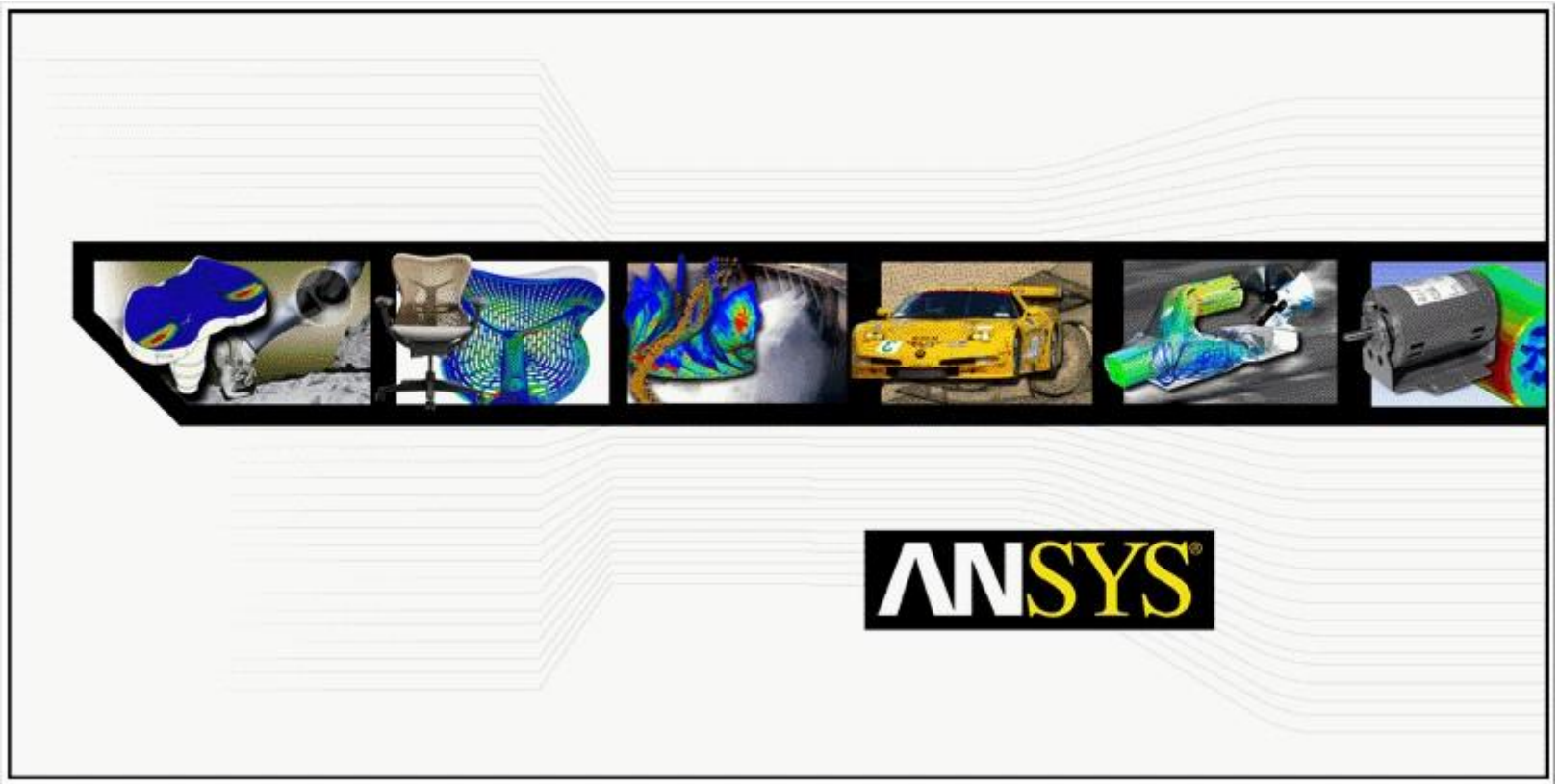
Uzdevums: 3D- sijas elements Beam 189

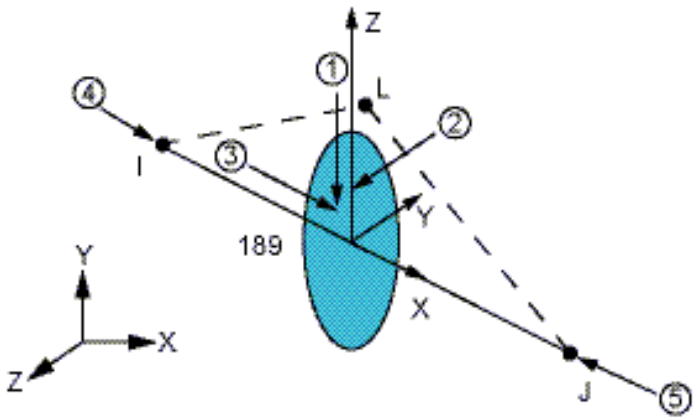
Programma: ANSYS 9

Autori: E. Skuķis



ANSYS elements: Beam 189, 3-D Quadratic Finite Strain Beam

Beam 189 ģeometrija



Mezgli
- I, J, K, L (L, orientācijas mezgls)

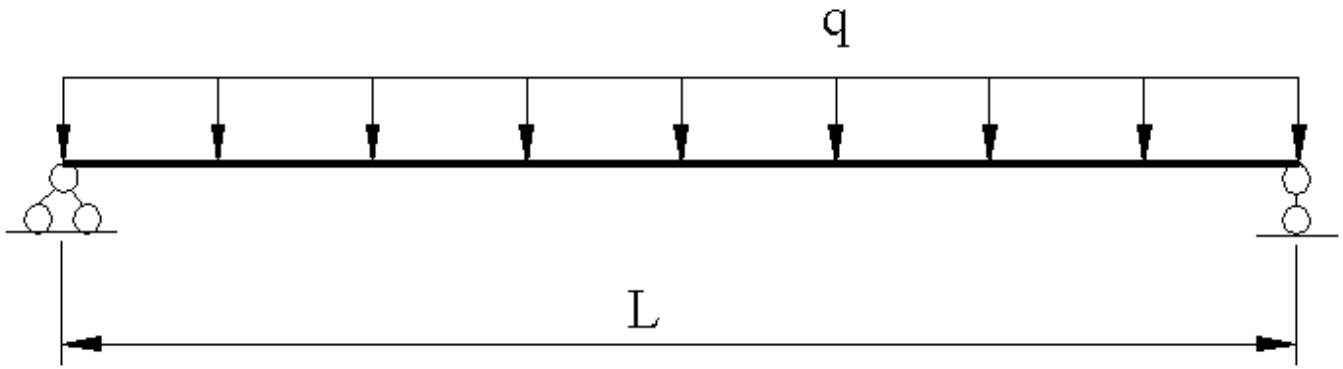
Brīvības pakāpes
- UX, UY, UZ, ROTX, ROTY, ROTZ

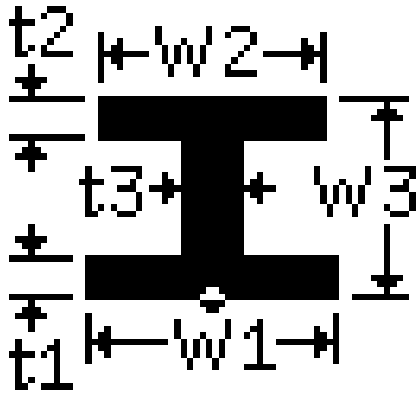
Materiāla īpašības
- EX, (PRXY or NUXY), ALPX, DENS,
- GXY, GYZ, GXZ, DAMP

Slodzes
- Vienmērīgi izkliedētas slodzes
  - konstante **1** (I-J) (-z normāles virzienā),
  - konstante **2** (I-J) (-y normāles virzienā),
  - konstante **3** (I-J) (+x perpendikulārā virzienā),
  - konstante **4** (J) (+x ass virzienā),
  - konstante **5** (I) (-x virzienā).

Papildus iespējas
- Materiāla plasticitāte
- Materiāla viskoelastība
- Materiāla šļūde
- Lielas deformācijas elementā
- Lieli relatīvie pārvietojumi elementā
- Iepriekš saspriegtu konstrukciju modelēšana

Dubult-T šķērsgriezuma profils GOST 8239-89 Nr.20





L	=	5	[m]
q	=	15	[kN/m]
W1	=	0.1	[m]
W2	=	0.1	[m]
W3	=	0.2	[m]
t1	=	0.008	[m]
t2	=	0.008	[m]
t3	=	0.0055	[m]

ANSYSA uzdevuma konstanšu definēšana

L = 5 Enter

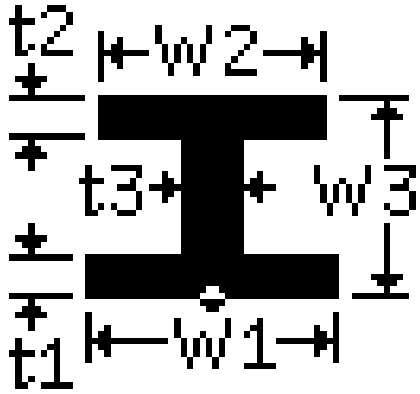
q = 15000 Enter

W1 = 0.1 Enter

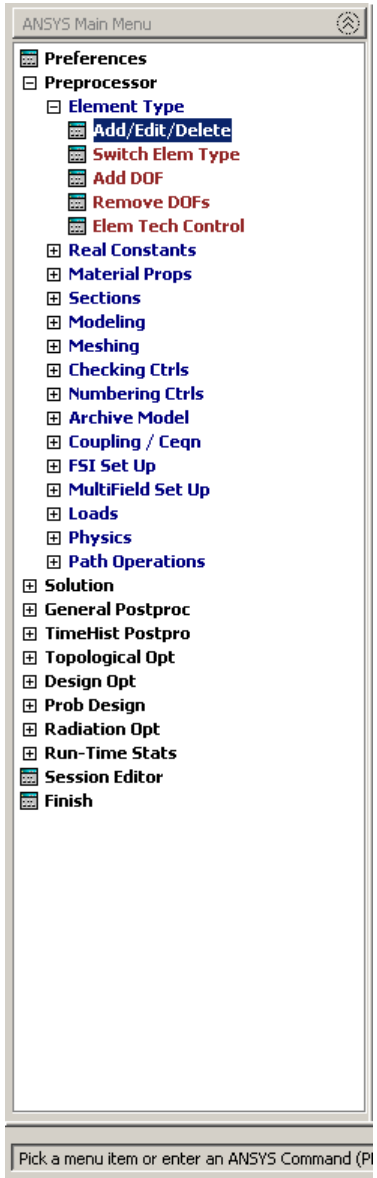
W3 = 0.2 Enter

t1 = 0.008 Enter

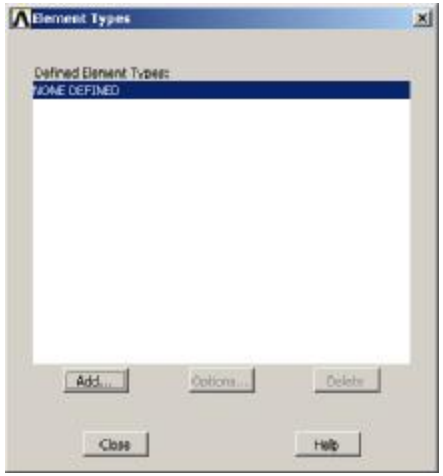
t3 = 0.0055 Enter



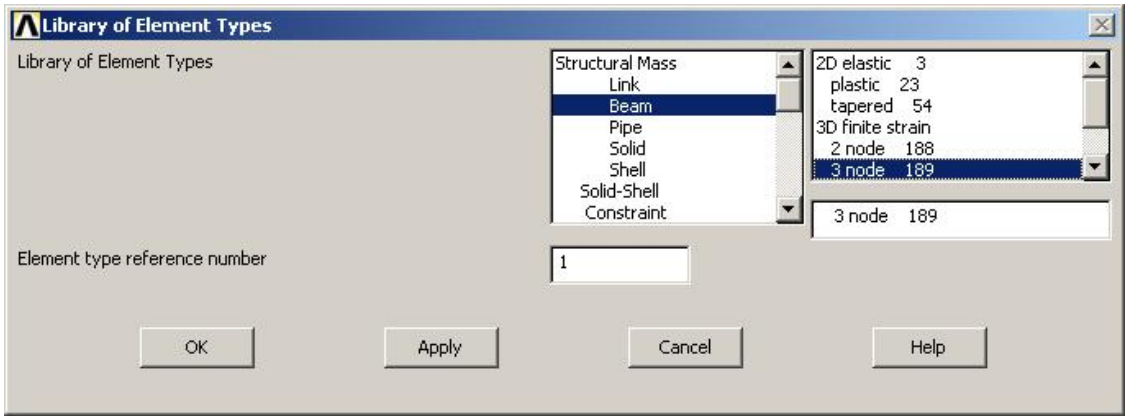
Elementa tipa definēšana – BEAM 189



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



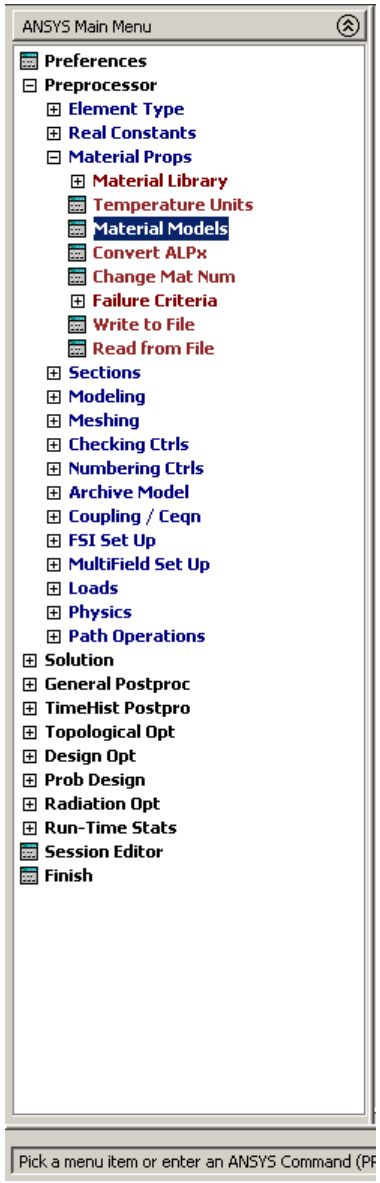
(2) Add...



