

**ARCHITECTURAL STRUCTURES I:  
STATICS AND STRENGTH OF MATERIALS**

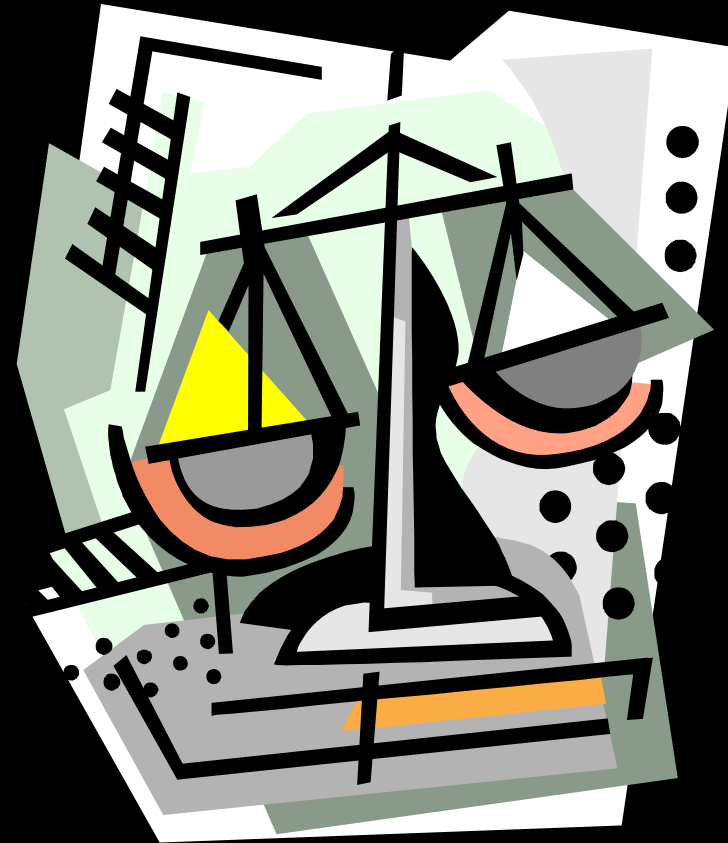
**ENDS 231**

**DR. ANNE NICHOLS**

**SPRING 2007**

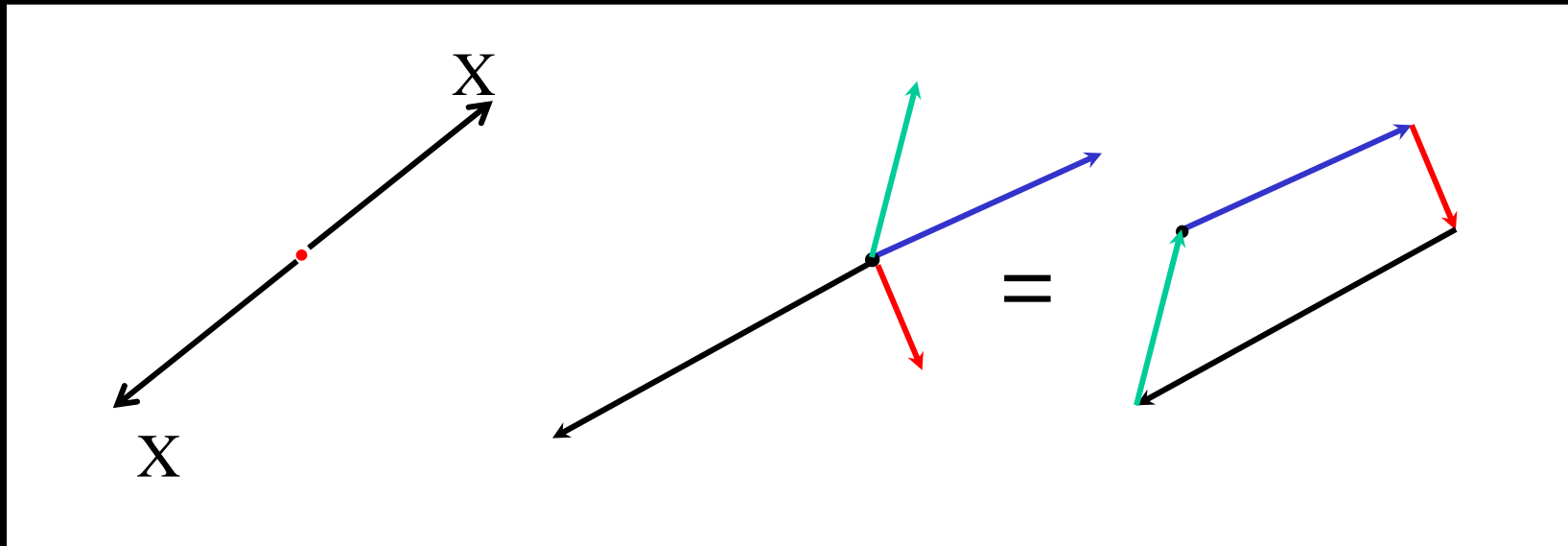
**lecture  
four**

**equilibrium  
of a particle**



# Equilibrium

- *balanced*
- *steady*
