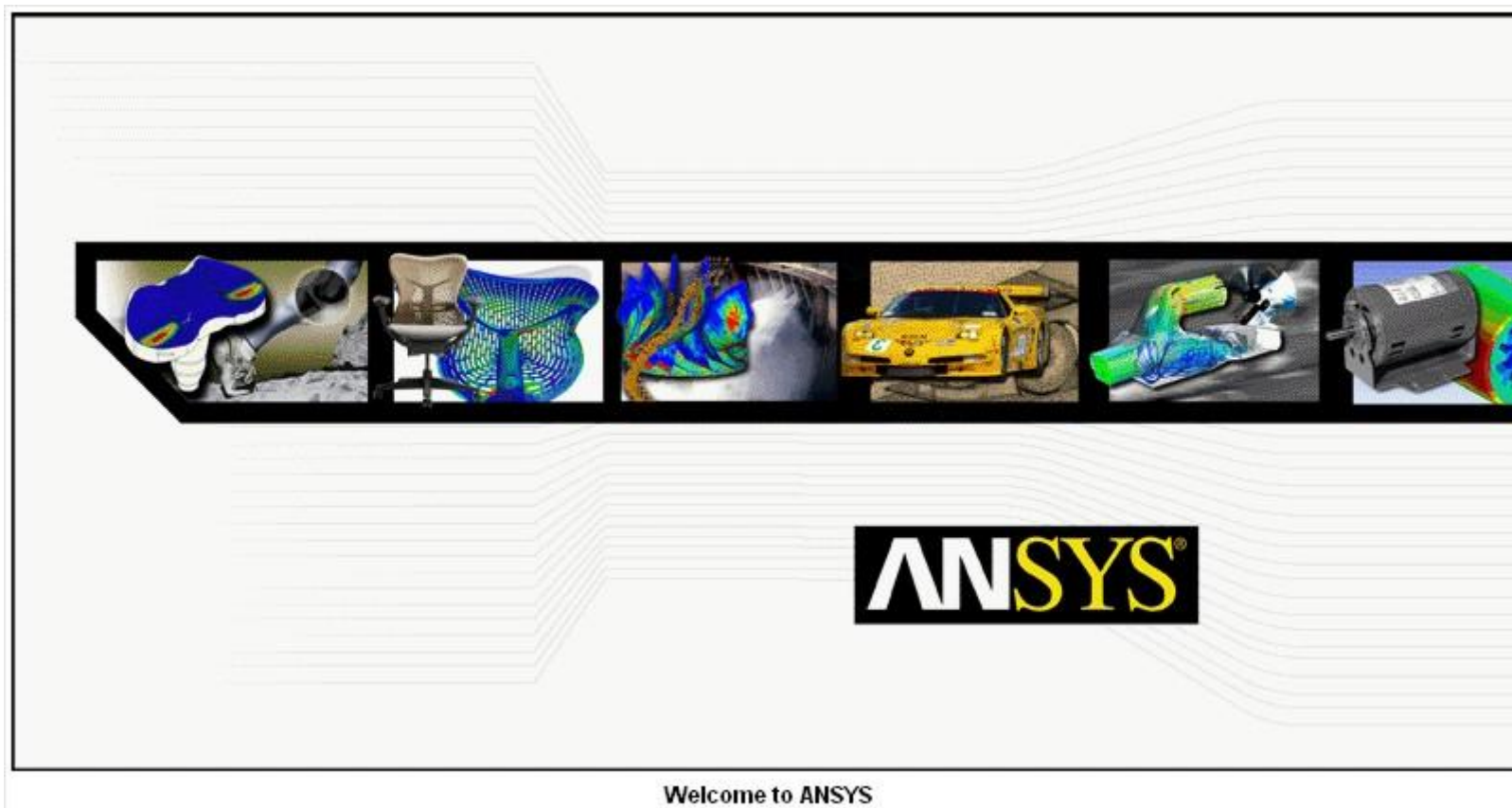


Rīgas Tehniskā universitāte Materiālu un Konstrukciju institūts

Uzdevums: 2D – sijas elements Beam 3

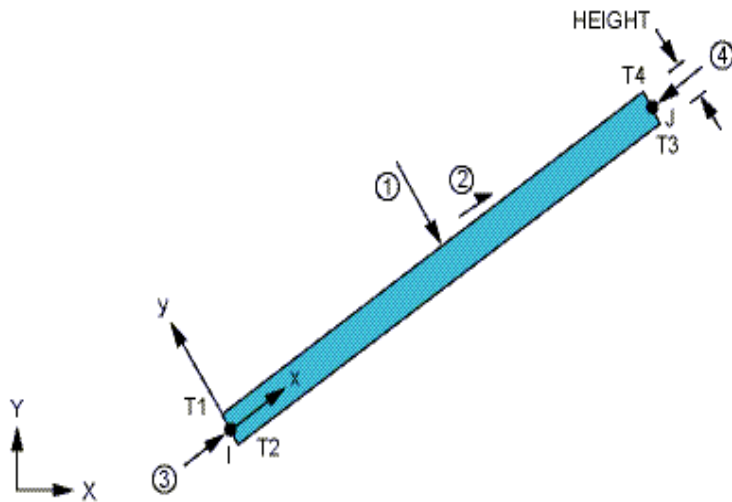
Programma: ANSYS 9

Autori: A. Ivaškovs



Beam 3 2-D sijas elements

Sijas elementa Beam 3 ģeometrija



Mezgli

I, J

Brīvības pakāpes

UX, UY, ROTZ

Materiāla īpašības

AREA, IZZ, HEIGHT,
SHEARZ, ISTRN, ADDMAS
EX, ALPX, DENS, GXY, DAMP

Slodzes

Vienmērīgi izkliedētas slodzes

konstante **1** (I-J) (-y normāles virzienā),

konstante **2** (I-J) (+x perpendikulārā virzienā),

konstante **3** (I) (+x ass virzienā),

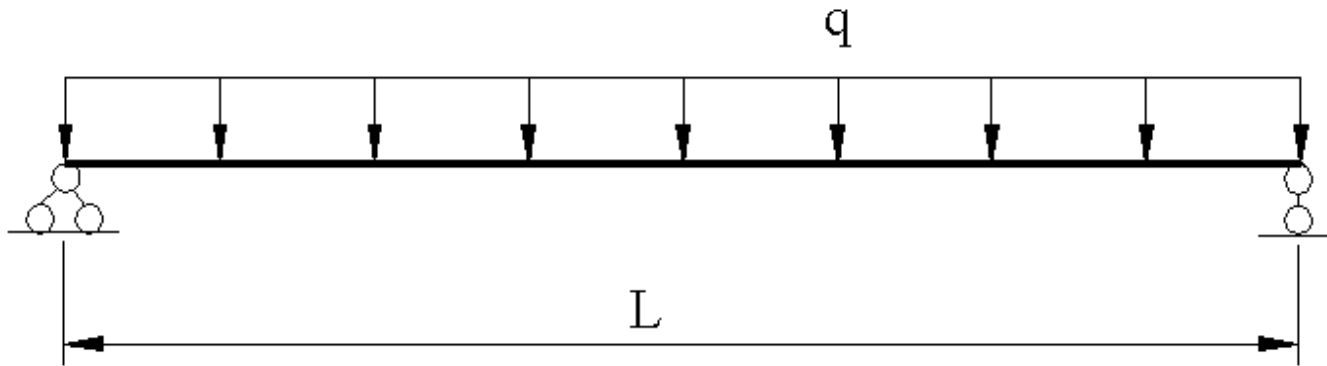
konstante **4** (J) (-x ass negatīvā virzienā).

Papildus iespējas

Materiāla šļūde

Lielas deformācijas elementā

3D sija modelēšana ar Beam189 palīdzību

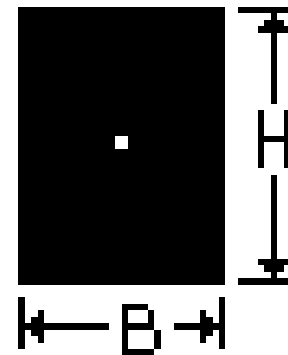
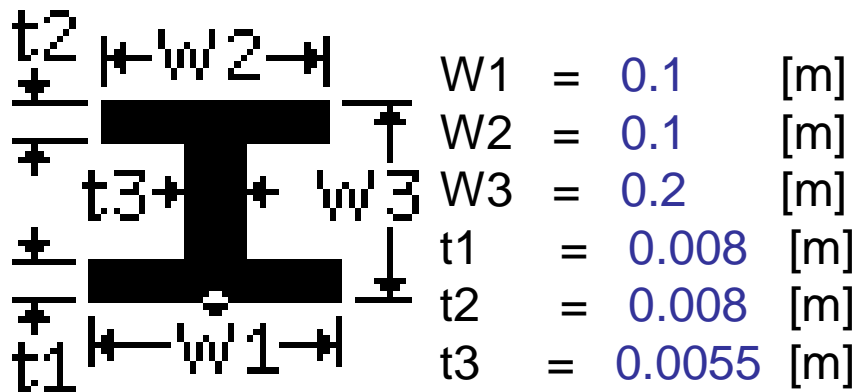


$$L = 5 \quad [\text{m}]$$

$$q = 15 \quad [\text{kN/m}]$$

**Dubult-T profila šķērsriezums
GOST 8239-89 Nr.20Б1**

**Ekvivalenta taisnstūra
profila šķērsriezums**



$$H = 0.2 \quad [\text{m}]$$

$$I = 0.0000194 \quad [\text{m}^4]$$

$$A = 0.0028 \quad [\text{m}^2]$$

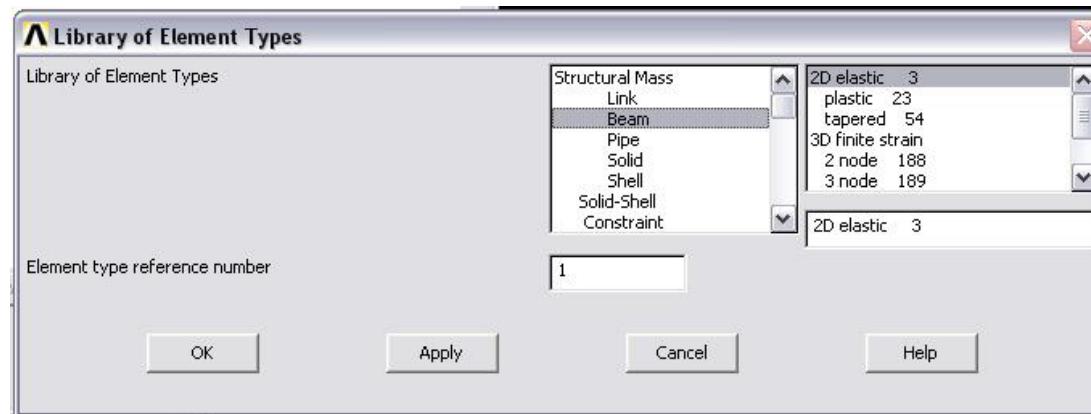
Elementa tipa definēšana – BEAM 3



(1) Preprocessor/
Element Type/
Add/Edit/Delete



(2) Add...