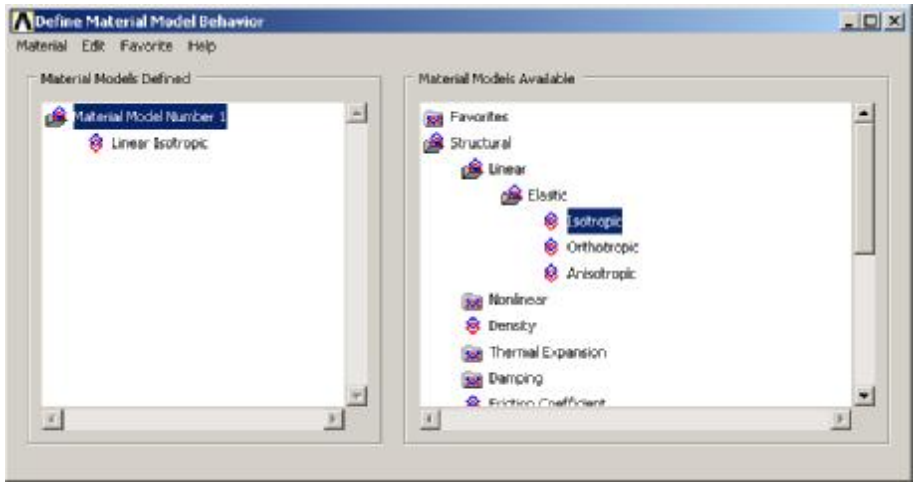
(3) Beam
3 node 189

(4) OK

Materiāla īpašību definēšana

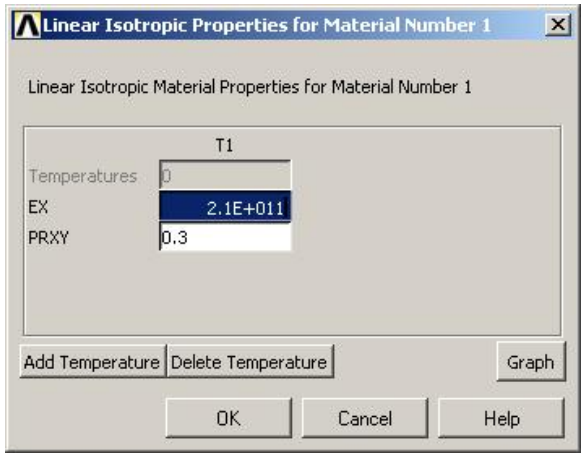


(1) Preprocessor/
Material Props/
Material Models



(2) Material Model Number

Structural
Linear
Elastic
Isotropic

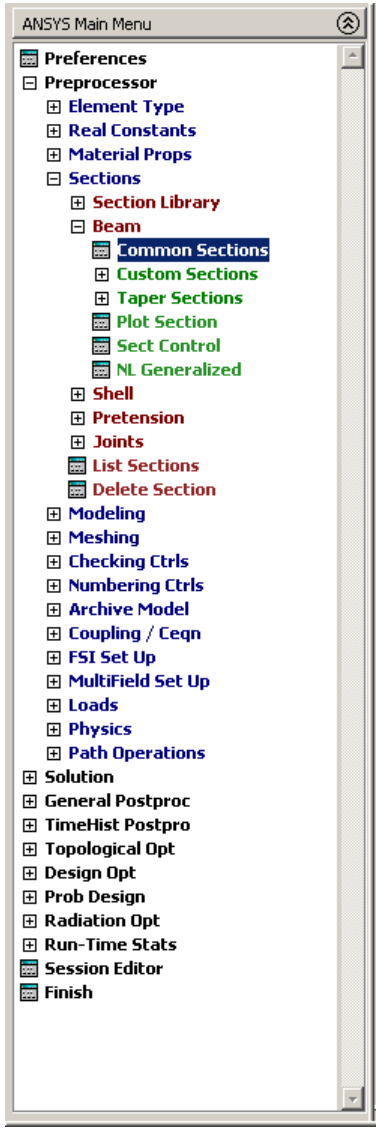


(3) Ex = 2.1E+011 [Pa] *Elastības modulis*

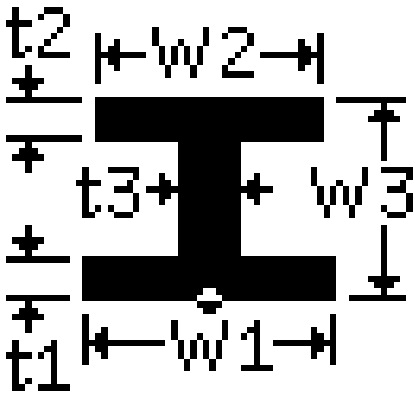
PRXY = 0.3 *Puasona koeficients*

OK

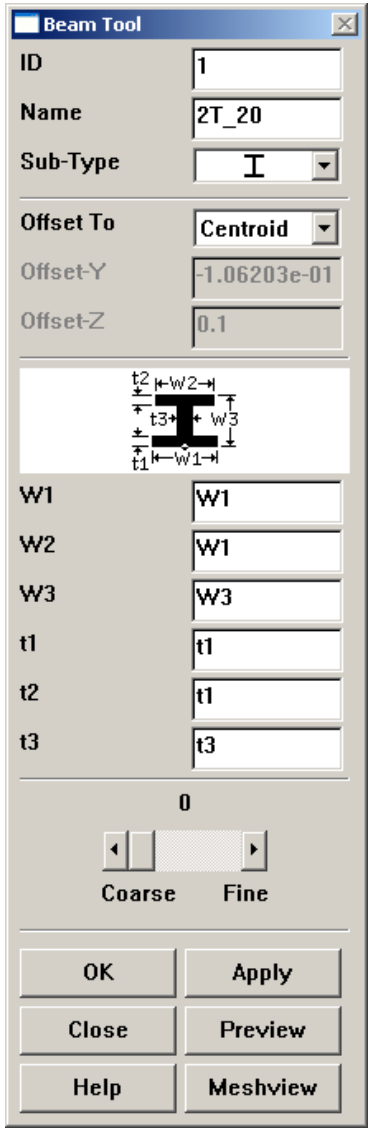
Šķērsgriezuma profila definēšana



(1) Preprocessor/
Sections/
Beam/
Common Sections/



P.S. Šķērsgriezuma papildus dalījums galīgos elementos *lokālu problēma aprēķinos*

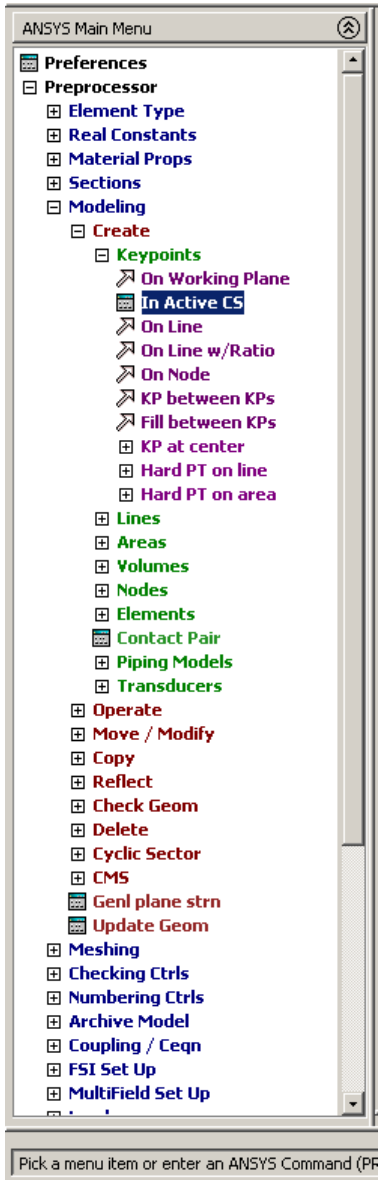


(2)

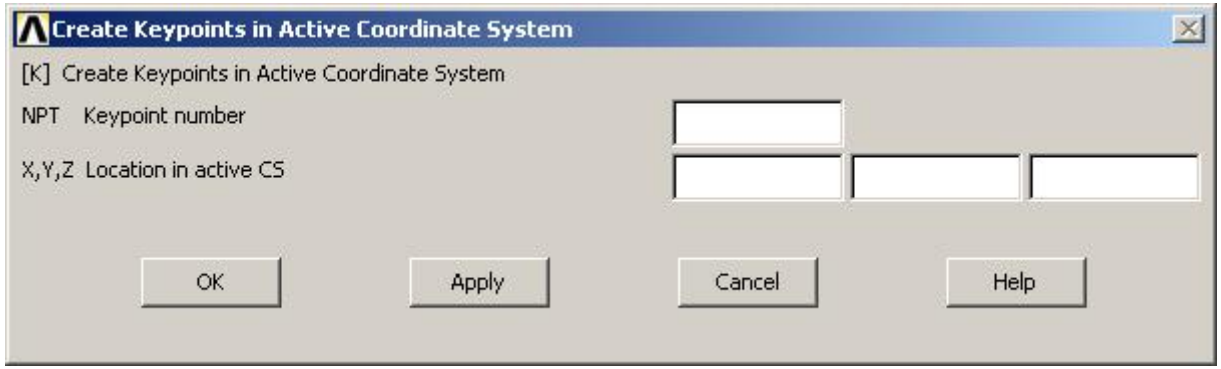
ID	1
Name	2T_200
Sub-Type	I
W1	W1
W2	W1
W3	W3
t1	t1
t2	t1
t3	t3

OK

Koordinātu mezglu definēšana



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

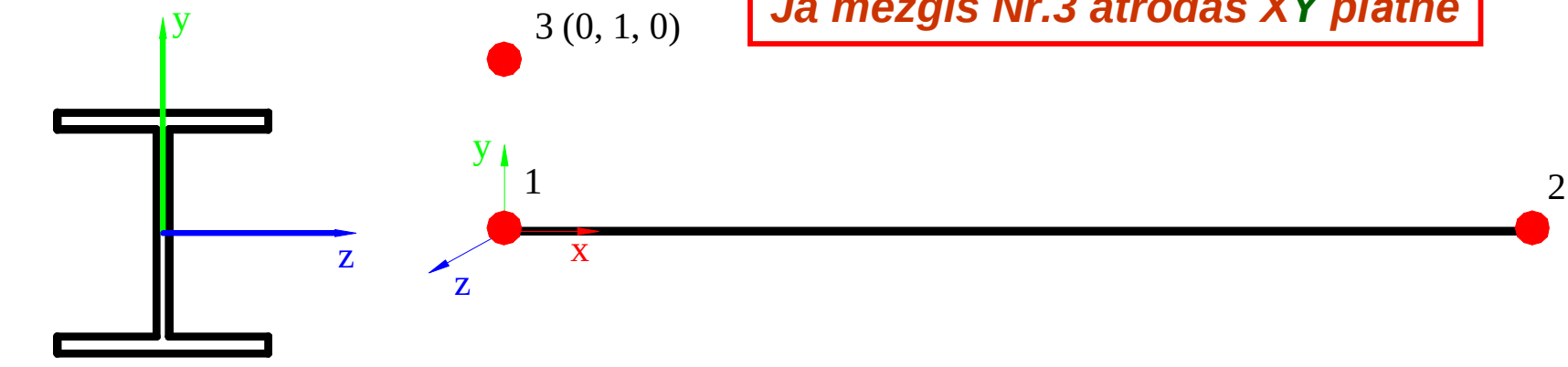


(2)

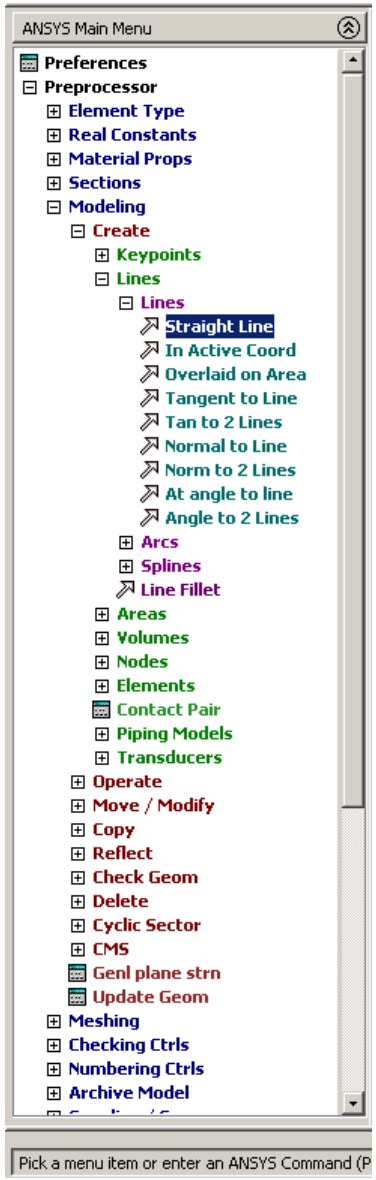
NPT	X,	Y,	Z	
1	0	0	0	Apply
2	L	0	0	Apply
3	0	1	0	OK

P.S. *Mezglu Nr.3 izmanto šķērsgriezuma profila orientācijai*

Šķērsgriezuma profila orientēšana

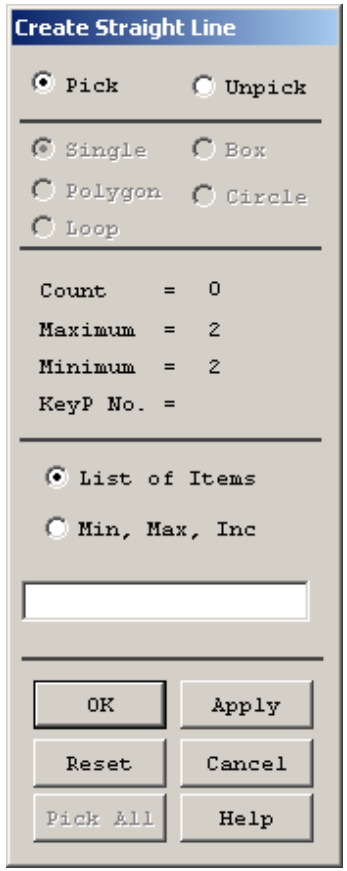


Līniju definēšana



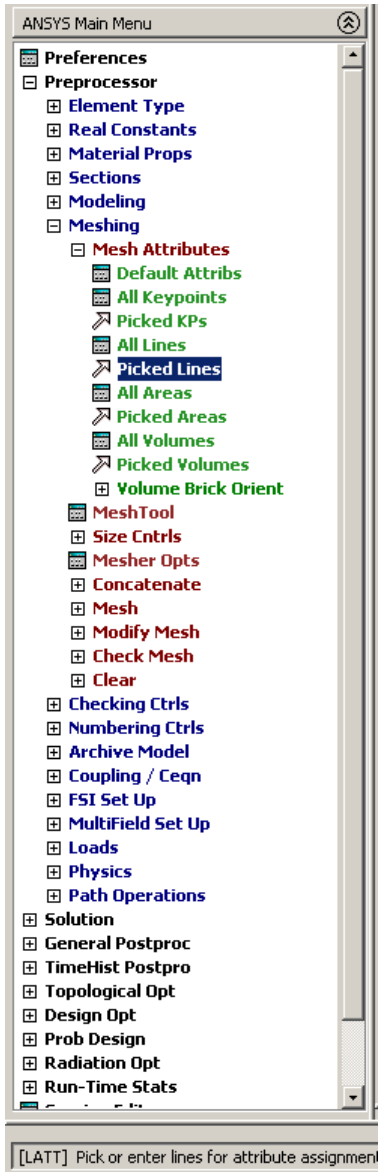
(1) Preprocessor/
Modeling/
Create/
Lines/
Lines/
Straight Line

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

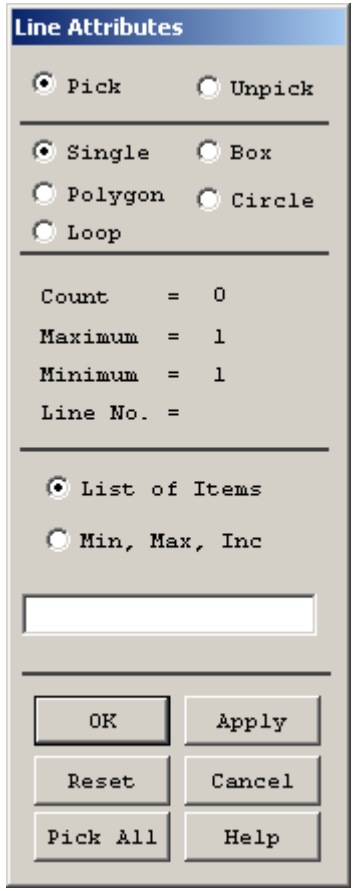


(3) OK

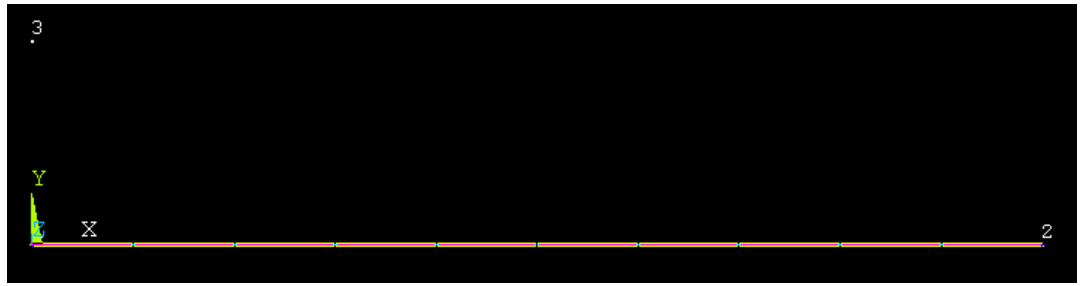
Elementa tipa piesaiste konkrētam ģeometriskam modelim



