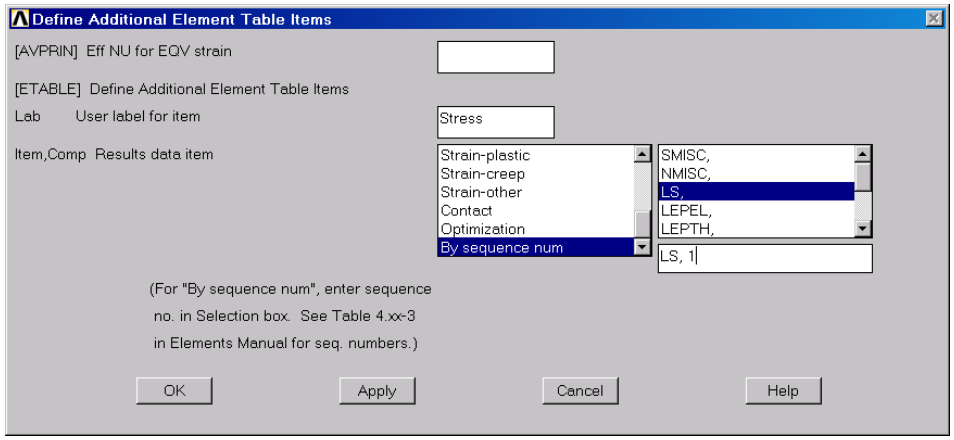
Element Coordinate System
• X-axis oriented from node i to j
• Z-axis aligned with global Z-axis
• Y-axis oriented as orthogonal right-hand system to X and Z and defines beam top and bottom



Element coordinate systems may be viewed by
Plot Controls > Symbols > ESYS element coordinate system: On
White – X-axis: Green – Y-axis: Blue – Z-axis

Getting Results From the Element Table

- From the **General Postprocessor** menu select **Element Table >Define Table**
- Click on 'Add...'
- Scroll down to “By sequence number”



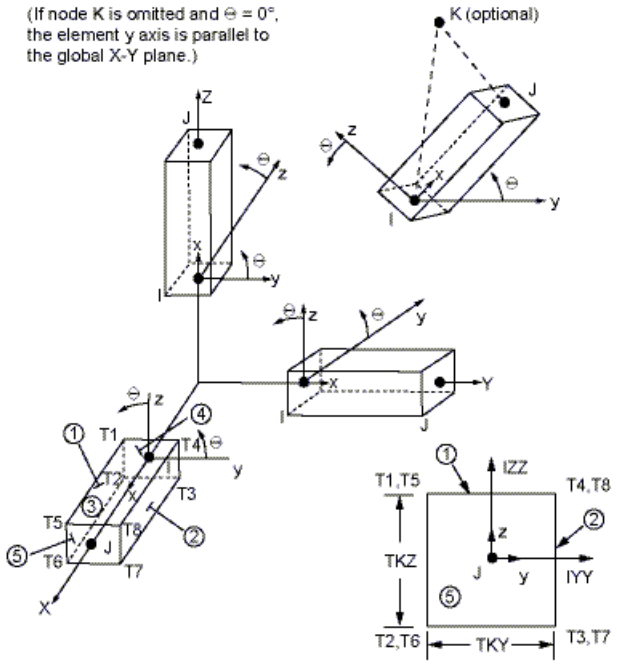
I and **J** are for the different ends of the beam
SDIR – direct or axial stress
SBYT – bending stress at top
SBYB – bending stress at bottom
SMAX – max of bending + axial
SMIN – min of bending + axial
MFORX – axial force
MFORY – Y force (or shear)
MMOMZ – bending moment

Table 3.2 BEAM3 Item and Sequence Numbers (KEYOPT(9) = 0)

Output Quantity Name	ETABLE and ESOL Command Input			
	Item	E	I	J
SDIR	LS	-	1	4
SBYT	LS	-	2	5
SBYB	LS	-	3	6
EPELDIR	LEPEL	-	1	4
EPELBYT	LEPEL	-	2	5
EPELBYB	LEPEL	-	3	6
EPTHDIR	LEPTH	-	1	4
EPTHBYT	LEPTH	-	2	5
EPTHBYB	LEPTH	-	3	6
EPINAXL	LEPTH	7	-	-
SMAX	NMISC	-	1	3
SMIN	NMISC	-	2	4
MFORX	SMISC	-	1	7
MFORY	SMISC	-	2	8
MMOMZ	SMISC	-	6	12
P1	SMISC	-	13	14
OFFST1	SMISC	-	15	16
P2	SMISC	-	17	18
OFFST2	SMISC	-	19	20
P3	SMISC	-	21	-
P4	SMISC	-	-	22

BEAM4 Inputs and Coordinate System

Figure 4.1 BEAM4 Geometry



BEAM4 Input Data

Real Constants

AREA, IZZ, IYY, TKZ, TKY, THETA

ISTRN, IXX, SHEARZ, SHEARY, SPIN, ADDMAS

For the two-node option, the default (θ = 0°) orientation of the element y-axis is parallel to the global X-Y plane. For the case where the element is parallel to the global Z axis, the element y axis is oriented parallel to the global Y axis (as shown).