(3) Beam
2D elastic 3

(4) OK

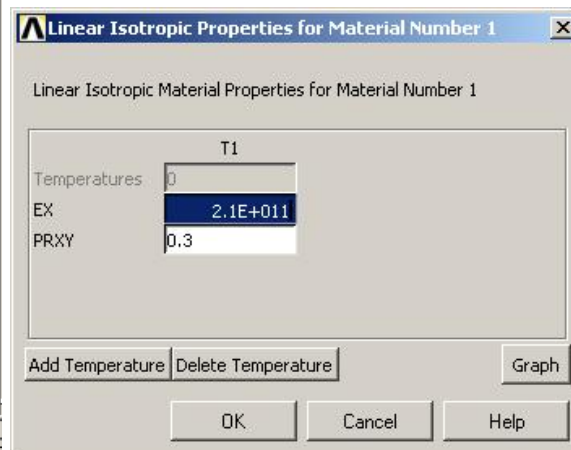
Materiāla īpašību definēšana

(1) Preprocessor/
Material Props/
Material Models



(2) Material Model Number

Structural
Linear
Elastic
Isotropic



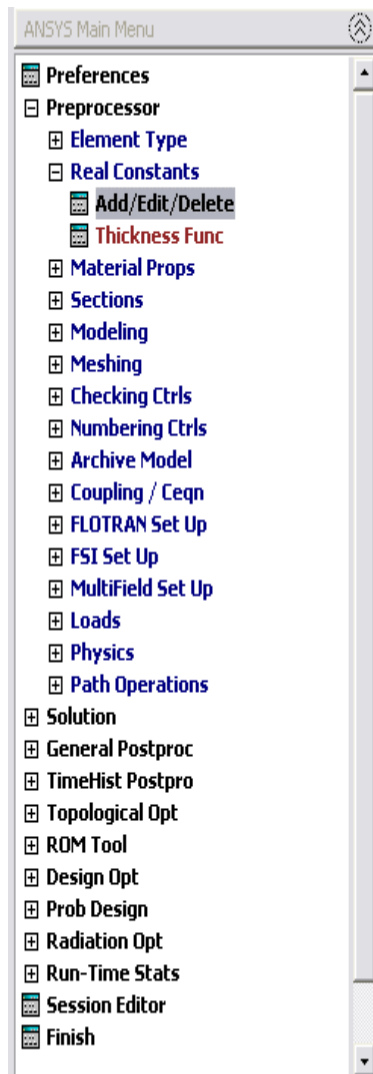
(3) $E_x = 2.1E+011$ [Pa] *Elastības modulis*

$\nu = 0.3$ *Puasona koeficients*

OK



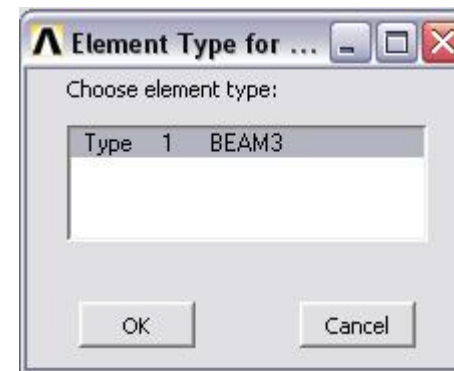
Šķērsriezuma profila definēšana



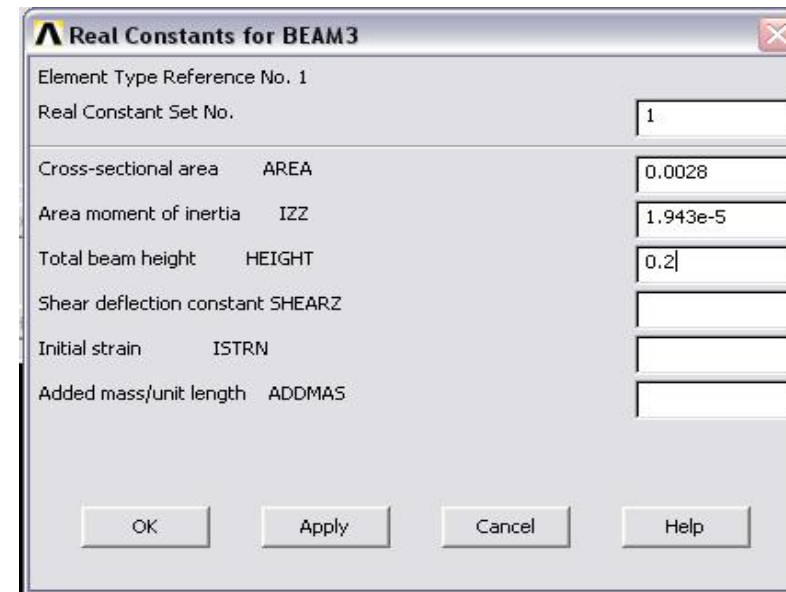
(1) Preprocessor/
Real Constants/
Add/Edit/Delete



(2) Add...



(3) OK

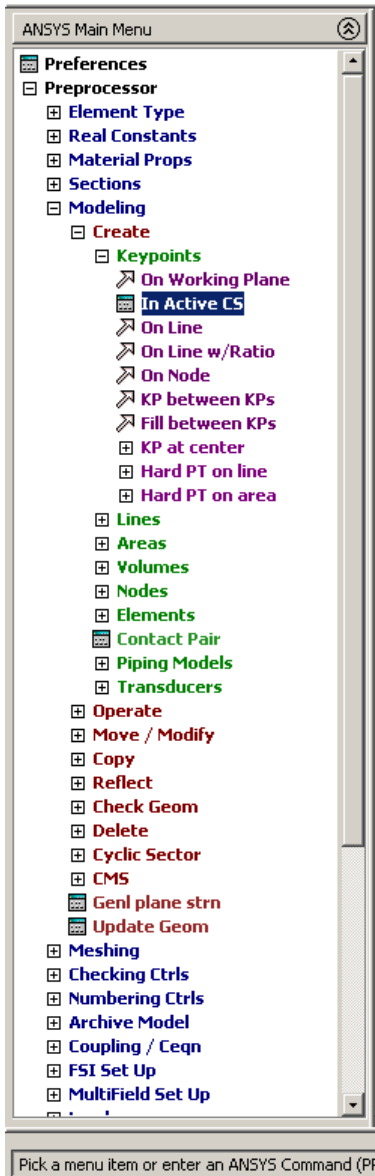


(4) AREA 0.0028
IZZ 0.00001943
HEIGHT 0.2

OK

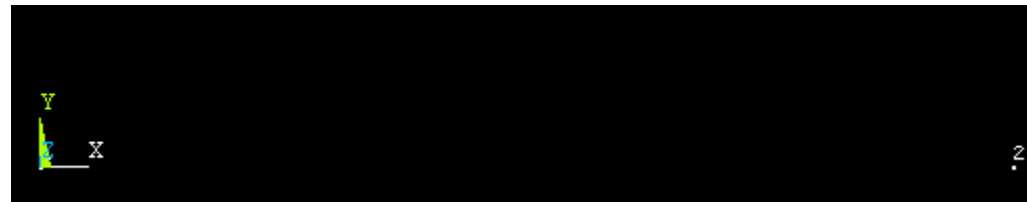
Koordinātu mezglu definēšana

(1) Preprocessor/
Modeling/
Create/
Keypoints/
In Active CS

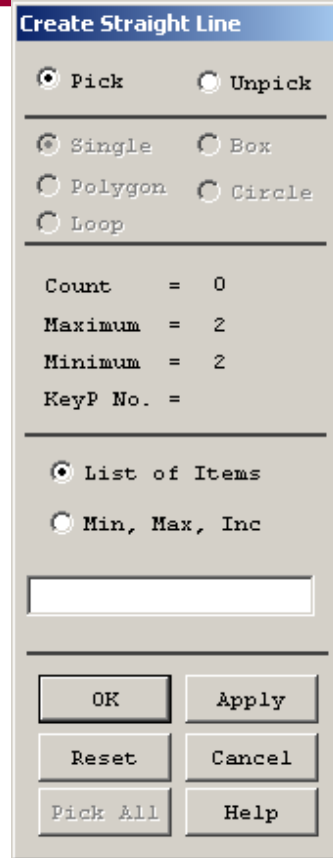
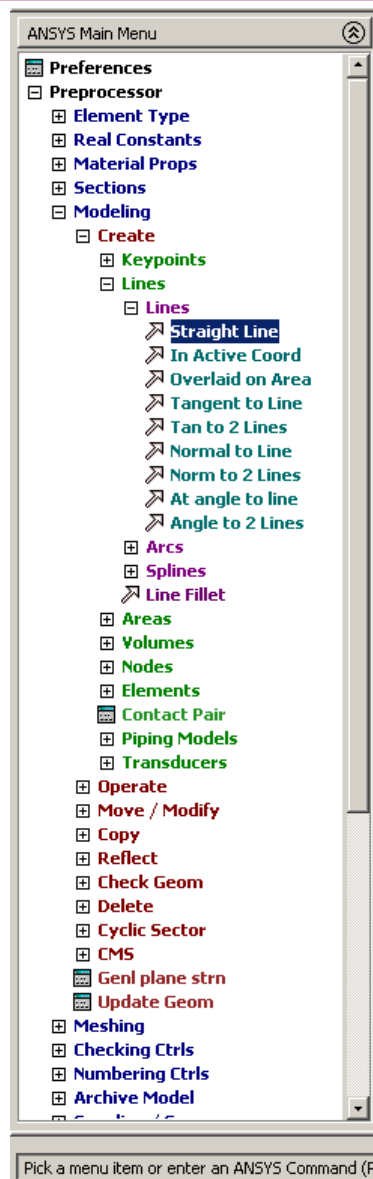


