Sign Convention for Problems in Structural Engineering

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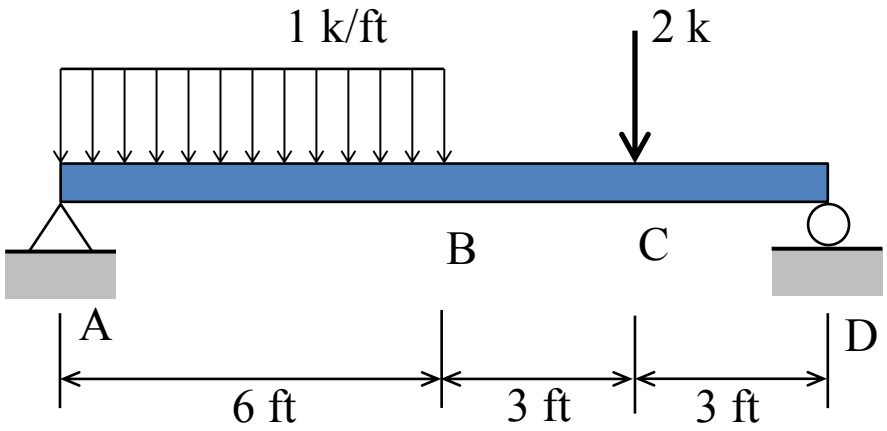
What is Sign Convention?

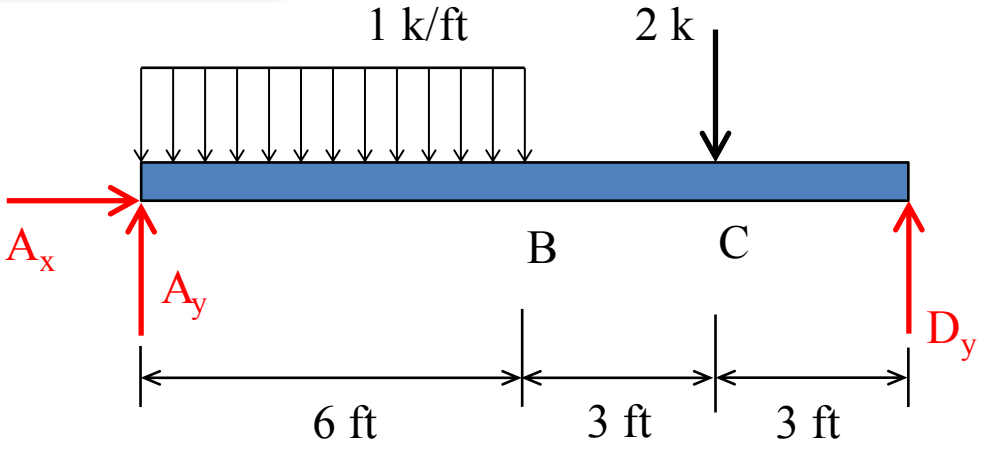
- Webster's Dictionary defines *convention* as *a custom that is widely accepted and followed;*
- The word *sign* in *sign convention* refers to the assignment of positive or negative signs to a number or quantity;
- In engineering, we use sign convention is used to communicate information **clearly and precisely**.

