

Static Equilibrium

Relationship between geometry and materials

Static Equilibrium 1: Resolving Forces

What forces?

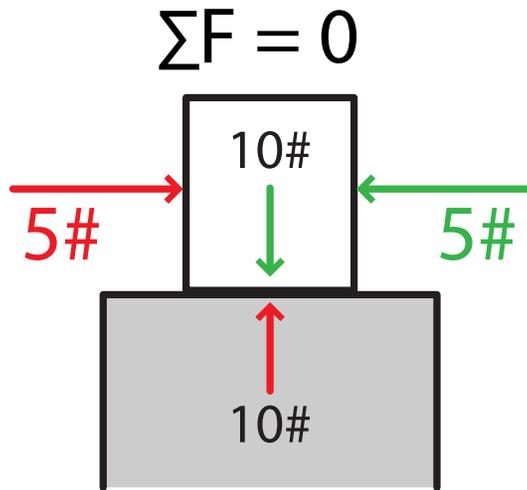
Tension, Compression (fails by crushing or buckling), Bending, shear, etc.

What is “statics”?

Statics is a method of solving basic structural problems, that is, a method to determine the values of external forces acting upon a structure, and the internal forces in each member of a structure.

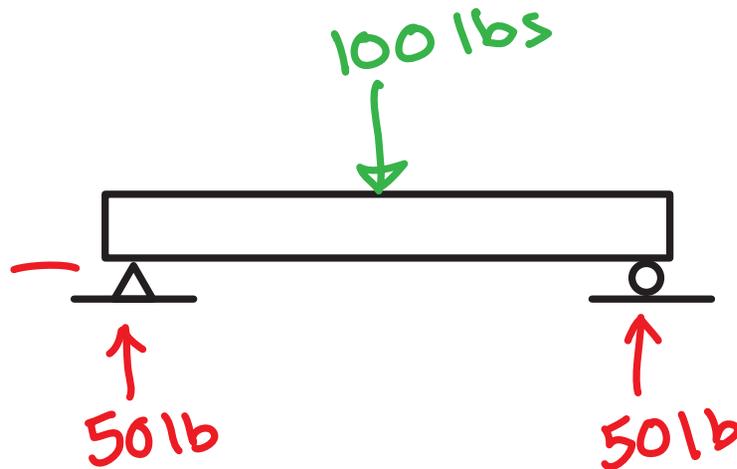
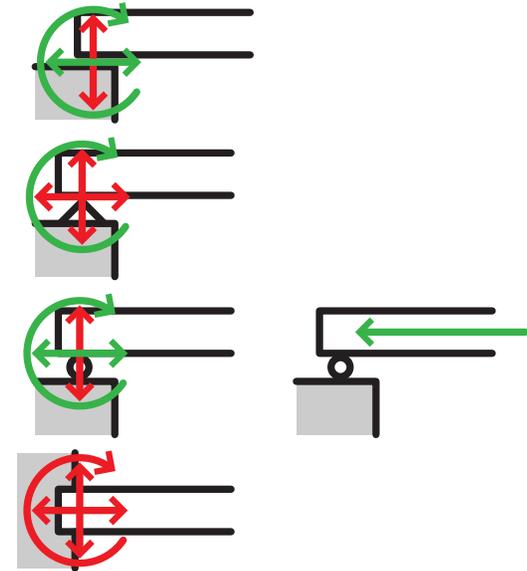
Structures for which statics can be used to solve for these forces are called, “statically determinate.”

- ① First tenet of "static equilibrium," or "structural zen":
All forces acting on a structure must add to zero..



Idealized structural support conditions

- 1) simple support
- 2) pinned support
- 3) roller support
- 4) fixed support



Static Equilibrium and Resolving Forces

Newton's 3rd Law of Motion

For every **action** there is an equal and opposite **reaction**



"Structural Behavior"

How does a structure respond to a force: primarily transferring loads through material resistance.

Material Resistance

e.g. a structure's ability to resist bending, etc.

Failure

- 1) when a structure becomes unstable
- 2) when an element breaks

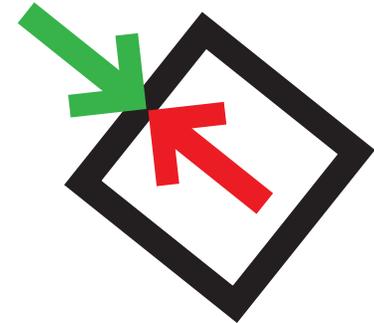
Concerned with "the nature of the failure."