| (2) NPT | X, | Y, | Z |
|---------|----|----|---|
| 1 | 0 | 0 | 0 |
| 2 | 5 | 0 | 0 |

Apply
OK



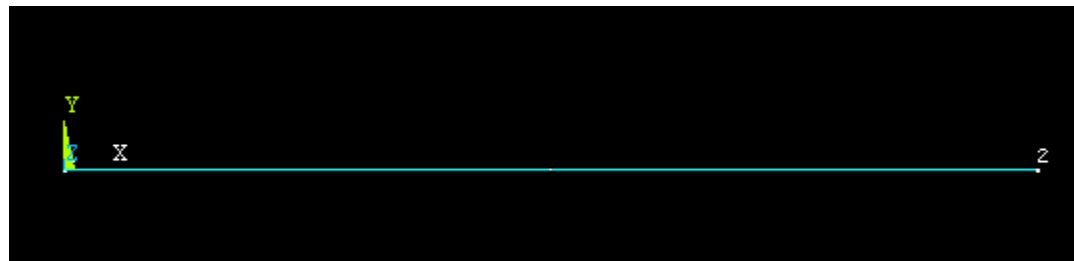
Līnijas definēšana



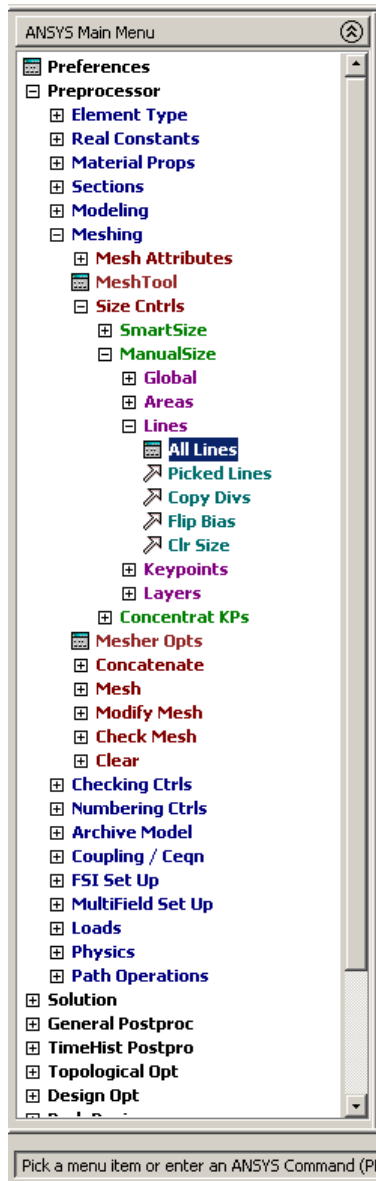
(1) Preprocessor/
Modeling/
Create/
Lines/
Lines/
Straight Line

(3) OK

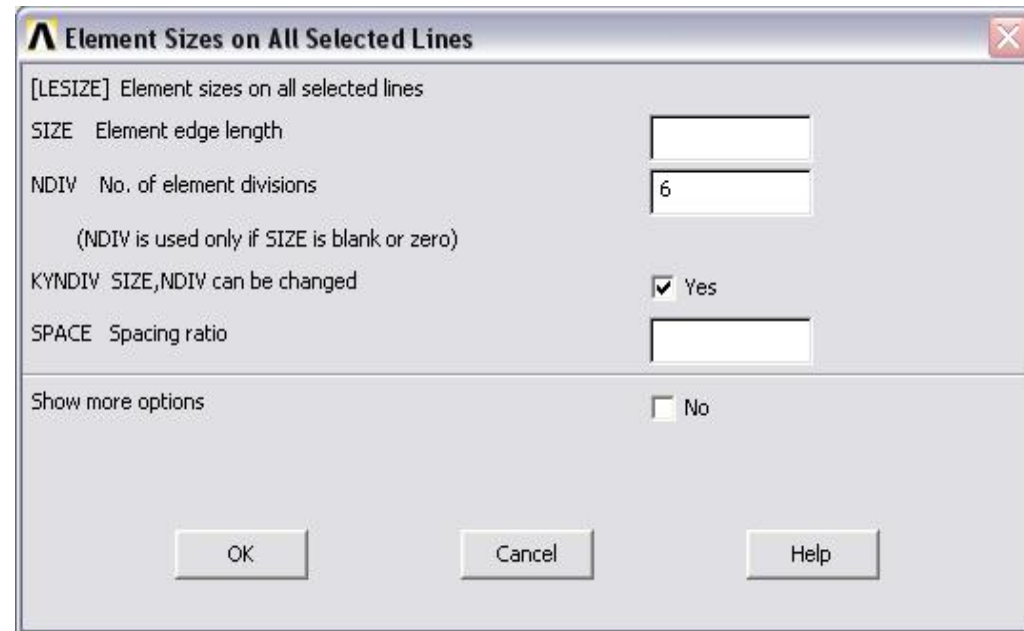
(2) Savienot punktu Nr.1 ar punktu Nr.2



Galīgo elementu izmēru definēšana

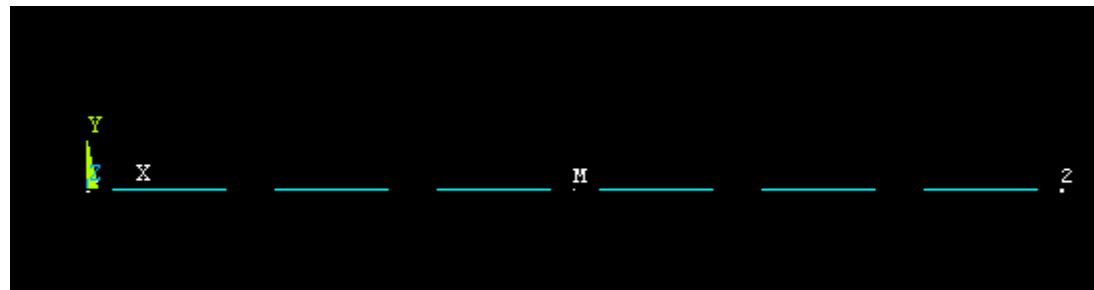


(1) Preprocessor/
Meshing/
Size Cntrls/
ManualSize/
Lines/
All Lines

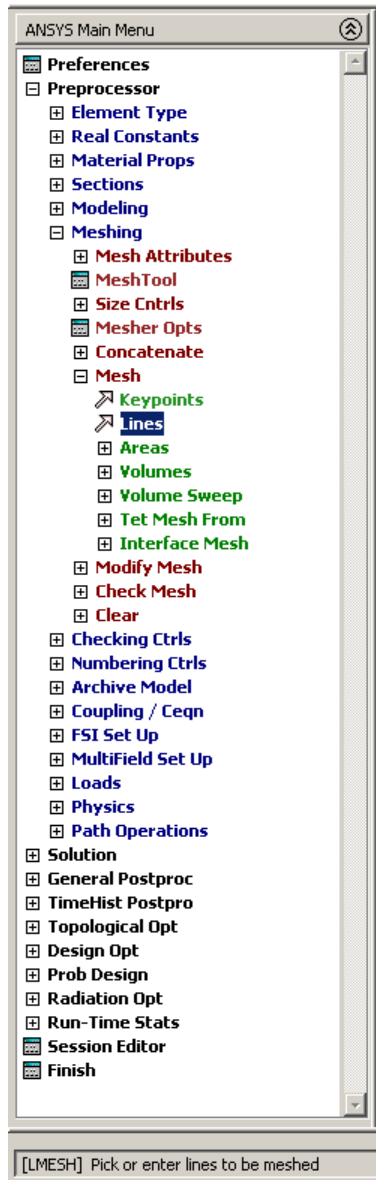


(2) NDIV 6

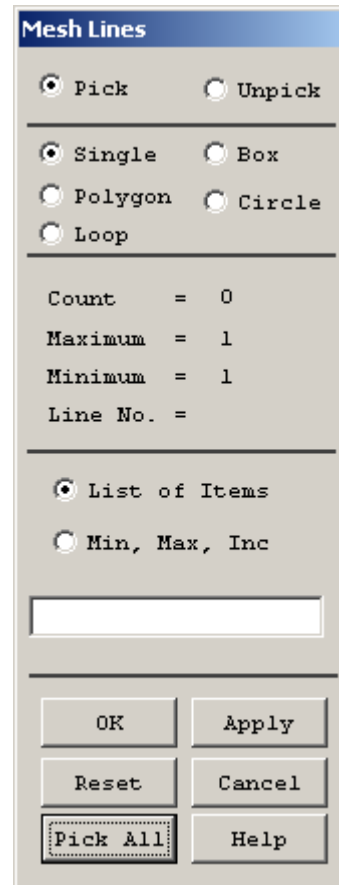
(3) OK



Sijas dalījums galīgos elementos

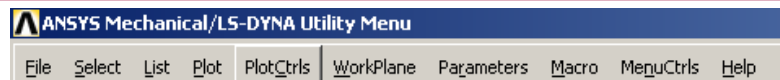


(1) Preprocessor/
Meshing/
Mesh/
Lines/

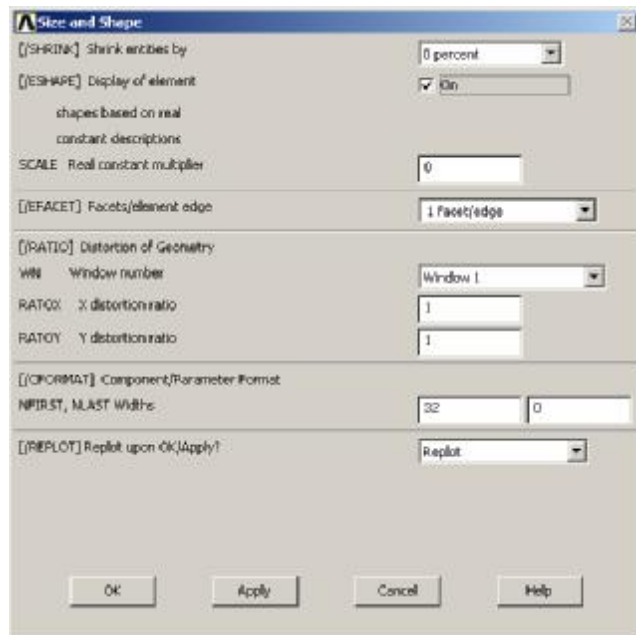
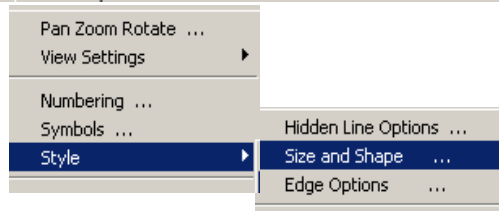


