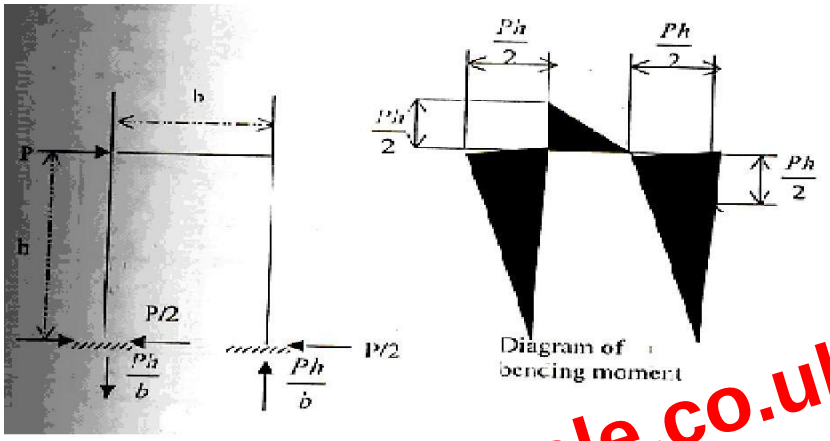
## EXPERIMENT NO. 4

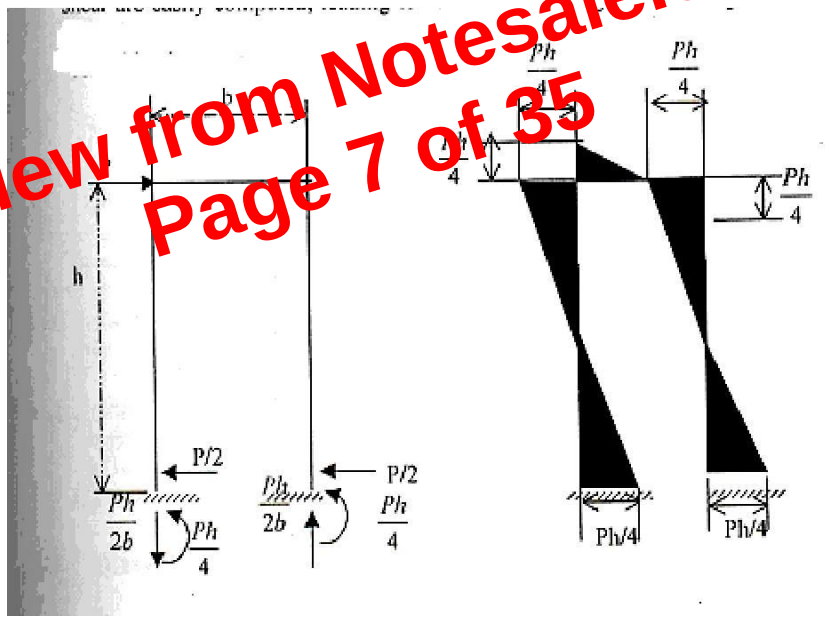
**Aim** : - To study the behavior of a portal frame under different end conditions.

**Apparatus:** - Portal Frame Apparatus, Weight's, Hanger, Dial Gauge, Scale, Verniar caliper.

**Formula** : - $P\,h/2 - R_{cy}\,b = 0,\ R_{cy} = ph/2b$

**Diagram:-**






**Theory** : - Structures are categorized as statically determinate or as statically indeterminate. Determinate structures can be analysed additional conditions to solve. The portal frame is an indeterminate structure to several degree of indeterminacy depending on the end conditions.

