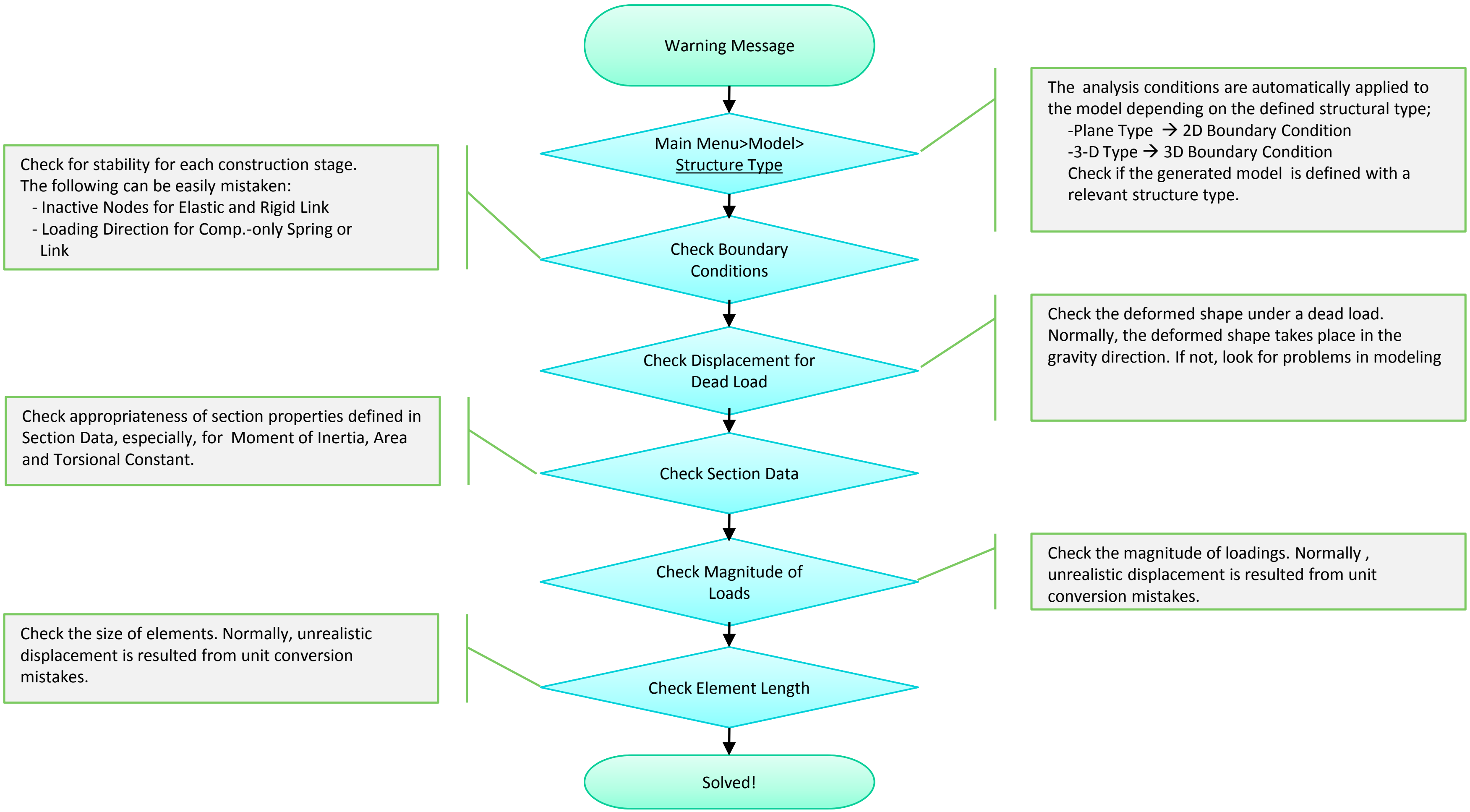
Troubleshooting
Common Singular/Large-Displacement Errors