(2) Pick All

Sijas izometriskā skata izveide



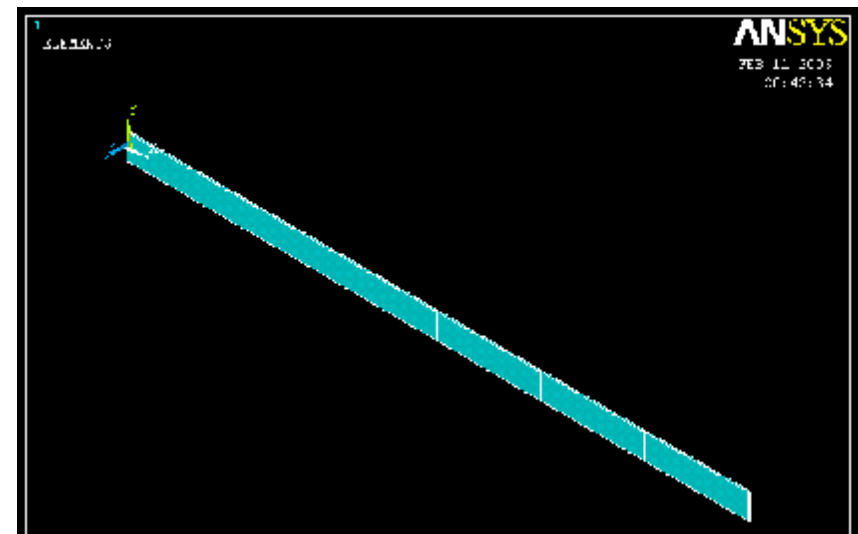
(1) PlotCtrls/ Style/ Size and Shape/



(2) Display of element
On

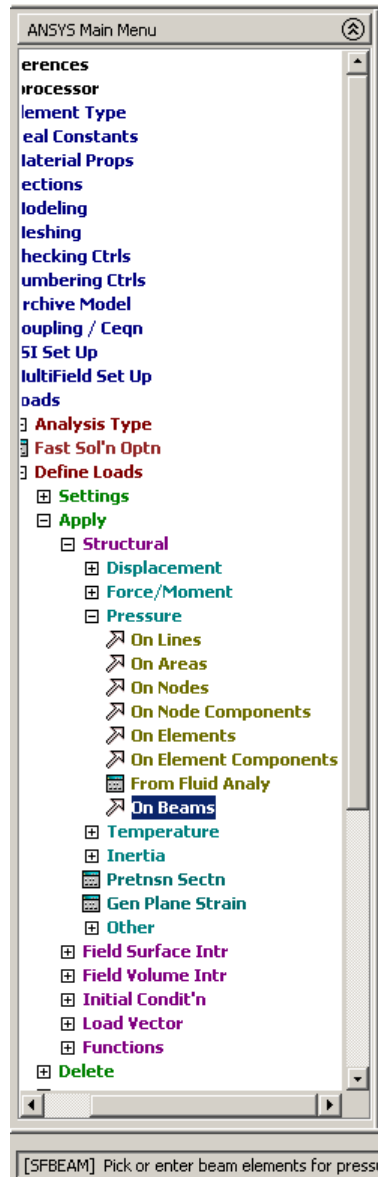


(4) OK

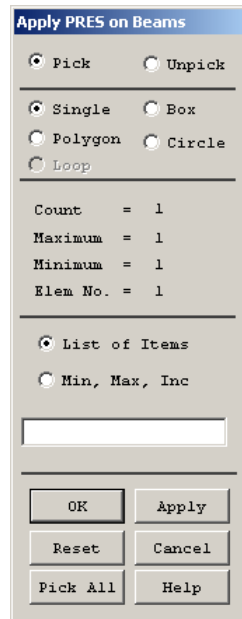
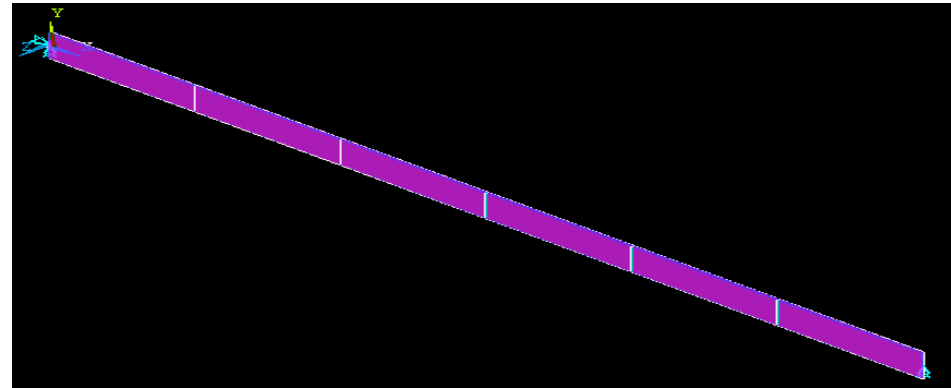


(3) OK

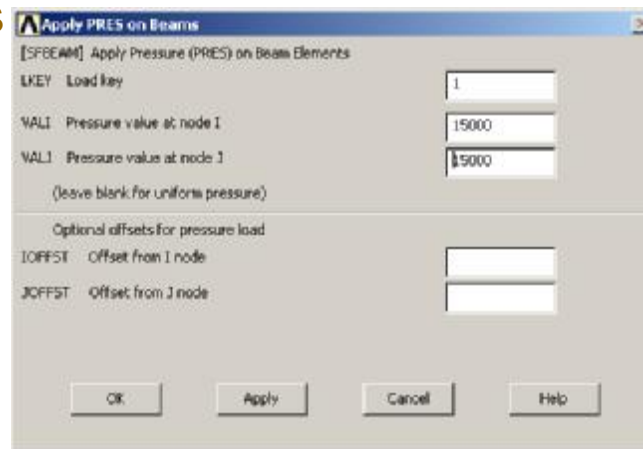
Sijas vienmērīgi izkliedētas slodzes definēšana



- (1) Preprocessor/
Loads/
Define Loads/
Apply/
Structural/
Pressure/
On Beams

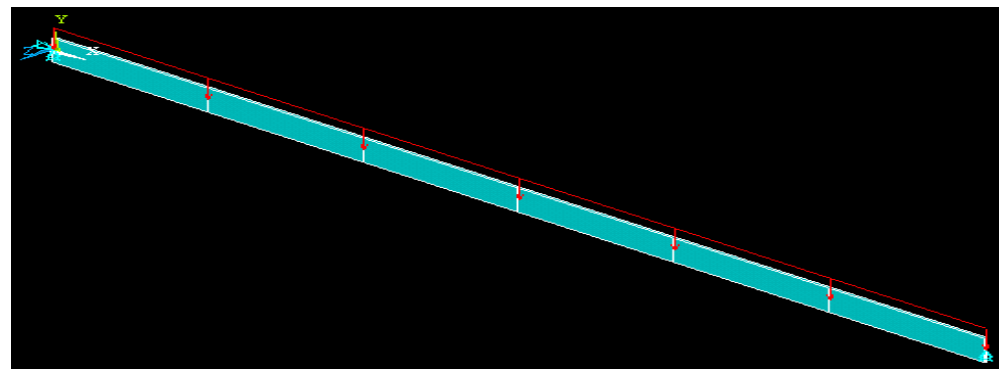


- (2) Pick All



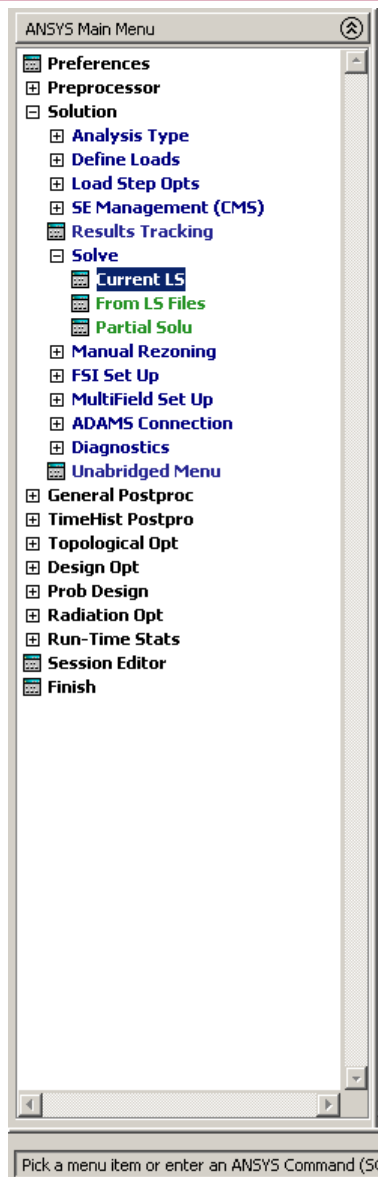
- (3) LKEY = 1
VALI = 15000 [N/m]
VALJ = 15000 [N/m]

