In the name of God

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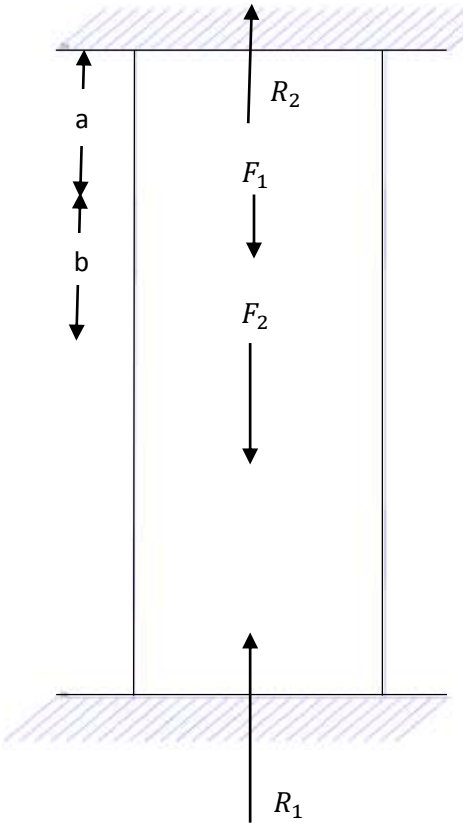
Abstract

Bodies analysis about their mechanic properties and numerical dissolve the problems might be so hard when do them by hand and general calculator. Thus in history of the technology , some engineers designed some method and software for analysis and dissolve hard problems.

We would like analysis Statically Indeterminate Reaction Force . So we use the Ansys program to analysis it.

The problem

S. Timoshenko, Strength of Material, Part I, Elementary Theory and Problems, 3rd Edition, D. Van Nostrand Co., Inc., New York, NY, 1955, pg. 26, problem 10.



Material Properties	Geometric Properties	Loading
$E = 30 \times 10^6$ psi	L = 10 in. a = b = 0.3 L	$F_1 = 2F_2 = 1000$ lb

Test Case

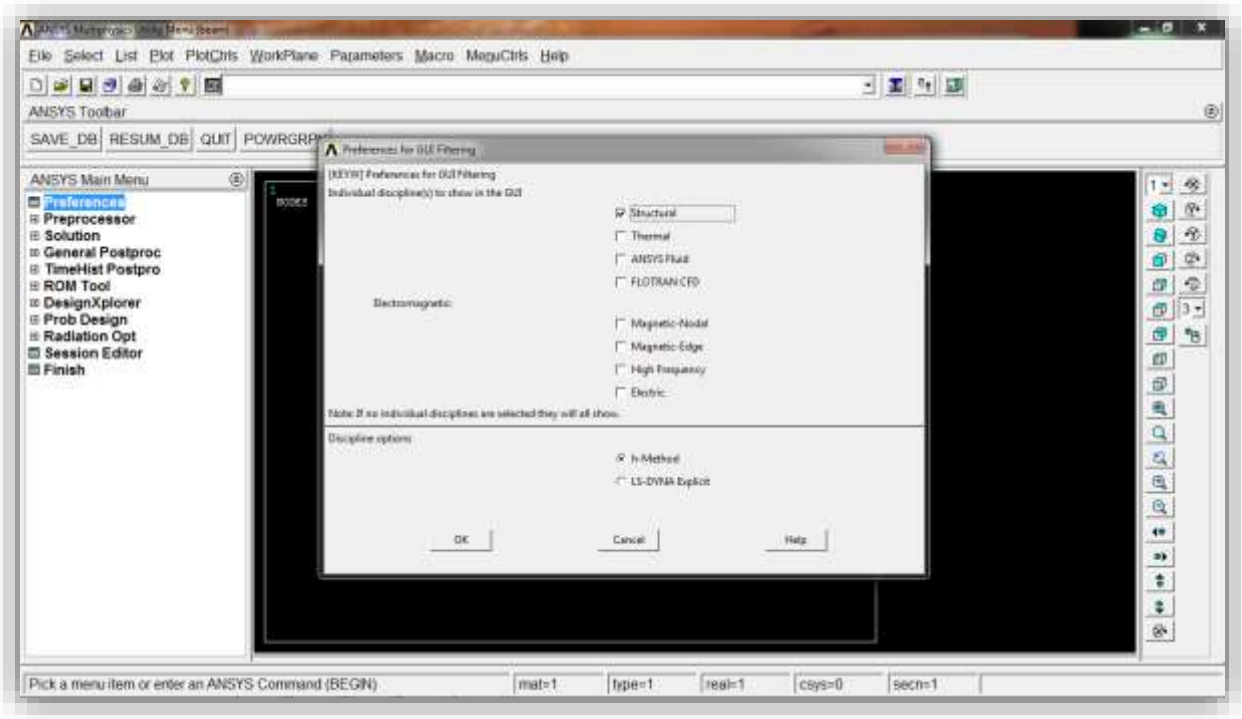
A prismatic bar with built-in ends is loaded axially at two intermediate cross-sections by forces F_1 and F_2. Determine the reaction forces R_1 and R_2.

ANSYS Analysis

First Step :

We have to identify the type of problem. In this problem we have structural problem.

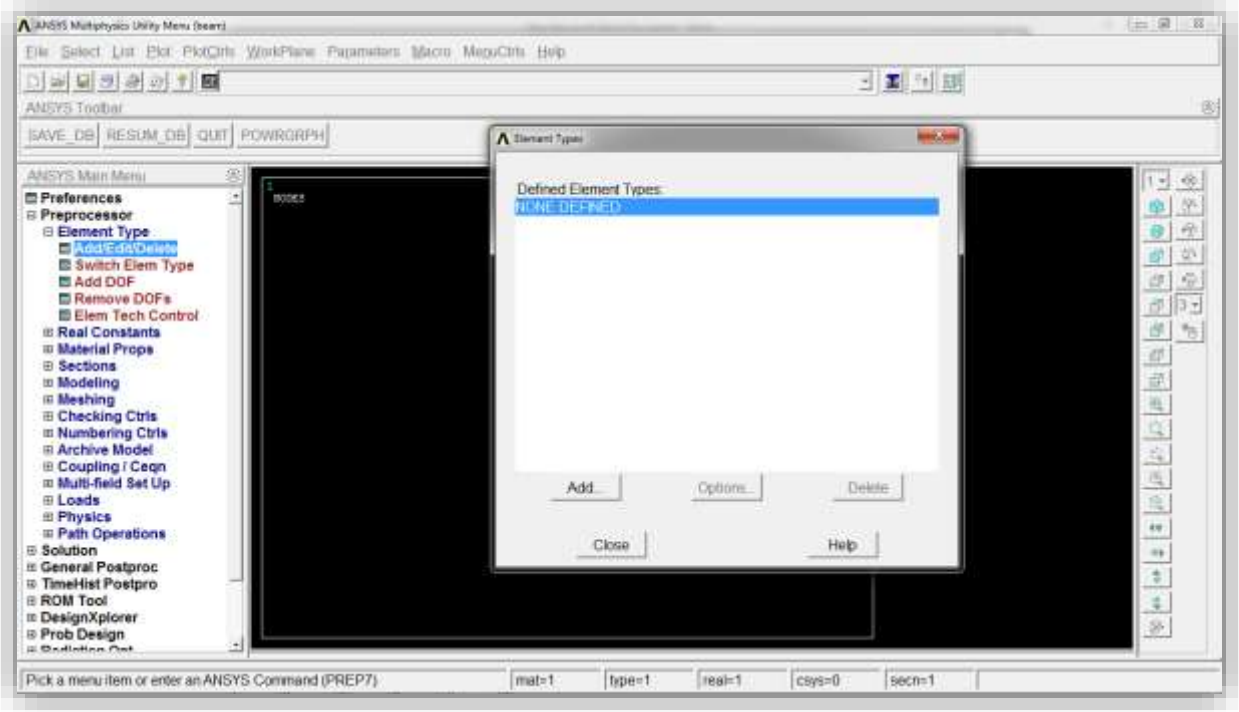
So we choos structural at Preferences window as shown is below;