(1) Preprocessor/
Meshing/
Mesh Attributes/
Picked Lines/

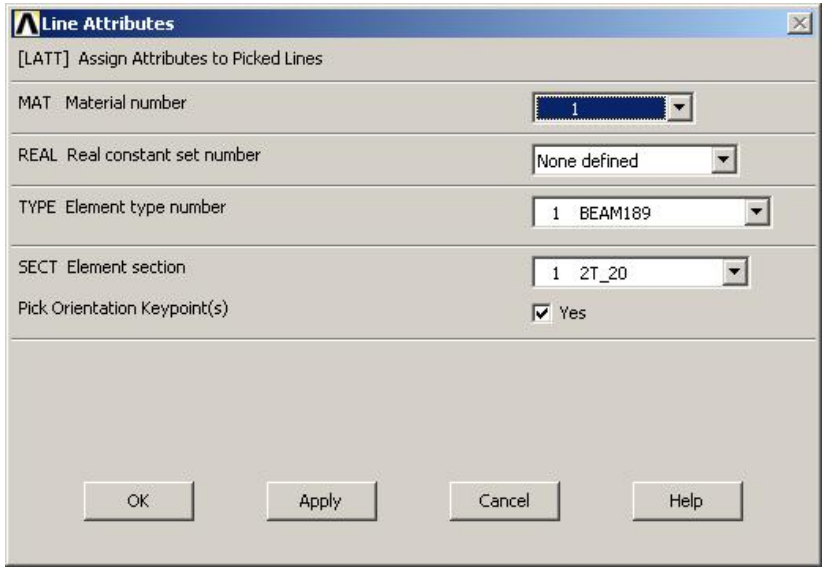


(2) Picked lines - Iezīmēt līniju



(3) OK

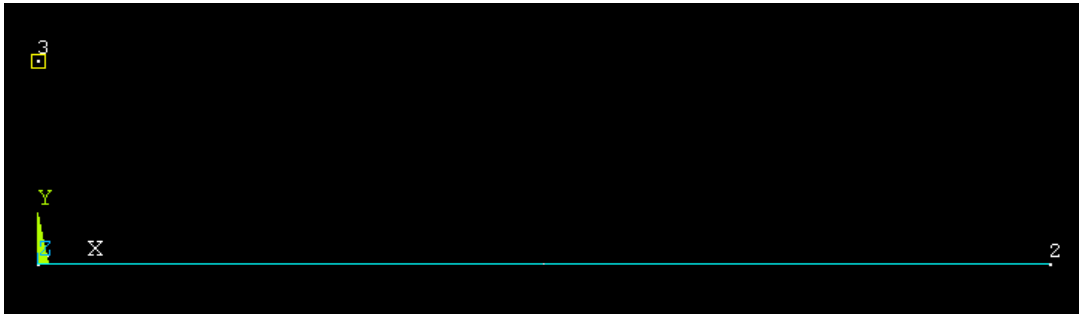
Elementa tipa piesaiste konkrētam ģeometriskam modelim



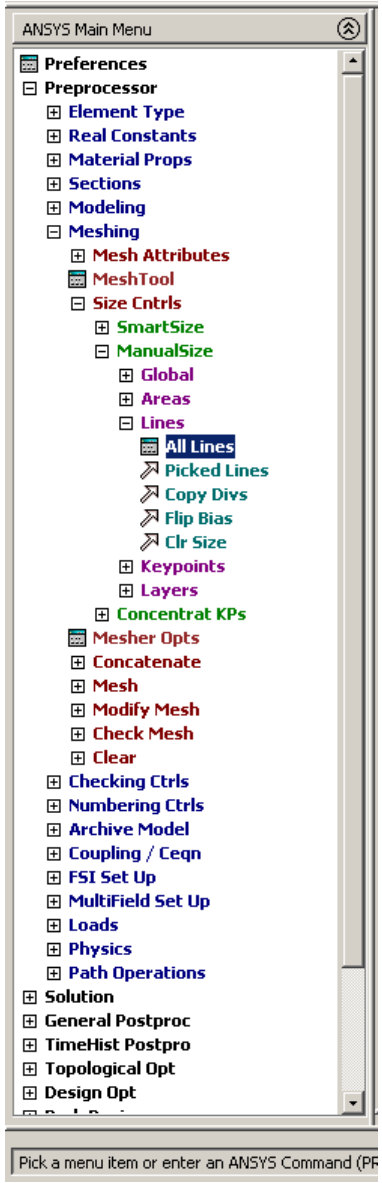
(1) Pick Orintation Keypoint(s) **Yes**

Atzīmēt koordinātu mezglu punktu Nr.3 tādejādi definējot šķērsgriezuma profila orientāciju. Orientācijas mezgls nedrīkst būt piesaistīts pie definējamā elementa.

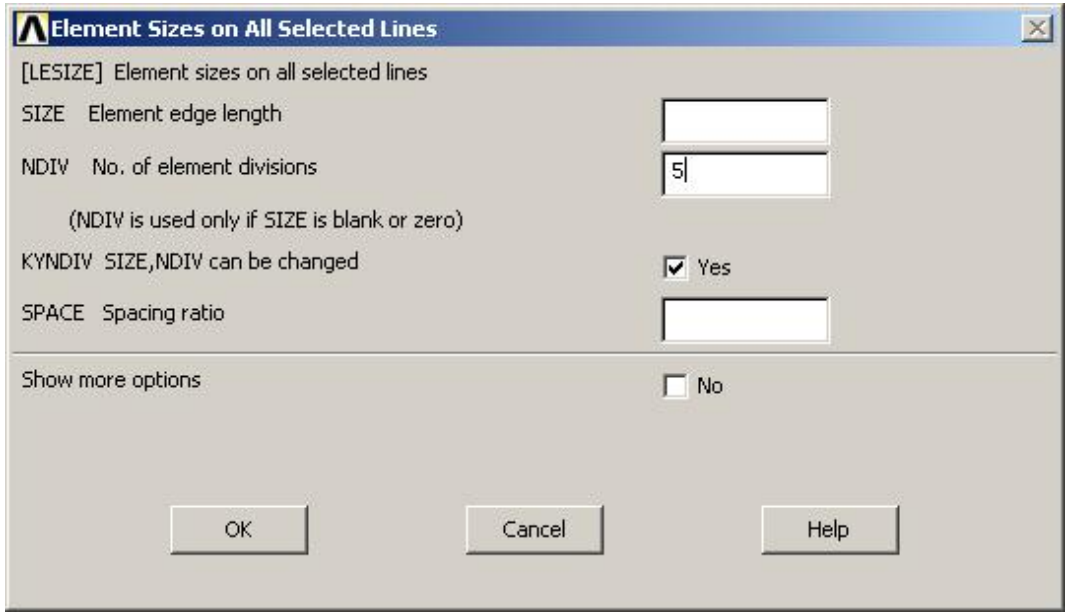
(2) OK



Galīgo elementu izmēru definēšana



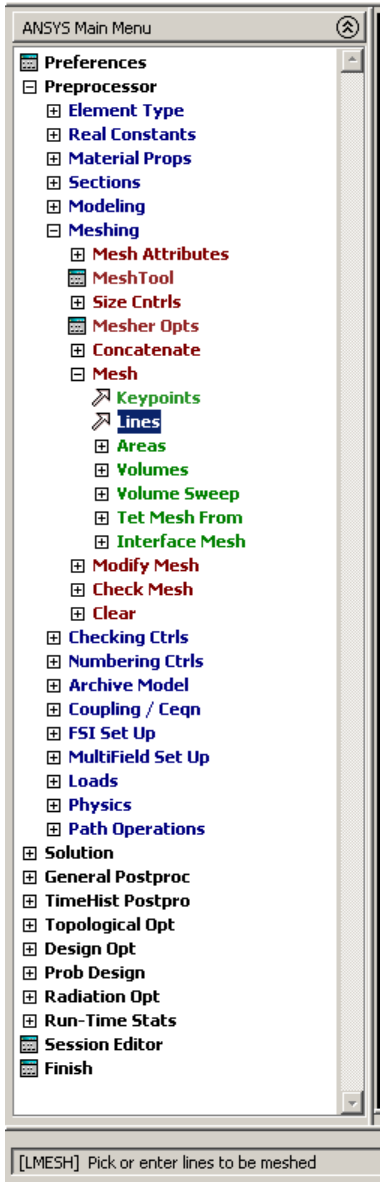
(1) Preprocessor/
Meshing/
Size Cntrls/
ManualSize/
Lines/
All Lines



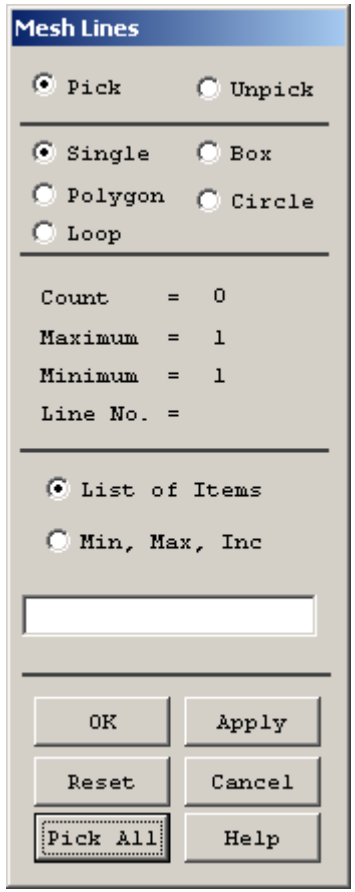
(2) NDIV 5
Elementa dalījums proporcionālās n daļās

(3) OK

Sijas dalījums galīgos elementos

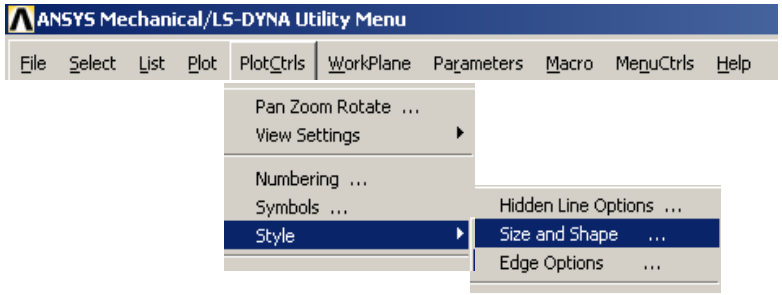


(1) Preprocessor/
Meshing/
Mesh/
Lines/

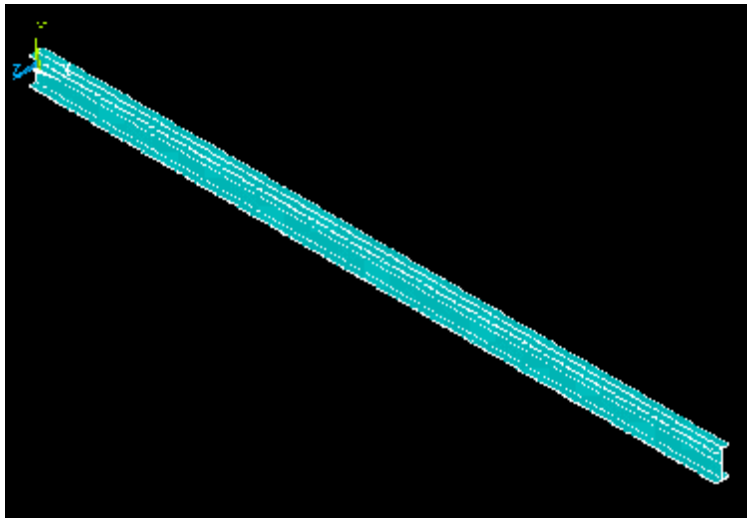


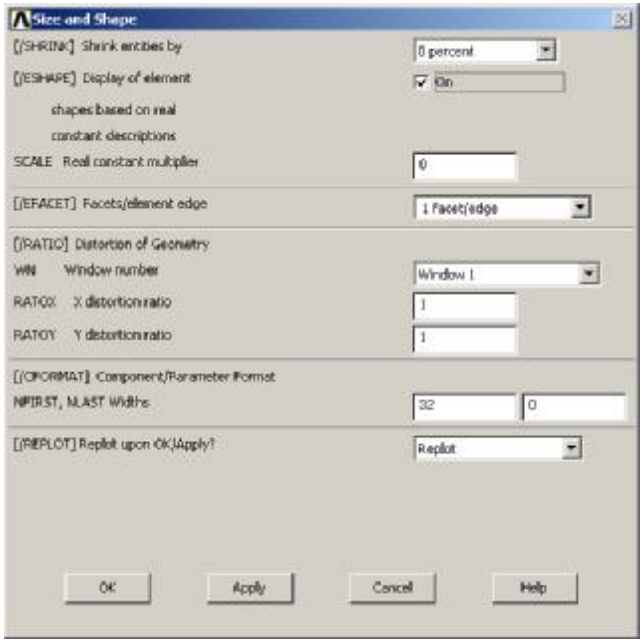
(2) Pick All

Sijas izometriskā skata izveide



(1) PlotCtrls/ Style/ Size and Shape/



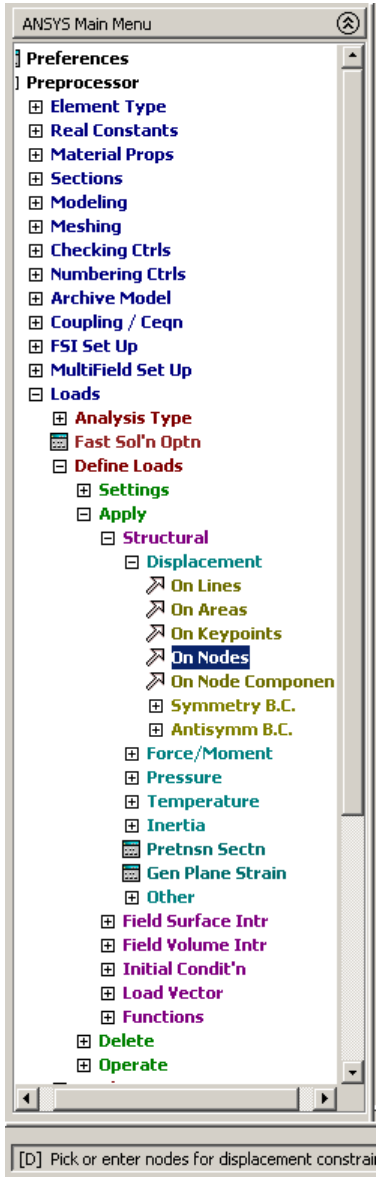


(2) Display of element
On

(3) OK

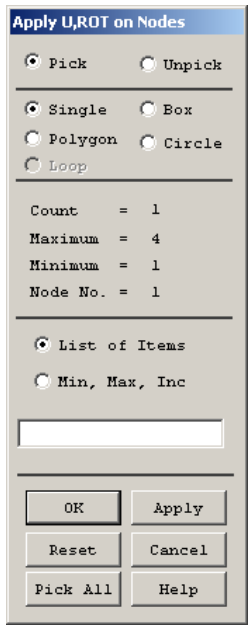
(4) OK

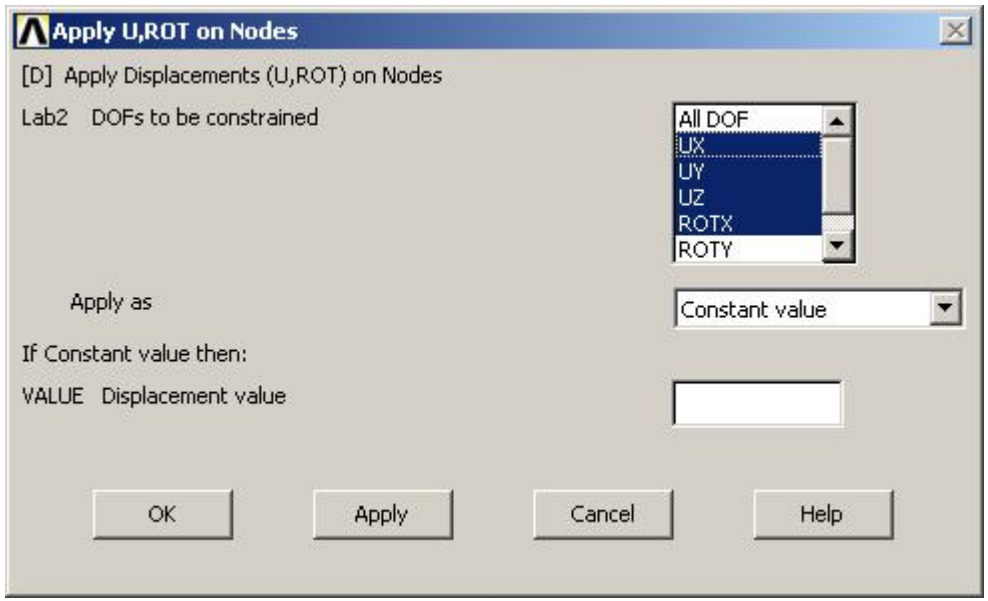
Elementa nostiprinājuma definēšana (*Mezgls Nr.1*)



