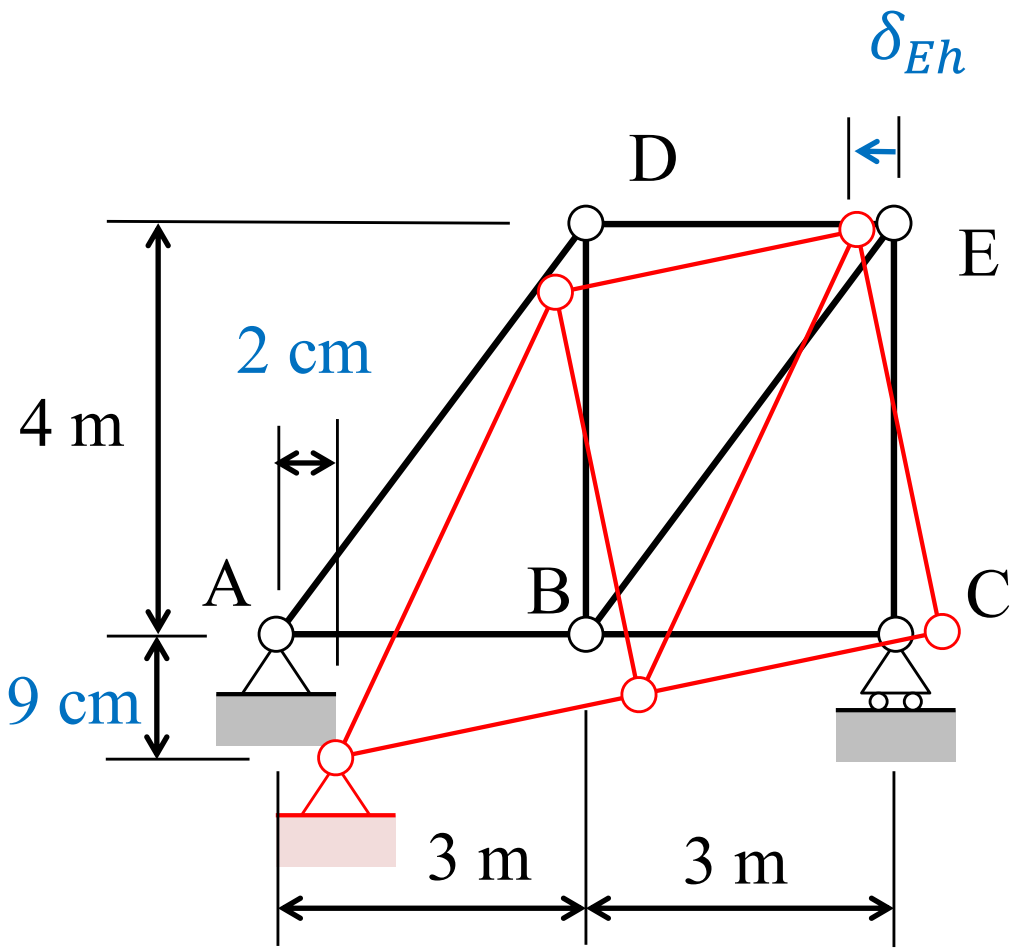
Virtual Work Truss Example
Support Settlement