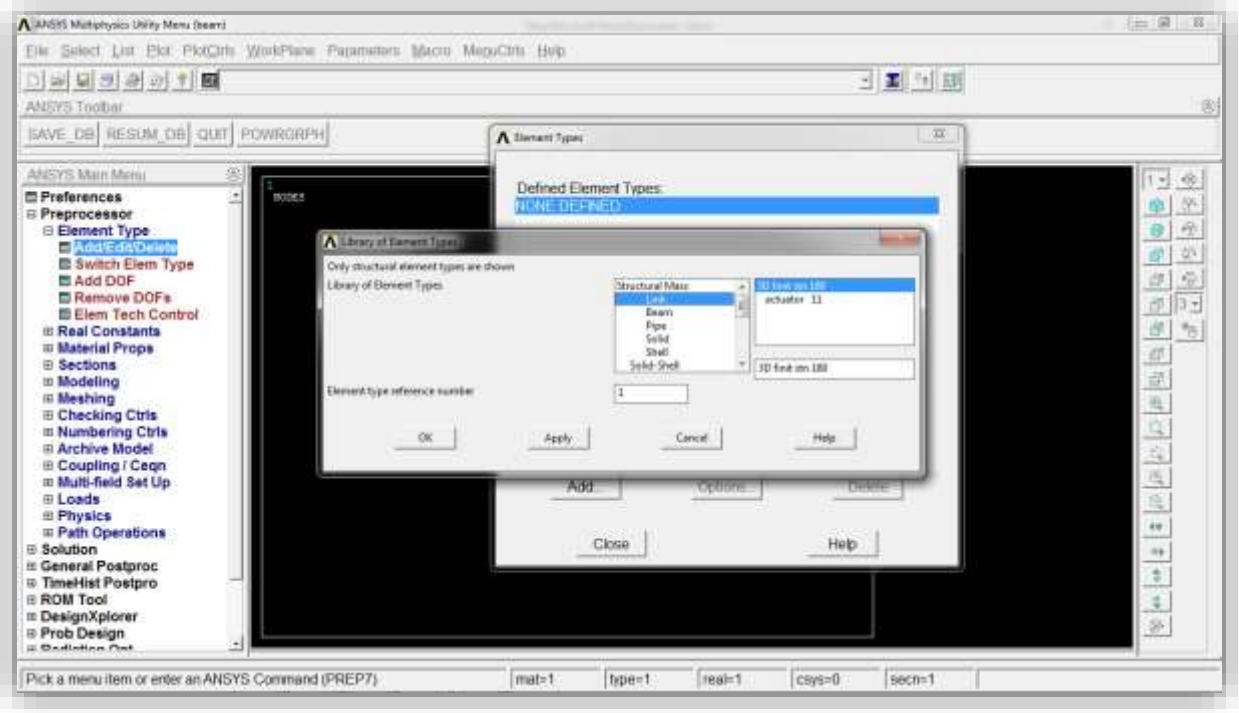


Second step:

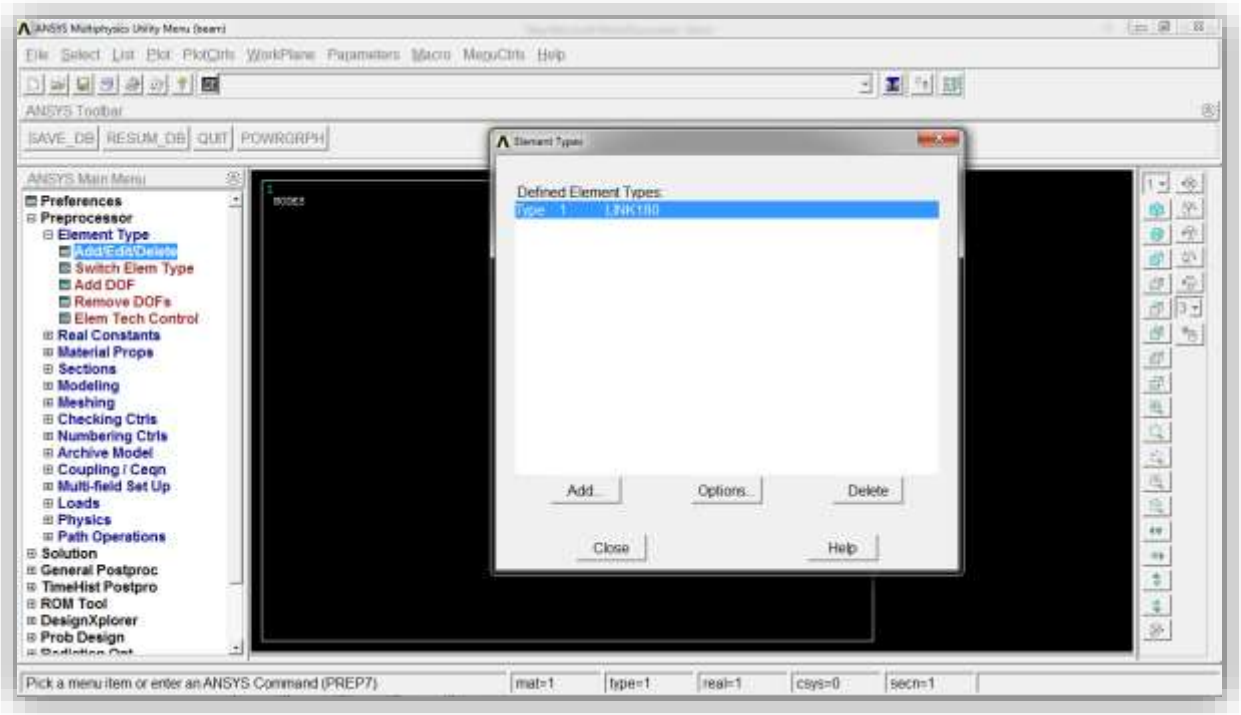
We have to identify element type for our problem to analysis the problem. So we choose element type by this way as shown in below:

Preprocessor ≫ Element type ≫ add





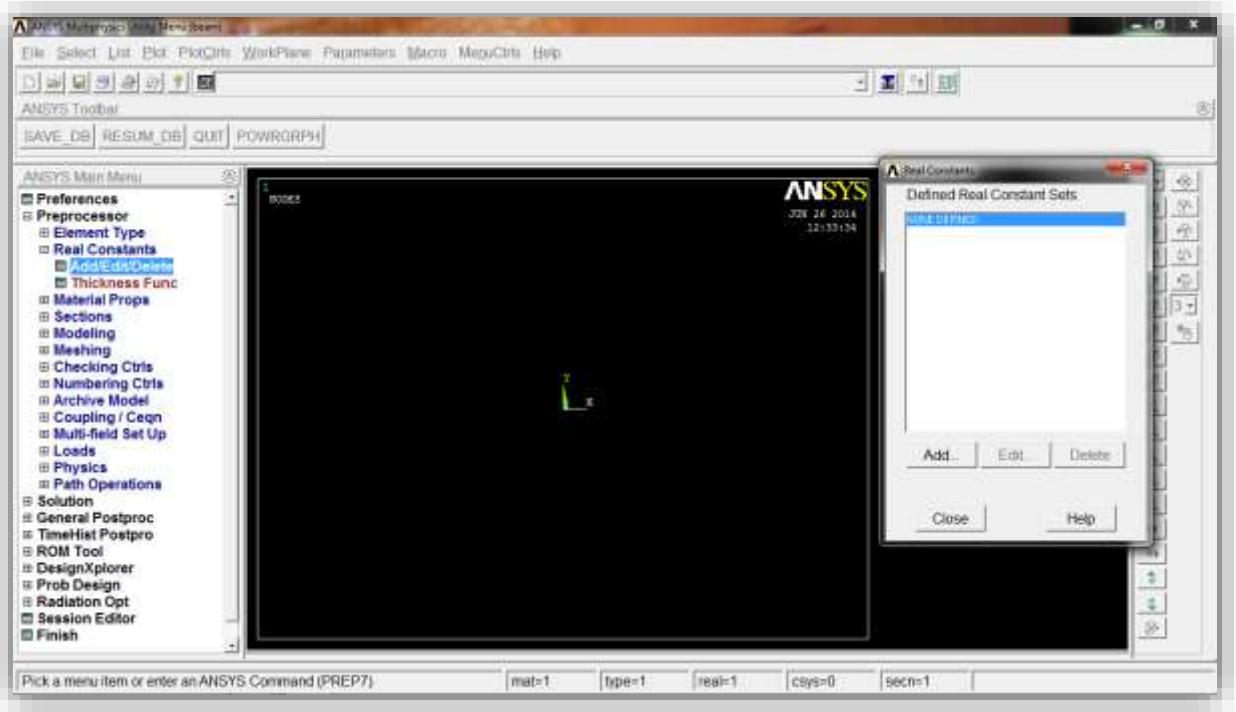
We have to choose Structural link then 3D finit stn 180 (LINK180) because we have a general link that just support tensile and compression stress. But LINK11 perform as spring.

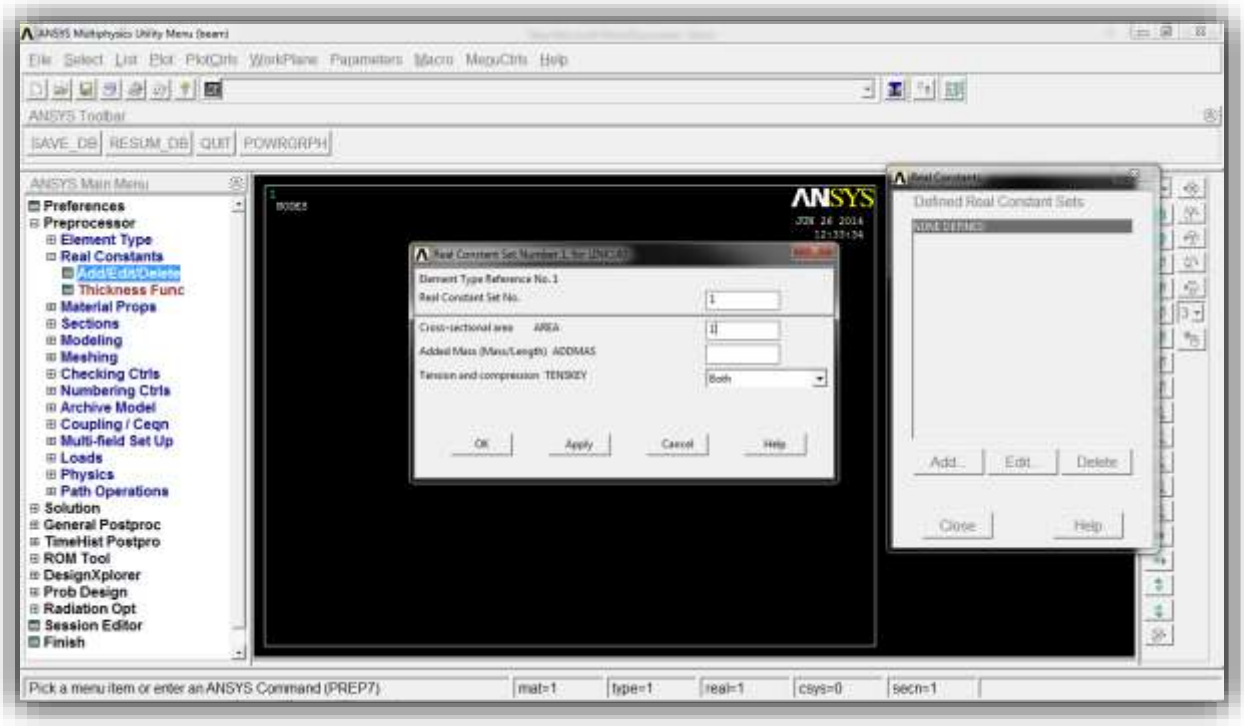


3th step:

In this step, we input the value of area section of link in the program. So we input it by the way as shown in below:

Preprocessor ≫ Real Constants ≫ Add

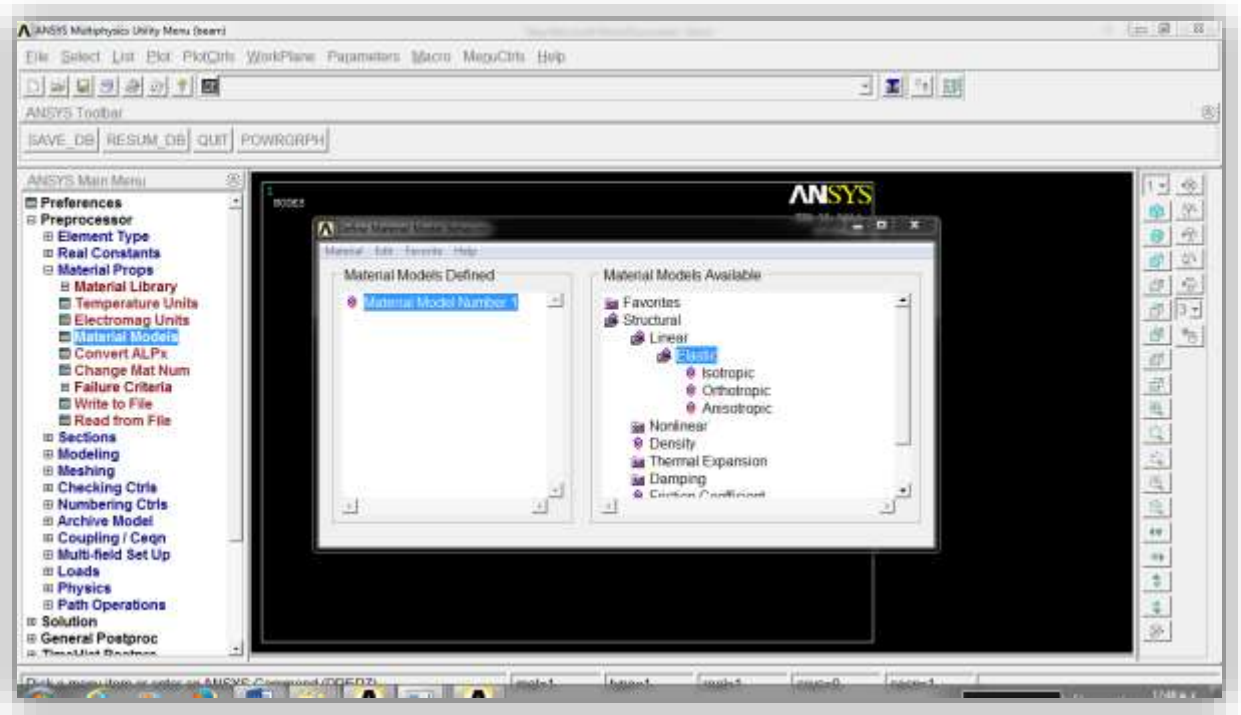




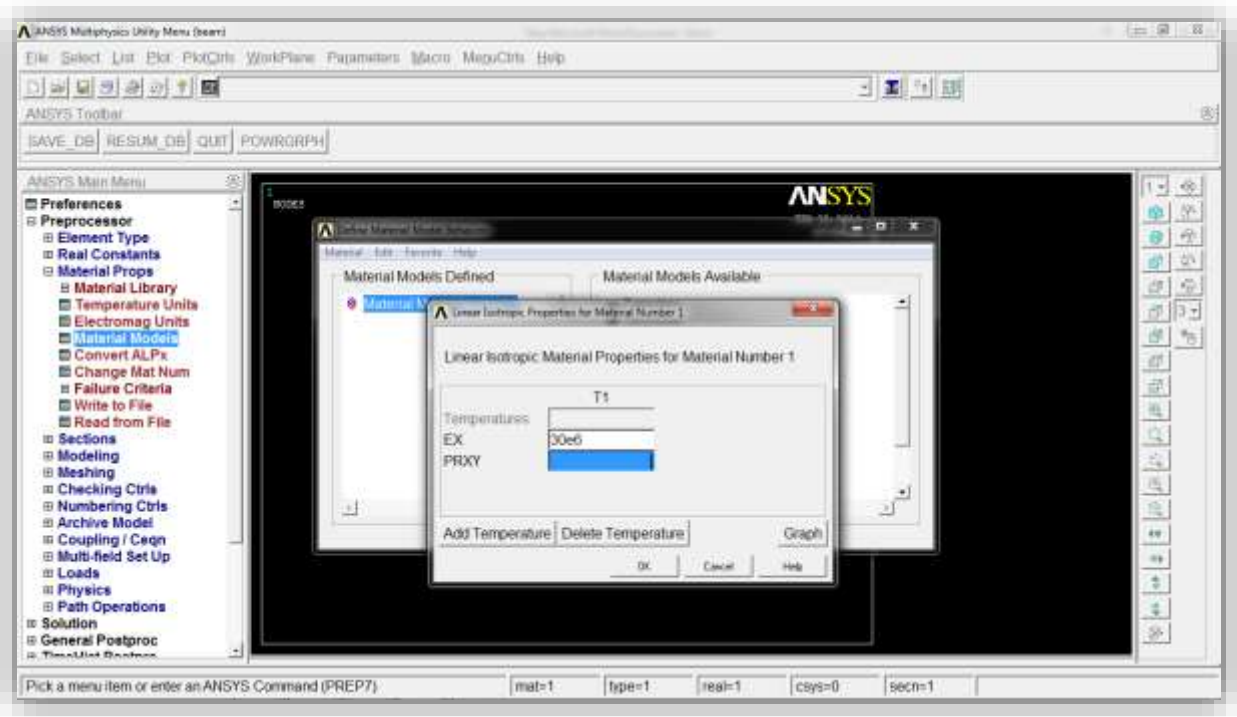
4th step:

We have to input the elastic Module. So we choose material model by this way as shown in below:

Preprocessor ≫ Material Props ≫ Material Models



We have 30×10^6 psi for elastic Module. Also We haven't any Poassion's factor.



5th step:

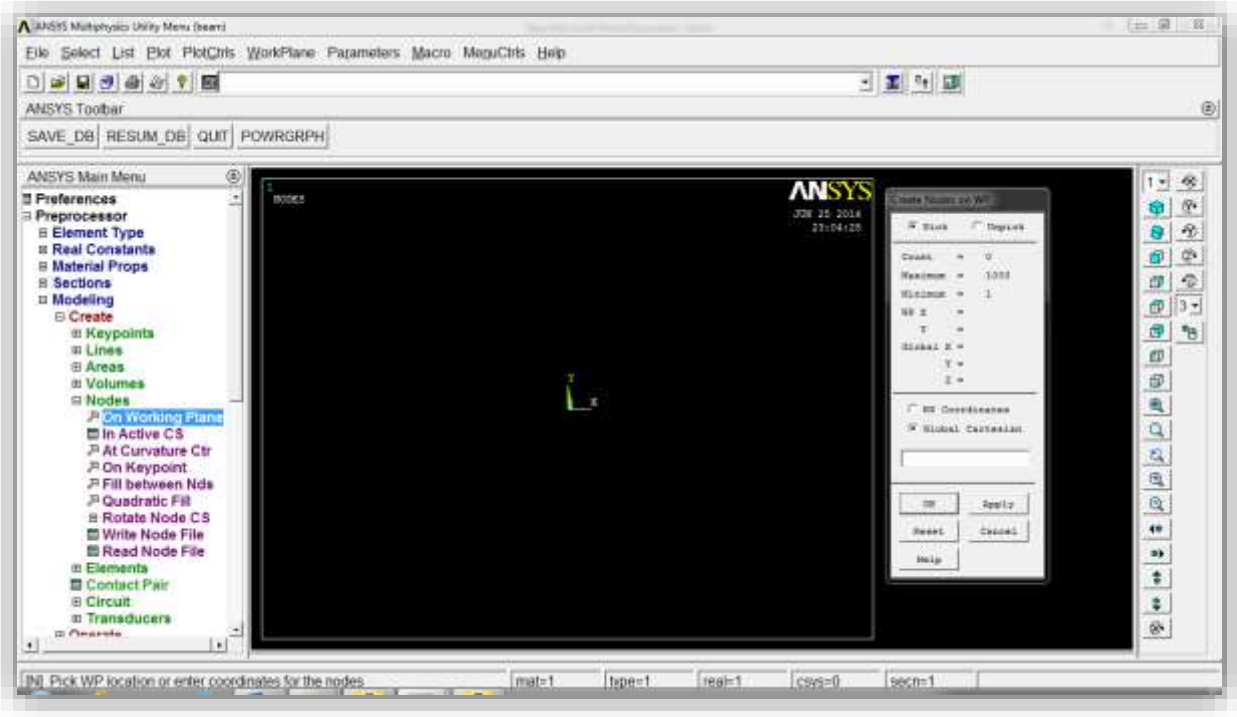
We create the link by Model tools. At first we have to create the nodes of link.