(1) Preprocessor/
Loads/
Define Loads/
Apply/
Structural/
Displacement/
On Keypoints

(2) Iezīmēt punktu Nr.1



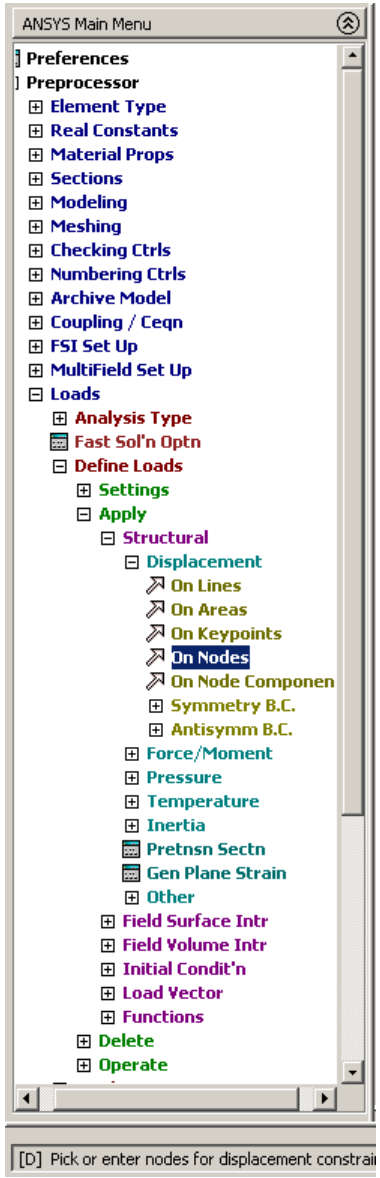


(3) OK

(4) UX, UY, UZ, ROTX

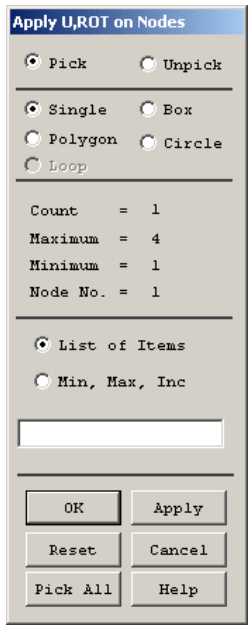
(5) Apply

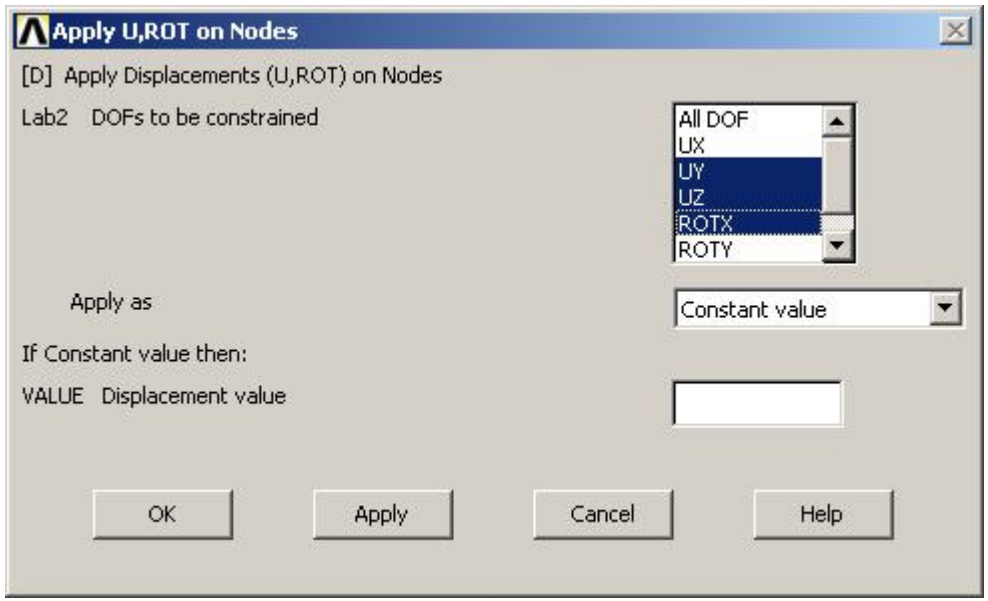
Elementa nostiprinājuma definēšana (*Mezgls Nr.2*)



(1) Preprocessor/
Loads/
Define Loads/
Apply/
Structural/
Displacement/
On Keypoints

(2) Iezīmēt punktu Nr.2



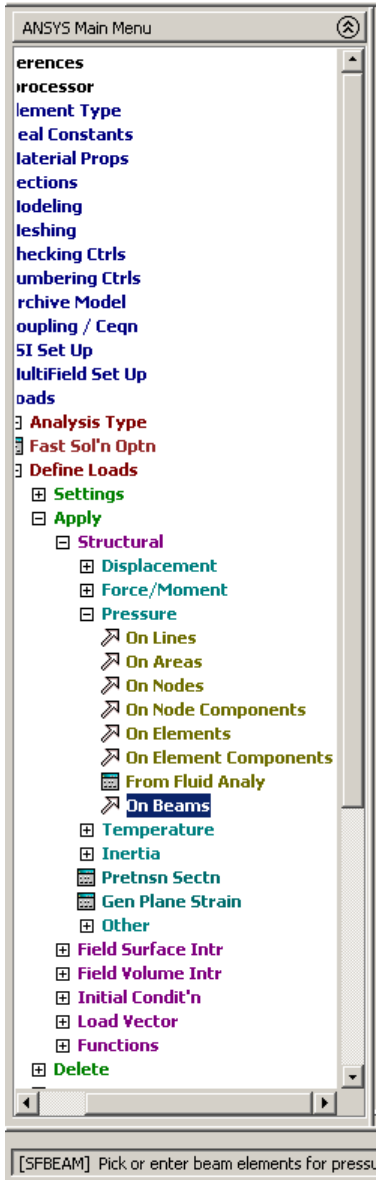


(3) OK

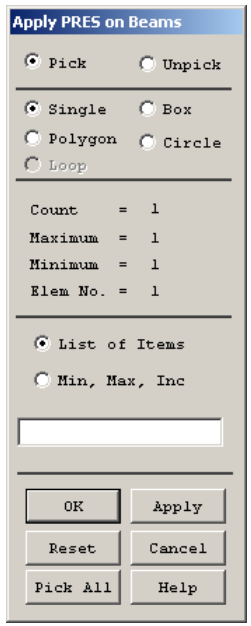
(4) UY, UZ, ROTX

(5) OK

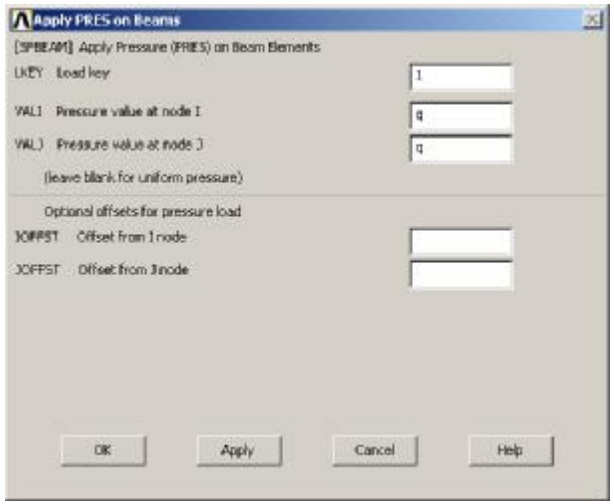
Sijas vienmērīgi izkliedētas slodzes definēšana



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

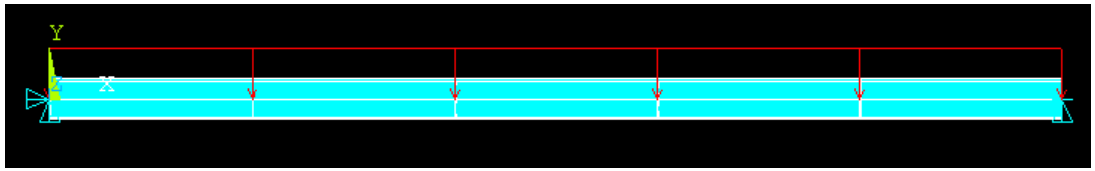


(2) Pick All

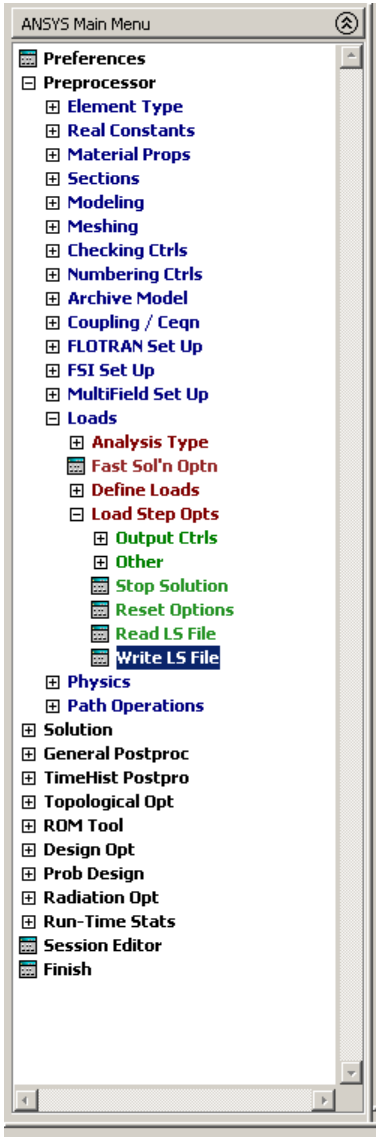


(3) LKEY = 1
VALI = q [N/m]
VALJ = q [N/m]

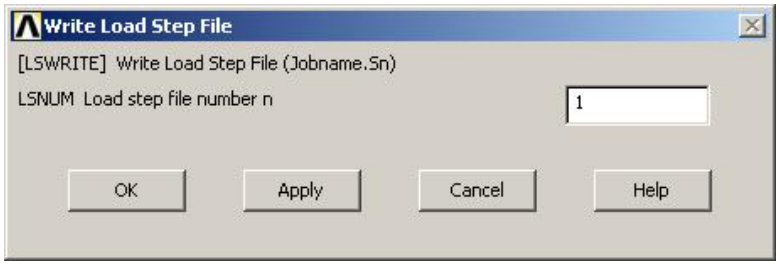
(4) OK



Uzdevuma aprēķina shēmas izveide un aprēķins



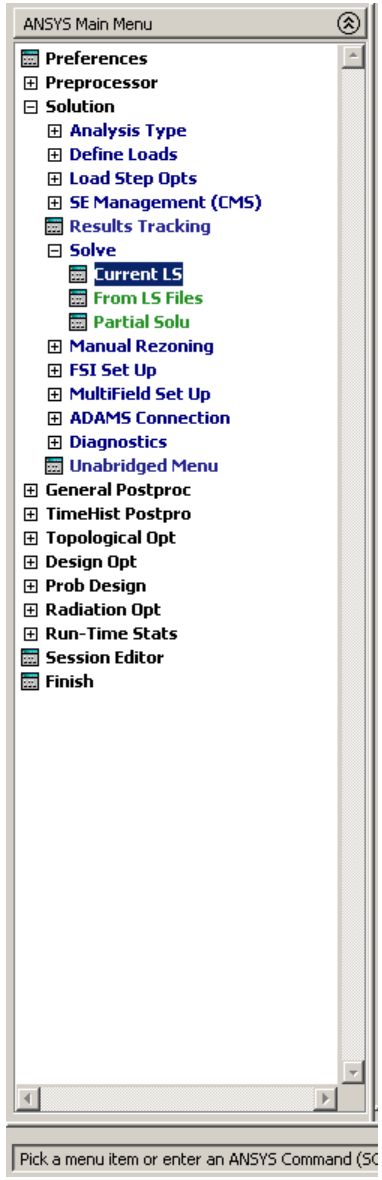
(1) Preprocessor/
Loads/
Load Step Opts/
Write LS File/



(2) LSNUM 1
OK

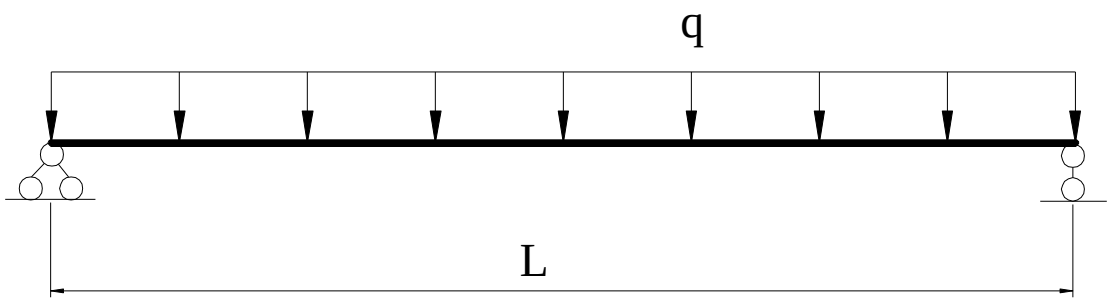
(3) Preprocessor/
Loads/
Load Step Opts/
Read LS File/

