Analysis of a Two-Dimensional Body in Equilibrium

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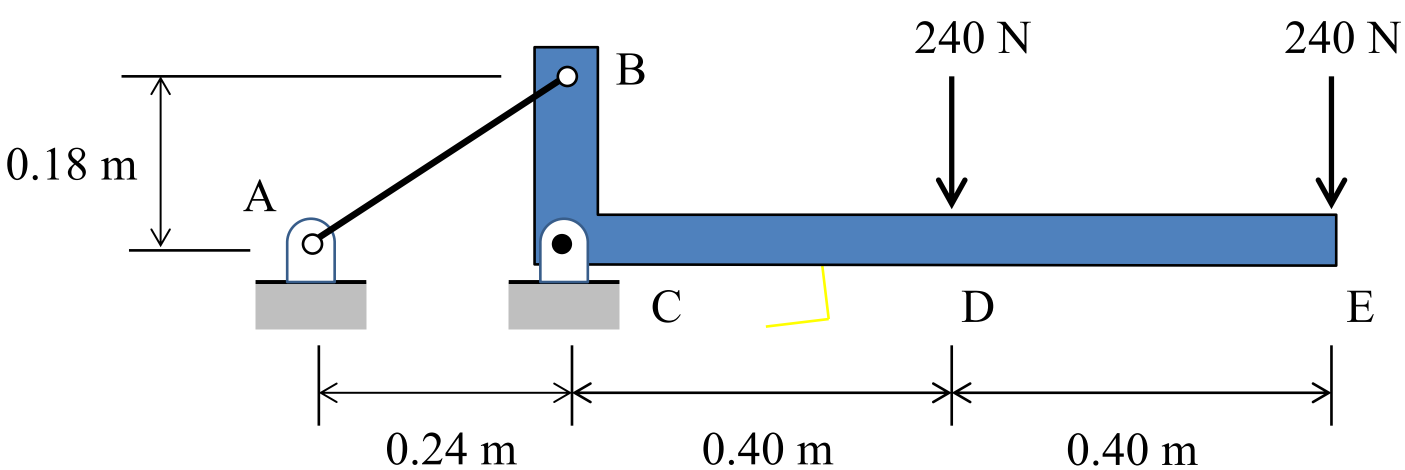
General Procedure for the Analysis of Bodies in Static Equilibrium

- Choose the free body to isolate;
- Draw a **Free Body Diagram (FBD)** of the body;
  - Isolate the body from all of its surroundings,
  - Magnitudes and directions of all known and unknown forces acting on the body should be included and clearly indicated,
  - Indicate dimensions on the FBD,
- Write the **equations of equilibrium** and solve the equations for the unknown quantities.

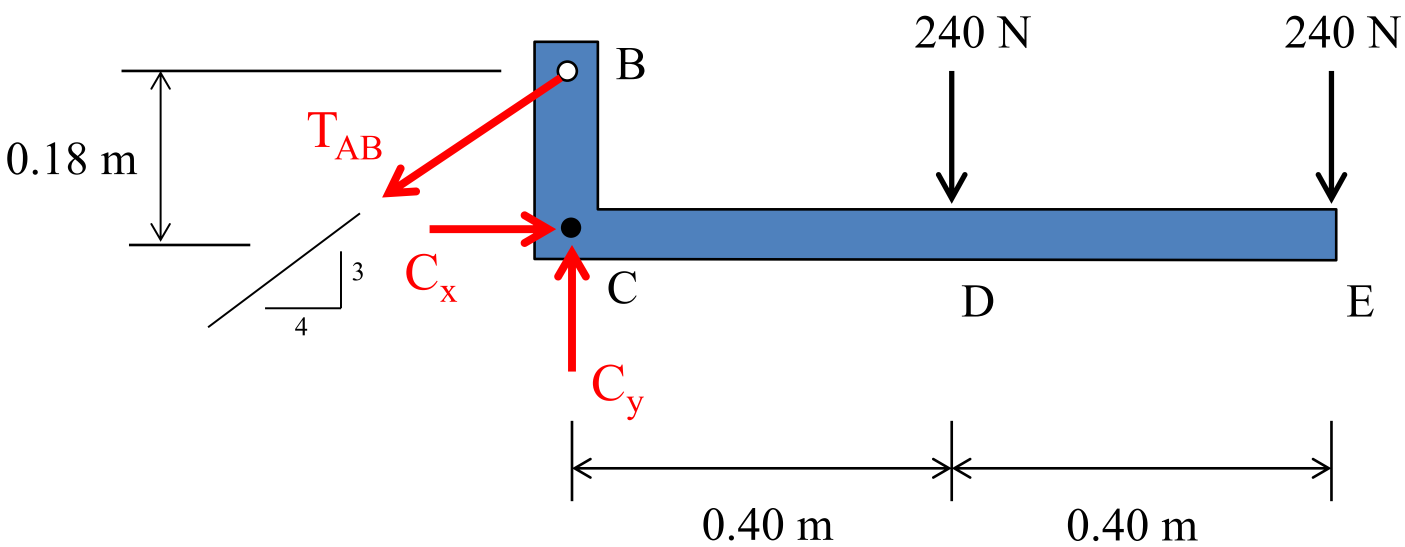
Two-Dimensional Statics Analysis Example