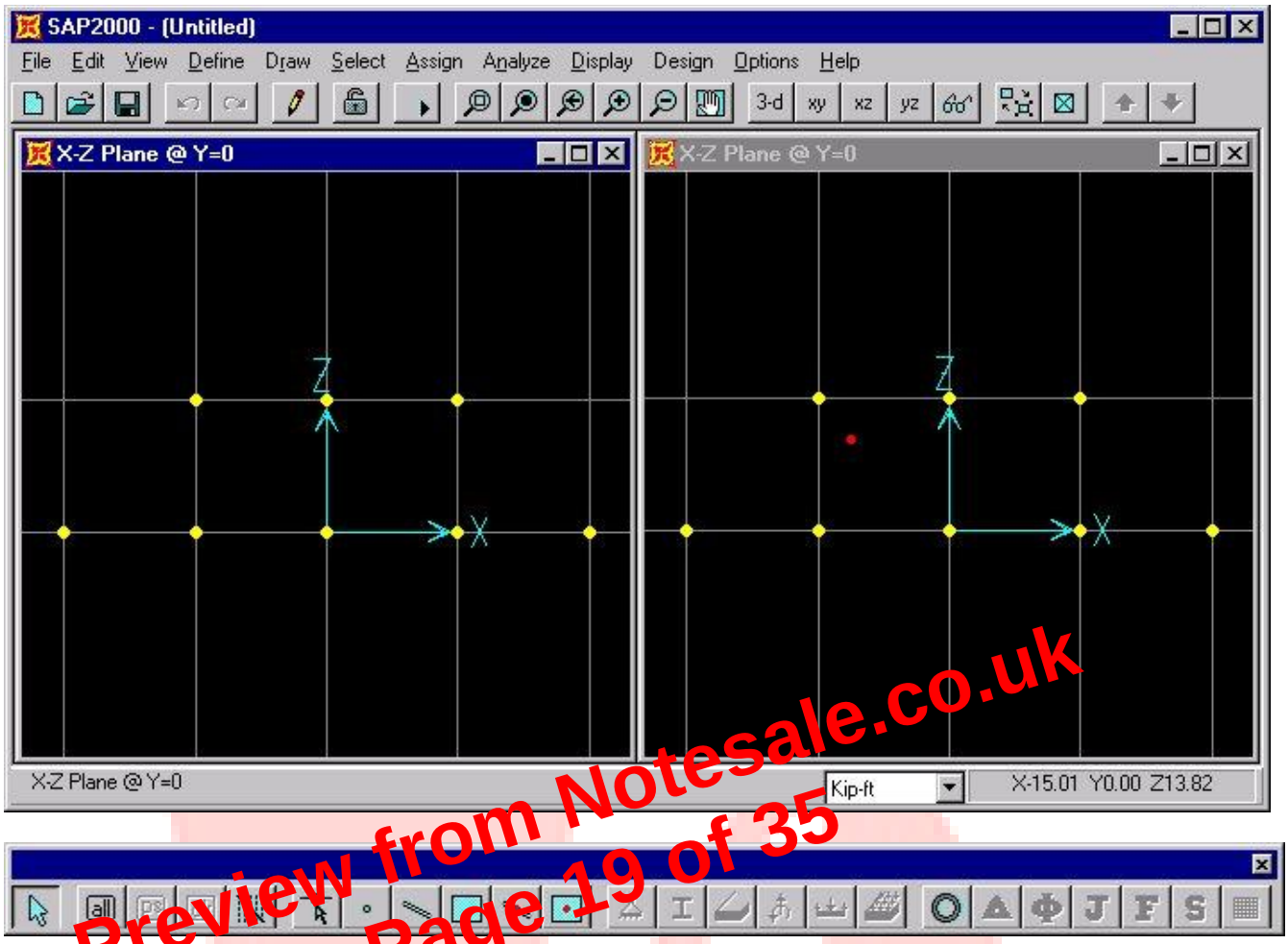
To know the behavior of any frame it is advisable to know its different deflected shapes under different loading condition, which can be obtained by vertical work energy method analytically.

Portal structures similar to the end portals of bridge have as their primary purpose, the transfer of horizontal loads applied at their top to their foundations. Clearance requirements usually lead to the use of statically indeterminate structure layout for portals, and approximate solutions are often used in their analysis.

Consider the portal shown in all the member of which are capable of carrying bending and shear as well as axial force. The legs are hinged at their base and rigidly connected to the cross girder at the top. This structure is statically indeterminate to the first degree; hence, one assumption must be made. Solution of this type of structure based on elastic considerations, show that the total horizontal shear on the portal will be divided almost equally between the two legs; it will therefore be assumed that the horizontal reactions for the two legs are equal to each other and therefore equal to $P/2^2$. The remainder of the analysis can now be carried out by statics .The vertical reaction on the right leg can be obtained by taking a moment about the hinge at the base of the left leg. The vertical reaction on the left leg can then be found by applying $\Sigma f_y = 0$ to the entire structure. Once the reactions are known, the diagrams of bending moment and shear are easily computed, leading to values for bending moment as given in fig (b). It is well to visualize the deformed shape of the portal under the action of the applied load.