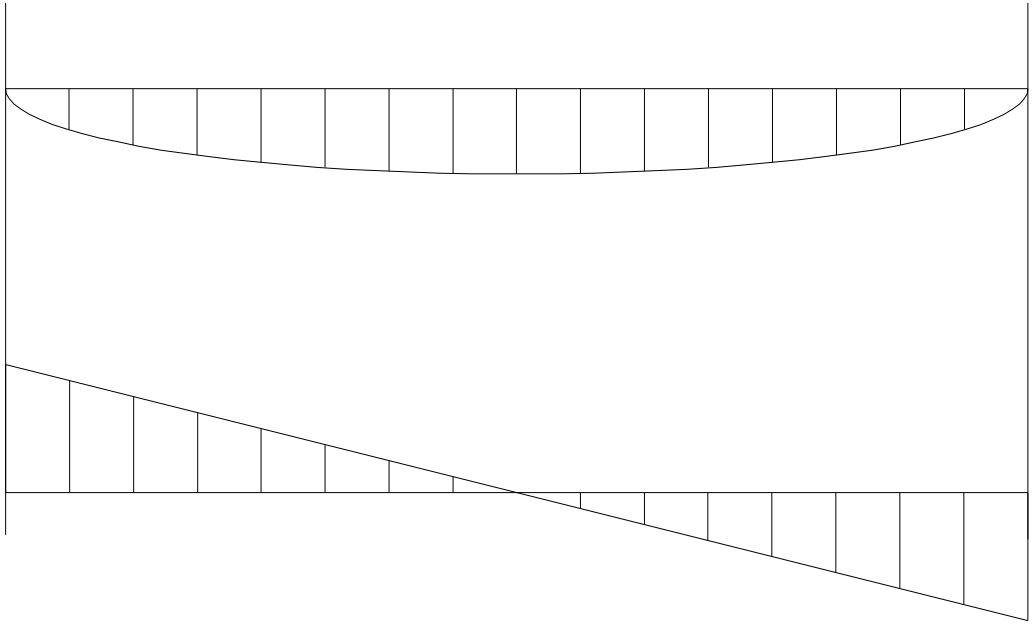
(3) LSNUM 1
OK



(5) Solution/
Solve/
Current LS/

Sijas piepūļu un pārvietojumu analītiskais aprēķins



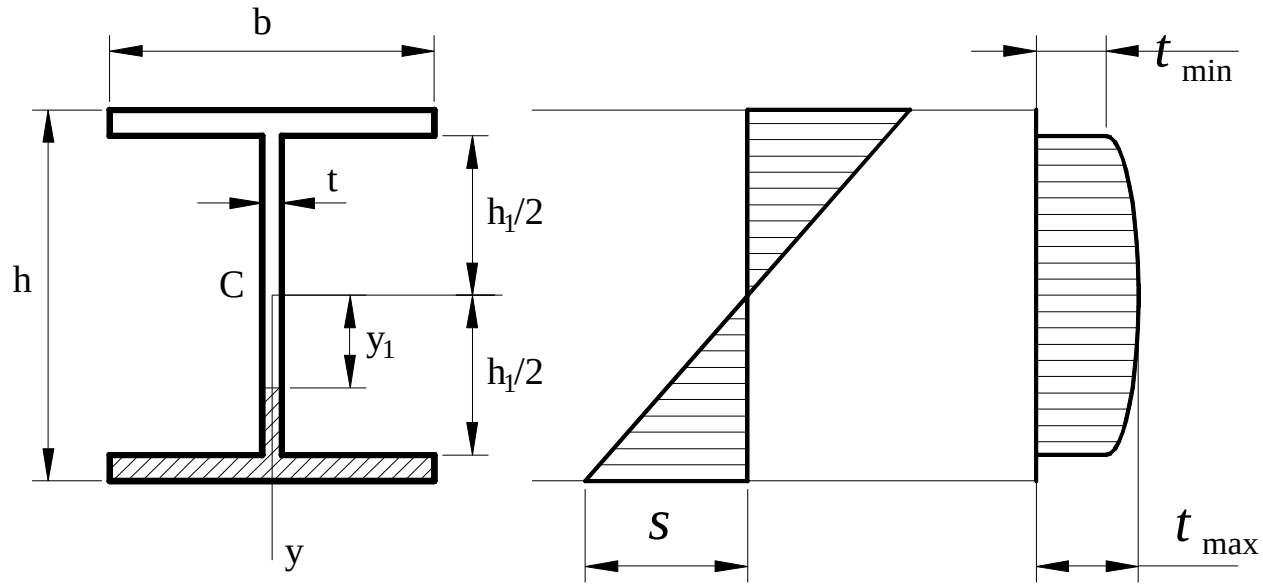


$$M_{\max} = \frac{gl^2}{8} = \frac{15000 \cdot 25}{8} = 46875[N \cdot m]$$

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

$$d = w_{\max} = \frac{5qL^4}{384EI} = \frac{5 \cdot 15 \times 10^3 \cdot 5^4}{384 \cdot 2.1 \times 10^{11} \cdot 1844 \times 10^{-8}} = 0.032[m]$$

Analītisks aprēķins spriegumu sadalījumam sijas šķērsgriezumā



$$s = \frac{M}{W} = 254.2 \times 10^6 [Pa]$$

$$t_{max} = \frac{Q}{I \cdot t}\left(\frac{bh^2}{8} - \frac{bh_1^{\,2}}{8} + \frac{th_1^{\,2}}{8}\right) = 40.92 \times 10^6 [Pa]$$

P.S. *http://www.bf.rtu.lv/?page=nvsd/materials*
"Būvmehānika, ievadkurss" (.pdf) - Fēlikss Bulavs, Ivars Radiņš
114-120 lpp.

Elementa BEAM 189 – piepūļu skaitlisko vērtību definēšana

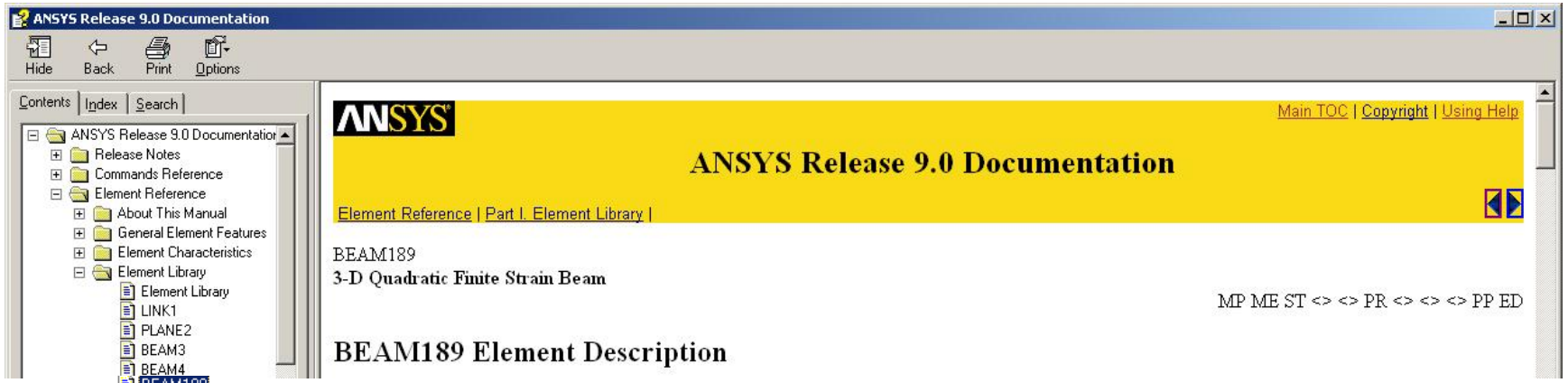
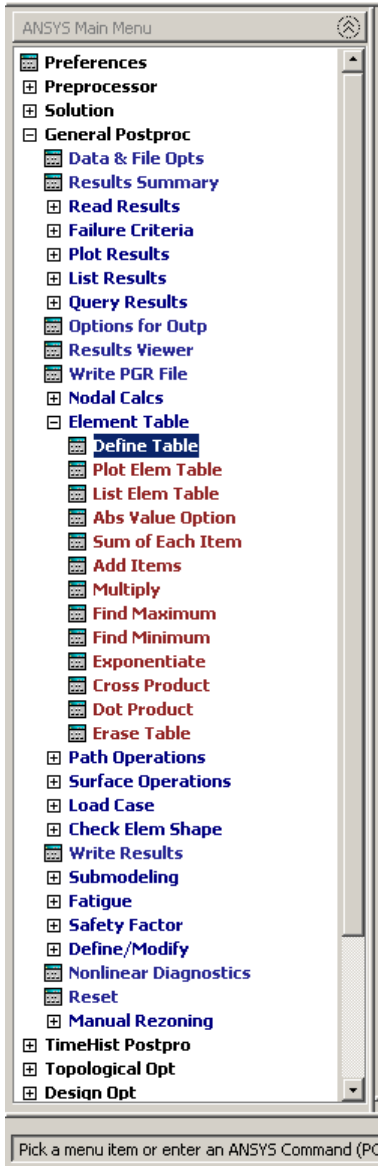


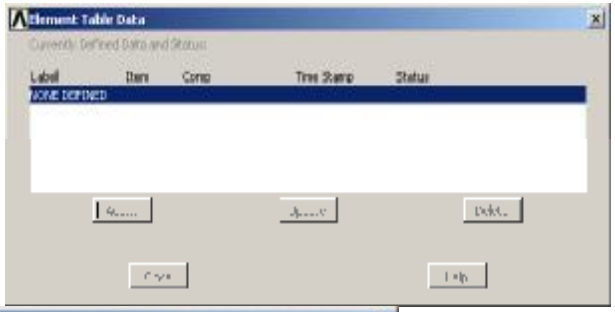
Table 189.2 BEAM 189 Item and Sequence Numbers

Output Quantity Name	ETABLE and ESOL Command Input		
	Item	I	J
FX	SMISC	1	14
MY	SMISC	2	15
MZ	SMISC	3	16
MX	SMISC	4	17
SFZ	SMISC	5	18
SFY	SMISC	6	19
EX	SMISC	7	20
KY	SMISC	8	21
KZ	SMISC	9	22
KX	SMISC	10	23

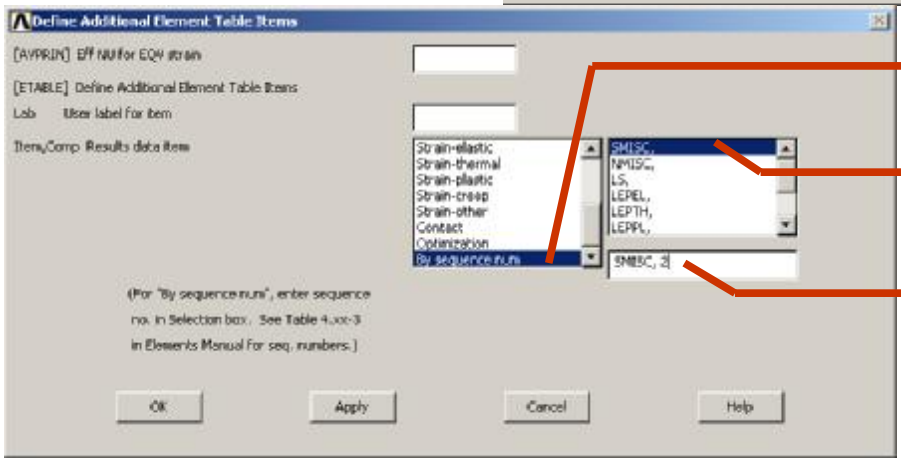
Momenta piepūļu skaitlisko vērtību definēšana



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



(2) Add..