An Example of Sign Convention in a Structural Engineering Problem



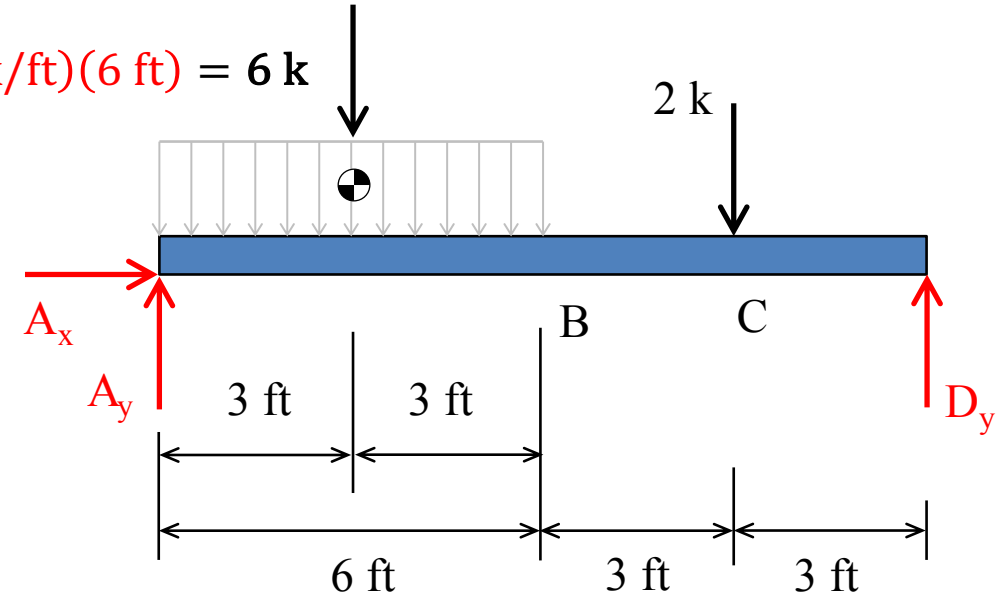
Find the support reaction for the beam at the roller support at point D

FBD of the beam



Rotational Equilibrium about point A to find D_y

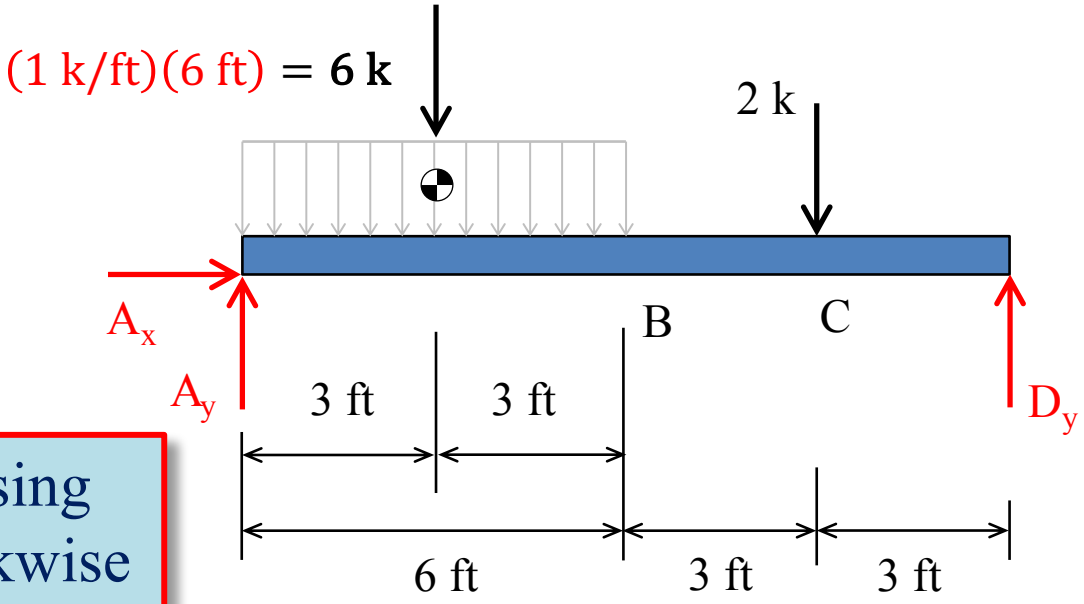
A common convention is to take counter-clockwise moments about a point as positive



