Benchmark Example No. 1

Joint Deflection of Plane Truss

SOFiSTiK | 2024

VERiFiCATiON
BE1 Joint Deflection of Plane Truss

VERiFiCATiON Manual, Service Pack 2024-4 Build 27

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Front Cover

6th Street Viaduct, Los Angeles Photo: Tobias Petschke

Overview	
Element Type(s):	TRUS
Analysis Type(s):	STAT
Procedure(s):	
Topic(s):	
Module(s):	ASE
Input file(s):	truss.dat

1 Problem Description

The problem consists of a plane truss structure, as shown in Fig. 1. Determine the vertical deflection at the free node 8.

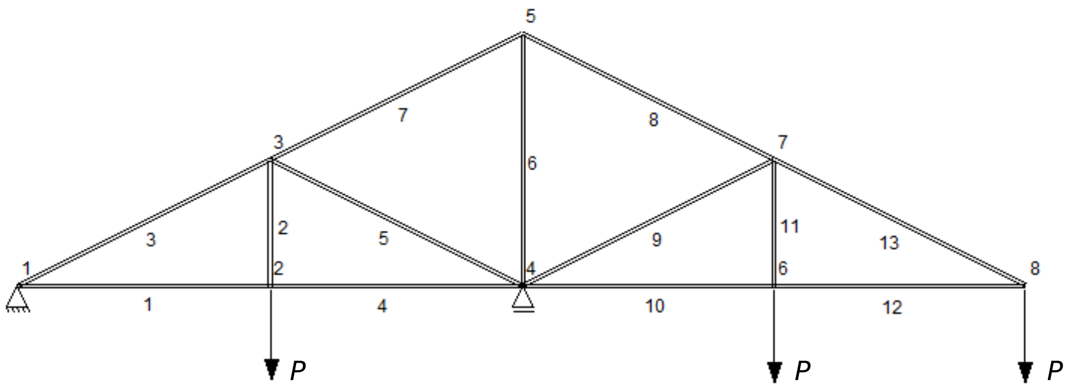

Figure 1: Problem Description

2 Reference Solution

The problem of determining the displacements of trusses can be treated in various ways. Popular among engineers, is to apply energy methods, e.g. the method of virtual work or Castigliano's theorem, to solve problems involving slope and deflection, that are based on the conservation of energy principle, and are more suitable for structures with complicated geometry such as trusses. Further information on this topic can be found in numerous engineering books, dealing with structural analysis [1].

3 Model and Results

The general properties of the model [2] are defined in Table 1. The total width of the truss is $60\ ft$, consisting of four spaces of $15\ ft$ each, and the total height is $15\ ft$. The load is applied equally at the three free nodes at the bottom of the truss. The results are presented in Table 2 and compared to the reference example [2]. Fig. 2 shows the deflections and the deformed shape of the structure.

Table 1: Model Properties

Material Properties	Geometric Properties	Loading
$E = 29\ 10^3\ ksi$	$l_{total} = 60\ ft = 18.288\ m$	$P = 20\ kip = 89.0\ kN$
$= 206842.773\ MPa$	$h_{total} = 15\ ft = 4.572\ m$	

Table 1: (continued)

Material Properties	Geometric Properties	Loading
$\nu = 0.3$	$l_2 = l_{11} = 7.5\,ft = 2.286\,m$	
	$l_1 = l_4 = l_6 = l_{10} = l_{12} = 15\,ft = 4.572\,m$	
	$A_1 = A_4 = 2\,in^2 = 12.90\,cm^2$	
	$A_2 = A_{11} = A_{10} = A_{12} = 1\,in^2 = 6.45\,cm^2$	
	$A_5 = A_9 = 1.5\,in^2 = 9.68\,cm^2$	
	$A_3 = A_6 = 3\,in^2 = 19.35\,cm^2$	
	$A_7 = A_8 = 4\,in^2 = 25.81\,cm^2$	

Table 2: Results

	SOF.	Ref. [2]	$\lvert e_r \rvert$ [%]
δ_8 $[mm]$	69.11	69.09	0.036

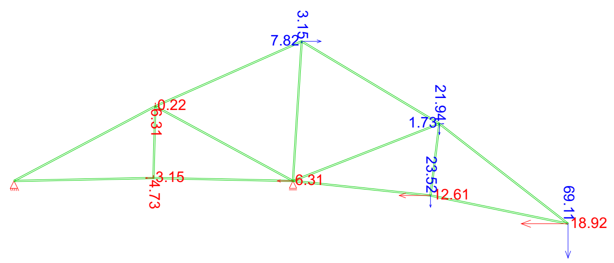

Figure 2: Problem Description

4 Conclusion

This example verifies the deflection of trusses. It has been shown that the behaviour of the truss is accurately captured. It should be noted that in the reference example [2] the deflection in inches was rounded to two decimal places, which leads to a higher relative error in Table 2. When comparing the SOFiSTIK result with an analytical solution rounded to four decimal places, the relative error decreases to 0.0004%.

5 Literature

[1] R. C. Hibbeler. *Structural Analysis*. 8th. Prentice Hall, 2012.
[2] J. C. McCormac. *Structural Analysis*. Wileys & Sons, 2007.