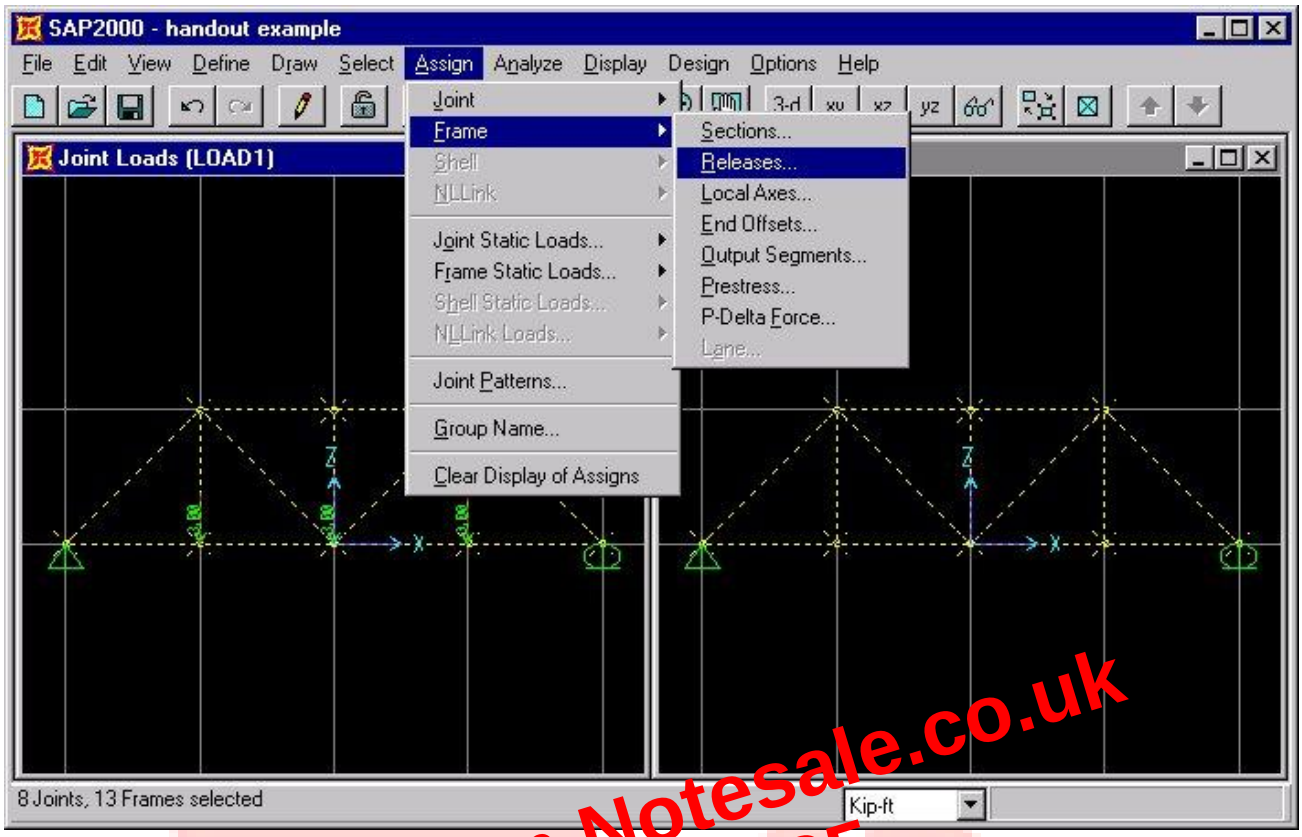


Consider now portal similar in some ways to of fig. (a) but with the bases of the legs fixed as shown in fig(c) This structure is statically indeterminate to the third degree, so that three assumptions must be made. As when the legs were hinged at their base, it will again be assumed that the horizontal reaction for the two legs are equal and hence equal to P/2. It will be noted that near the center of each leg there is point of reversal of curvature. These are points of inflection, where the bending moment is changing sign and hence has zero value.