Deformation

how something changes shape

Vectors

- 1 Direction
- 2 Magnitude
- 3 Point of Application



Consider The Hierarchy of Parts

1) Connections and Supports

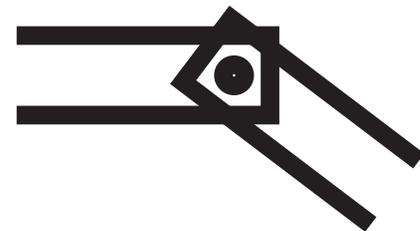
2) Elements

3) Assemblies

combinations of elements that work together

4) Systems

combinations of elements/assemblies that work together



Steps Required To Solve Statics Problems

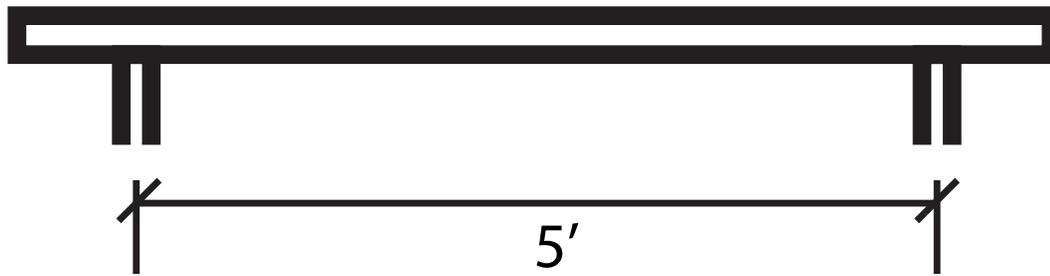
(using the “Tenets of Static Equilibrium”)

- 1) Draw a free-body diagram of the problem
- 2) Draw all known forces (i.e. actions)
- 3) Draw all unknown forces (i.e. reactions)
- 4) Apply the 1st tenet (sum of forces = 0)
- 5) Apply 2nd tenet (sum of moments = 0)
- 6) Solve for unknown forces

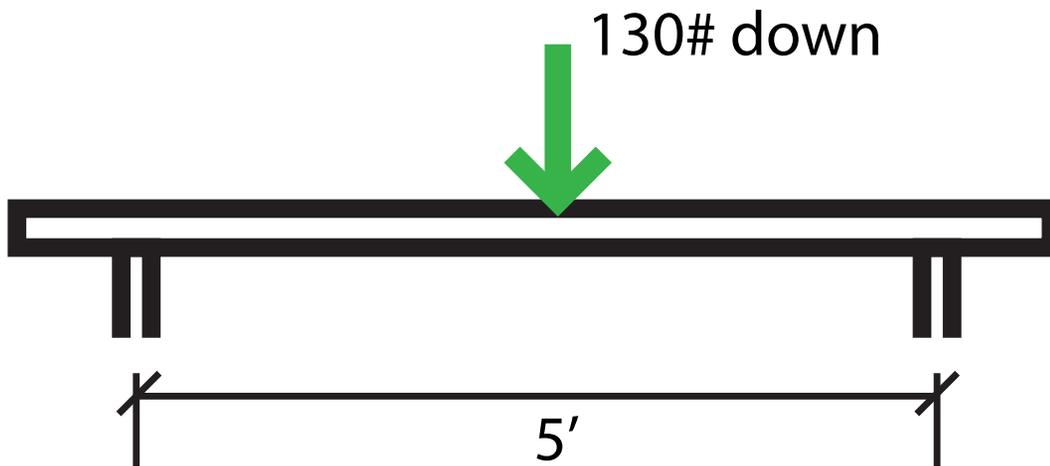
(Note: Problems that can be solved with these steps are called “statically determinate”)