A light bracket is supported by a rod at point B, a pin support at point C, and subjected to point loads at points D and E as shown. Neglecting the weight of the bracket, determine:

- The axial tension in rod AB;
- The reaction at the pin support at C.



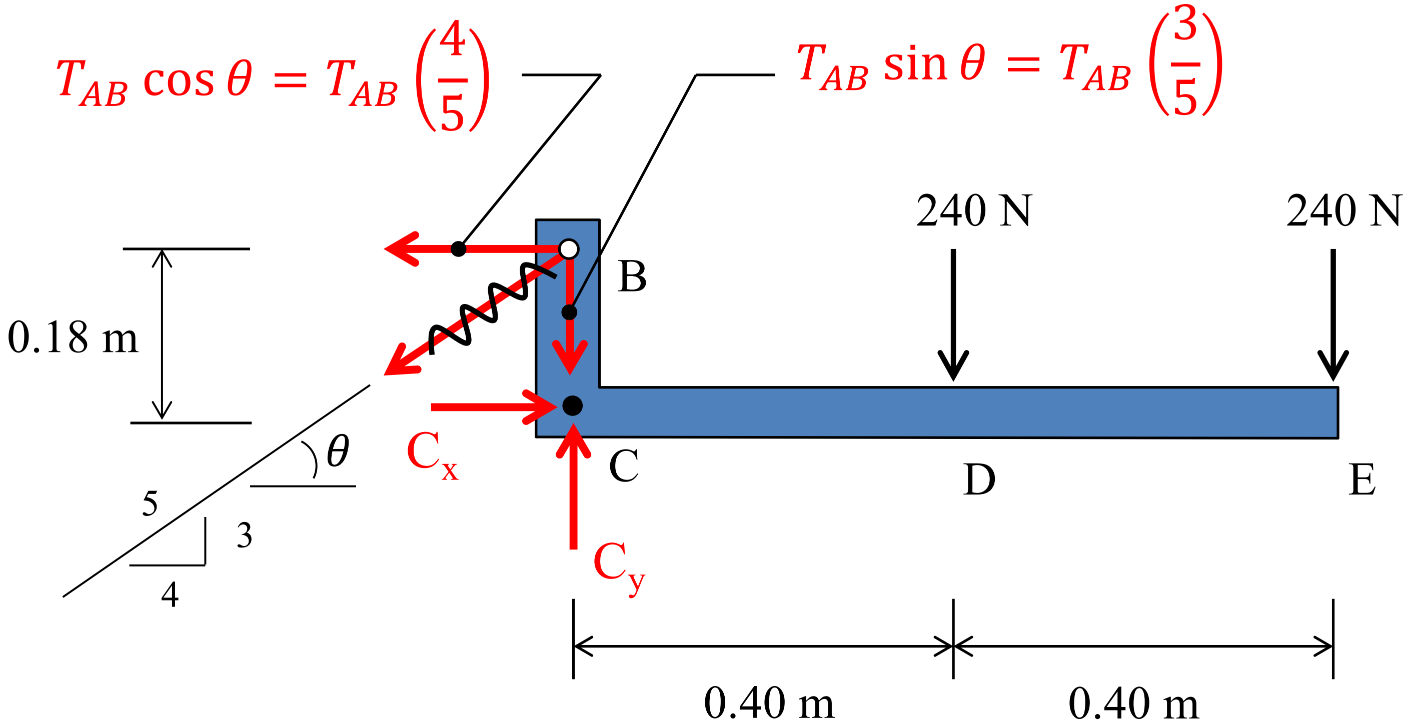
Free-Body Diagram of the bracket



Notes

- The dimensions, the line of action of the force T_{AB}, and the applied forces are known (shown in black text);
- The reaction force at the pin support at C is unknown and expressed as two unknown components (shown in red text);
- The senses of the unknown forces are guesses at this point;
- There are 3 total unknowns and we have 3 equations of equilibrium available to solve for the unknowns.