$$\circlearrowleft + \sum M_A = 0$$

$D_y = 3$ k

Rotational Equilibrium about point A to find D_y

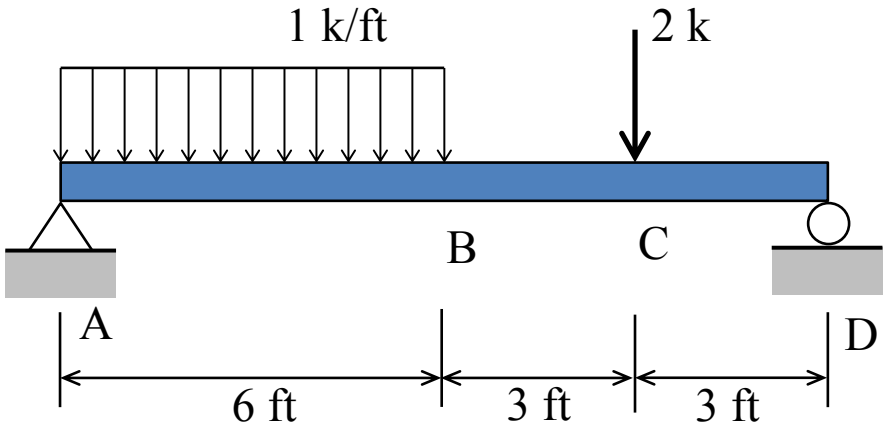


Repeat the calculation using the convention that clockwise moments are positive

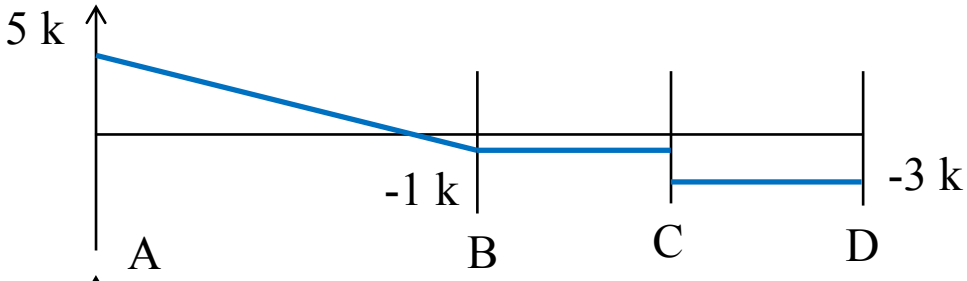
$$\circlearrowleft + \sum M_A = 0$$

$D_y = 3$ k

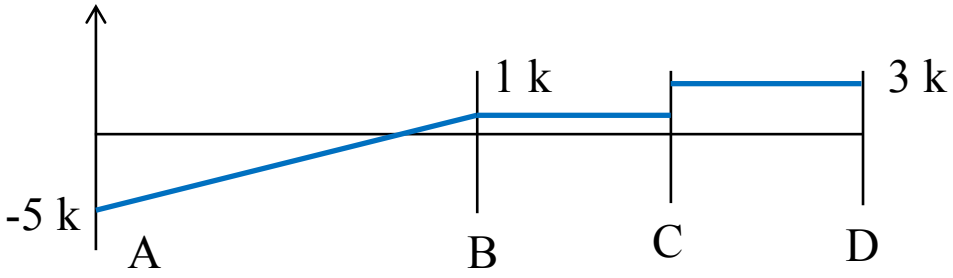
Another Example of Sign Convention in a Structural Engineering Problem



For the beam, which shear diagram is correct?