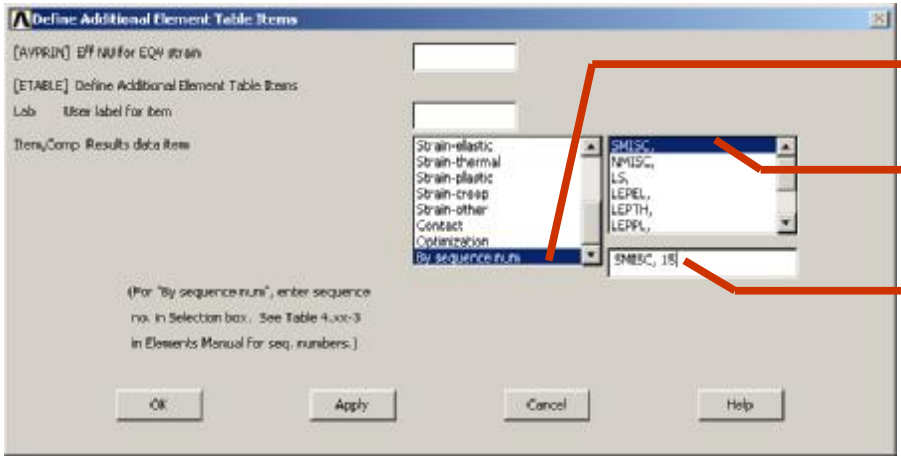


(3) By sequence num

SMISC

2

Apply



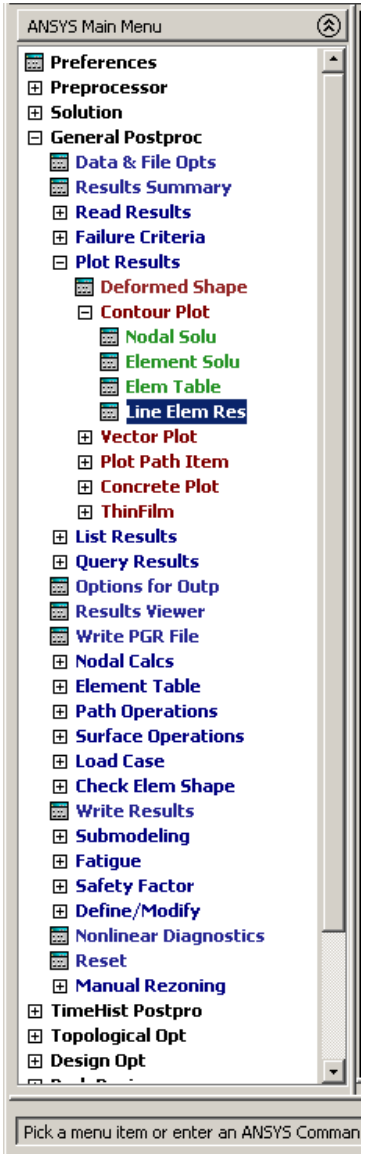
(4) By sequence num

SMISC

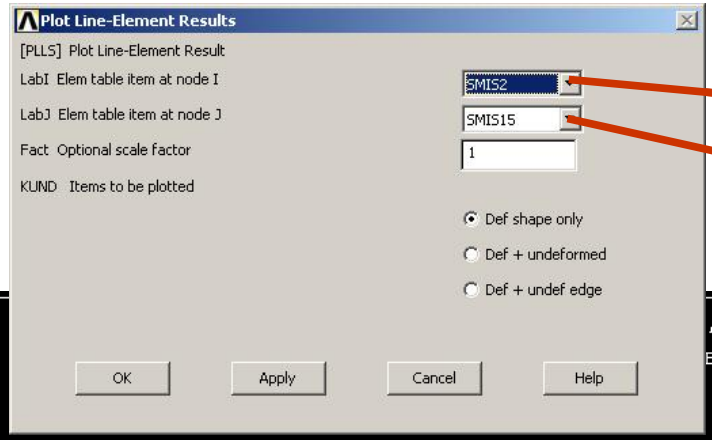
15

OK

Momentu epīras grafiska izveide

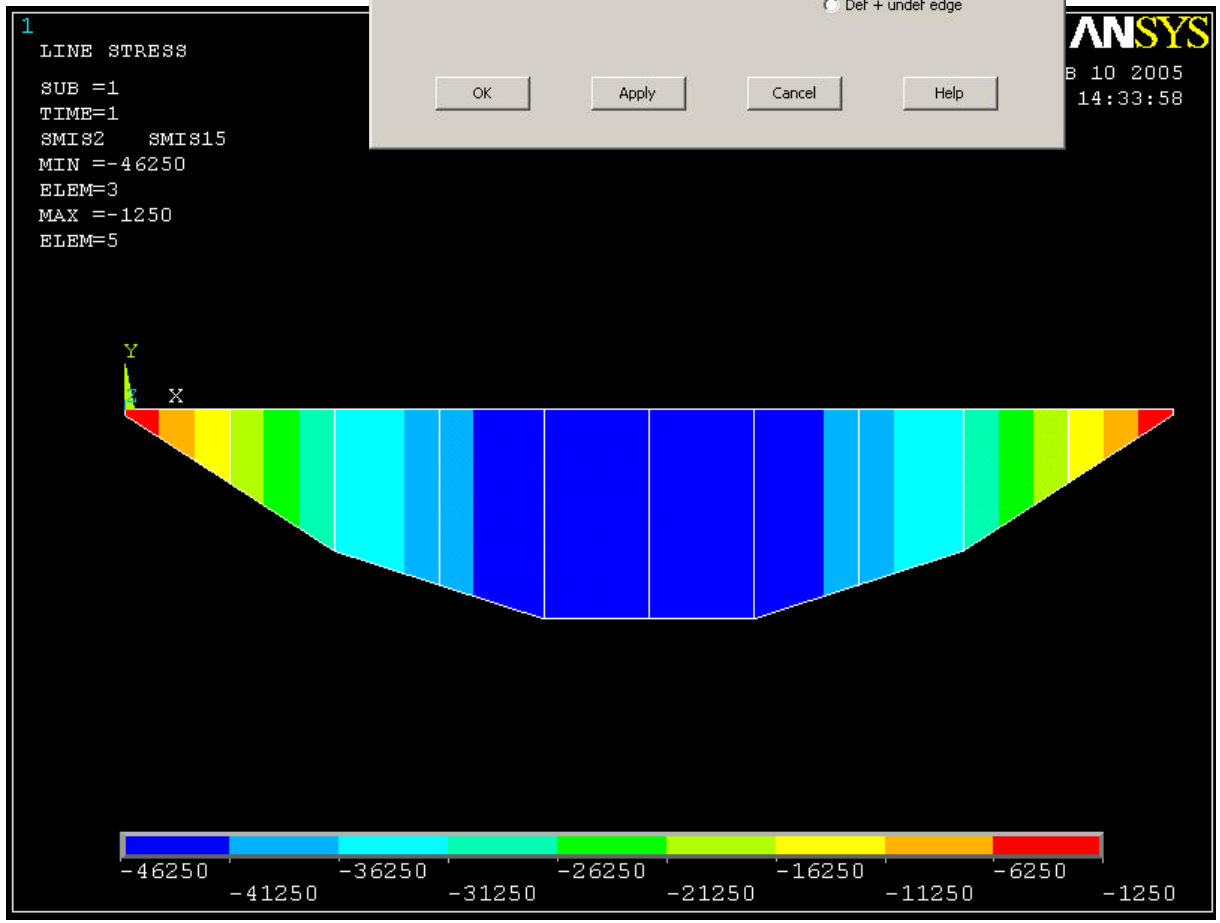


(1) General Postproc/
Plot Resukts/
Contour Plot/
Line Elem Res

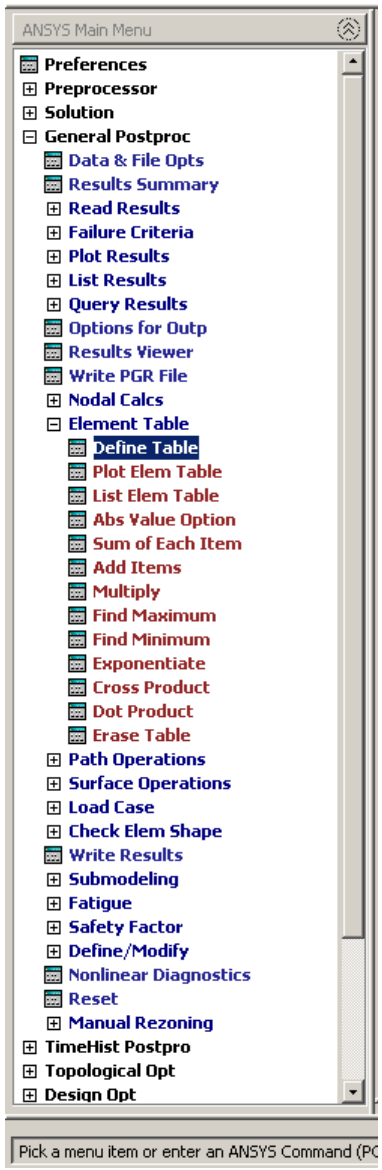


(2)
SMIS2
SMIS15

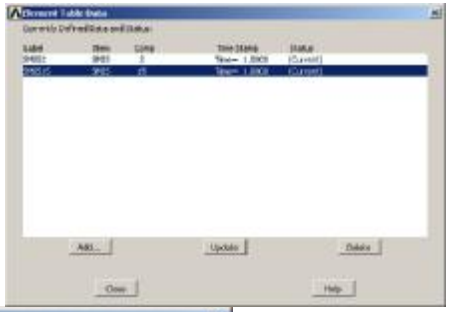
Ok



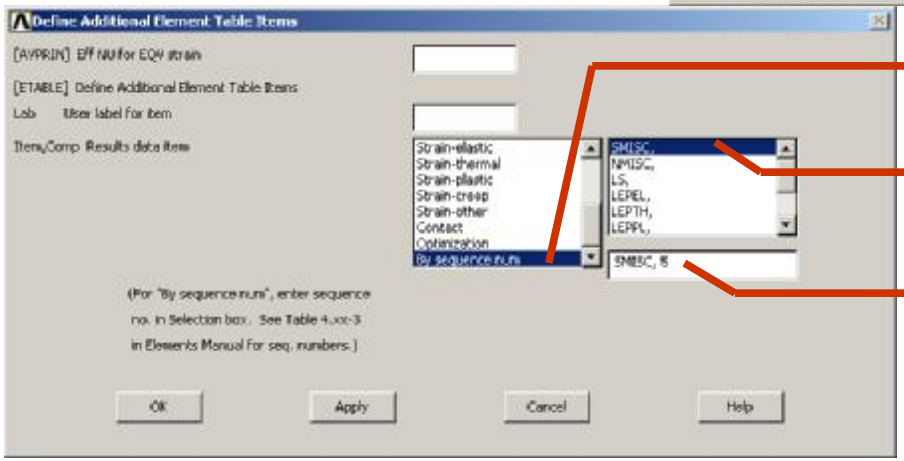
Šķērsspēka piepūļu skaitlisko vērtību definēšana



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



(2) Add..