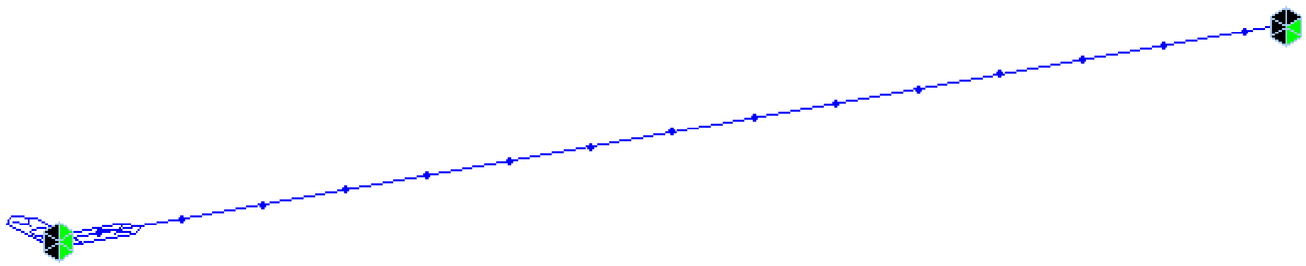
Caused by

Misuse of Boundary Conditions
Construction Stage Definition
Duplicate Elements
Improper Element/Node Coordinate
Improper Mesh Connectivity

Misuse of Boundary Conditions

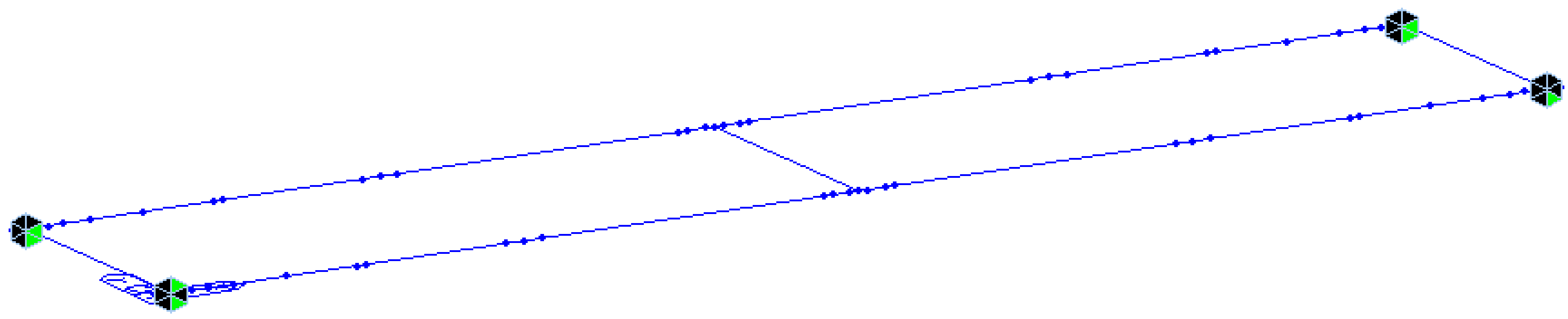


1. 3D Analysis Condition in 2D Analysis



Description

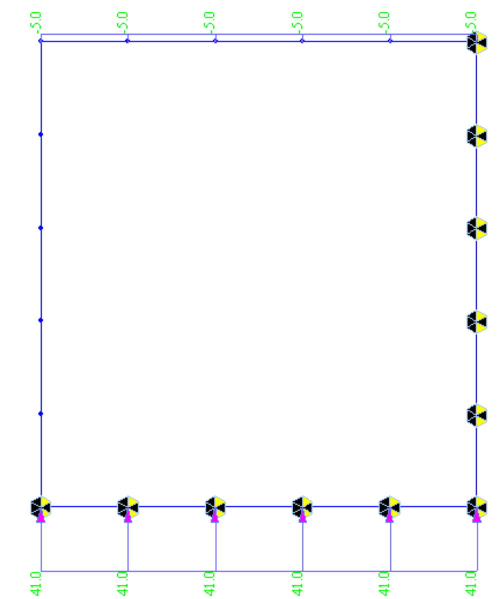
- The above model is a simple beam with a hinge and a roller support at each end. Loading is applied in the XZ plane. Therefore, the beam will behave in the 2D XZ plane only. In such a model, it is recommended to define XZ Plane for Structure Type to obtain proper analysis results.
- When Structure Model is defined in "XZ Plane" (Model>Structure Type), the user does not have to restrain the Y displacement and X, Z rotation dof's.
- However, for 3D Structure Type, which is the default option, the user needs to define additional boundary conditions to prevent instability from singular errors. The program recognizes the analysis model as a 3D structure although it is intended to behave only on the XZ plane. Therefore, Y displacement and X & Z rotation must be restrained.