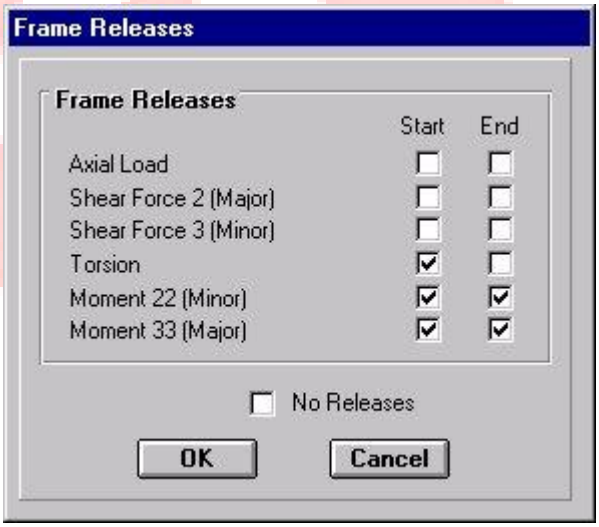



**Step 4: Draw Frame Elements -** To define each frame element, select the **Draw Frame Element** button on the lower tool bar. To define an element, click on a joint at the beginning of the element and than on the joint at the end of the element. To end a series of element definitions, simply double-click on the final joint. For this truss problem, the frame elements are shown below:

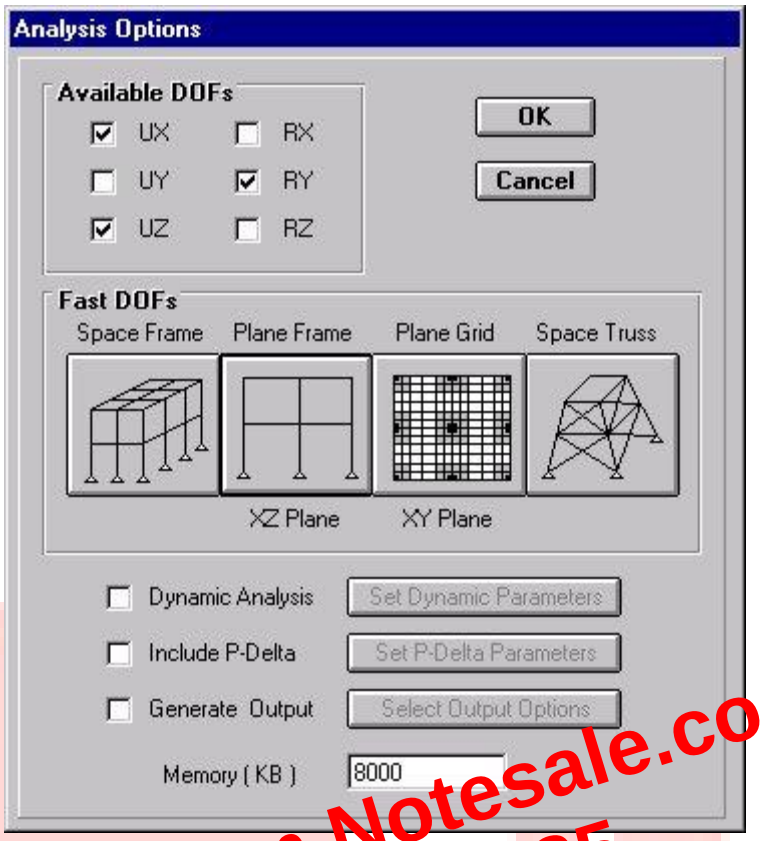





In this example, the structure is a truss, which by definition has no moment capacity at each joint. To release the moment capacity, click on the check boxes that are associated with the **Moment 22**, **Moment 33**, and **Torsion**. Torsion can only be released at one end of the element, whereas, the other moment must be released at both the **Start** and **End** of the element.




After the moments are released, the truss structure should appear in the SAP2000 interface window as follows:






To restrict SAP2000 to variables in the x-z plane, select the **Plane Frame** button and click **OK**. The truss structure is now ready for analysis. To analyze the model press the **Run Analysis** button  .

If the analysis is successful, the **Analysis Complete** window will appear and report the the analysis is complete. Click **OK** and the SAP2000 interface window will display an exaggerated deflected shape of the modeled structure.