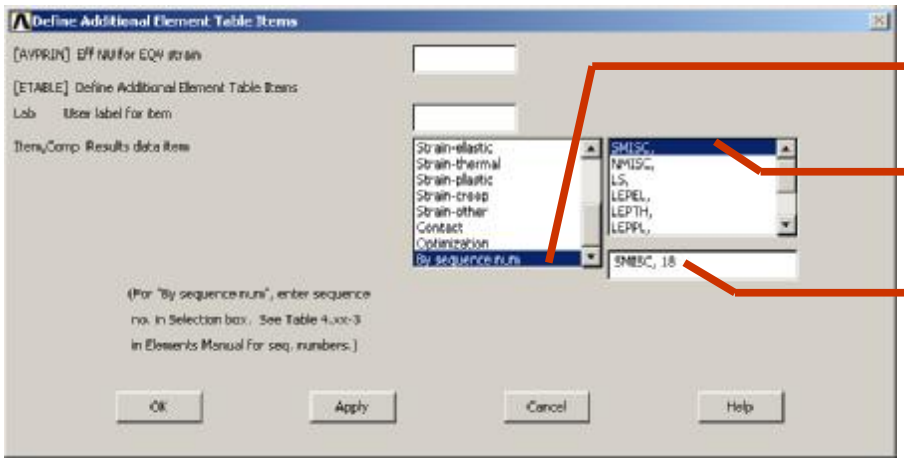


(3) By sequence num

SMISC

5

Apply



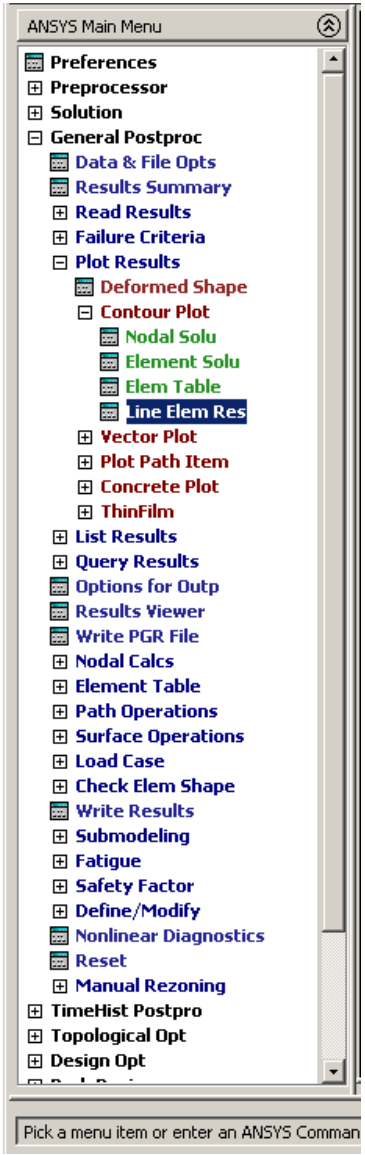
(4) By sequence num

SMISC

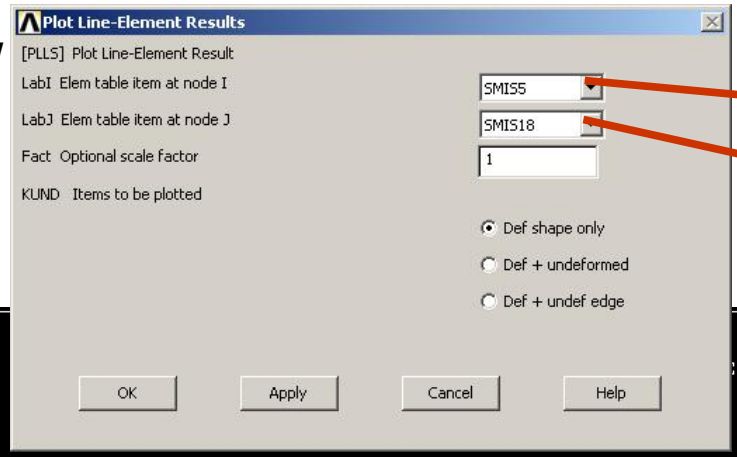
18

OK

Šķērsspēka epīras grafiska izveide

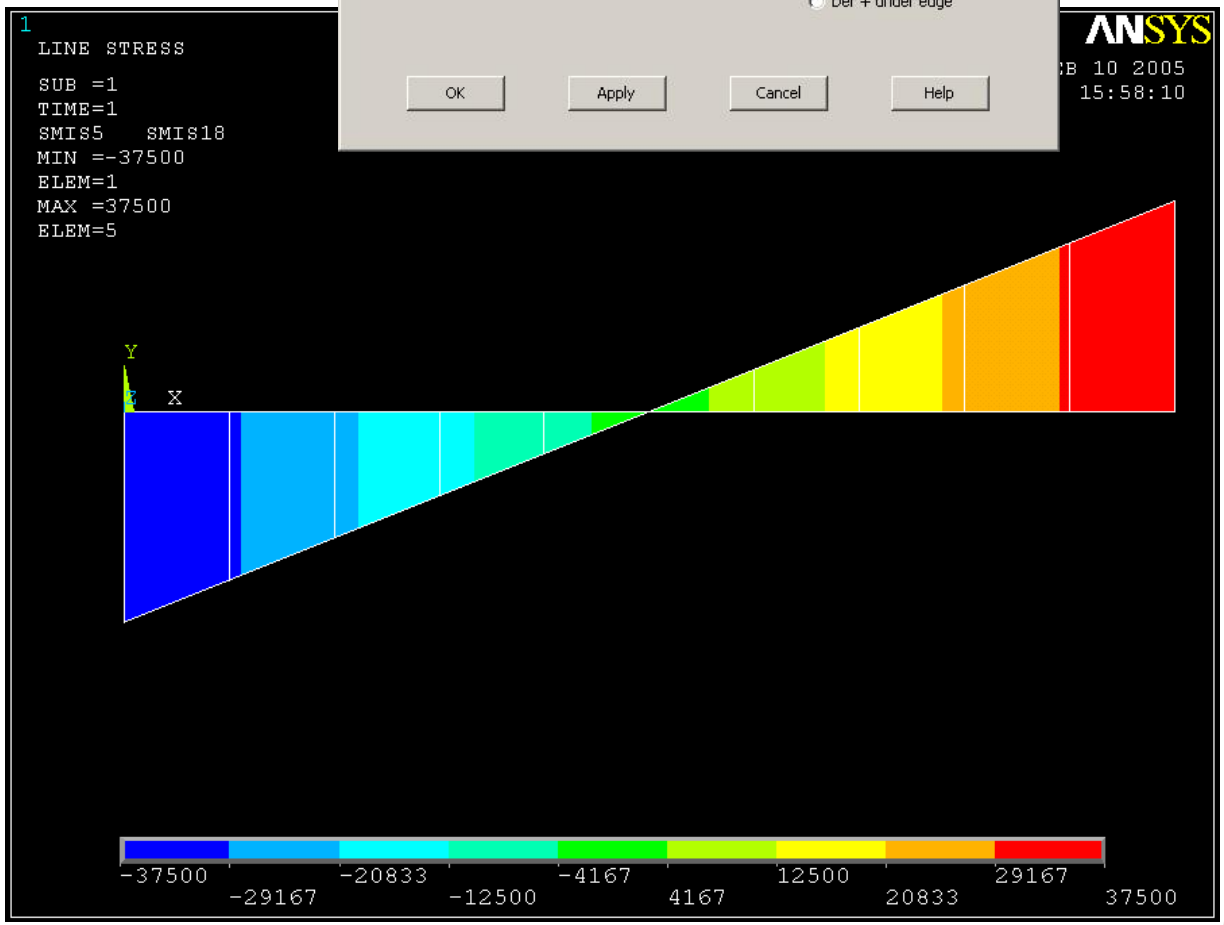


(1) General Postproc/
Plot Resukts/
Contour Plot/
Line Elem Res

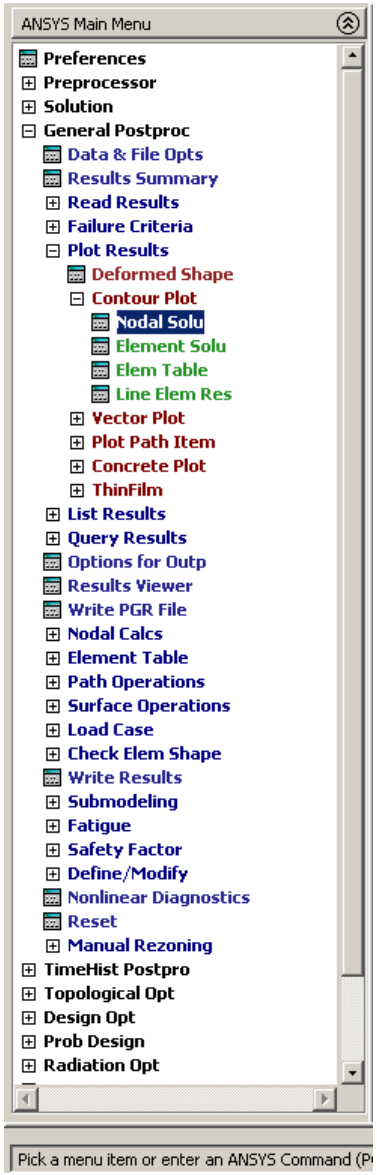


(2)
SMIS5
SMIS18

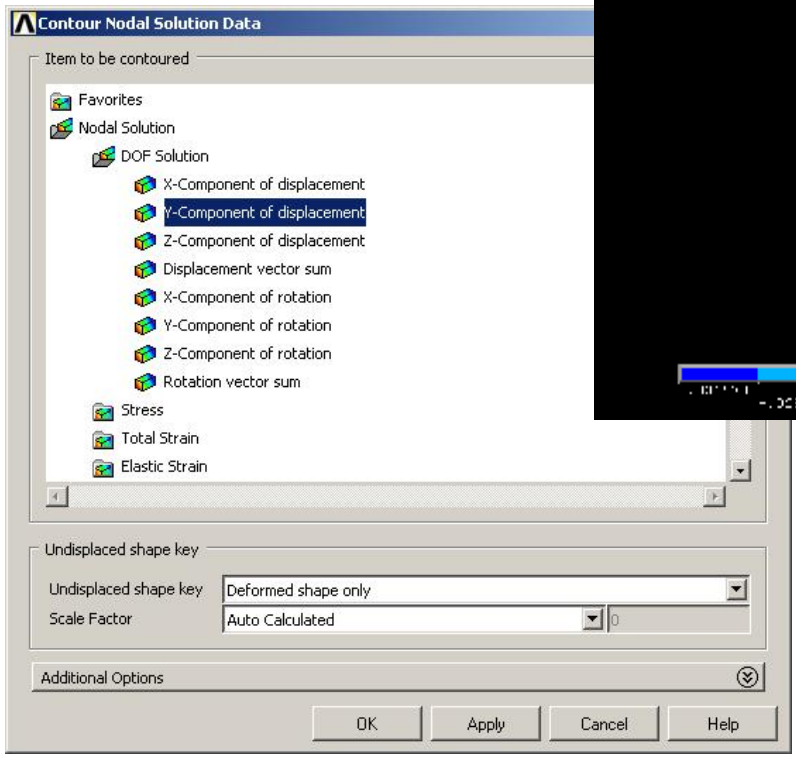
Ok

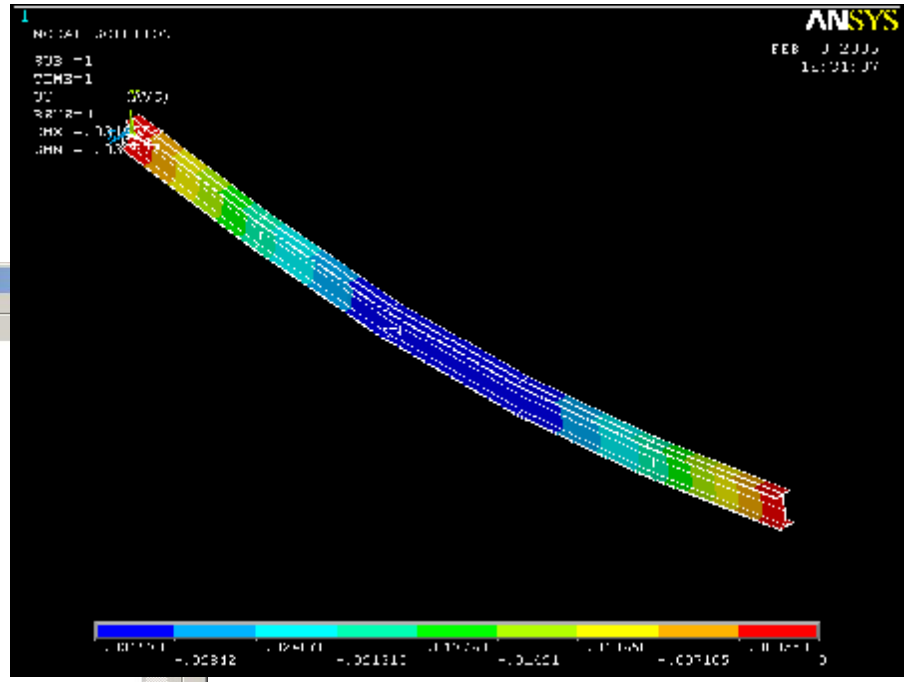


Sijas pārvietojumi Y-ass virzienā grafiska izveide



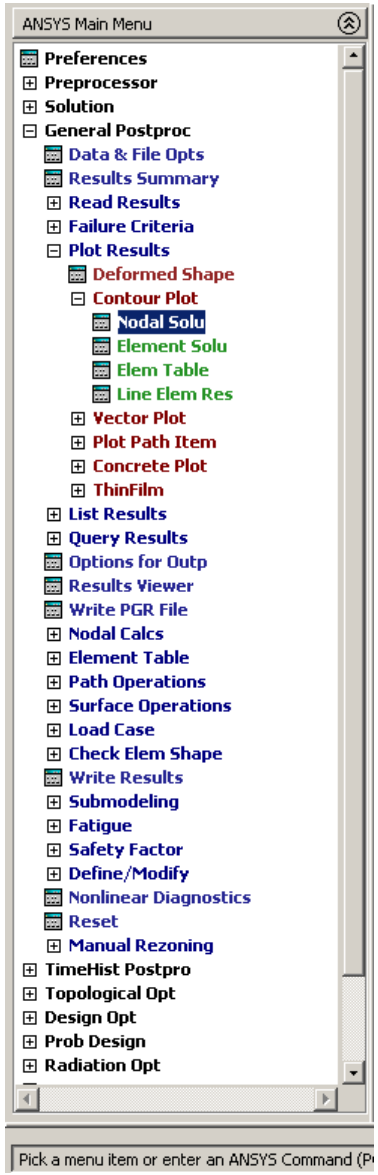
(1) General Postproc/
Plot Results/
Contour Plot/
Nodal Solu/



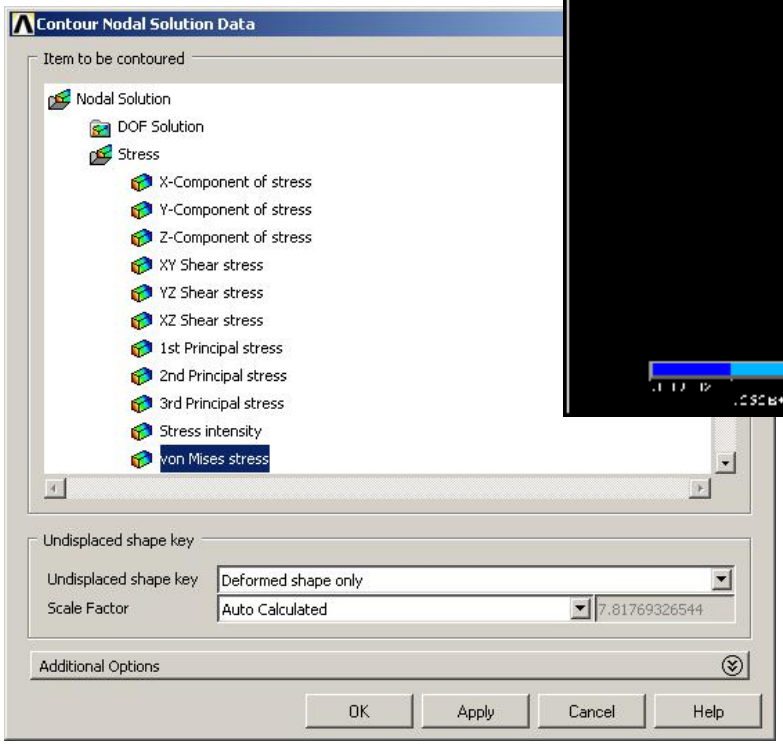


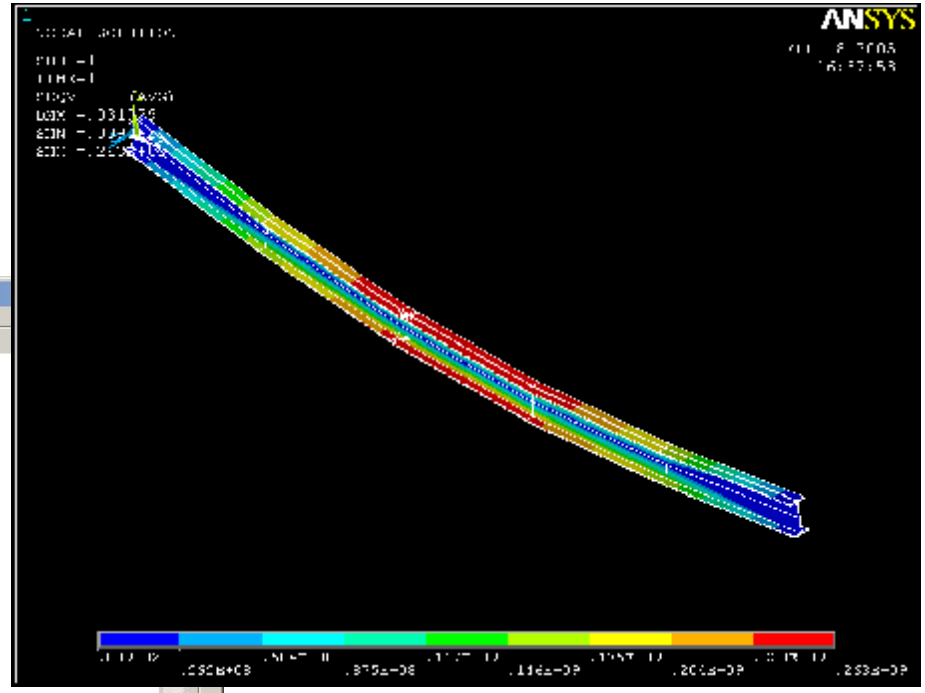
(2) Nodal Solution
DOF Solution
Y-Component of displacement

Spriegumu sadalījumu sijā grafiska izveide



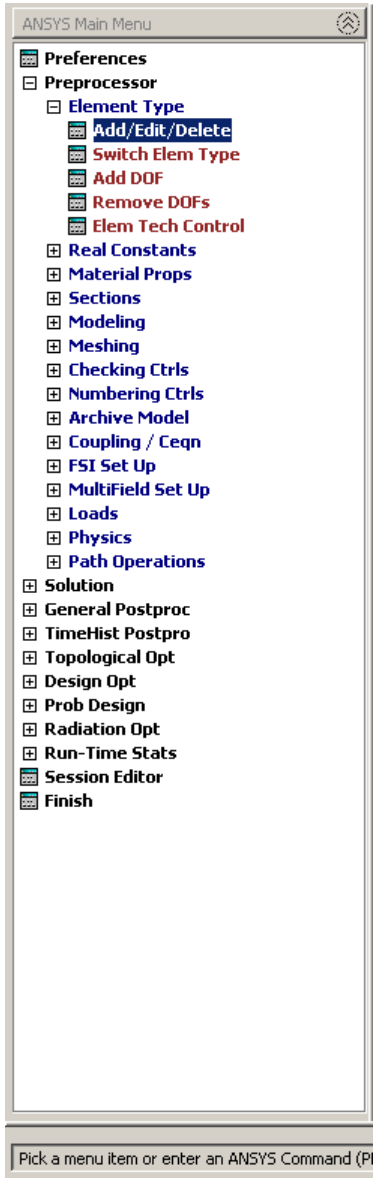
(1) General Postproc/
Plot Results/
Contour Plot/
Nodal Solu/



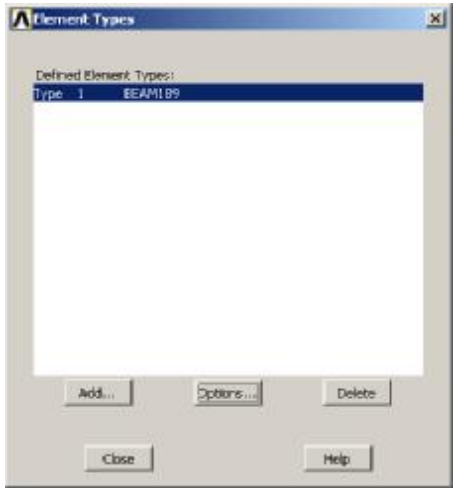


(2) Nodal Solution
Stress
von Misses stress

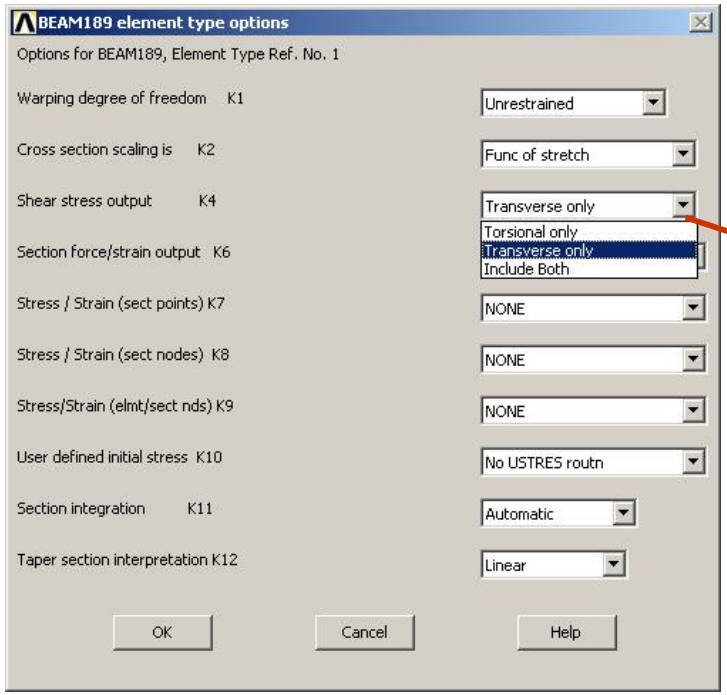
Tangenciālo spriegumu aprēķina definēšana



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



(2) Options...

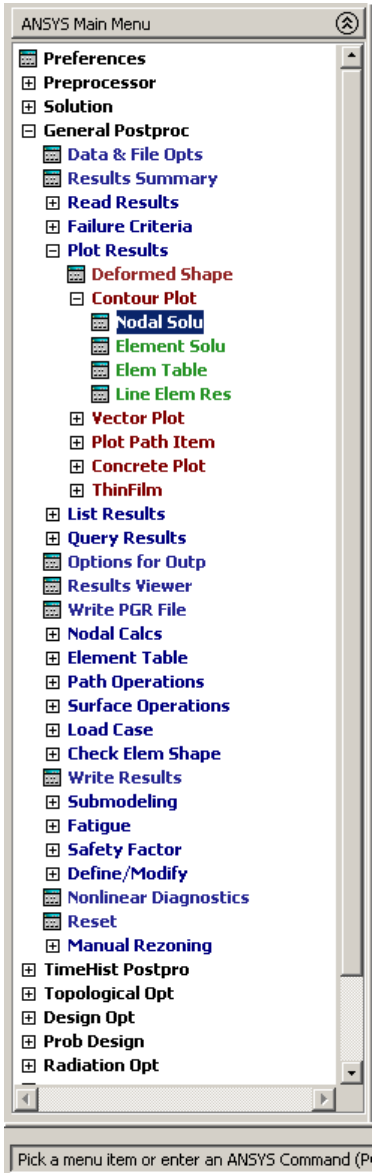


(3) Shear stress output K4
Tangenciālo spriegumu aprēķina definēšana
Transverse only

(4) OK

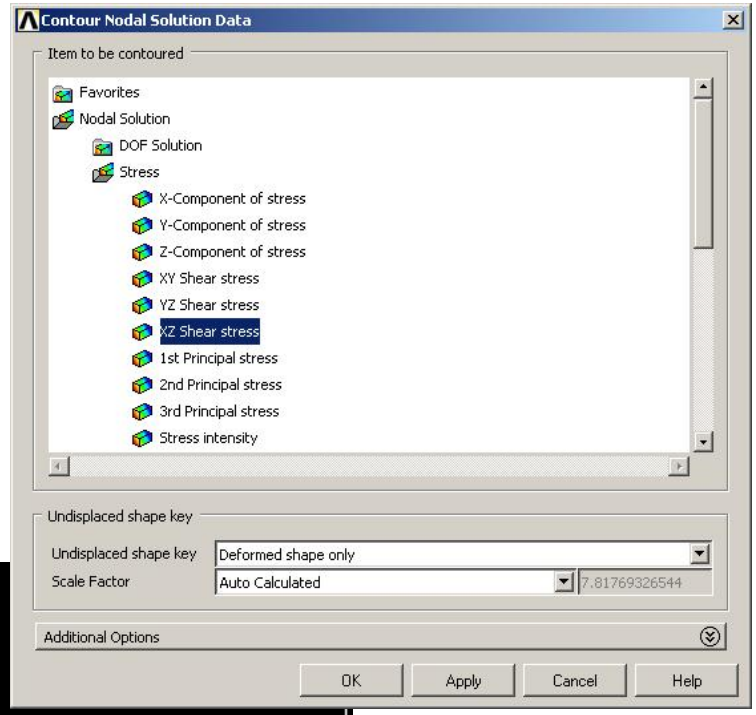
(5) Uzdevumu atkārtoti aprēķināt!