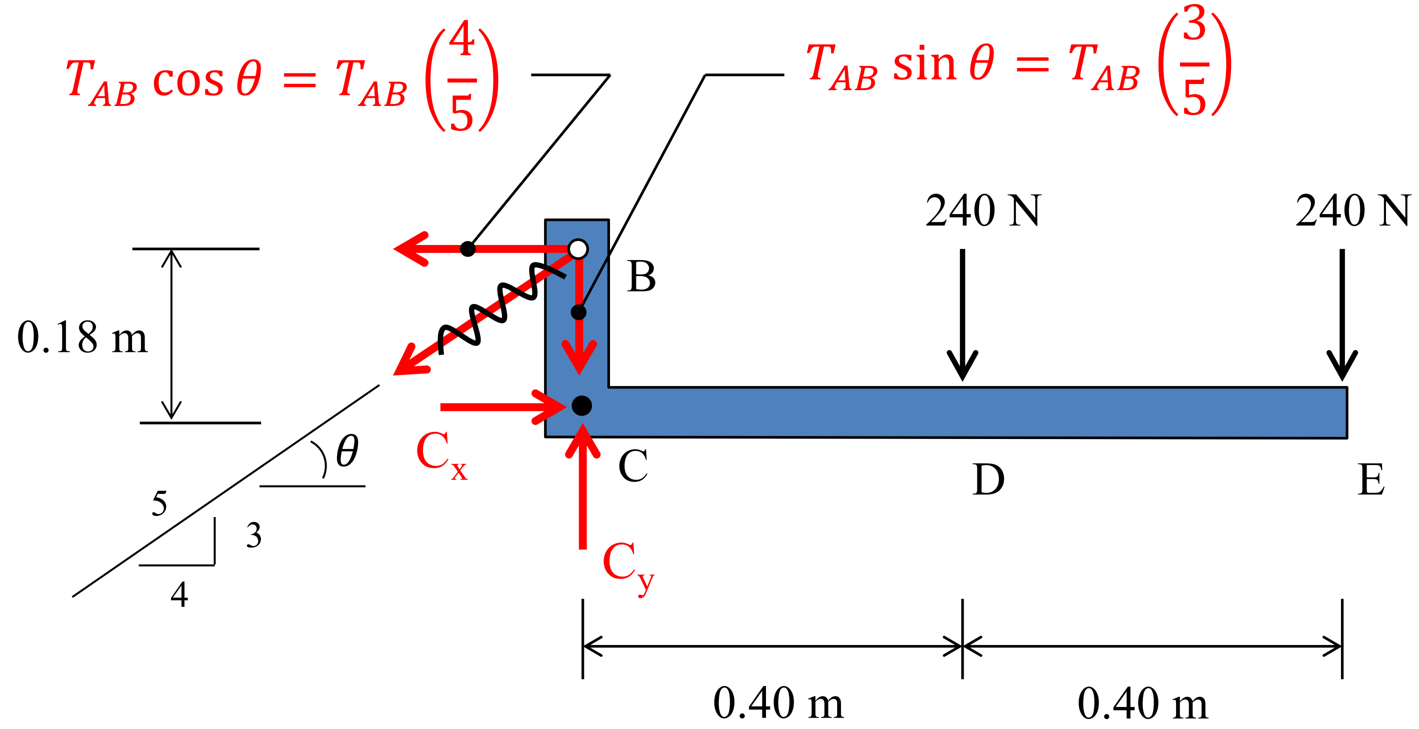
Express vectors in terms of components and apply equations of equilibrium



Strategy

- Often (as in this problem) we can isolate one unknown with the moment equilibrium equation;
- Point B or point C would be the best choices to take moment equilibrium about in order to isolate one unknown.