- (4) OK



MKI

Sija aprēķins

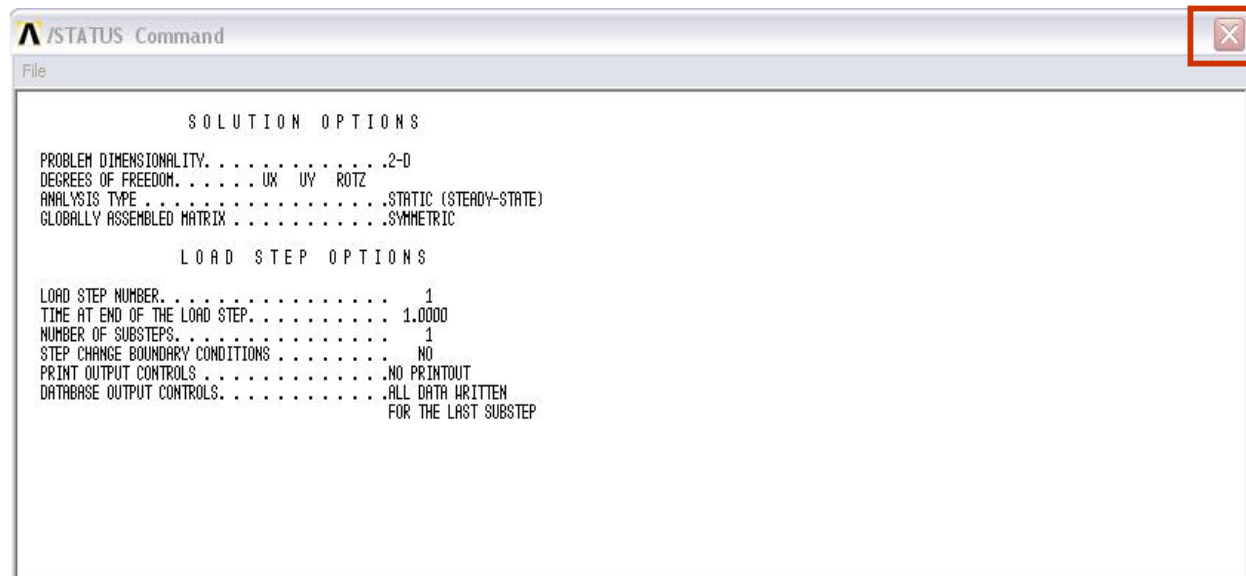


(1) Preprocessor/
Solution/
Solve/
Current LS/

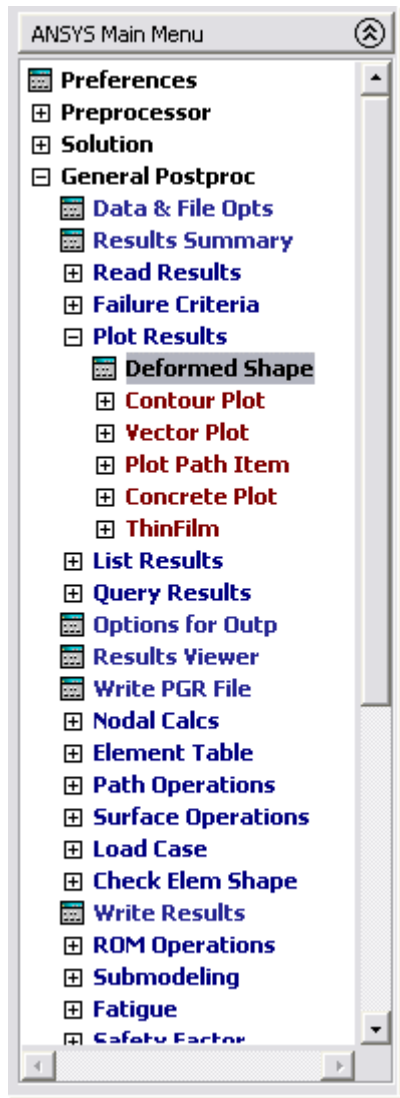


(2) Close

(3) Close

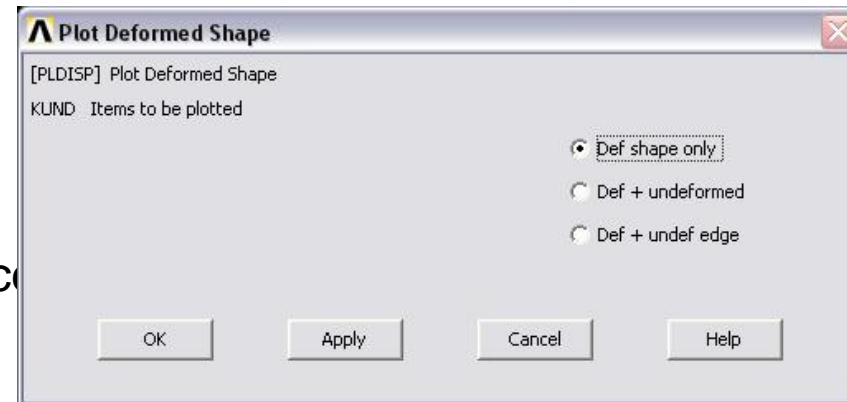


Sijas deformētā stāvokļa grafiska izveide



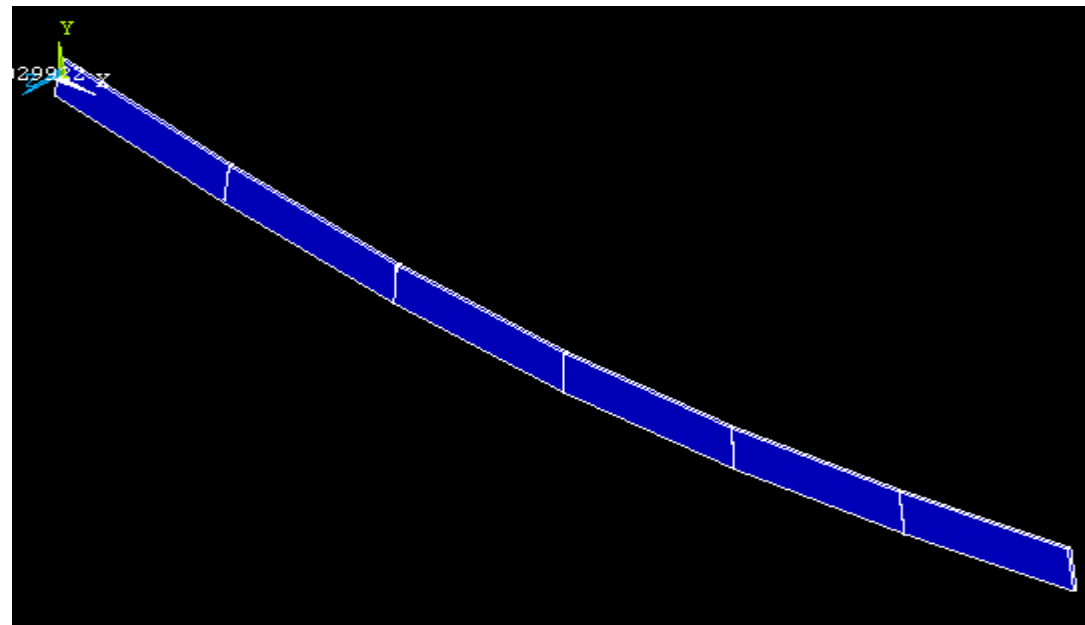
(1) General Postproc/
Plot Results/
Deformed Shape/

(1) General Postproc/
Plot Results/
Control Plot/
Nodal Solu/

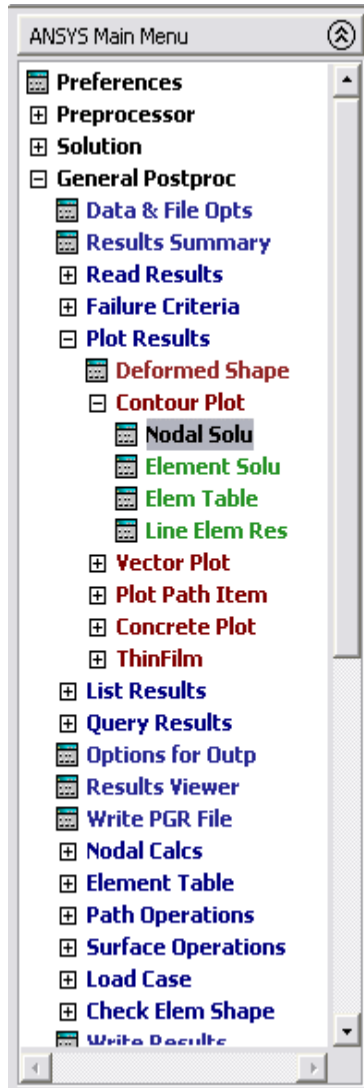


(2) Def shape only

(3) OK



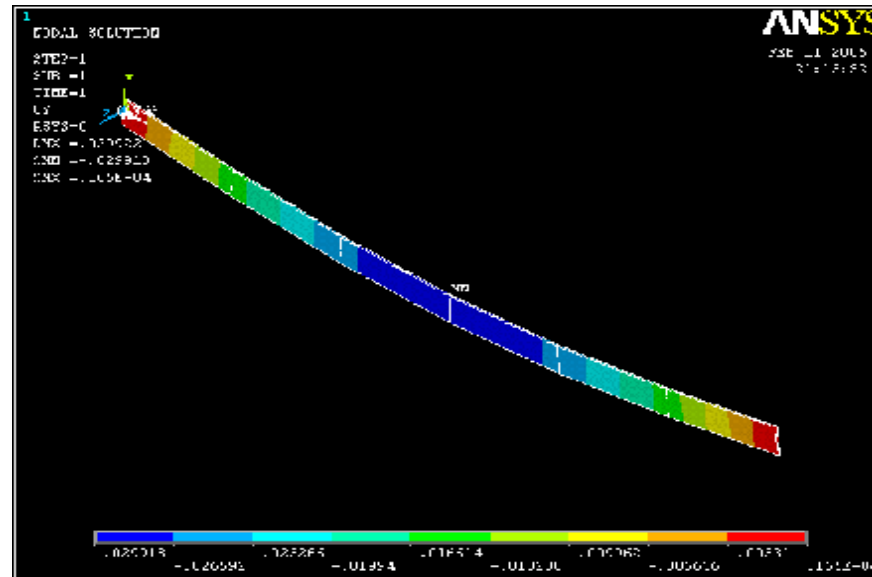
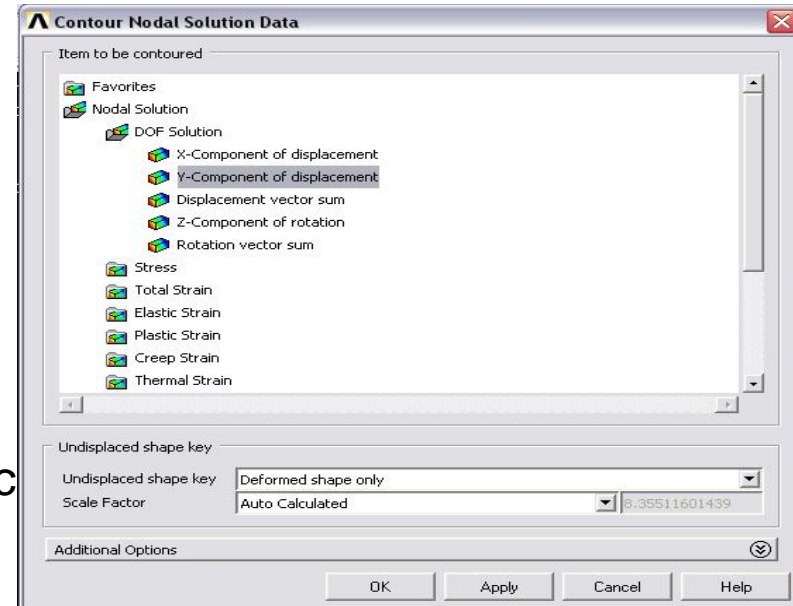
Sijas pārvietojumi Y-ass virzienā grafiska izveide



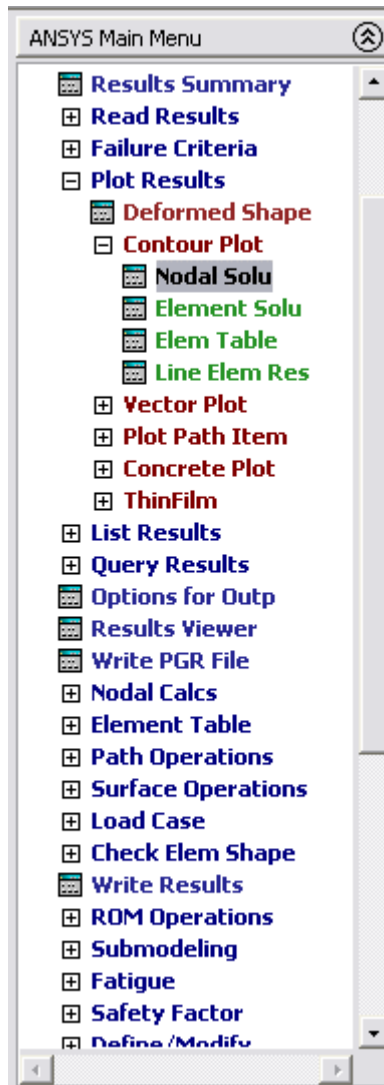
(1) General Postproc
Plot Results/
Control Plot/
Nodal Solu/

