Stadium Truss Static Analysis

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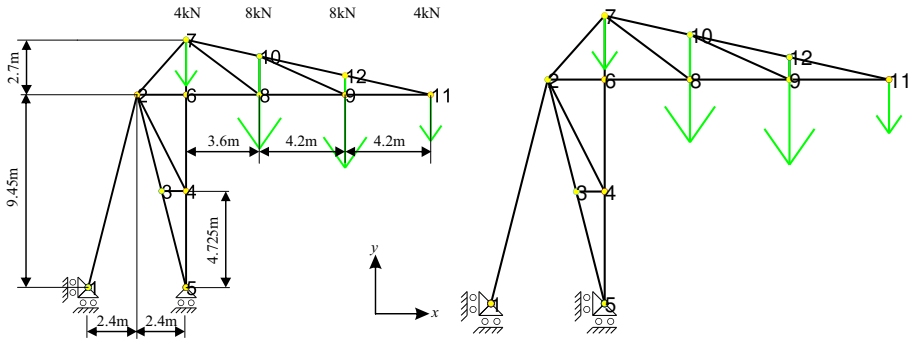
1 Problem Statement

An illustration of a truss, commonly used in stadiums, is provided in Figure. 1a. Prior to modeling, one may notice that the truss is statically indeterminate since node 5 can easily move in the x-direction. The instability of the truss can also be explained through the number of equations and unknowns. Let e be the number of elements and n the number of nodes. The total number of unknowns in the problem is the summation of force in each member ($e = 20$) and reaction forces at supports (here 3) which becomes 23. The number of equations for a truss in the two-dimension is $2 \times n = 2 \times 12 = 24$. Therefore, the number of equations is greater than the number of unknowns (24¿23). To transform the truss into a statically determinate truss, two approaches may be acquired.

- The node 5 x-degree-of-freedom should be restrained so that node 5 cannot move along the x-axis.
- A member should be added between node 1 and node 5.

In the following, the first strategy is implemented in the numerical model (see Figure. 1b).



(a) The indeterminate truss.

(b) The determinate truss.

Figure 1: The geometry, coordinate system and boundary conditions of the truss.

2 Numerical Model

The present problem is modeled as a linear elastic problem due to the absence of contact. In addition, the boundary condition is not a function of time. The displacement is assumed to be infinitesimal and the stress-strain relation follows the Hooke's law.

2.1 Mechanical Properties

The numerical model unit is set to SI unit in meter. Table. 1 summarizes the mechanical properties of the truss members.

Table 1: Mechanical properties of the truss members.

Property	Symbol	Unit	Value
Young's modulus	E	Pa	2E11
Poisson's ratio	ν	-	0.3
Area	A	m^2	1E-02

2.2 Solver

The solver for this problem is set to **Static, Linear perturbation** because the problem is a static analysis and can be solved within a single step.

2.3 Mesh Study

As a truss member is a tow-force member, the stress value all over the length of each member remains constant; hence, each member represents an element.

2.4 Element Type

The element type for this problem is T2D2 which is a 2-node linear two-dimensional truss element.

3 Result and Discussion

The deformed shape of the truss is given in Figure. 2. The blue and red color indicates the members under tension and compression, respectively.

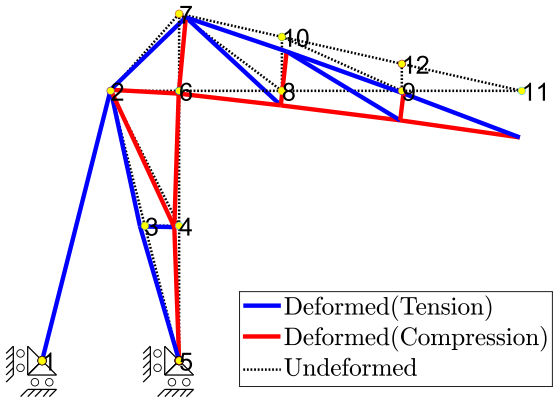


Figure 2: Unreformed state of the truss (Deformation scale factor=250).