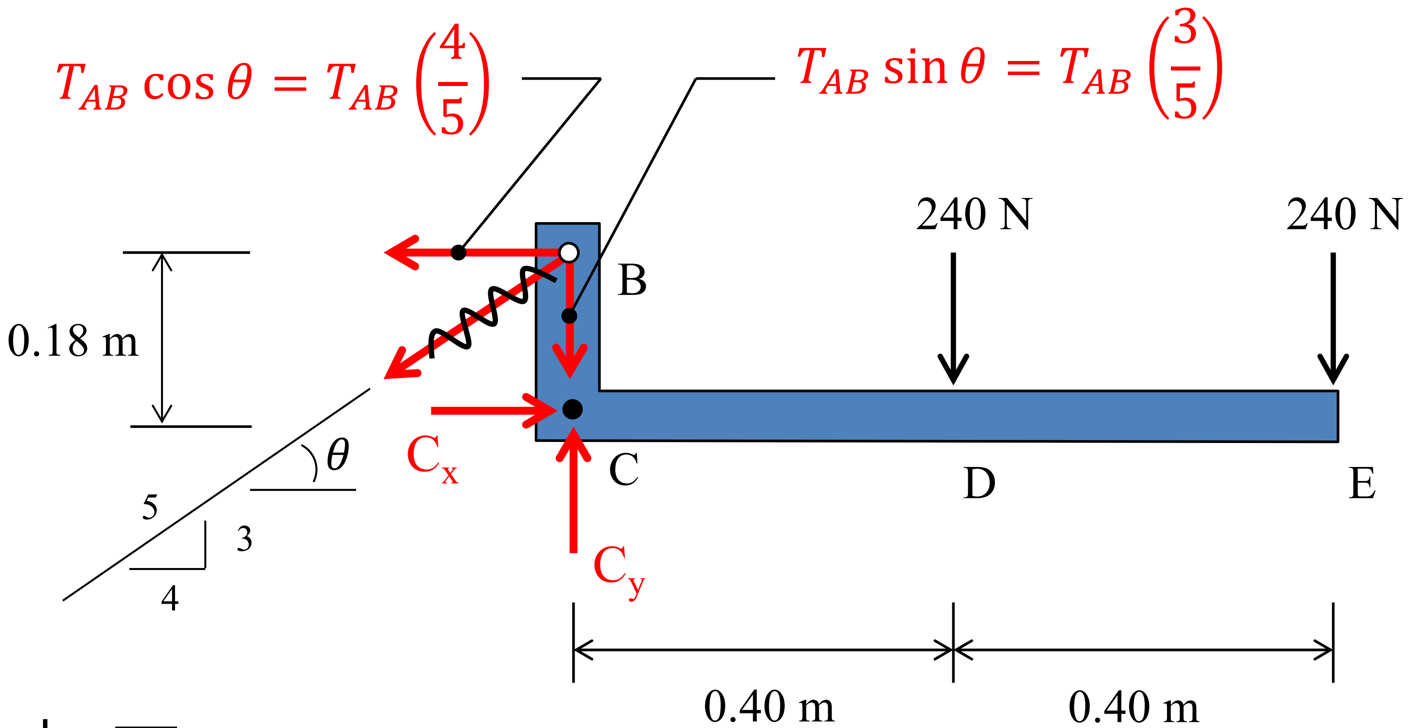
Start with moment equilibrium about point C to find the tension in rod AB



$$\circlearrowleft + \sum M_C = 0$$

$T_{AB} = 2000$ N

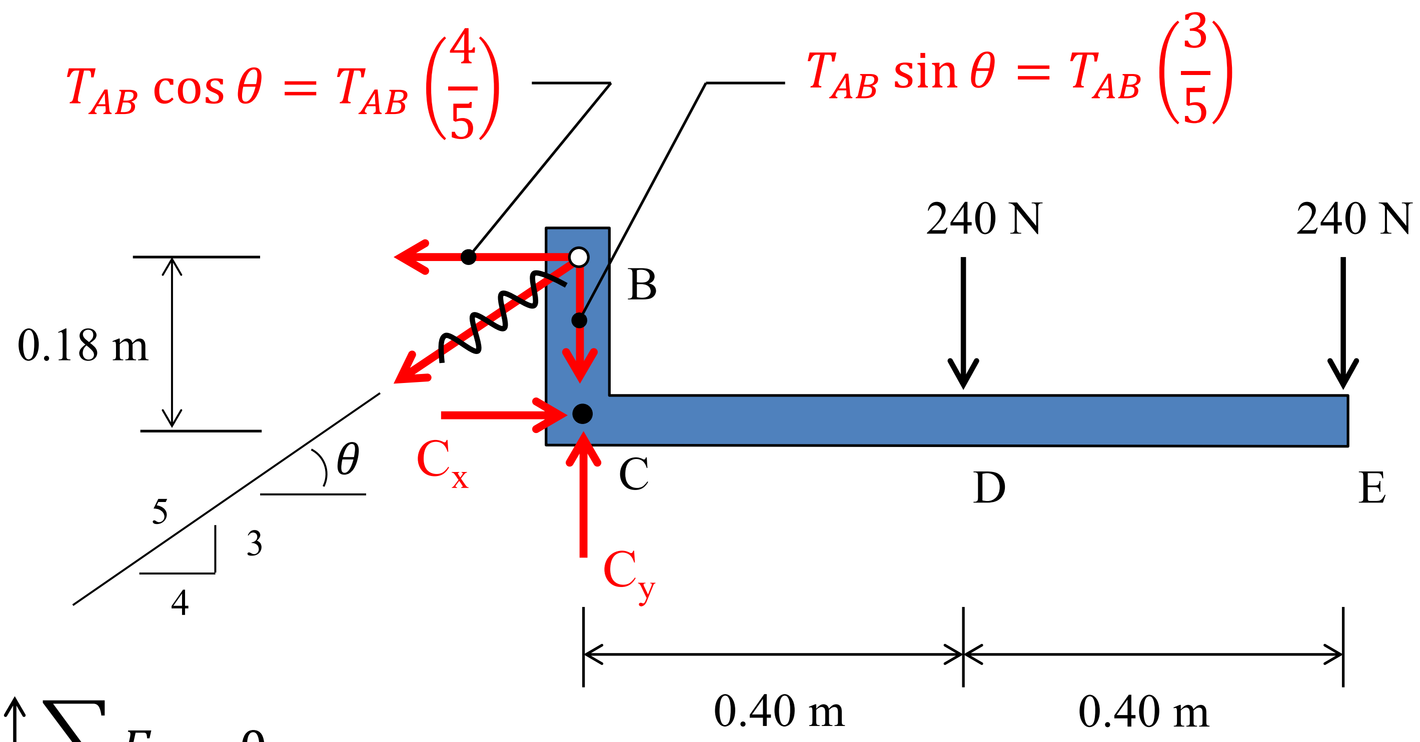
Next apply the force equilibrium in the x direction to find the horizontal component of the support reaction at C



