GeoStudio Example File Verification – bars in a truss

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Introduction

The purpose of this example is to verify the behavior of bar elements in SIGMA/W when the structural elements are not connected to any other regular soil elements. All of the results are verified by comparison with hand-calculations.

Numerical Simulation

Figure 1 shows the problem configuration for this example.

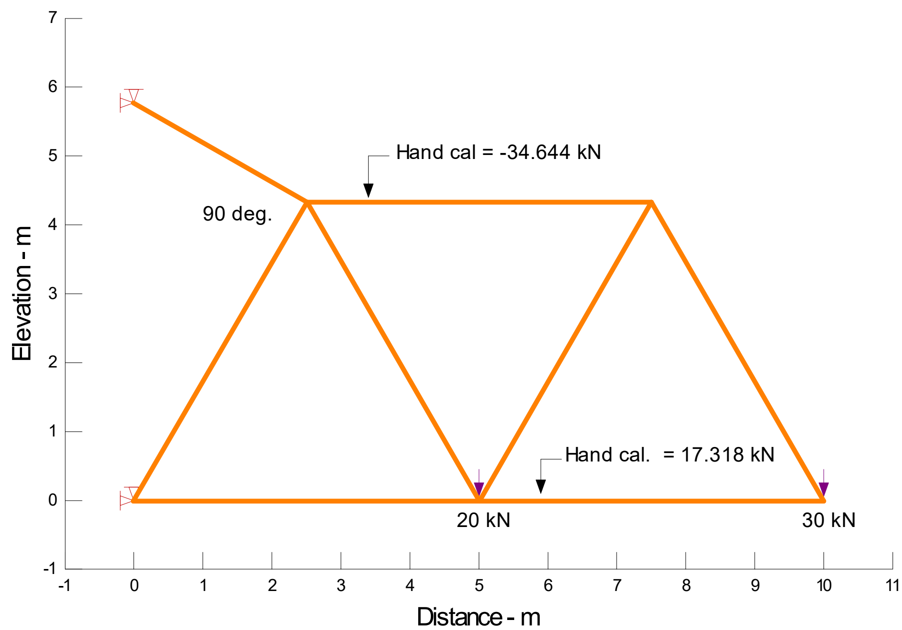


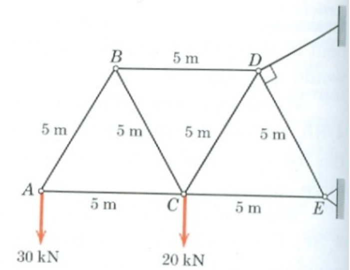
Figure 1. Problem configuration.

Results and Discussion

Using the View-Result Information command, reveals that all the SIGMA/W computed axial forces and boundary reactions match the hand-calculated values in the book example (Figure 2).

Sample Problem 4/1

Compute the force in each member of the loaded cantilever truss by the method of joints.

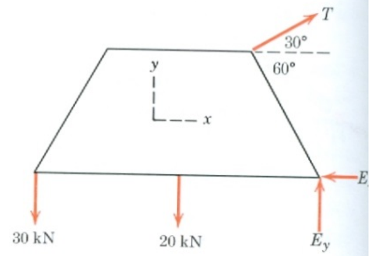


Solution. If it were not desired to calculate the external reactions at D and E, the analysis for a cantilever truss could begin with the joint at the loaded end. However, this truss will be analyzed completely, so the first step will be to compute the external forces at D and E from the free-body diagram of the truss as a whole. The equations of equilibrium give

$[\Sigma M_E = 0]$ $\quad 5T - 20(5) - 30(10) = 0 \qquad T = 80.0$ kN

$[\Sigma F_x = 0]$ $\quad 80.0 \cos 30° - E_x = 0 \qquad E_x = 69.3$ kN

$[\Sigma F_y = 0]$ $\quad 80.0 \sin 30° + E_y - 20 - 30 = 0 \qquad E_y = 10.0$ kN



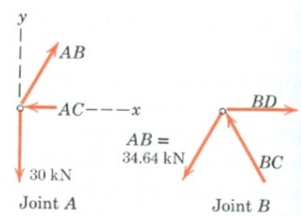
Next we draw free-body diagrams showing the forces acting on each of the connecting pins. The correctness of the assigned directions of the forces is verified when each joint is considered in sequence. There should be no question about the correct direction of the forces on joint A. Equilibrium requires

$[\Sigma F_y = 0]$ $\quad 0.866AB - 30 = 0 \qquad AB = 34.64$ kN T $\qquad$ *Ans.*

$[\Sigma F_x = 0]$ $\quad AC - 0.5(34.64) = 0 \qquad AC = 17.32$ kN C $\qquad$ *Ans.*

where T stands for tension and C stands for compression.

Joint B must be analyzed next, since there are more than two unknown forces on joint C. The force BC must provide an upward component, in which case BD must balance the force to the left. Again the forces are obtained from



$[\Sigma F_y = 0]$ $\quad 0.866BC - 0.866(34.64) = 0 \qquad BC = 34.64$ kN C $\qquad$ *Ans.*

$[\Sigma F_x = 0]$ $\quad BD - 2(0.5)(34.64) = 0 \qquad BD = 34.64$ kN T $\qquad$ *Ans.*

① Note that we draw the force arrow on the same side of the joint as the member which exerts the force. In this way tension (arrow away from the joint) is distinguished from compression (arrow toward the joint).

Joint C now contains only two unknowns, and these are found in the same way as before:

$[\Sigma F_y = 0]$ $\quad 0.866CD - 0.866(34.64) - 20 = 0$

$CD = 57.74$ kN T $\qquad$ *Ans.*

$[\Sigma F_x = 0]$ $\quad CE - 17.32 - 0.5(34.64) - 0.5(57.74) = 0$

$CE = 63.51$ kN C $\qquad$ *Ans.*

Finally, from joint E there results

$[\Sigma F_y = 0]$ $\quad 0.866DE = 10.00 \qquad DE = 11.55$ kN $\qquad$ *Ans.*

and the equation $\Sigma F_x = 0$ checks.

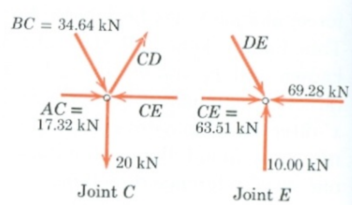


Figure 2. Excerpt from Meriam (1978) example.

Summary and Conclusions

This example compares simulated results in SIGMA/W to a textbook example (Meriam, 1978) of a loaded cantilever truss.

References

Meriam, J.L. 1978. *Engineering Mechanics – Statics and Dynamics*. John Wiley & Sons, SI Version. p. 134.