Topic: Unstable Structure

Common Question:

In attempting to perform an analysis, I get "Unstable Structure." Do you have any suggestions on what to look for and how to resolve this problem?

Response

There are many reasons why structural analysis software such as MASTAN2 will indicate "Unstable Structure." Below are the primary ones. In reviewing these, please keep in mind that every node has six degrees of freedom (3 translation and 3 rotation) and all d.o.f. in a structural system must be restrained from moving freely. This restraint may be provided by elements connected to the node and/or by a support condition.

1. Suppose you intend to perform a 2D planar analysis and therefore have only provided properties and support conditions for a 2D planar analysis. However, when you go to run the analysis, the Analysis Type is incorrectly set to Space Frame or Space Truss, which is intended for a 3D analysis. To properly restrain the out-of-plane degrees of freedom and successfully perform you 2D analysis, set the Analysis Type to Planar Frame (x-y) or Planar Truss (x-y).

2. All nodes must be connected to at least one element. To see if you have any spurious or unrestrained nodes, under the Geometry menu select Remove Node(s). At the bottom menu select the All Unattached button. This will select any and all nodes that are not connected to an element. To delete these extra nodes, select Apply.

3. A minimum number of Section Properties must be defined. For a truss, the area A must be provided. To analyze a 2D planar frame, the area A and moment of inertia Izz must be defined (unless the member has been rotated, in which case Iyy is needed). For a 3D space frame, the area A, both moments of inertia Izz and Iyy, and torsion constant J must be provided (the warping coefficient Cw may be provided as desired but it is not required). To perform material nonlinear analyses, plastic section modulii Zzz and/or Zyy should also be provided.

4. A material with a non-zero E value must be attached to all elements. For a material nonlinear analysis, the yield strength Fy should also be included.

5. Elements are only connected if they share a common node. For example, if you would like to frame a beam into a column, the elements representing the column will need to provide a node for the element representing the beam to attach to. Likewise, for a brace to frame into a beam, the beam will need to be modeled by at least two elements in order to provide a common node for the element representing the brace to attach to it.

6. In defining a flexural connection as pinned, you must make sure that at least one element framing into the node at this connection is preventing the node's rotational degrees of freedom from spinning freely. In other words, avoid putting in pinned ends (moment releases) for all element ends framing into a common node. To model a pinned connection, put in pinned ends for all but one element (don't worry, it won't attract moment). Likewise at a support; be sure to provide some restraint so that the nodes rotational degrees of freedom cannot spin freely.