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

$C_x = 1600$ N

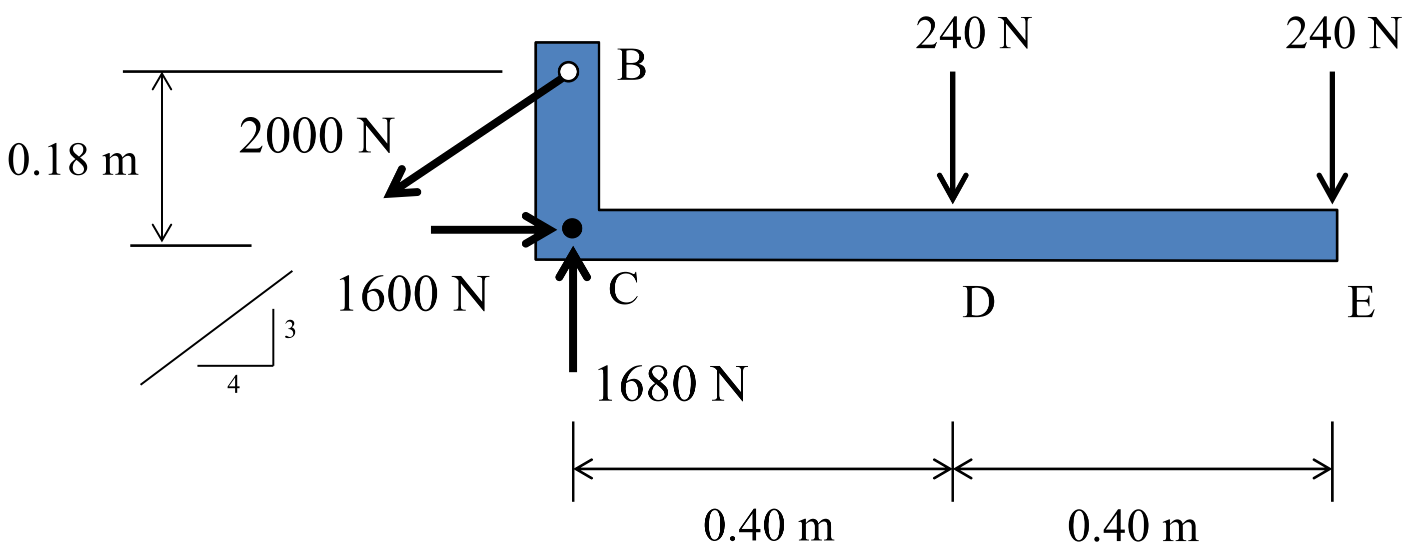
Next apply the force equilibrium in the y direction to find the vertical component of the support reaction at C



$$+\uparrow \sum F_y = 0$$

$C_y = 1680$ N

Show results on a FBD of the bracket



Can also express the reaction at the pin support in terms of its magnitude and angle

$$C = \sqrt{(1600)^2 + (1680)^2} = \mathbf{2320\ N} \quad \theta = \tan^{-1}\left(\frac{1680}{1600}\right) = \mathbf{46.4°}$$