Steven Vukazich
San Jose State University

Example Using the Principle of Virtual Work

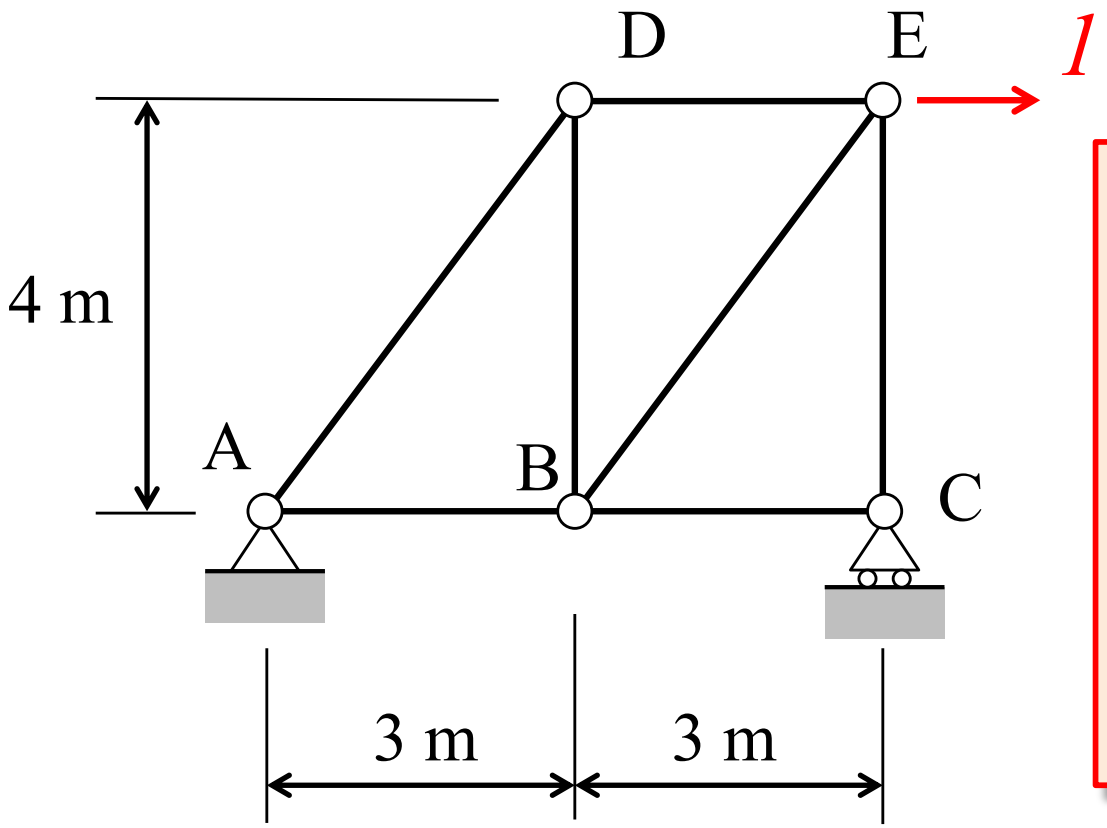


Consider the idealized truss structure with a pin support at A and a roller support at C.

Find the horizontal displacement of point E due to the pin support settling 9.0 cm and moving 2.0 cm to the right using the Principle of Virtual Work

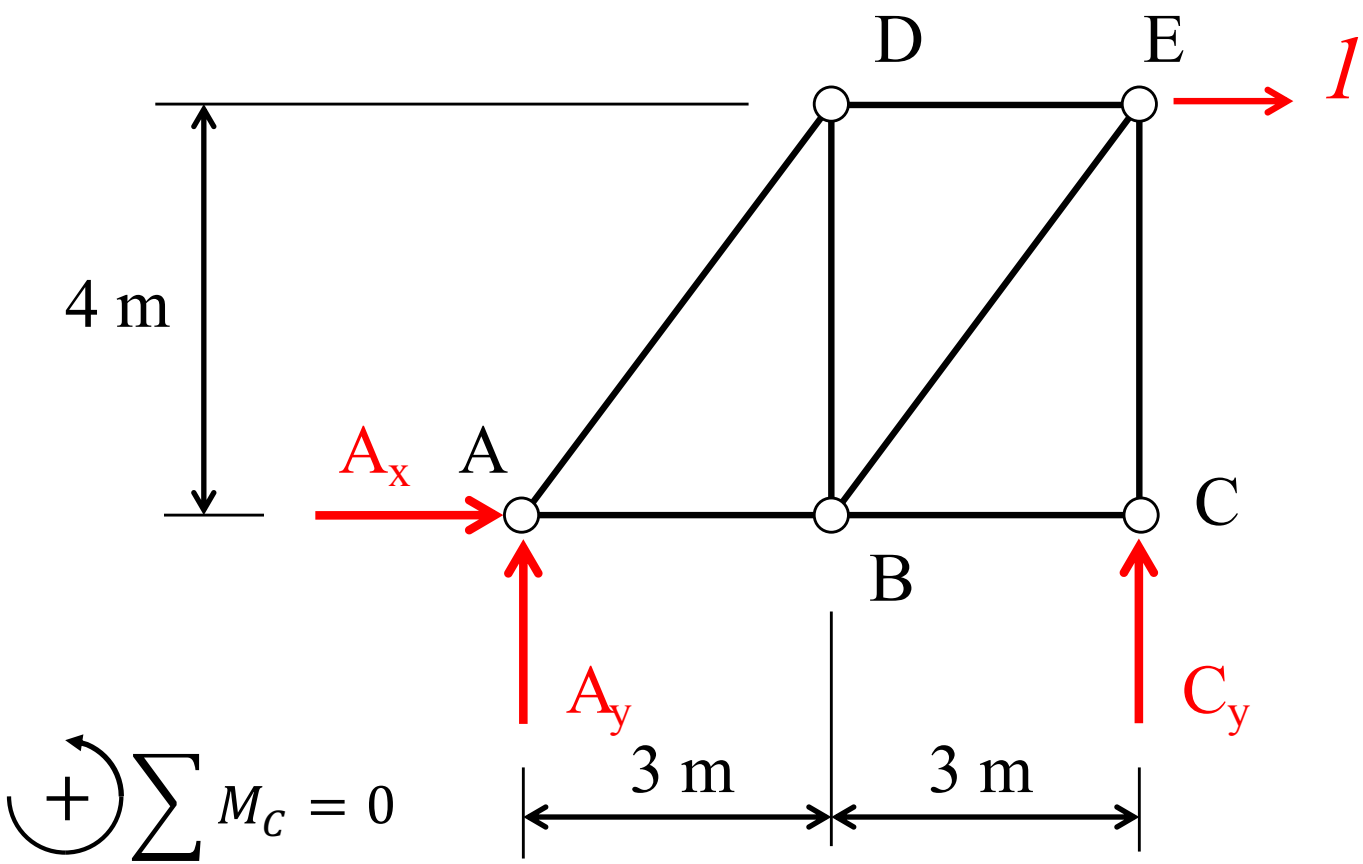
For all truss members use:
$A = 25\ \text{cm}^2$
$E = 210\ \text{GPa} = 210\ \text{kN/mm}^2$