EXAMPLE

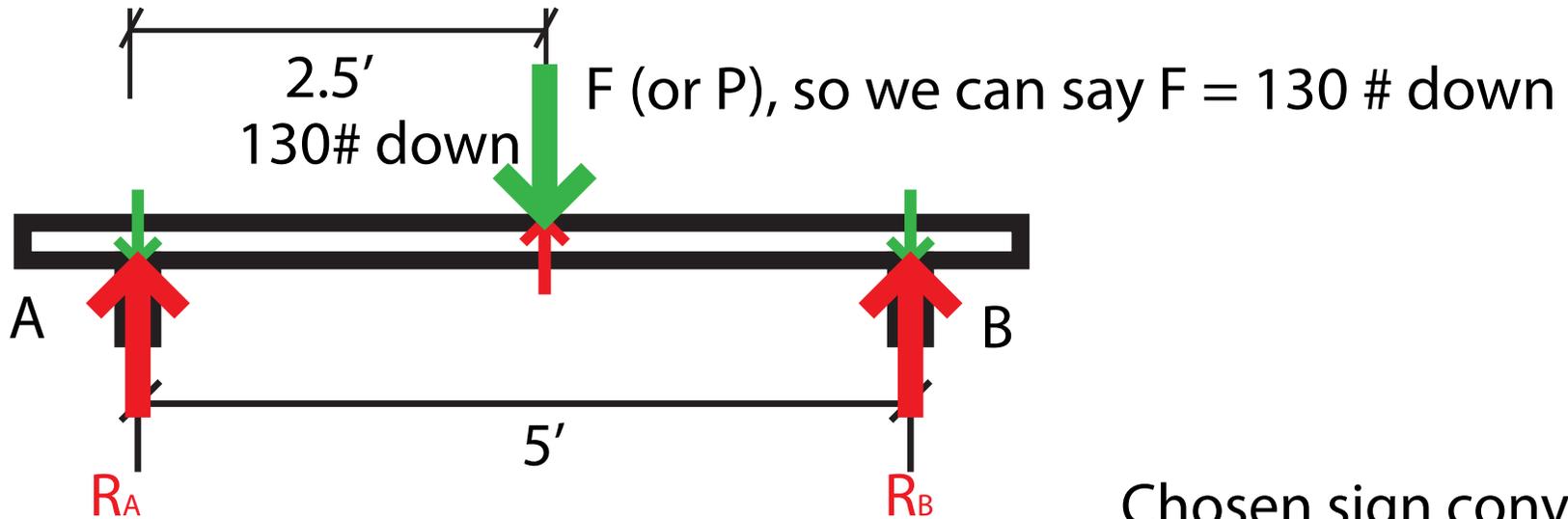
Free-body diagram



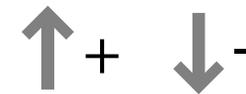
Draw known forces



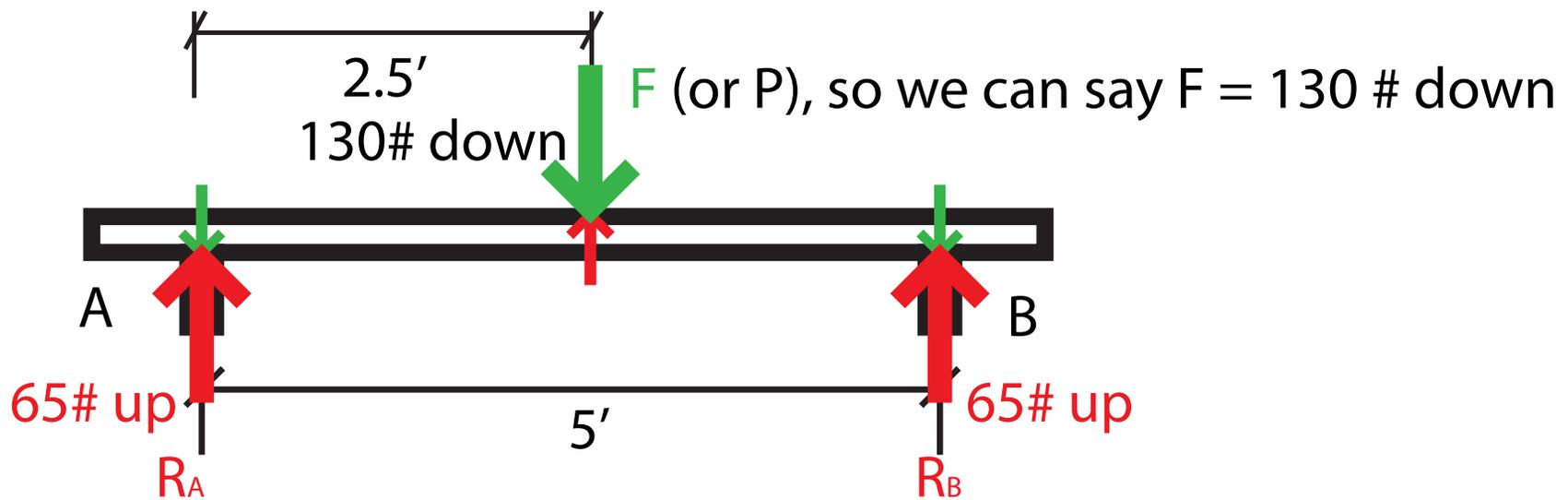
Draw and label the unknown forces



Chosen sign convention.



Apply 1st Tenet ($\Sigma F = 0$)



Rewrite the equation $\Sigma F = 0$ with the known and unknown forces.

$$-130\# + R_A + R_B = 0$$

assumption : $R_A = R_B$ because of symmetry
(from our own intuition)

substitute R_A for R_B

$$-130\# + R_A + R_A = 0$$

$$-130\# + 2 \cdot R_A = 0$$

$$2 \cdot R_A = 130\#$$

$R_A = 65\#$ up (because we guessed up, and the number was positive, we are right that the reaction is up).

B/c of our assumption, $R_B = 65\#$ up as well

Apply 1st Tenet ($\Sigma F = 0$)

$$\Sigma F = F + R_A + R_B = 0$$

$$\Sigma F = (-130\#) + R_A + R_B = 0$$

$$\Sigma F = (-130\#) + (+65\#) + (+65\#) = 0$$

