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

\[ (1 \text{ k/ft})(6 \text{ ft}) = 6 \text{ k} \]

\[ \sum M_A = 0 \]

\[ D_y = 3 \text{ k} \]
Rotational Equilibrium about point A to find $D_y$

Repeat the calculation using the convention that clockwise moments are positive

$\sum M_A = 0$

$D_y = 3 \text{ k}$
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

\[ + \sum F_x = 0 \]

\[ + \uparrow \sum F_y = 0 \]

\[ + \bigcirc \sum M_o = 0 \]
Common Sign Conventions Used in Structural Engineering

Distributed Loads

Internal Forces for a horizontal beam

V – Shear force
M – Bending moment
F – Axial force

Top fibers in compression
Bottom fibers in tension

Tension positive