Virtual System to Measure δ_{Eh}



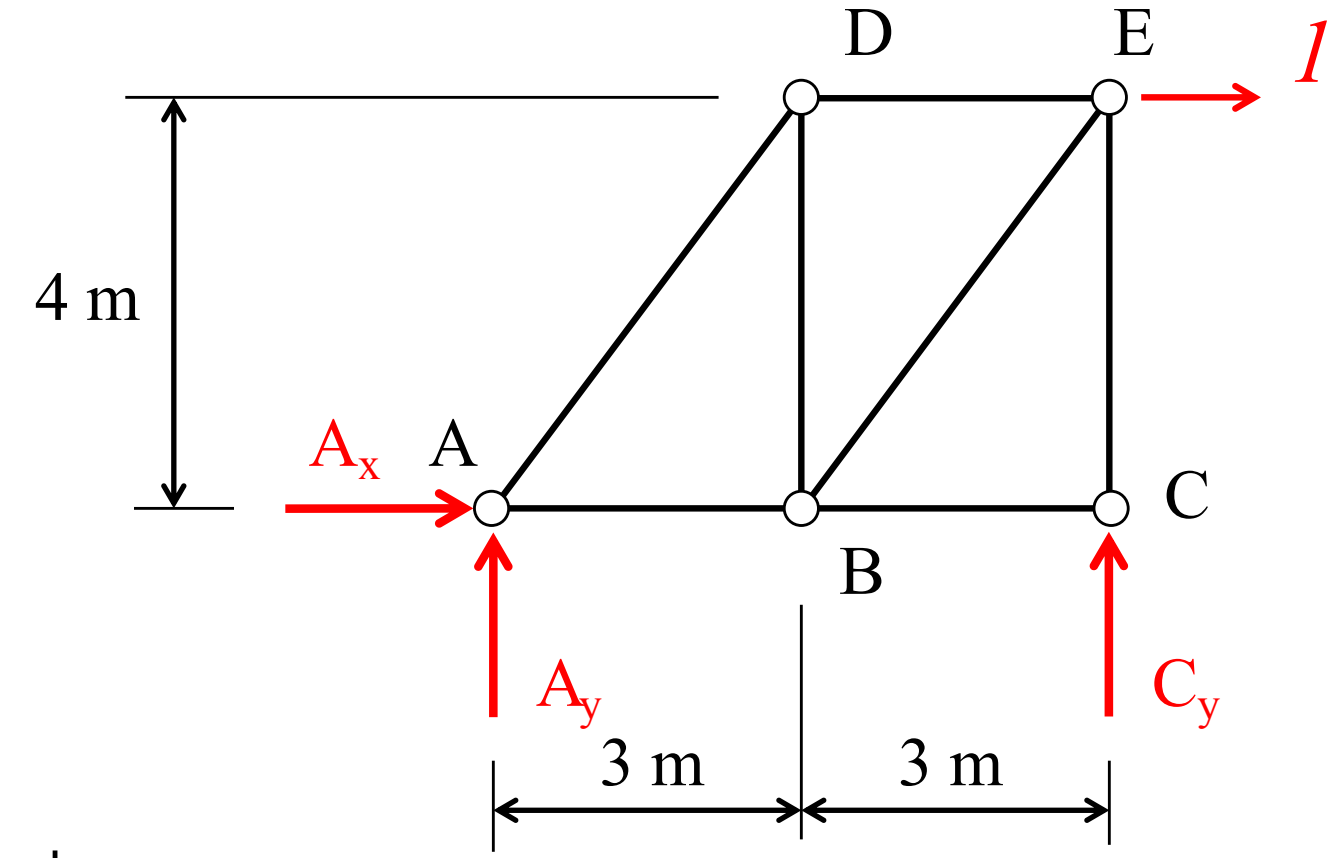
1. Remove all loads from the structure;
2. Apply a unit, dimensionless virtual load **in-line** with the real displacement, δ_{Eh}, that we want to find;
3. Perform a truss analysis to find all truss member support reactions, R_Q