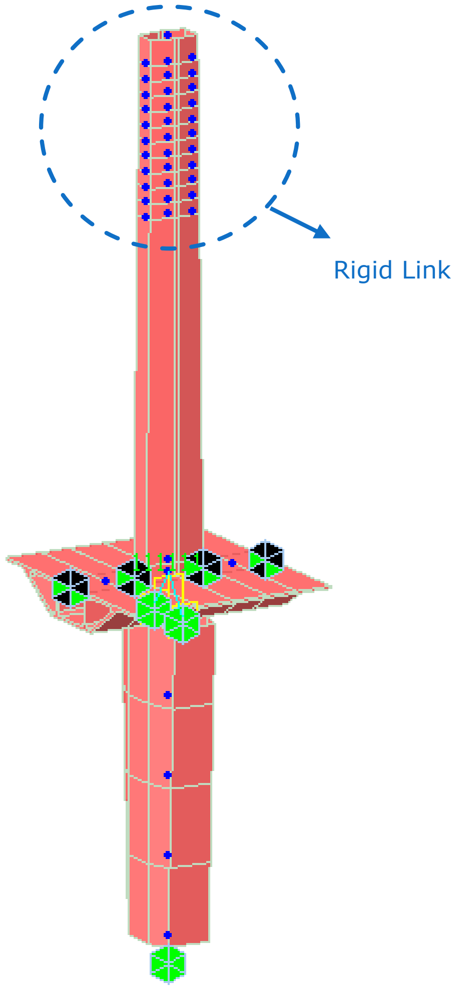
Description

- The above model is an example of 3D frame model, which is erroneously defined with XY Plane in “Model > Structure Type.” The reactions will be in the Z-direction. In this case, the model should have been defined as a 3D Structure.
- At times, such a structure is erroneously defined with XZ Plane in which case Y displacement and X & Z rotations are restrained automatically. The unintentional constraints will result in wrong output in Analysis.

Description

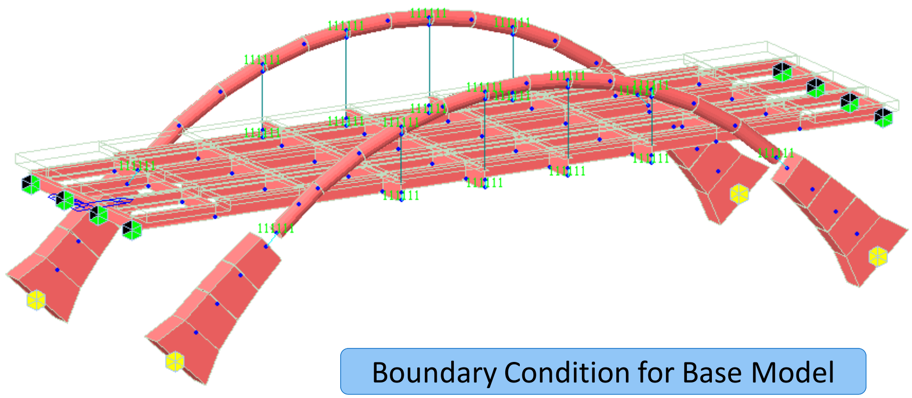


- This model is an underground structure, which is modeled with Comp.-only springs to consider the characteristic of soil supporting the structure.
- If the structure becomes subjected to uplift or active unbalanced soil pressure, the Comp.-only springs may be in tension.
- In addition to uplift and soil pressure, selfweight and other loads may be acting on the structure simultaneously. Therefore, it is meaningless to check tension forces in Comp.–only Springs for a single loading case such as uplift or active soil pressure.
- Load Combination results are also incorrect, as the incorrect load cases are combined. In order to obtain correct analysis results, simultaneously acting loads must be defined in a single load case.
- For this, midas Civil provide the following function: Load > Create Load Case Using Load Combinations. This function converts load combinations to load cases.
- When the function is used, the user must delete the individual load cases, which are used in the load combinations, to avoid singular error.