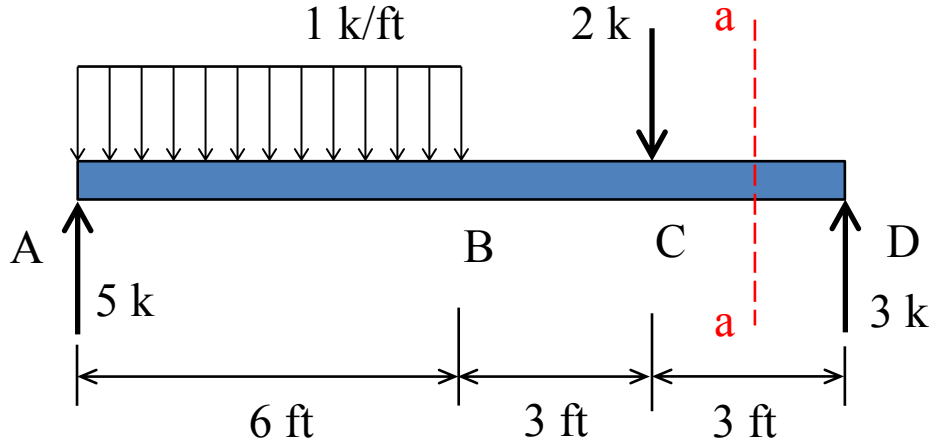
Shear diagram 1



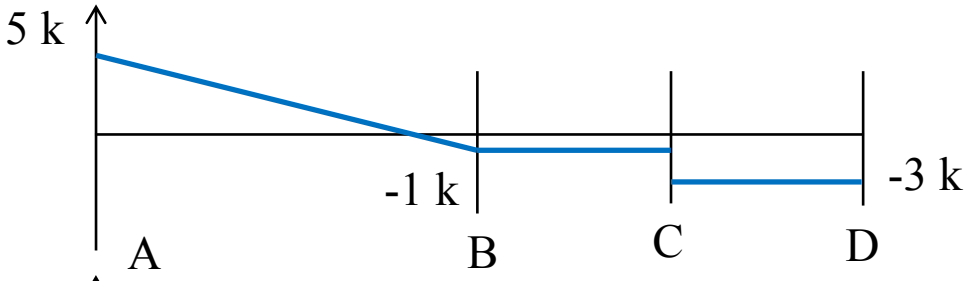
Shear diagram 2

Answer

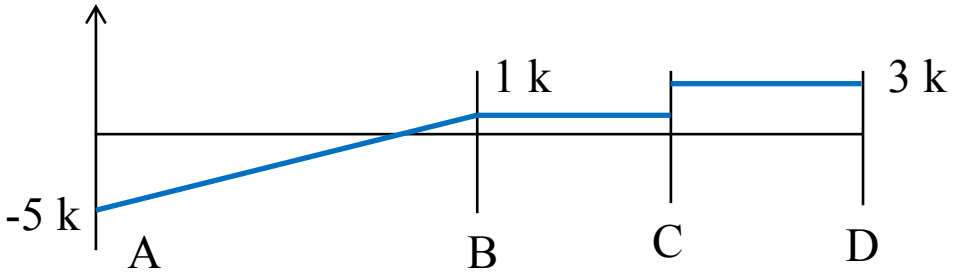
Either could be correct (or incorrect) depending on the sign convention chosen