(2) Nodal Solution
DOF Solution
Y-Components of displac

(3) OK



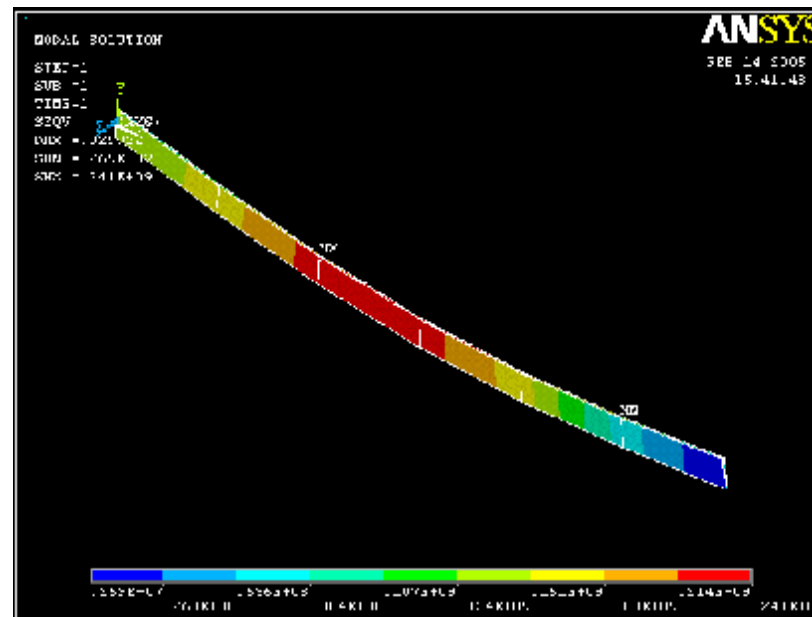
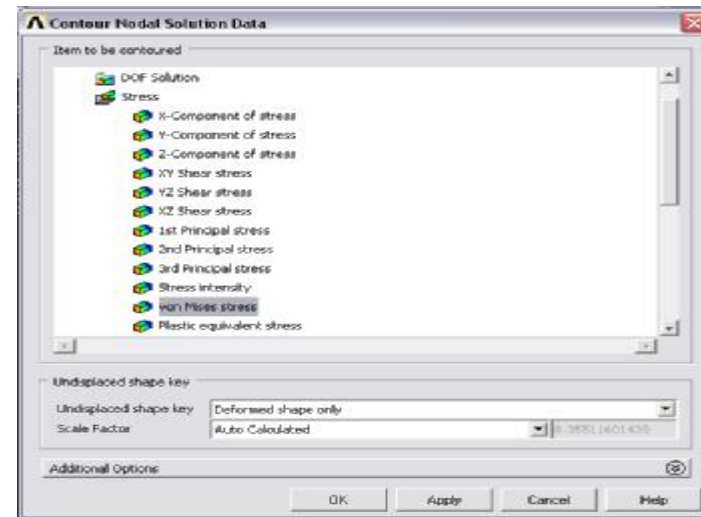
Ekvivalento spriegumu sadalījumu sijā grafiska izveide



(1) General Postproc
Plot Results/
Contour Plot/
Nodal Solu/

(2) Nodal Solution
DOF Solution
Stress
von Mises stress

(3) OK



Elementa BEAM 3 – piepūļu skaitlisko vērtību definēšana

ANSYS Release 9.0 Documentation

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BEAM3
2-D Elastic Beam

BEAM3 Element Description

BEAM3 is a uniaxial element with tension, compression, and bending about the z-axis at each node: translations in the nodal x and y directions, and rotation about the z-axis. For more details about this element see the [Element Reference](#) for more details about this element [unsymmetric beam \(BEAM54\)](#).

Figure 3.1 BEAM3 Geometry

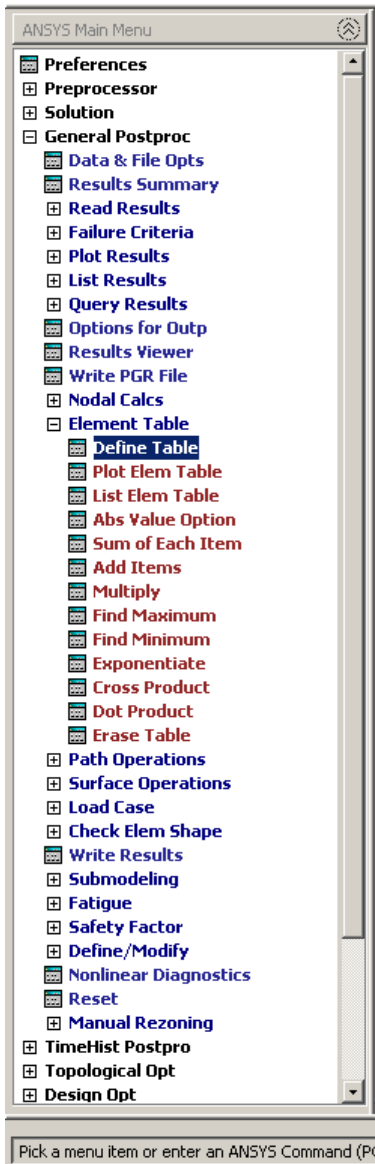
BEAM3 Input Data

Figure 3.1: "BEAM3 Geometry" shows the geometry defined by two nodes, the cross-sectional area in the element (ISTRN) is given by Δ/L , where Δ is the cross-sectional area and L is the length of the element, and the zero strain length. The initial cumulative iteration.

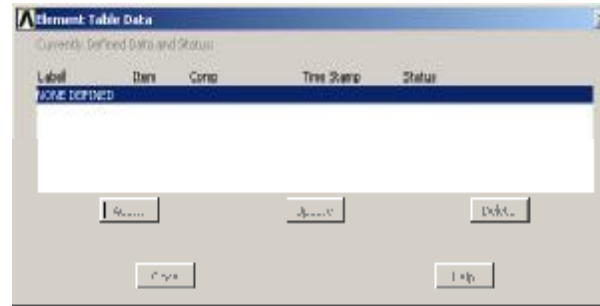
You can use the element in an axisymmetric analysis. The area and moment of inertia must be input on a full element. You can use a zero value of SHEAR STIFFNESS (CSK) if used only with shear deformation.

| 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 |
| EPTBYT | LEPTH | - | 2 | 5 |
| EPTBYB | 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 |

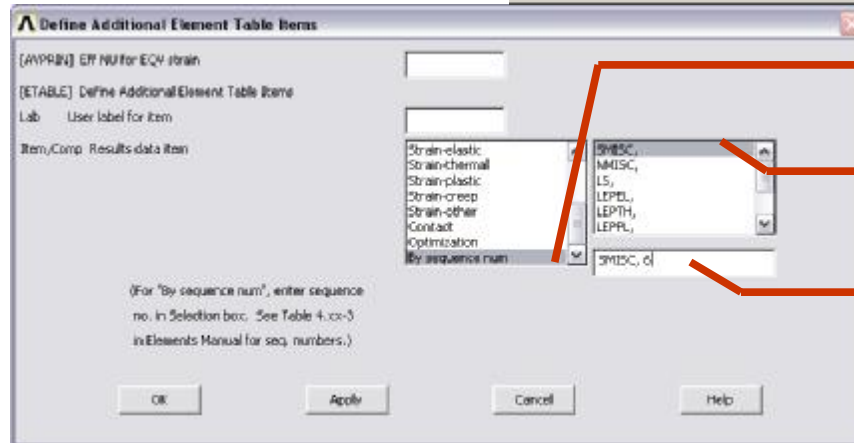
Momenta piepūļu skaitlisko vērtību definēšana



(1) General Postproc/
Element Table/
Define Table/



(2) Add..