So we create them by way as shown in below:

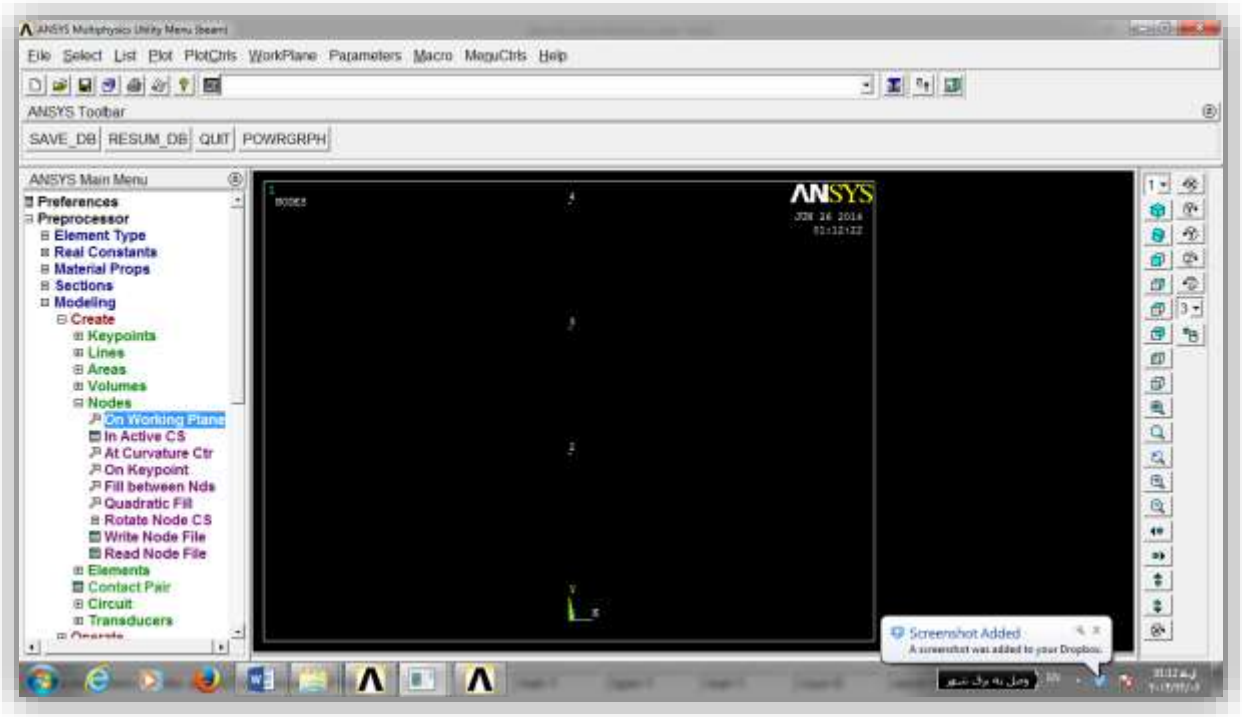
Preprocessor ≫ Modeling ≫ Create ≫ Nodes ≫ On Working Plane

Nodes :(x,y)

1) (0,0) 2) (0,4) 3) (0,7) 4) (0,10)

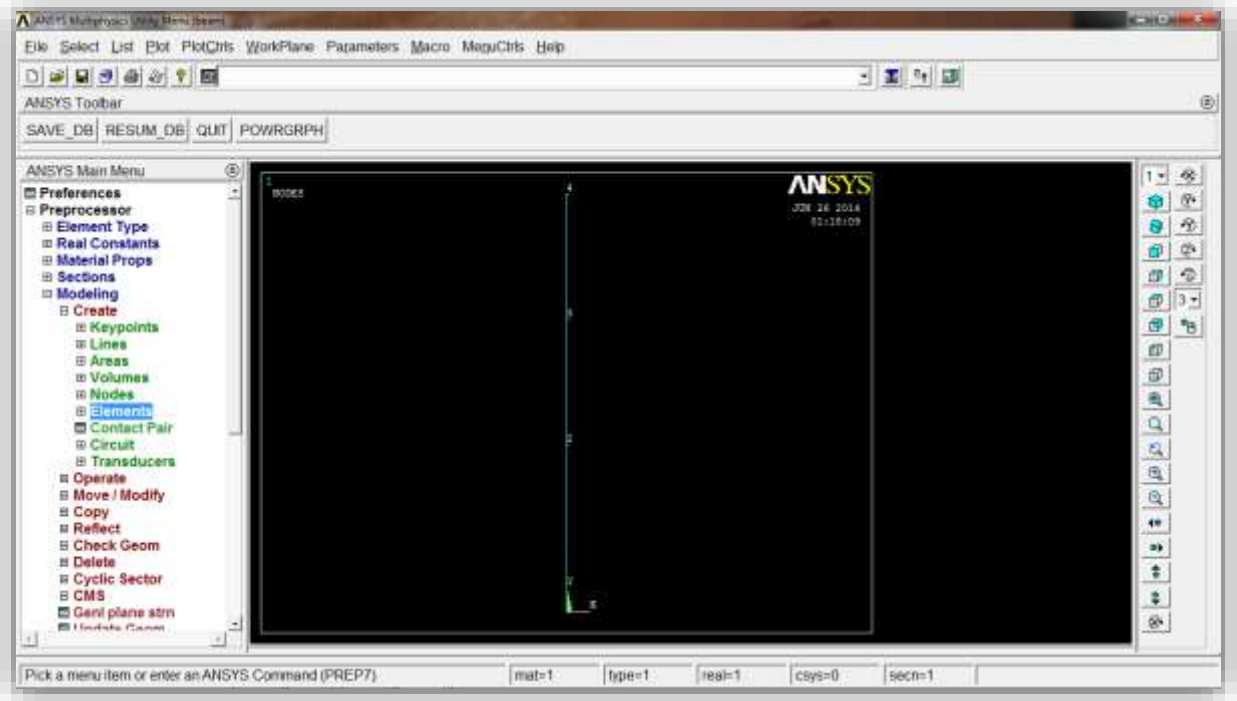


Now, we have to join the nodes together by elements. So we do it by the way thar as shown



in below:

Preprocessor ≫ Modeling ≫ Create ≫ Elements ≫ Auto Numbered ≫ Thru Nodes

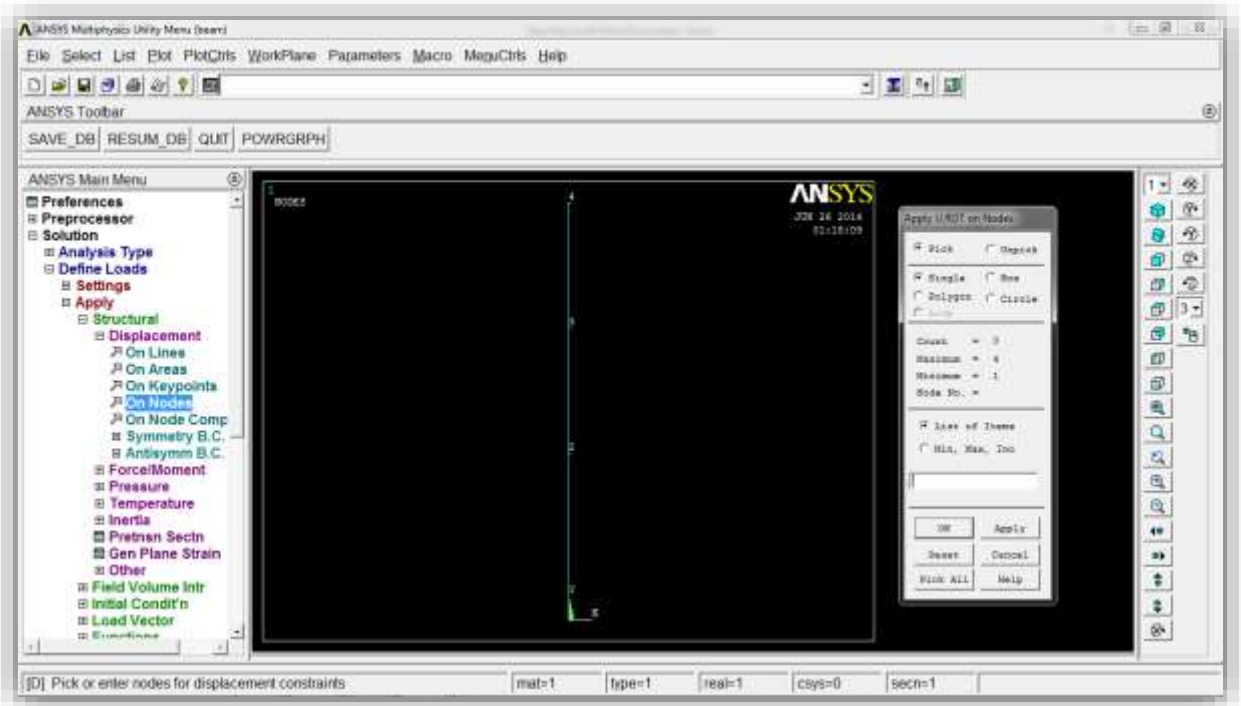


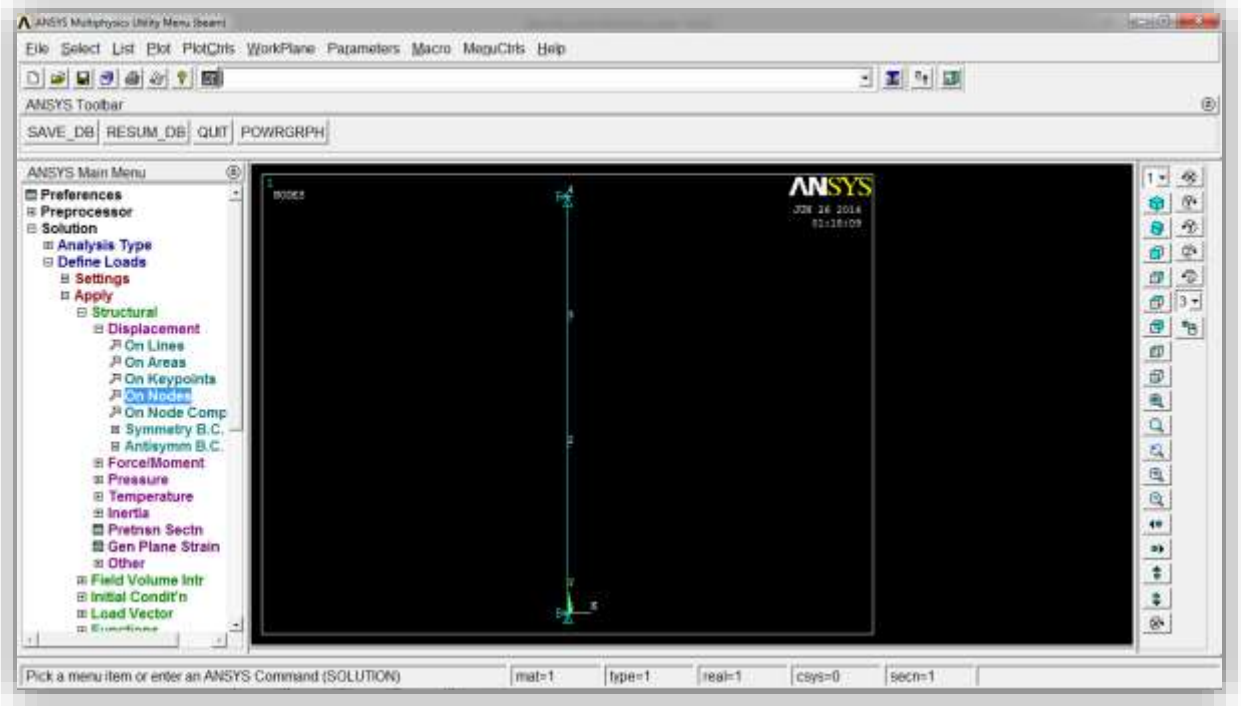
6th step:

Now , We define the supports at node 1 and 4 that we have welding connection.

So we do by this way as shown in below:

Solution ≫ Define Loads ≫ Apply ≫ Structural ≫ Displacement ≫ On Nodes

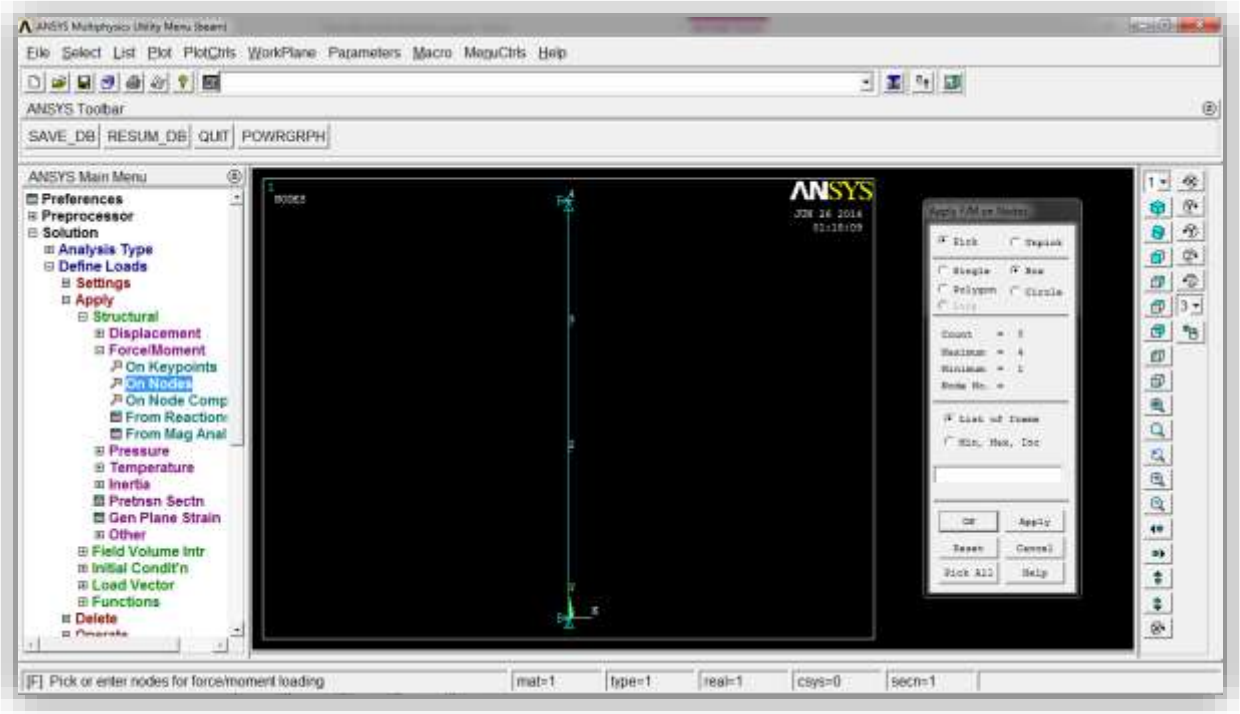


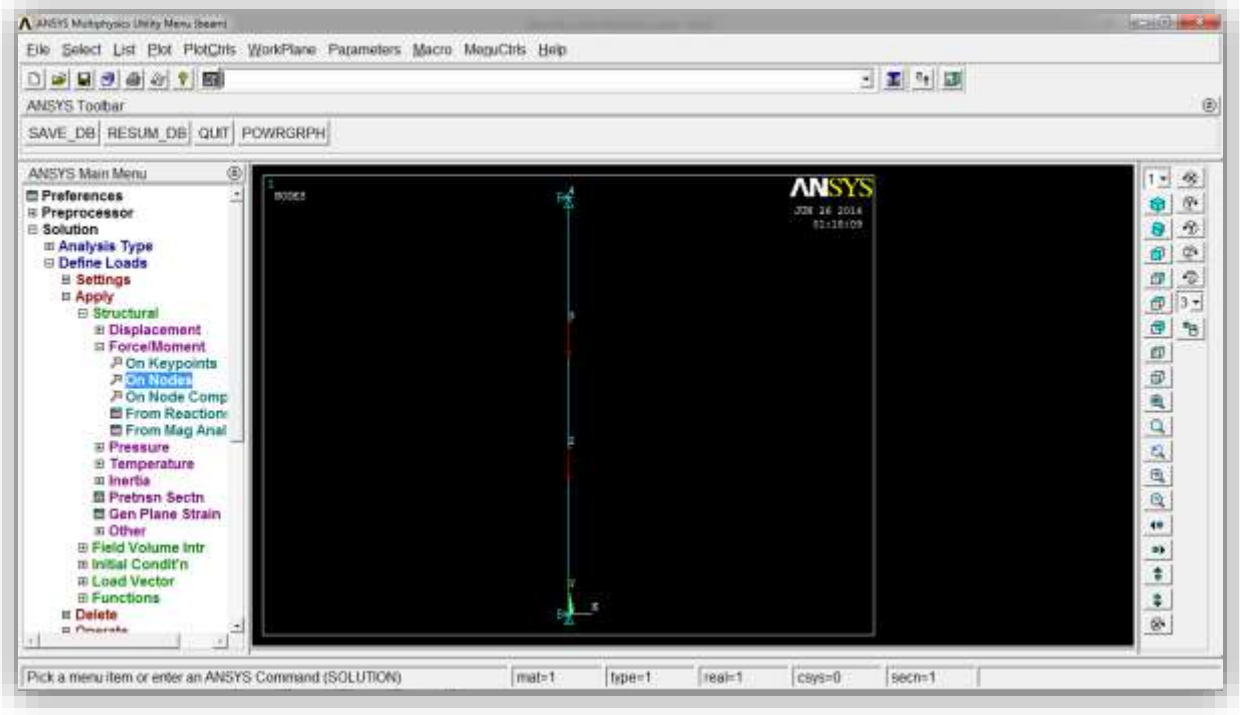


7th step:

We define the loads at node 2 and 3 with their value -1000 and -500 respectively. So we do by this way as shown in below:

Solution ≫ Define Loads ≫ Apply ≫ Structural ≫ Force/Moment ≫ On Nodes

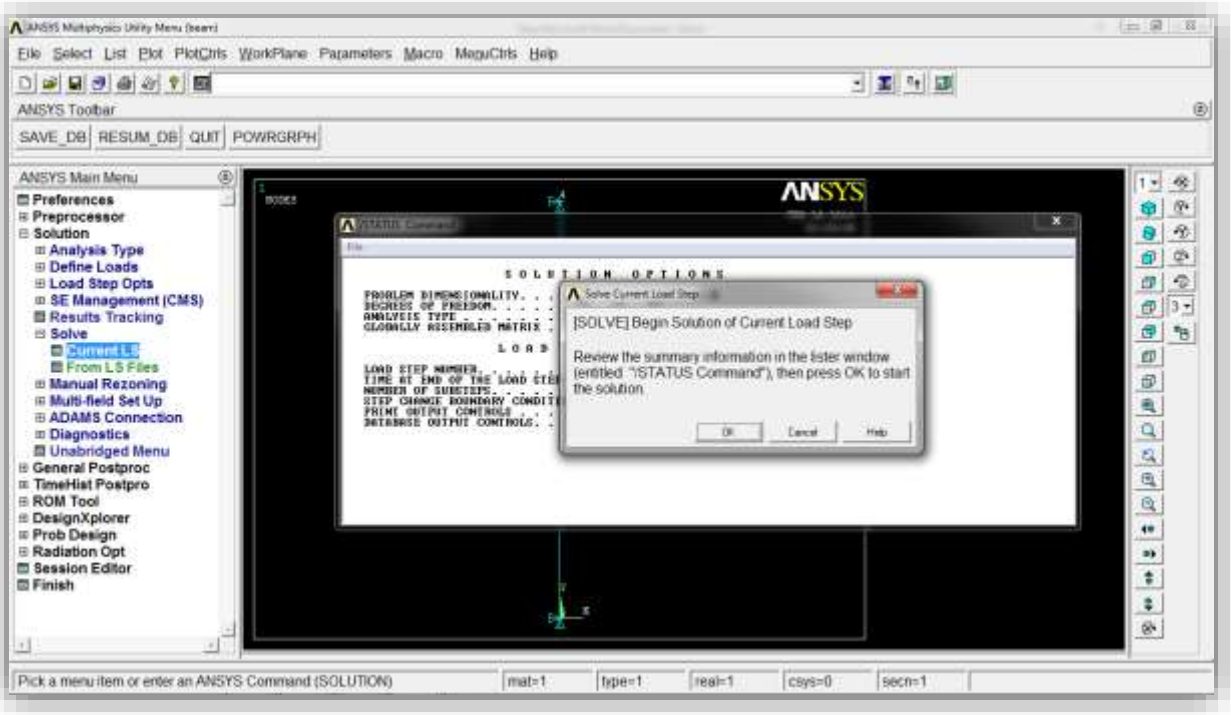


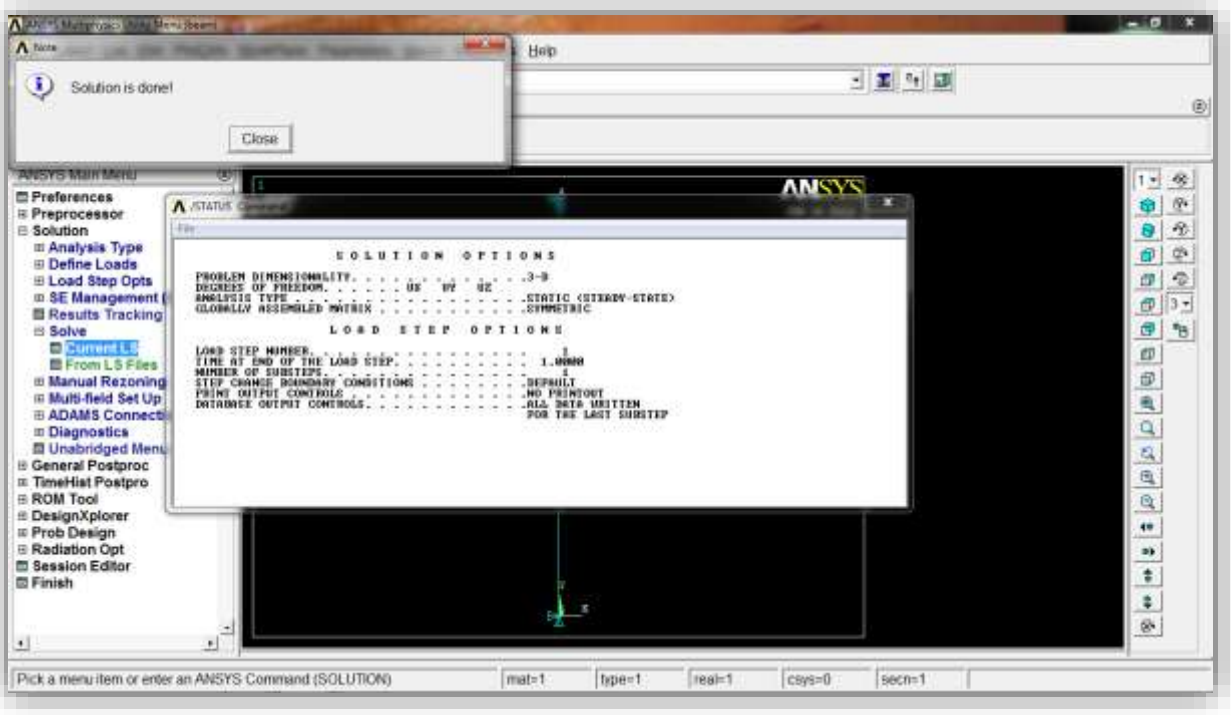


8th step:

Now, We solve the problem. Thus we do by the way as shown in below:

Solution ≫ Solve ≫ Current LS ≫ OK

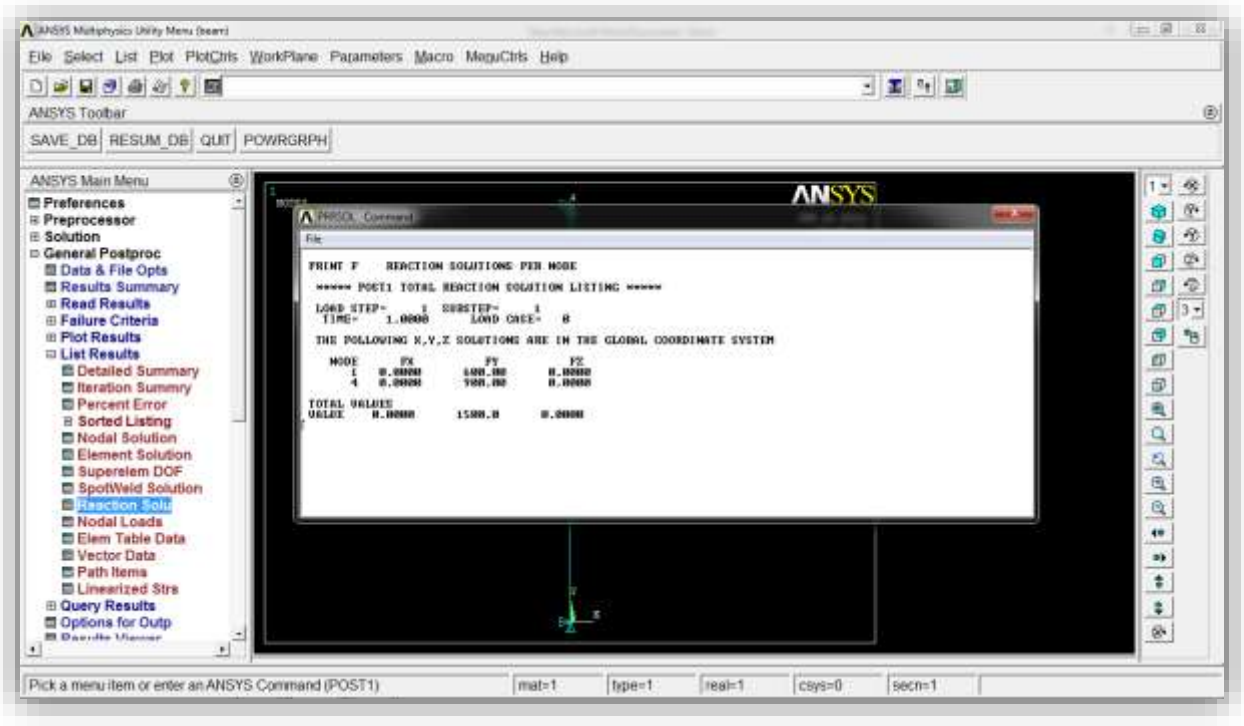




9th step:

Finally we read the result and obtain our answer. So for obtain the reaction force:

General Postproc ≫ List Results ≫ Reaction Solu

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PRINT F     REACTION SOLUTIONS PER NODE

  ***** POST1 TOTAL REACTION SOLUTION LISTING *****

  LOAD STEP=      1  SUBSTEP=      1
   TIME=     1.0000       LOAD CASE=    0

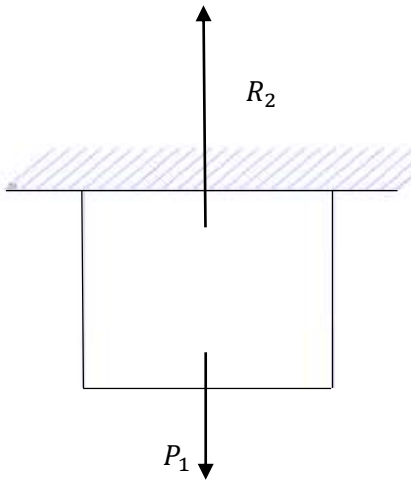
  THE FOLLOWING X,Y,Z SOLUTIONS ARE IN THE GLOBAL COORDINATE SYSTEM

    NODE        FX          FY          FZ
       1    0.0000       600.00      0.0000
       4    0.0000       900.00      0.0000

 TOTAL VALUES
 VALUE     0.0000       1500.0      0.0000
```

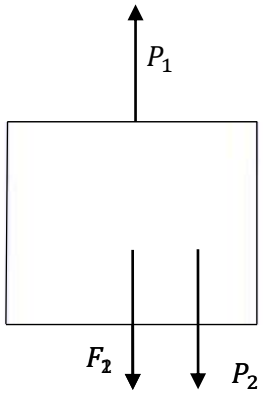
Numerical Analysis

$$\sum F_y = 0 \;\Rightarrow\; R_1 + R_2 = F_1 + F_2$$



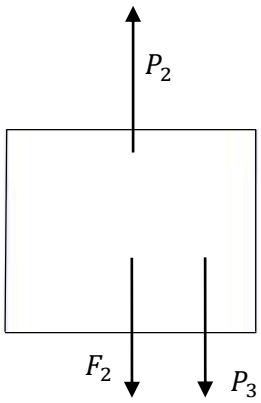
$$\sum F_y = 0 \;\Rightarrow\; P_1 = R_2$$

$$\Delta_1 = \frac{(R_2)a}{AE}$$



$$\sum F_y = 0 \;\Rightarrow\; P_2 = -F_1 + P_1 = -F_1 + R_2$$

$$\Delta_2 = \frac{(-F_1 + R_2)b}{AE}$$



$$\sum F_y = 0 \;\Rightarrow\; P_3 = -F_2 + P_2 = -F_1 - F_2 + R_2$$

$$\Delta_3 = \frac{(-F_1 - F_2 + R_2)(L - (a+b))}{AE}$$

$$\Delta_1 + \Delta_2 + \Delta_3 = 0 \Rightarrow R_2 = \frac{F_1 \times (L-a) + F_2\big(L - (a+b)\big)}{L} = \frac{1000 \times 7 + 500 \times 4}{10} = 900\ lb$$

$$R_1 = 600\ lb$$