Consider the shear force at section a-a

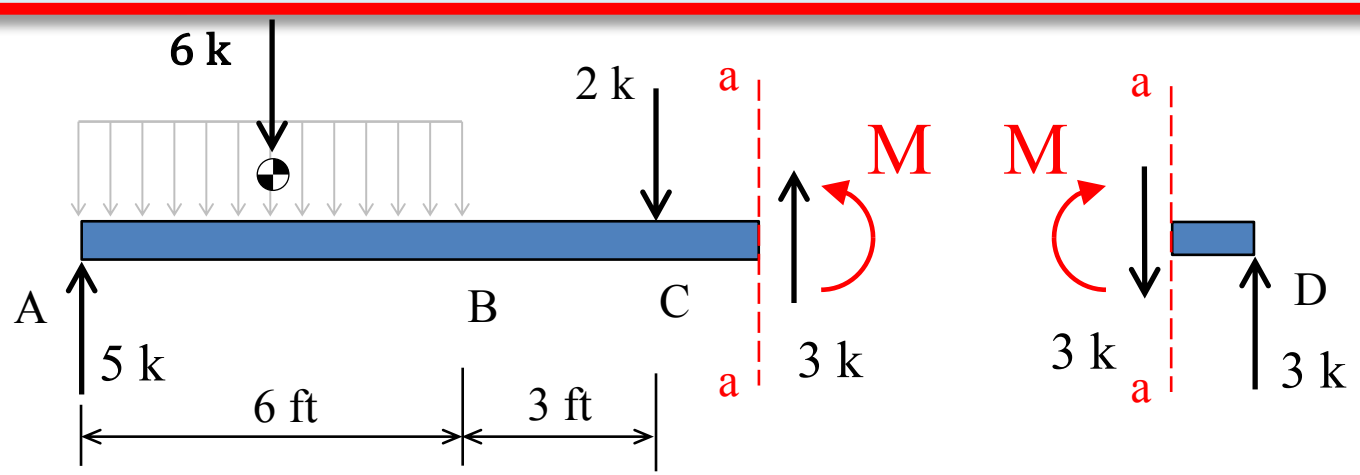


Shear diagram 1

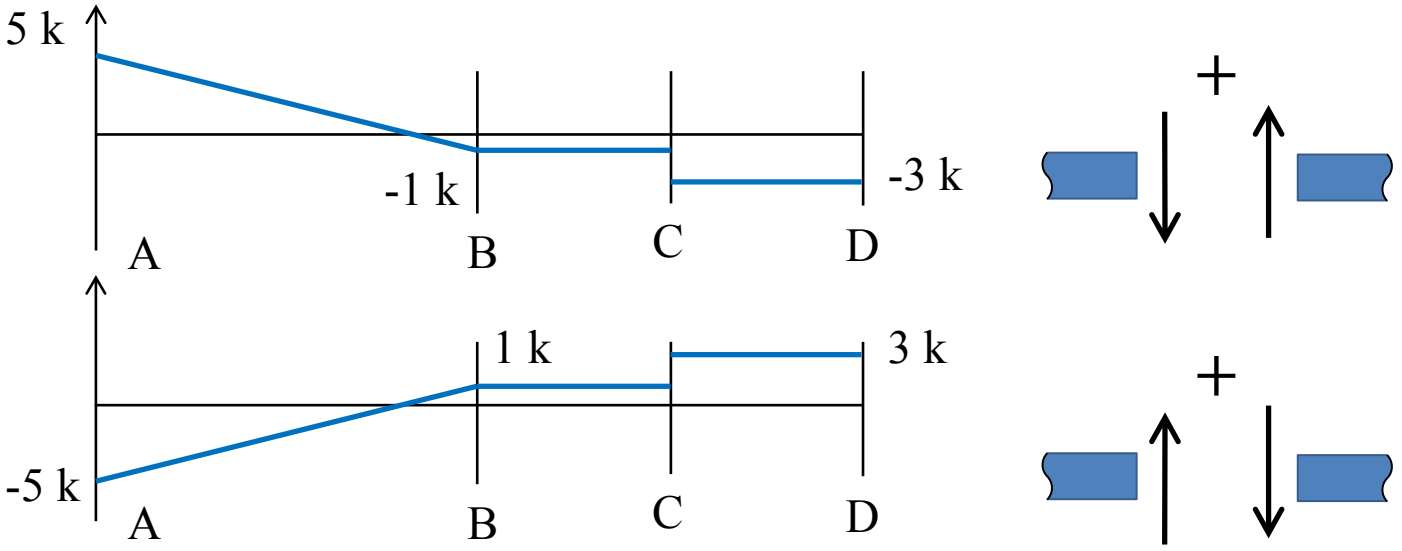


Shear diagram 2

Both diagrams are correct with the sign convention for positive shear shown next to each diagram



There is only one solution that satisfies force equilibrium

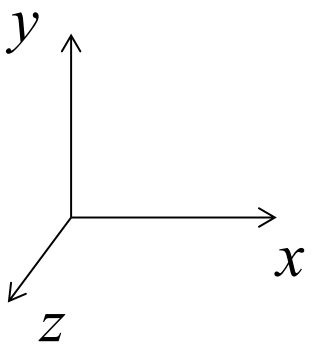


Notes

- Any diagram or calculation is not complete until the sign convention is clearly stated;
- Results are independent of the chosen sign convention;
- In engineering, many common conventions are used – **always check the sign convention**. This is particularly important when interpreting results from computer programs.

Common Sign Conventions Used in Structural Engineering

Coordinate System



Equilibrium Calculations

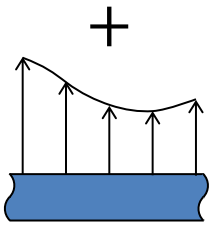
$$\xrightarrow{+} \sum F_x = 0$$

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

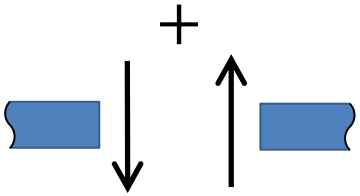
$$\circlearrowleft^{+} \sum M_O = 0$$

Common Sign Conventions Used in Structural Engineering

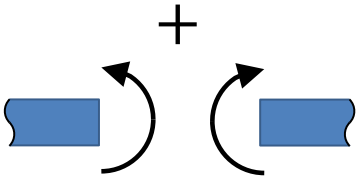
Distributed Loads



Internal Forces for a horizontal beam

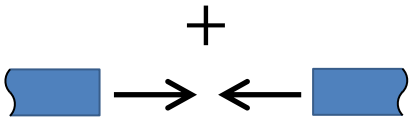


V – Shear force



M – Bending moment

Top fibers in compression
Bottom fibers in tension



F – Axial force

Tension positive