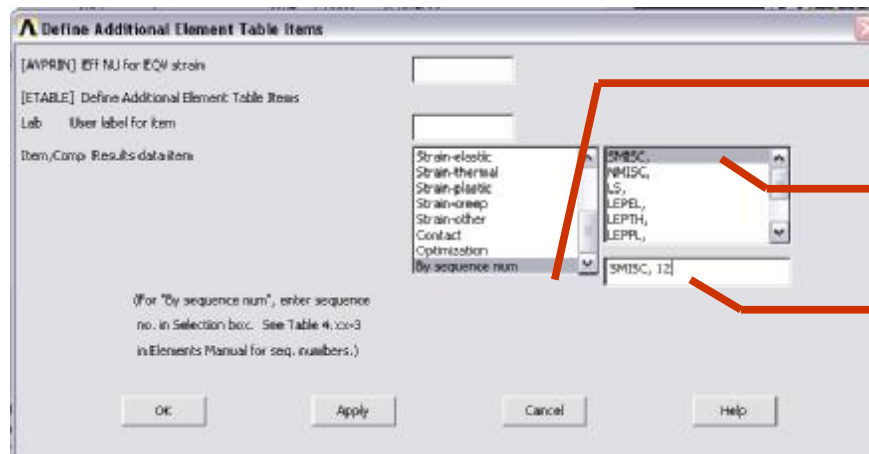


(3) By sequence num

SMISC

6

Apply



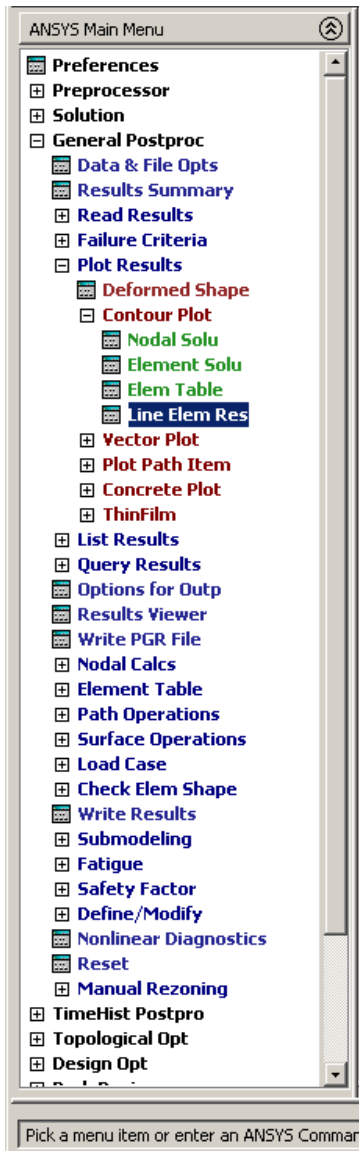
(4) By sequence num

SMISC

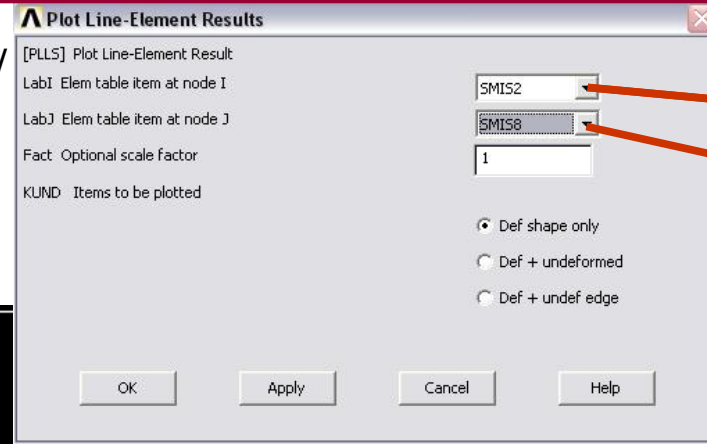
12

OK

Momentu epīras grafiska izveide

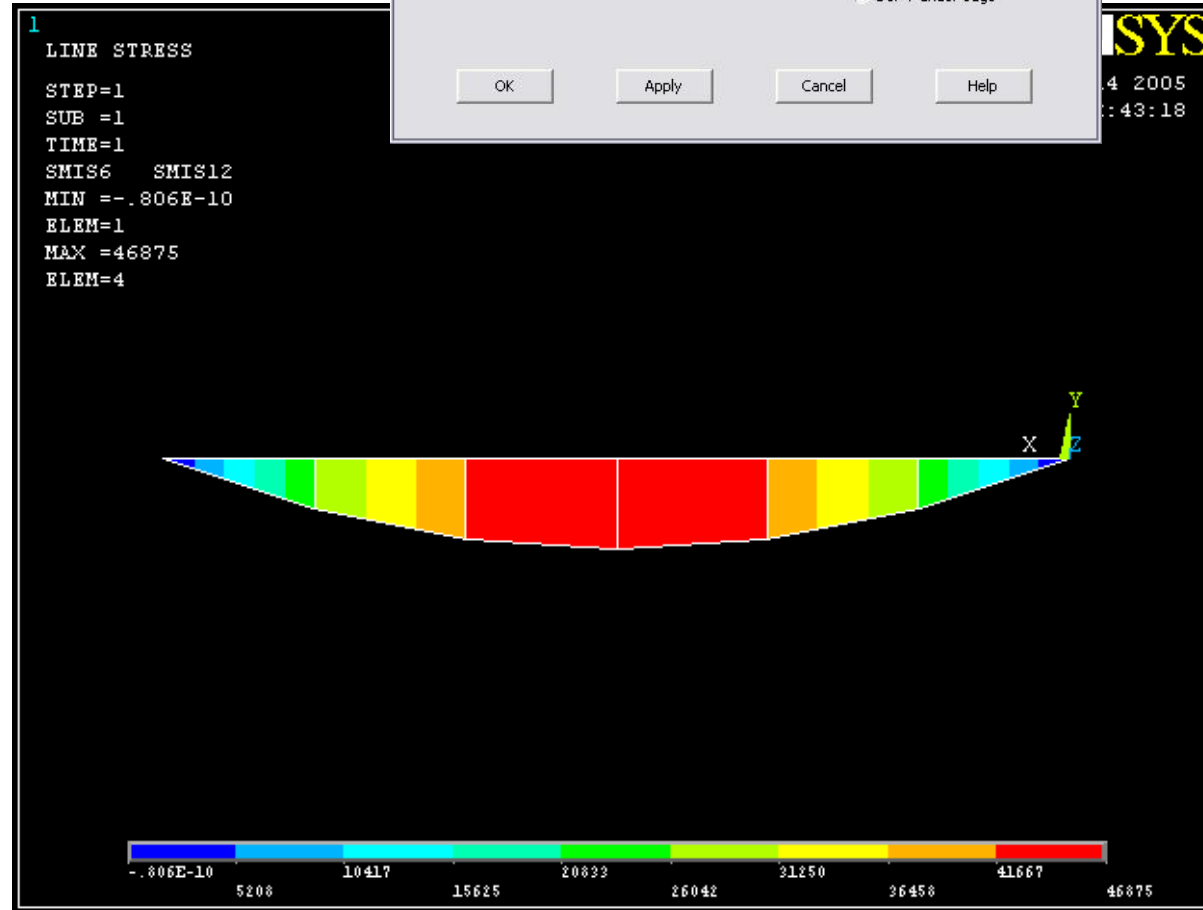


(1) General Postproc/
Plot Results/
Contour Plot/
Line Elem Res

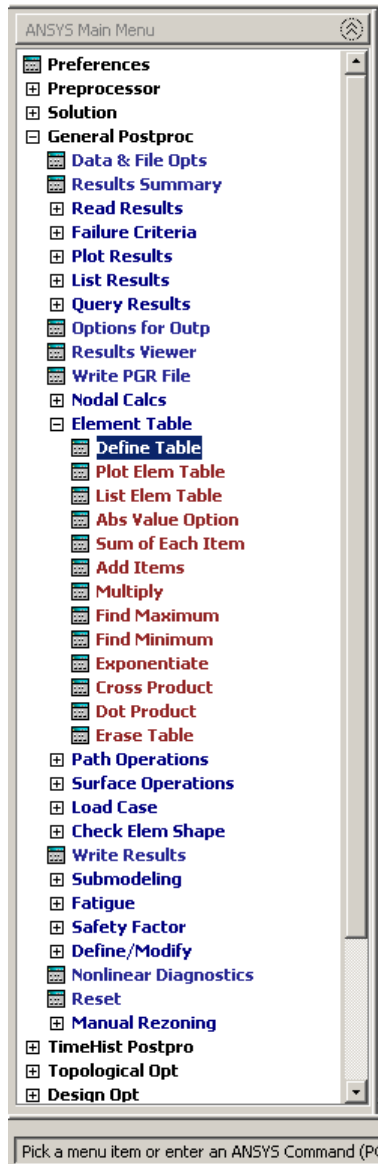


(2) SMIS6
SMIS12

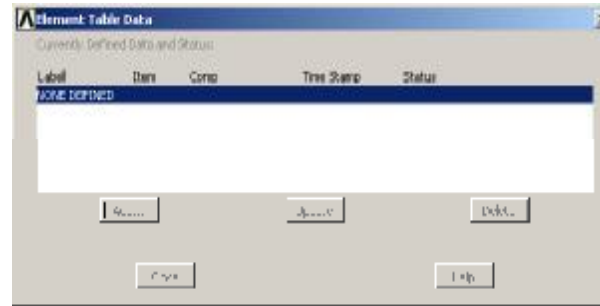
(3) Ok



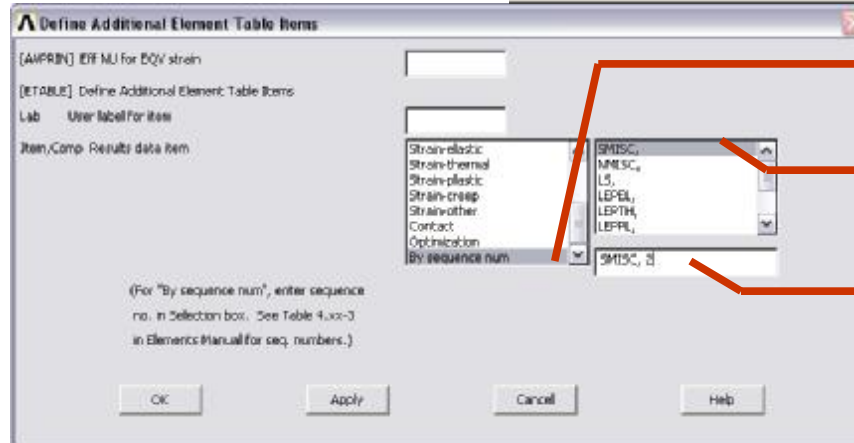
Šķērsspēka piepūļu skaitlisko vērtību definēšana



(1) General Postproc/
Element Table/
Define Table/



(2) Add..