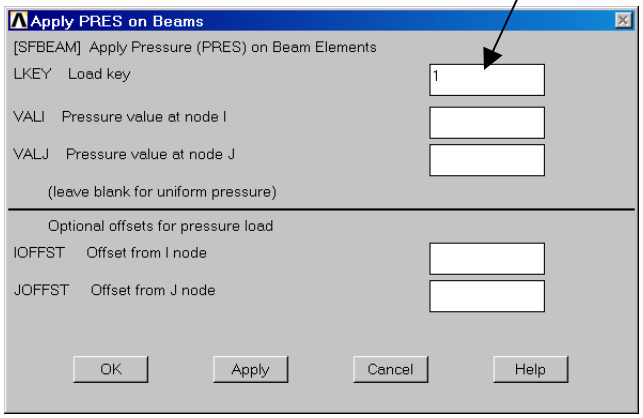
The third node (K), if used, defines a plane (with I and J) containing the element x and z axes

Surface Loads

Pressures --

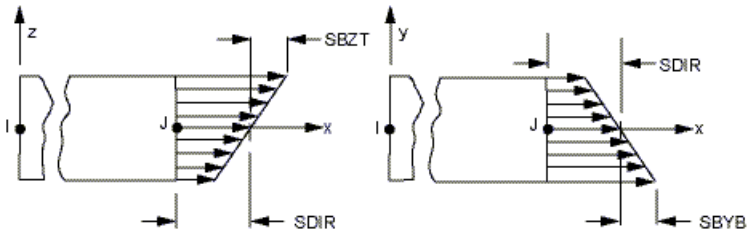
face 1 (I-J) (-Z normal direction)
face 2 (I-J) (-Y normal direction)
face 3 (I-J) (+X tangential direction)
face 4 (I) (+X axial direction)
face 5 (J) (-X axial direction)
(use negative value for opposite loading)

These are the LKEY values when applying pressures to beams



BEAM4 Element Table

Figure 4.2 BEAM4 Stress Output



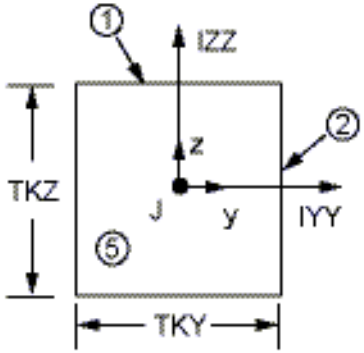
Note – SBZT and SBZB are bending about IYY (beam y-axis) and SBYT and SBYB are bending about IZZ (beam y-axis). I think the notation comes from the top and bottom in the Z direction.

MMOMY is the moment about the beam IYY axis, however

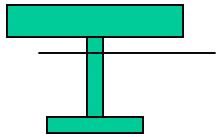
Table 4.3 BEAM4 Item and Sequence Numbers (KEYOPT(9) = 0)

Output Quantity Name	ETABLE and ESOL Command Input			
	Item	E	I	J
SDIR	LS	-	1	6
SBYT	LS	-	2	7
SBYB	LS	-	3	8
SBZT	LS	-	4	9
SBZB	LS	-	5	10
EPELDIR	LEPEL	-	1	6
EPELBYT	LEPEL	-	2	7
EPELBYB	LEPEL	-	3	8
EPELBZT	LEPEL	-	4	9
EPELBZB	LEPEL	-	5	10
SMAX	NMISC	-	1	3
SMIN	NMISC	-	2	4
EPTHDIR	LEPTH	-	1	6
EPTHBYT	LEPTH	-	2	7
EPTHBYB	LEPTH	-	3	8
EPTHBZT	LEPTH	-	4	9
EPTHBZB	LEPTH	-	5	10
EPINAXL	LEPTH	11	-	-
MFORX	SMISC	-	1	7
MFORY	SMISC	-	2	8
MFORZ	SMISC	-	3	9
MMOMX	SMISC	-	4	10
MMOMY	SMISC	-	5	11
MMOMZ	SMISC	-	6	12
P1	SMISC	-	13	14
OFFST1	SMISC	-	15	16
P2	SMISC	-	17	18
OFFST2	SMISC	-	19	20
P3	SMISC	-	21	22
OFFST3	SMISC	-	23	24
P4	SMISC	-	25	-
P5	SMISC	-	-	26

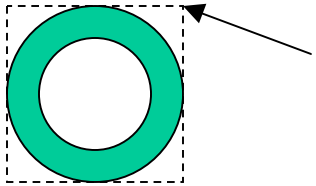
BEAM3 and BEAM4 Caveats



Computed stress will not be correct for non-symmetric sections as distance to outer fiber assumed to be half the height.



Maximum stress calculation also assumes rectangular section which can produce errors.



$$\sigma_{max}=\sigma_{bymax}+\sigma_{bzmax}+\sigma_{x}$$

BEAM54 (2-D Elastic Tapered Unsymmetric Beam) and **BEAM44** (3-D Elastic Tapered Unsymmetric Beam) elements overcome these limitations but the real constant inputs are much more detailed. Section properties may be used to have ANSYS calculate real constants for you (next time)