- *resultant of forces on a particle is 0*



# Equilibrium

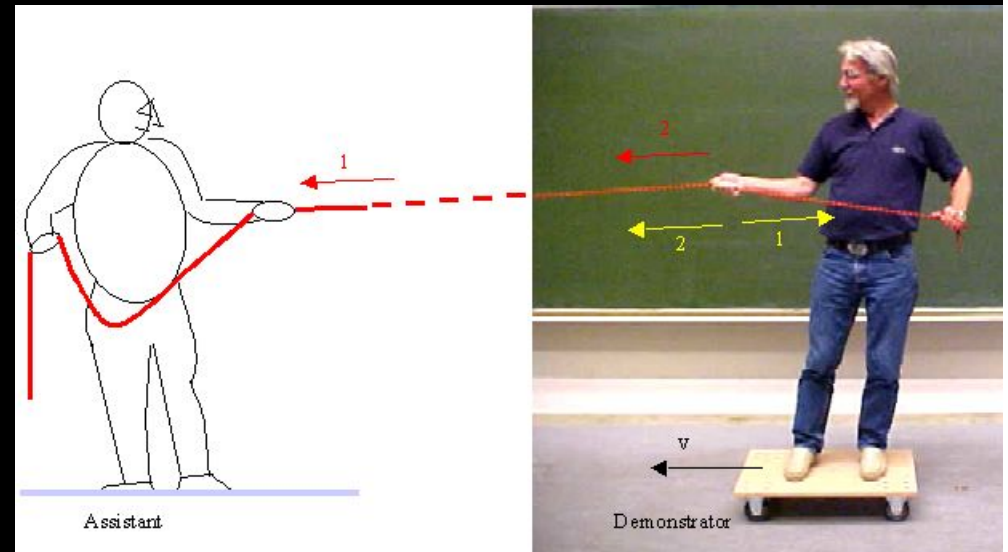
- analytically

$$R_x = \sum F_x = 0$$

$$R_y = \sum F_y = 0$$

$$\left( M = \sum M = 0 \right)$$

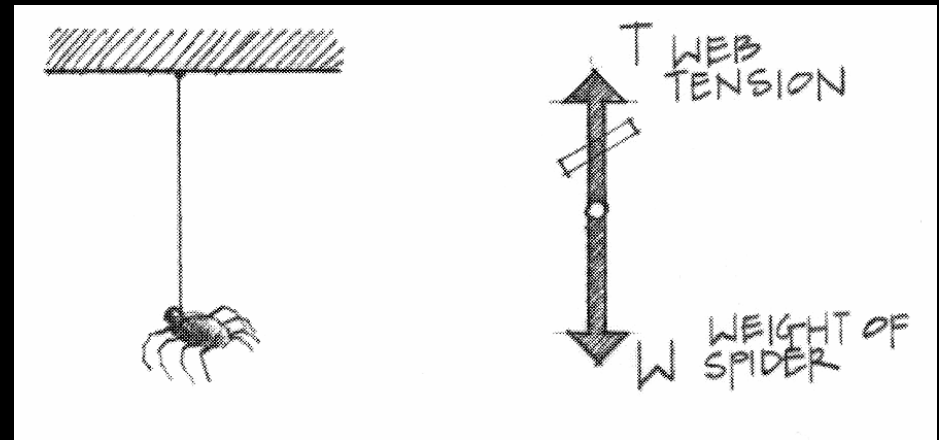
- Newton convinces us it will stay at rest and won't rotate