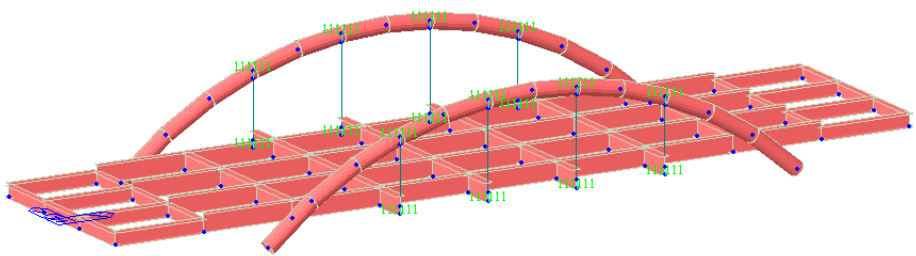


Description

- This model represents a construction stage at which the pier top is activated in a cable stayed bridge construction analysis. Attention is drawn to the blue marked nodes.
- Rigid Link is used to tie the pier top and the cables. It can be easily mistaken that the rigid links do not get activated when the pier top becomes activated based on the thinking that the cables are not installed at this stage. And a subsequent error is committed by activating the rigid links and the cables at the same time.
- With the error, no relationship exists between the master node and the slave nodes. That is, some displacement takes place at the master node while the slave nodes remain unchanged when the cables are activated because no relationship existed.
- As a result, the analysis model is incorrect because the master node has already displaced, and the cables are connected to the undisplaced slave nodes.



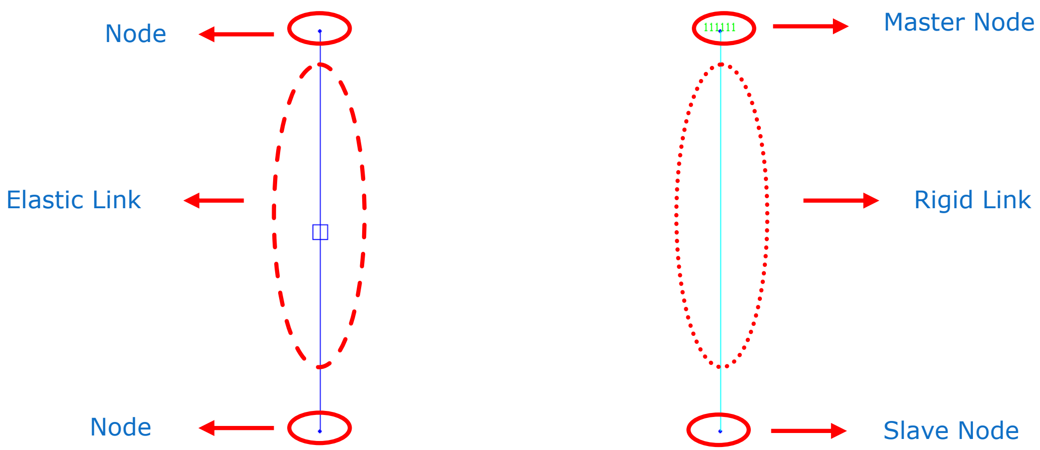
Boundary Condition for Base Model



Boundary Condition during Construction Stage

Description

- The top image shows the boundary condition for the base model.
- The bottom image shows an image at a construction stage of the structure, which contains no boundary condition resulting in structural instability.
- It is important to check that boundary conditions at each construction stage are defined (activated) to maintain structural stability.