Find Support Reactions



$A_y = -0.667$

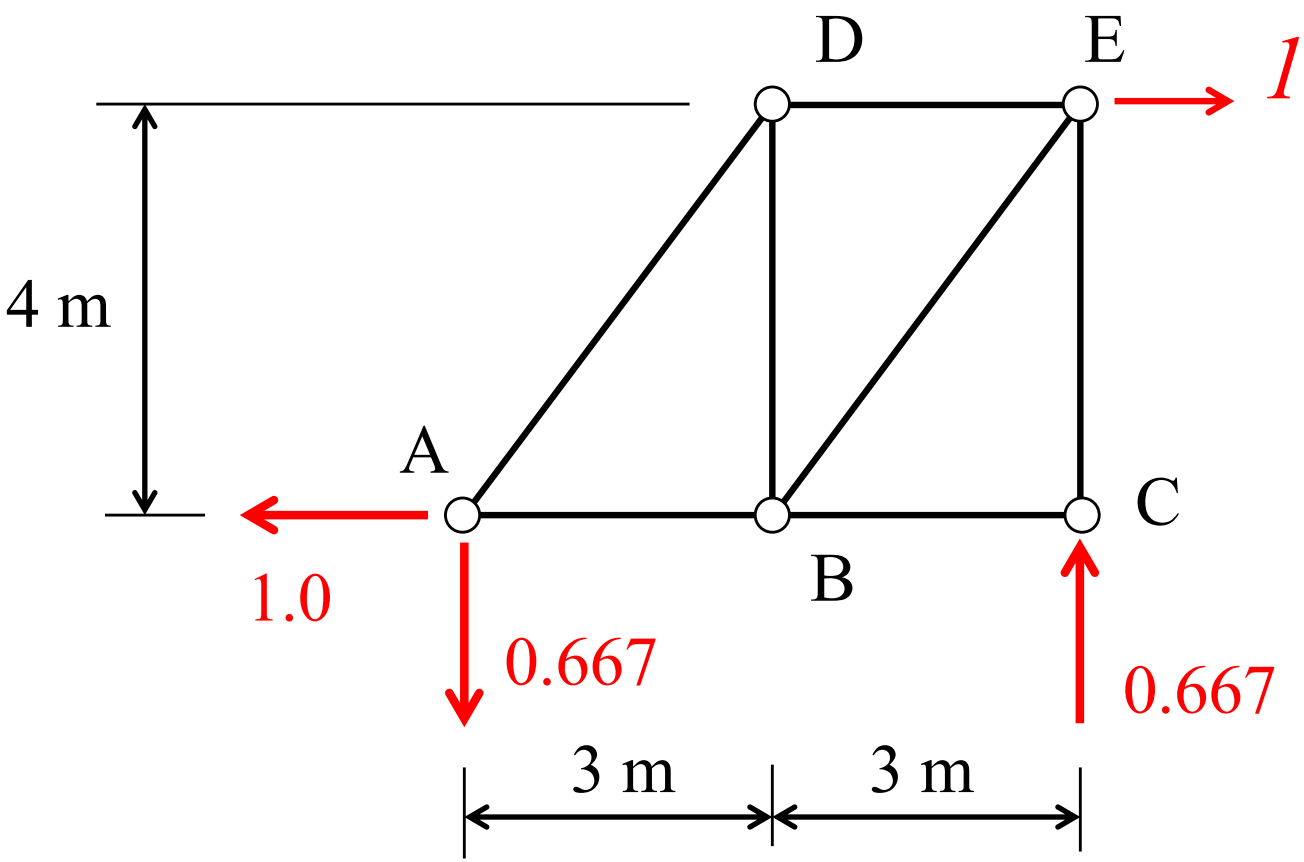
Find Support Reactions



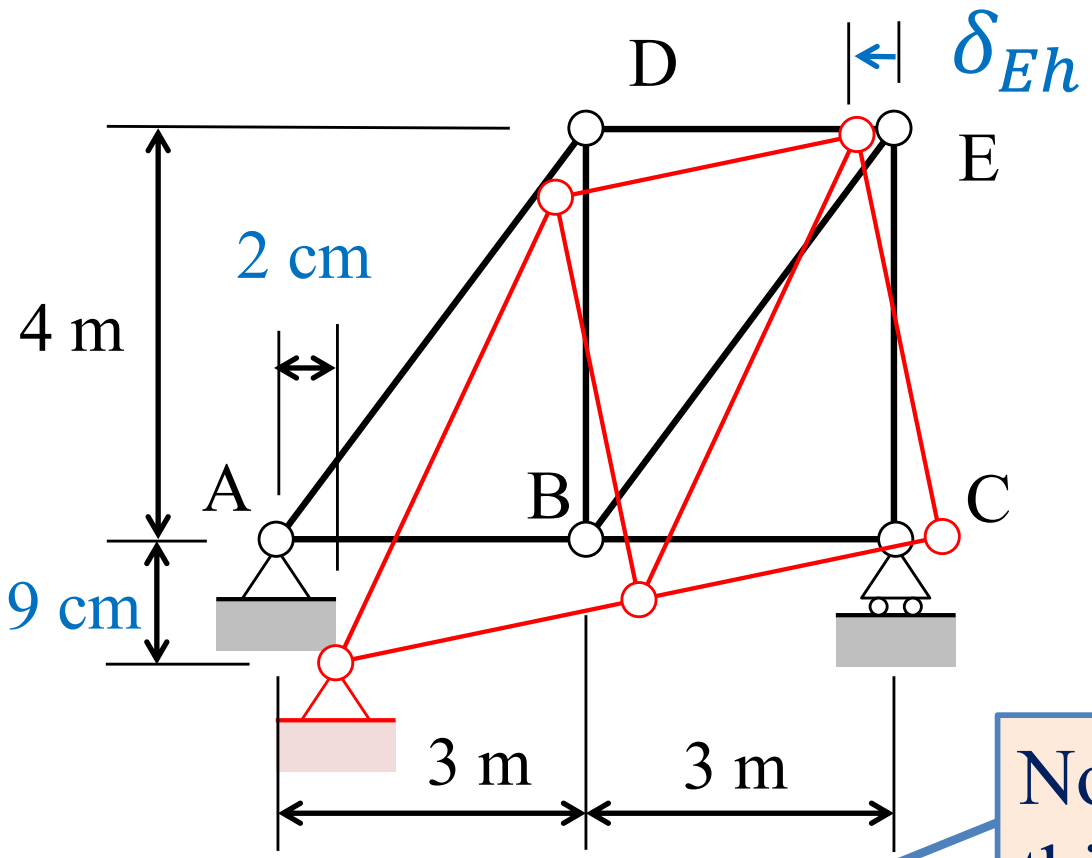
$$\xrightarrow{+} \sum F_x = 0$$

$A_x = -1.0$

Virtual System Support Reactions



Use the Principle of Virtual Work to Find δ_{Eh}



$$1 \cdot \delta_{Eh} + \sum R_Q \delta_s = 0$$

No internal work in this problem

From the virtual analysis

Evaluate the Virtual Work Expression

$$1 \cdot \delta_{Eh} + \sum R_Q \, \delta_s = 0$$

A_y and A_x are the support reactions in the virtual system

δ_{sv} and δ_{sh} are the real support movements

$$1 \cdot \delta_{Eh} + A_y \delta_{sv} - A_x \delta_{sh} = 0$$

Internal work is zero for this problem

δ_{sv} and A_y are in the same direction

δ_{sh} and A_x are in opposite directions

$$\delta_{Eh} + (0.667)(9.0 \text{ cm}) - (1.0)(2.0 \text{ cm}) = 0$$

$$\delta_{Eh} + 6.0 \text{ cm} - 2.0 \text{ cm} = 0$$

$$\delta_{Eh} = -4.0 \text{ cm}$$

Negative result, so deflection is in the opposite direction as the virtual unit load

$$\delta_{Eh} = 4.0 \text{ cm to the left}$$

Results for δ_{Eh}

$\delta_{Eh} = 4.0$ cm to the left