# Equilibrium

- *collinear force system*

$$\sum F_{in-line} = 0$$



$$\left[ R_x = \sum F_x = \underline{0} \quad R_y = \sum F_y = \underline{0} \right]$$
$$\left( \underline{M = \sum M = 0} \right)$$

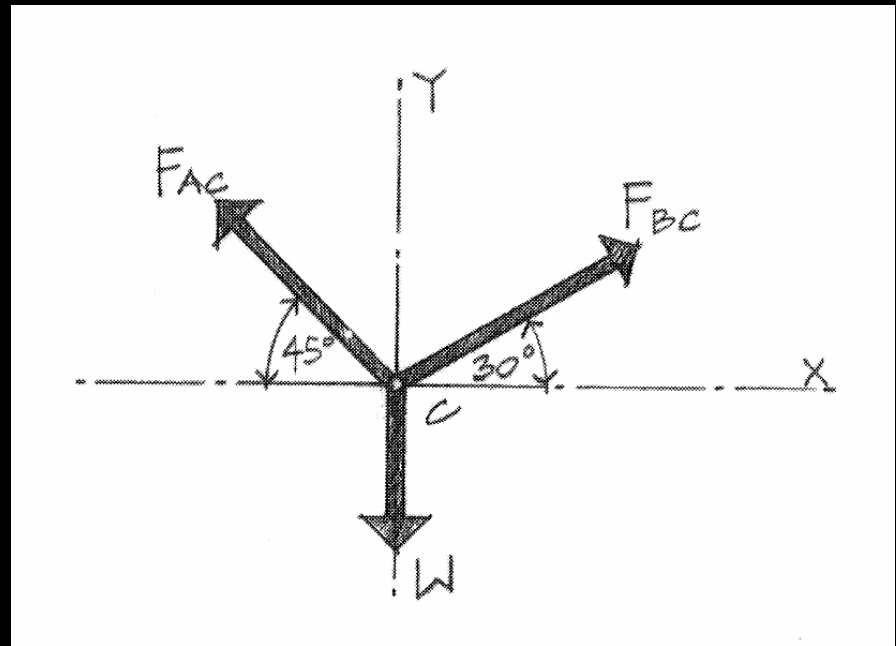
# Equilibrium

- *concurrent force system*

$$R_x = \sum F_x = \underline{0}$$

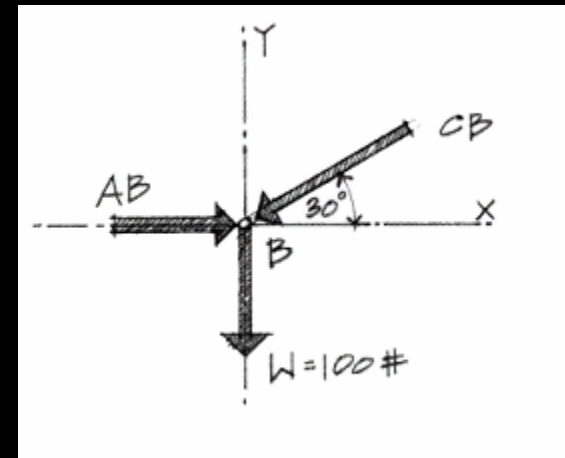
$$R_y = \sum F_y = \underline{0}$$

$$\left( \underline{M = \sum M = 0} \right)$$



# Free Body Diagram

- *FBD (sketch)*
- *tool to see all forces on a body or a point including*
  - *external forces*
  - *weights*
  - *force reactions*
  - *external moments*
  - *moment reactions*
  - *internal forces*



# *Free Body Diagram*

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- *sketch FBD*
- *resolve each force into components*
  - *known & unknown angles*
  - *known & unknown forces*
- *are any forces related to other forces?*
- *write only as many equilibrium equations as needed*

# *Free Body Diagram*

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- *solve equations*
  - *most times 1 unknown easily solved*
  - *plug into other equation(s)*
  
- *common to have unknowns of*
  - *force magnitudes*
  - *force angles*



# Cables

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- *simple*
- *uses*
  - *suspension bridges*
  - *roof structures*
  - *transmission lines*
  - *guy wires, etc.*
- *have same tension all along*
- *can't stand compression*



# Cables Structures

- *use high-strength steel*
- *need*
  - *towers*
  - *anchors*
- *don't want movement*