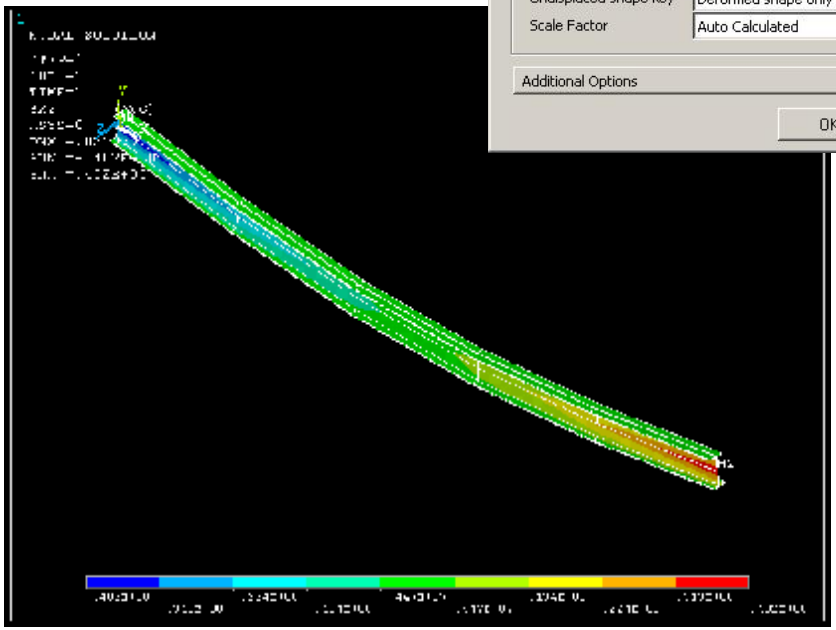
Sijas tangenciālo spriegumu grafiska izveide

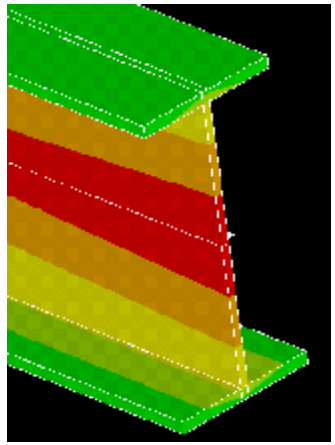


(1) Preprocessor/
Plot Results/
Control Plot/
Nodal Solu/

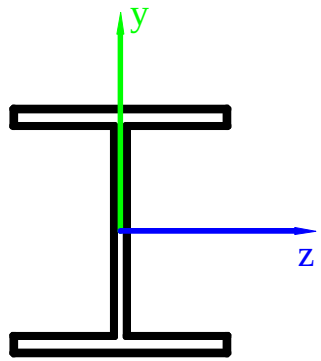
(2) Nodal Solution
Stress
XY Shear stress







Iegūto rezultātu salīdzinājums

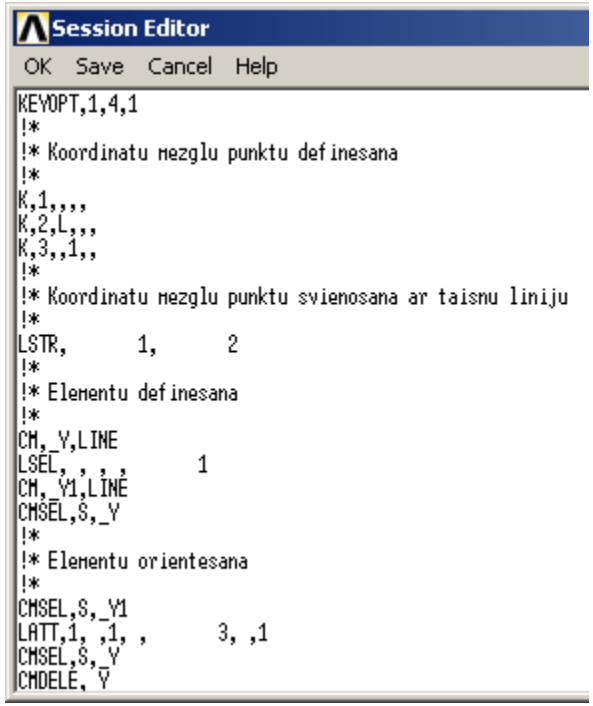


	UY [m]	M [N*m]	Q [N]	σ [MPa]	τ_{max} [MPa]
Analītiskais aprēķins	0.032	46875	37500	254	40.9
Ansys	0.032	46250	37500	263	40.2
$\lvert\Delta\rvert$ [%]	**0**	**1.3**	**0**	**3.5**	**1.7**

Sijas šķērsgriezuma profila orientēšana maiņa izmantojot Sesssion Editor

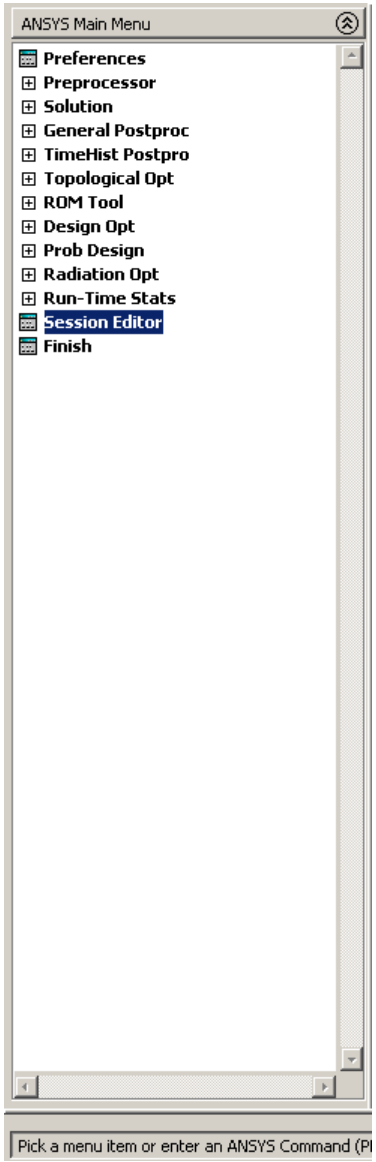
(1) Session Editor

```
!*
!* Koordinatu mezglu punktu definesana
!*
K,1,,,,
K,2,L,,,
K,3,,,1,
```



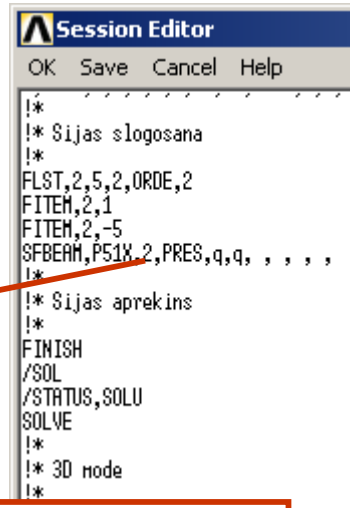
Izmantojot Log file vai Session Editor koordinātas 3. mezglam nomaina no K,3,,**1,**, *(0,1,0)* uz K,3,,,**1**, *(0,0,1)*, tādejādi mainot kooridinātu mezgla punkta atrašanās plakni no XY uz plakni XZ.

Sijas slodzes orientēšanas maiņa izmantojot Sesssion Editor

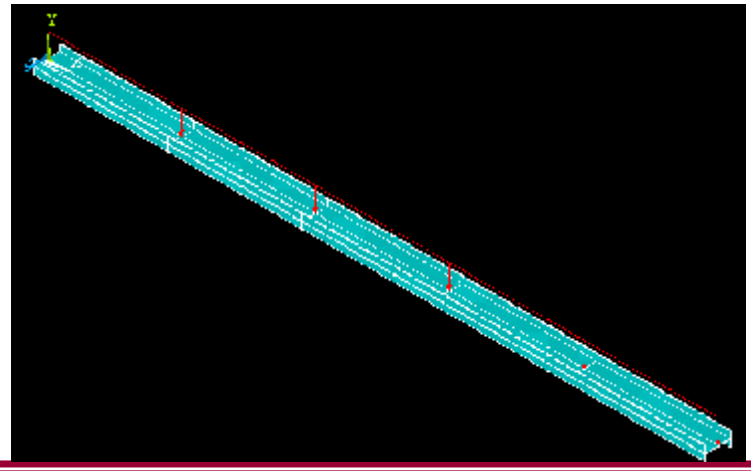


(1) Session Editor

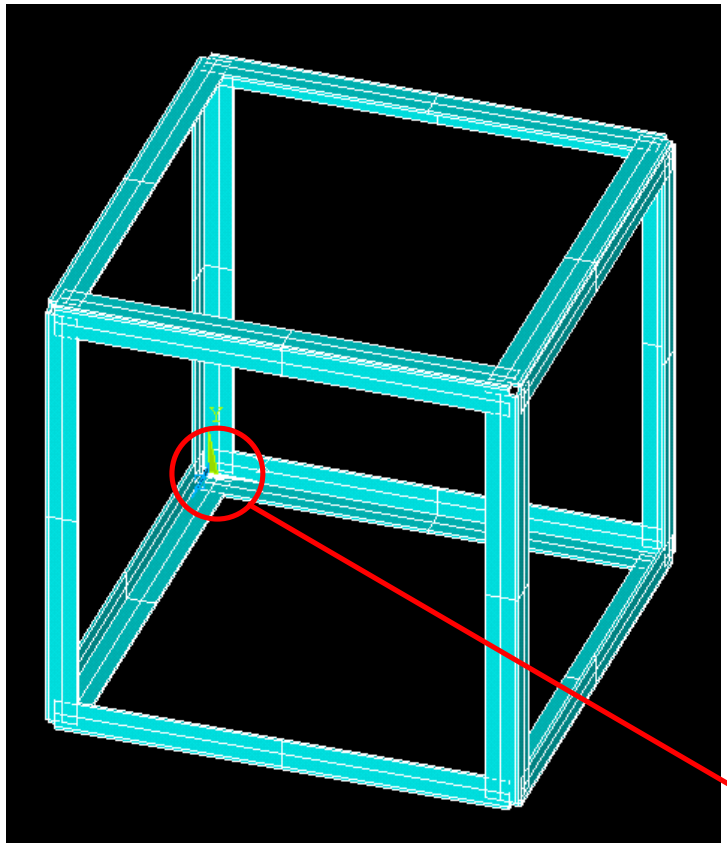
```
!*
!* Sijas slogosana
!*
FLST,2,5,2,ORDE,2
FITEM,2,1
FITEM,2,-5
SFBEAM,P51X,2,PRES,q,q, , , , ,
```



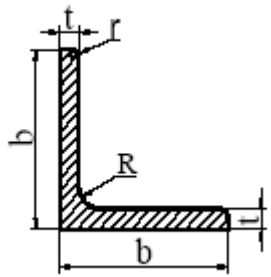
Izmantojot Log file vai Session Editor nomaina slogojuma orientāciju no SFBEAM,P51X,**1**,PRES,q,q, , , , , uz SFBEAM,P51X,**2**,PRES,q,q, , , , , ,tādejādi mainot slogojuma plakni no XY uz plakni XZ.

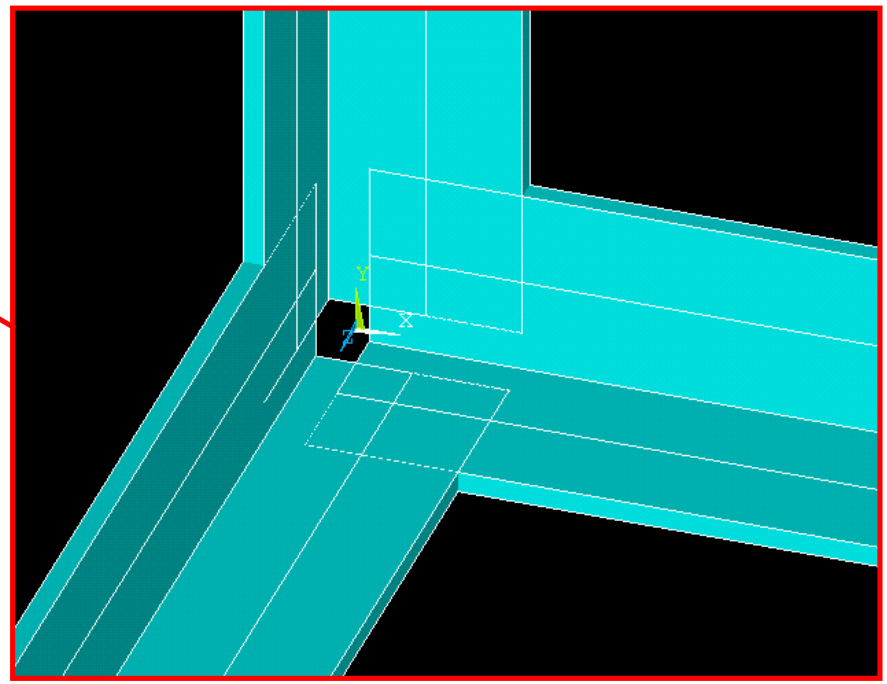


Elementu orientācijas iespējams telpiskas konstrukcijas izveidē



Velmētā tērauda vienādplauktu leņķprofils GOST 8509-93





Log fails ar paskaidrojumiem - !* paskaidrojumi

```
!*Sijas geometrija (m)
*SET,L,5
*SET,q,15000
*SET,w1,0.1
*SET,w2,0.1
*SET,w3,0.2
*SET,t1,0.008
*SET,t2,0.008
*SET,t3,0.0055
/PREP7
!* Elementa tipa izvele
!*
ET,1,BEAM189
!*
!* Materiala ipasibu definesana (Pa)
!*
MPTEMP,,,,,,,,
MPTEMP,1,0
MPDATA,EX,1,,2.1E11
MPDATA,PRXY,1,,0.3
!*
!* Skersgriezuma parametru definesana (m)
!*
SECTYPE,   1, BEAM, I, 2T_20, 0
SECOFFSET, CENT
SECDATA,W1,W2,W3,t1,t2,t3,0,0,0,0
!*
```

```
!* Koordinatu mezglu punktu definesana
!*
K,1,,,,
K,2,5,,,
K,3,,1,,
!*
!* Koordinatu mezglu punktu svienosana ar taisnu liniju
!*
LSTR,      1,      2
!*
!* Elementu definesana
!*
CM,_Y,LINE
LSEL, , , ,      1
CM,_Y1,LINE
CMSEL,S,_Y
!*
!* Elementu orientesana
!*
CMSEL,S,_Y1
LATT,1, ,1, ,      3, ,1
CMSEL,S,_Y
CMDELE,_Y
CMDELE,_Y1
!*
!* Dalijums galigos elementos
!*
LESIZE,ALL, , ,5, ,1, , ,1,
LMESH,      1
!*
```

Log fails ar paskaidrojumiem - !* paskaidrojumi

```
!* Elementa nostaprinajuma definēšana (Mezgls Nr.1)
!*
FLST,2,1,1,ORDE,1
FITEM,2,1
!*
/GO
D,P51X, , , , , ,UX,UY,UZ,ROTX, ,
!*
!* Elementa nostaprinajuma definēšana (Mezgls Nr.2)
!*
FLST,2,1,1,ORDE,1
FITEM,2,2
!*
/GO
D,P51X, , , , , ,UY,UZ,ROTX, , ,
!*
!* Sijas slogošana
!*
FLST,2,5,2,ORDE,2
FITEM,2,1
FITEM,2,-5
SFBEAM,P51X,1,PRES,q,q, , , , ,
!*
!* Sijas aprekins
!*
FINISH
/SOL
/STATUS,SOLU
SOLVE
!*
!* 3D mode
!*
/SHRINK,0
/ESHAPE,1.0
/EFACET,1
/RATIO,1,1,1
/CFORMAT,32,0
/REPLOT
EPLOT
!*
!* M un Q-epiras
!*
FINISH
/POST1
AVPRIN,0, ,
ETABLE, ,SMISC, 2
!*
AVPRIN,0, ,
ETABLE, ,SMISC, 15
!*
AVPRIN,0, ,
ETABLE, ,SMISC, 5
!*
AVPRIN,0, ,
ETABLE, ,SMISC, 18
!*
!* M-epiras buvesena
!*
PLLS,SMIS2,SMIS15,1,0
```