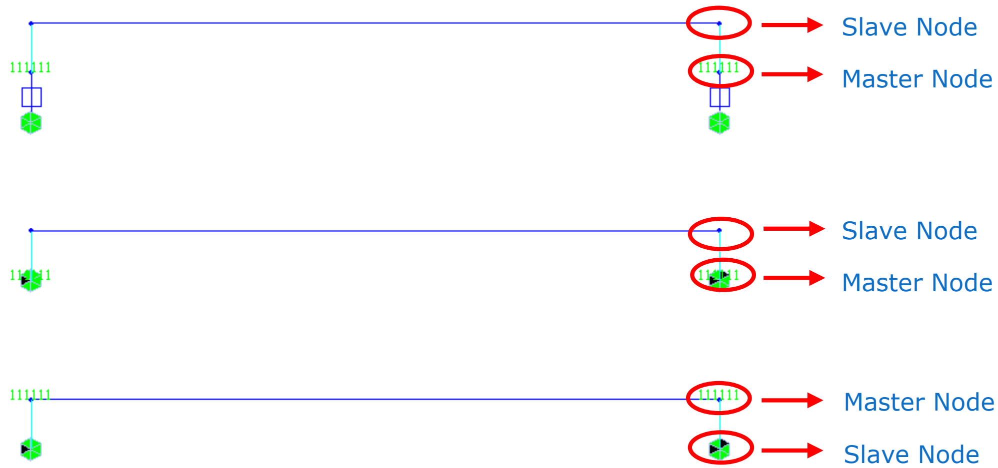
Description

- This type of error is often encountered when boundary conditions are defined using Elastic Link or Rigid Link during construction stage analysis.
- Often, the user does not activate nodes to which Elastic Link or Rigid Link is connected when the link elements are activated. As a result. the links are not actually activated.
- Therefore, nodes to which Elastic Link or Rigid Link is connected must be activated at a previous stage or at the same stage that the link elements are activated.

Model 1 : OK

Model 2 : Improper

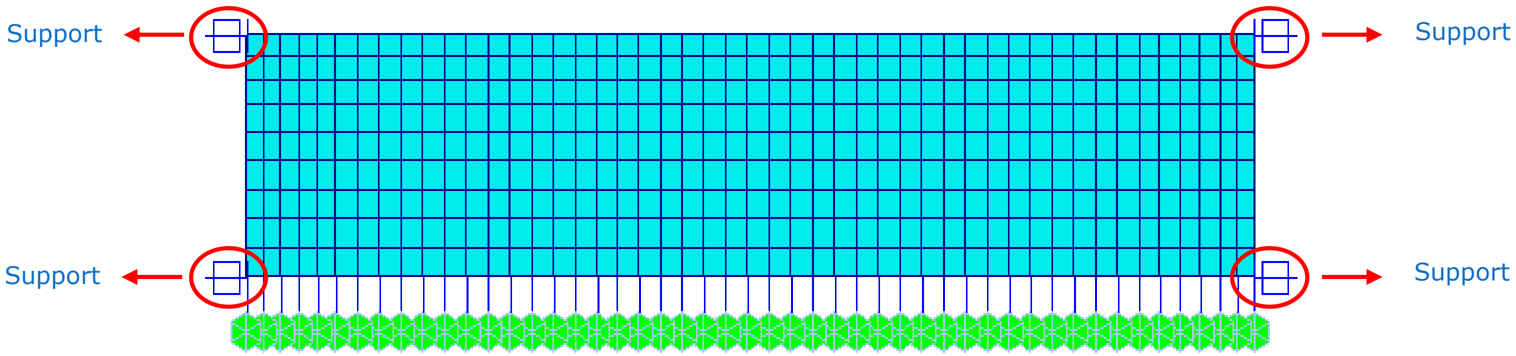
Model 3 : Improper



Description

- Model 1 is defined with a correct boundary condition (Rigid Link → Elastic Link → Support).
- In Model 2, the support boundary condition is applied to the Master Node of Rigid Link. This results in applying the support boundary condition to both Master and Slave Nodes. This must be avoided.
- In Model 3, the support boundary condition is applied to the Slave node. Since the Slave node is constrained by the Master node, the boundary condition at the Slave Node will be ignored.