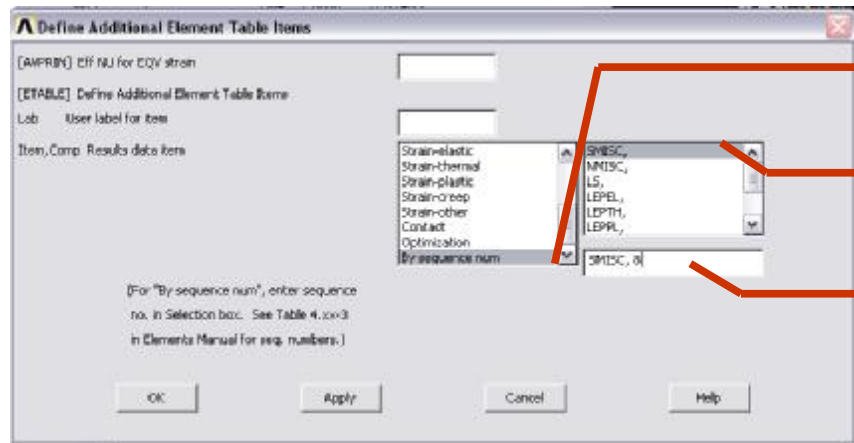


(3) By sequence num

SMISC

2

Apply



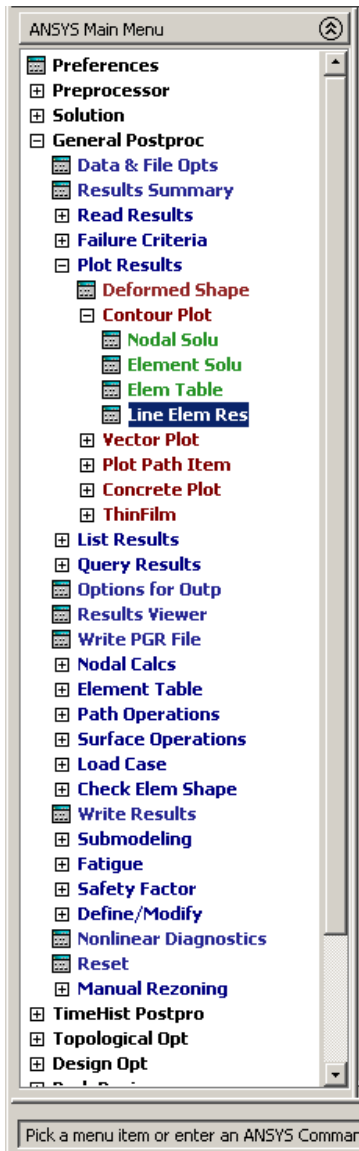
(4) By sequence num

SMISC

8

OK

Šķērsspēka epīras grafiska izveide

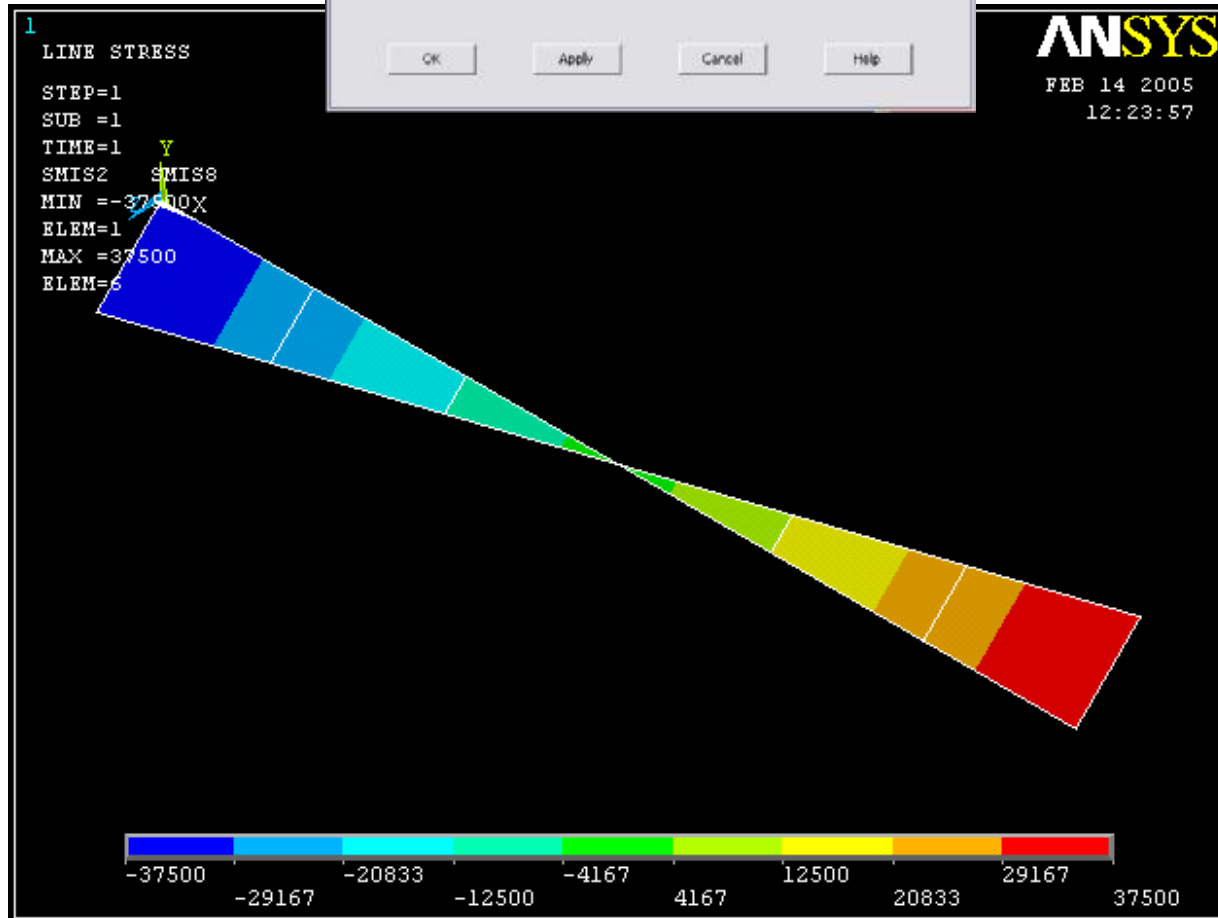


(1) General Postproc/
Plot Results/
Contour Plot/
Line Elem Res

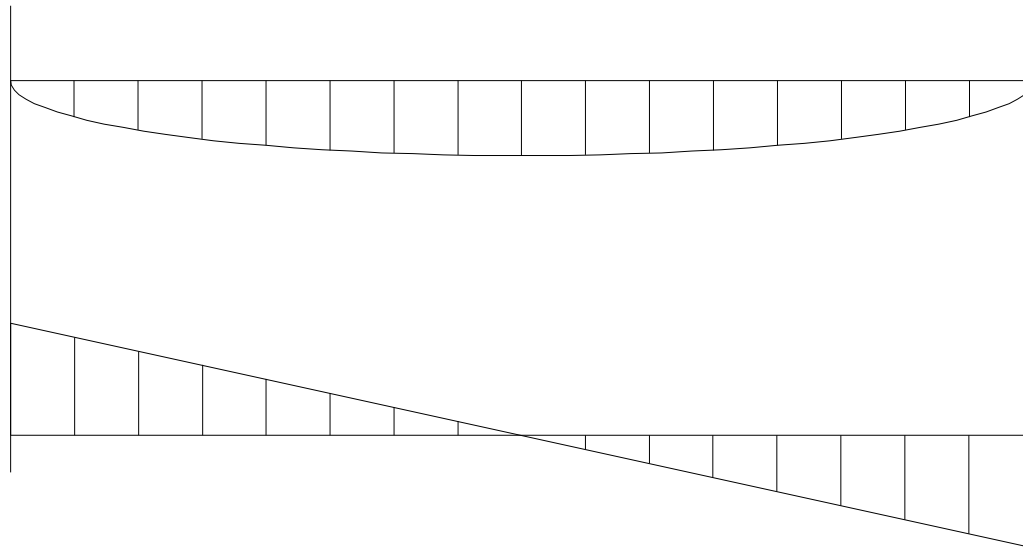
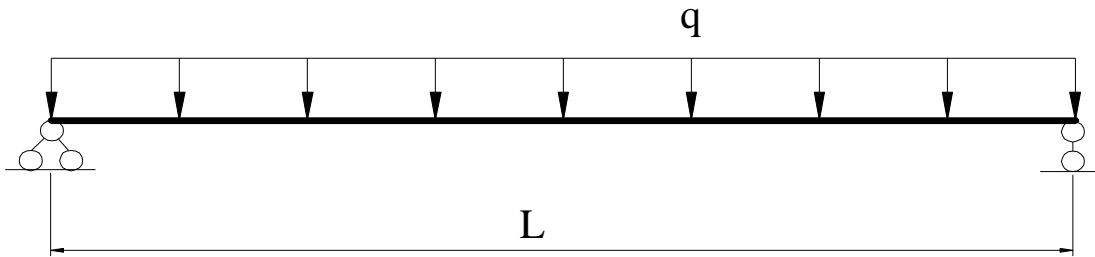


(2) SMIS2
SMIS8

(3) Ok



Sijas analītiskais aprēķins



$$M_{\max} = \frac{gl^2}{8} = \frac{15000 \cdot 25}{8} = 46875 [N \cdot m]$$

$$Q_{\max} = \frac{ql}{2} = \frac{15000 \cdot 5}{2} = 37500 [N]$$

$$d = w_{\max} = \frac{5qL^4}{384EI} = \frac{5 \cdot 15 \times 10^3 \cdot 5^4}{384 \cdot 2.1 \times 10^{11} \cdot 1943 \times 10^{-8}} = 0.0299 [m]$$

$$s = \frac{M}{W} = \frac{46875}{194.3 \times 10^{-6}} = 241.2 \times 10^6 [Pa]$$

Rezultātu salīdzināšana

| | UY [m] | M [Nm] | Q [N] | $\sigma \times 10^6$ [Pa] |
|-----------------------|----------|----------|----------|---------------------------|
| Analītiskais aprēķins | 0.0299 | 46875 | 37500 | 241.2 |
| ANSYS | 0.0299 | 46875 | 37500 | 241 |
| $ \Delta $ [%] | 0 | 0 | 0 | 0.1 |

Log fail

```
!* Elementa tipa izvele
!*
ET,1,BEAM3
!*
!* Materiala ipasibu definesana (Pa)
!*
MPTEMP,,,,,,,,
MPTEMP,1,0
MPDATA,EX,1,,2.1e11
MPDATA,PRXY,1,,0.3
!*
!* Skersgriezuma parametru definesana (m)
!*
R,1,0.0028,1.943e-5,0.2, , ,
!*
!* Koordinatu mezglu punktu definesana
!*
K,1,0,0,0,
K,2,5,0,0,
!*
!* Koordinatu mezglu punktu svienosana ar taisnu liniju
!*
LSTR, 1, 2
!*
!* Dalijums galigos elementos
!*
LESIZE,ALL, , ,6, ,1, , ,1,
LMESH, 1
!*
!*
*/SHRINK,0
/ESHAPE,1.0
/EFACET,1
/RATIO,1,1,1
/CFORMAT,32,0
/REPLOT
!*
!* 3D skats
!*
/VIEW,1,1,1,1
/ANG,1
/REP,FAST
FLST,2,1,1,ORDE,1
FITEM,2,1
!*
!* Elementa nostiprinajuma definēšana (Mezglis Nr.1)
!*
/GO
D,P51X, , , , ,UX,UY, , , ,
FLST,2,1,1,ORDE,1
FITEM,2,2
!*
!* Elementa nostiprinajuma definēšana (Mezglis Nr.2)
!*
/GO
D,P51X, , , , ,UY, , , , ,
FLST,2,6,2,ORDE,2
FITEM,2,1
```

Log fail

```
!*  
!* Sijas slogošana  
!*  
FITEM,2,-6  
SFBEAM,P51X,1,PRES,15000,15000, , , , ,  
FINISH  
/SOL  
/STATUS,SOLU  
SOLVE  
!*  
!* Sijas aprekins  
!*  
FINISH  
/POST1  
PLDISP,0  
!*  
!* Parvietojumi pa Y asi  
!*  
/EFACET,1  
PLNSOL, U,Y, 0,1.0  
!*  
!* Momenta epīras  
!*  
/EFACET,1  
PLNSOL, S,EQV, 0,1.0  
AVPRIN,0, ,  
ETABLE, ,SMISC, 6  
!*  
AVPRIN,0, ,  
ETABLE, ,SMISC, 12  
!*
```

```
!*  
PLLS,SMIS6,SMIS12,1,0  
!*  
!* Šķērspēķas epīras  
!*  
AVPRIN,0, ,  
ETABLE, ,SMISC, 2  
!*  
AVPRIN,0, ,  
ETABLE, ,SMISC, 8  
!*  
!*  
PLLS,SMIS2,SMIS8,1,0
```