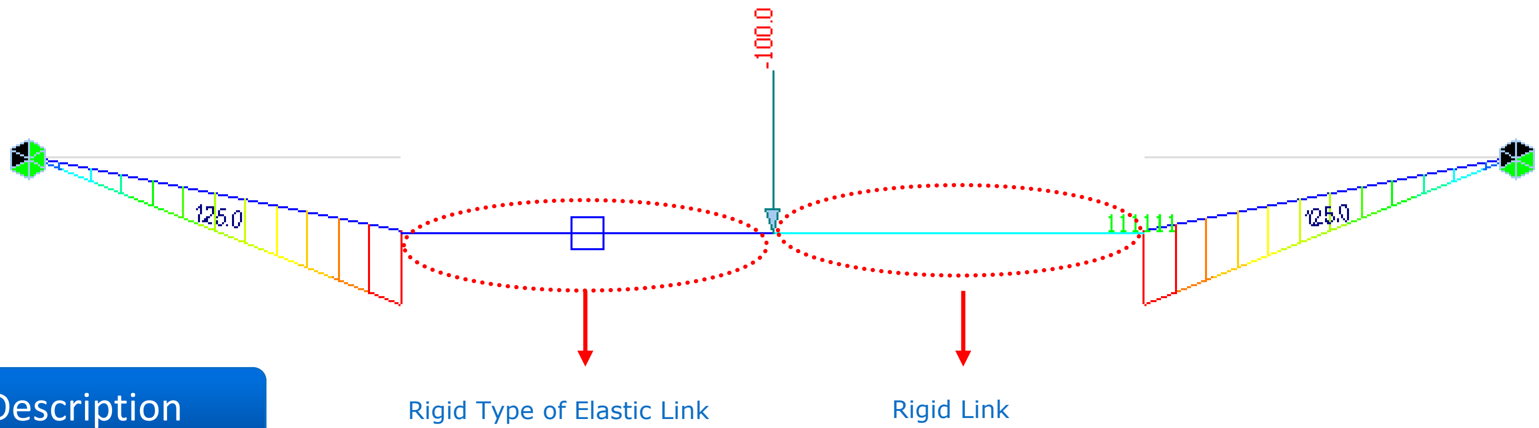
8. Elastic Link + Support



Description

- The model results in singular errors where Elastic Link has not been assigned boundary conditions.
- In such a case, the links will be considered as beam elements having the equivalent stiffness.
- In order to correct this, the ends of the elastic links must be assigned proper boundary conditions or Point Spring Support.

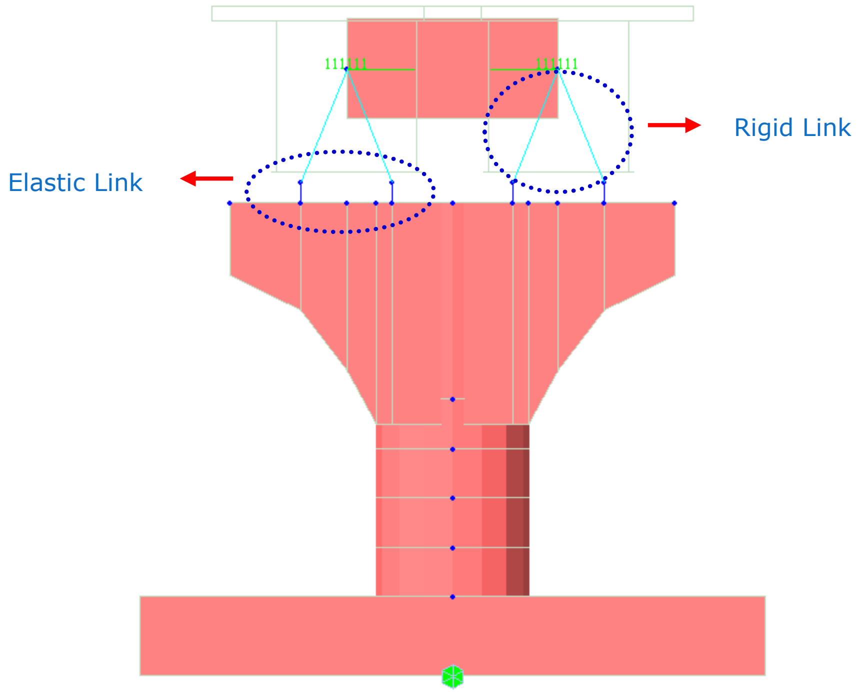
9. Rigid Type Elastic Link vs. Rigid Link



Description

- Rigid Type of Elastic Link and Rigid Link are similar in that both are used to simulate rigid behavior. However, the user must be cautious in using them because their internal processes are different in the program.
- The Rigid Type of Elastic Link is treated as an element which has the stiffness of 100,000 times the maximum stiffness among the frame members. However, such exceptionally large stiffness may cause a numerical error because of the relatively high stiffness of the link element.
- Therefore, when the model contains an element, which has large stiffness to replicate a rigid action, it is recommended that Rigid Link be used rather than Rigid Type Elastic Link.
- Rigid Link geometrically constrains the relative movements between the Master and Slave Nodes without being affected by large stiffness of other members.

10. Stiffness of Elastic Link in Seismic Analysis



Description

- When super and sub structures are modeled together, Elastic Link is used to define moving directions of the bearing.
- Large stiffness such as the magnitude of 10,000,000tf/m is input to reflect Elastic Link stiffness in the constrained directions. However, the stiffness of Elastic Link in the constrained directions varies depending on the stiffness of the members constituting the model.
- The user thus goes through a trial and error process to find suitable stiffness for the model to reflect the effects of restraints in each direction.