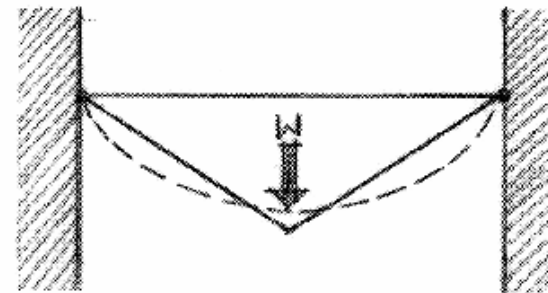
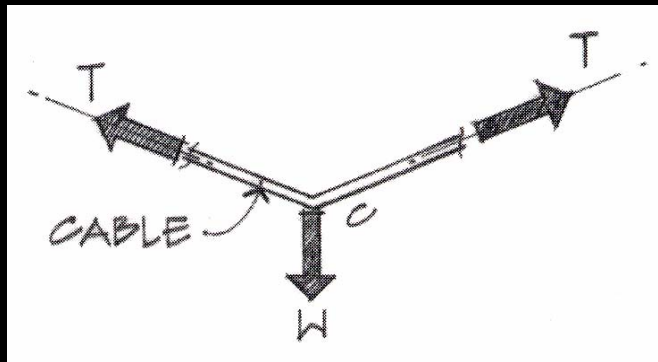
# *Cable Structures*

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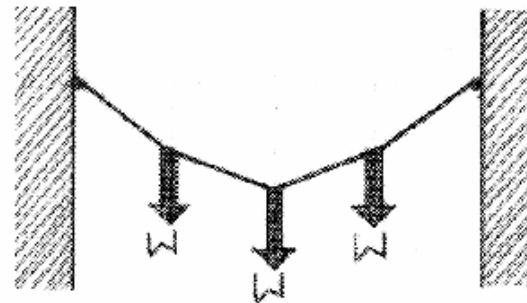


# Cable Loads

- *straight line between forces*
- *with one force*
  - concurrent
  - symmetric



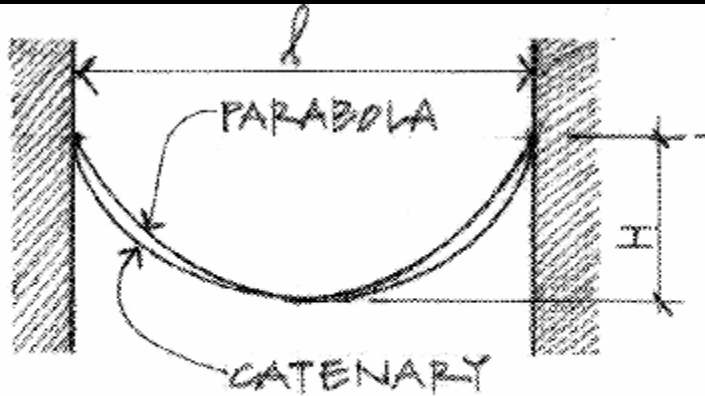
(a) *Simple concentrated load—triangle.*



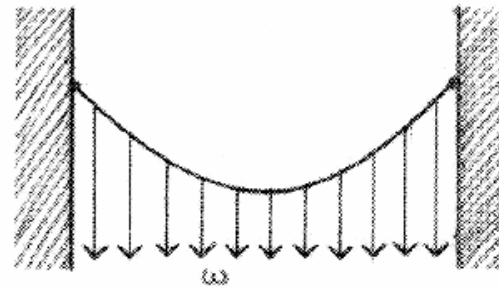
(b) *Several concentrated loads—polygon.*

# Cable Loads

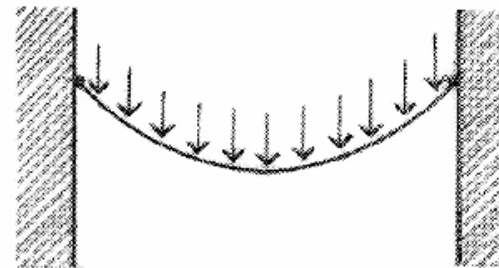
- *shape directly related to the distributed load*



(e) Comparison of a parabolic and a catenary curve.



(c) Uniform loads (horizontally)—parabola.



(d) Uniform loads (along the cable length)—catenary.

# Cable Loads

- *trig:*  $T_x = T \cos \theta$

$$T_y = T \sin \theta$$

- *parabolic (catenary)*

– *distributed uniform load*

$$y = 4h(Lx - x^2) / L^2$$

$$L_{total} = L \left( 1 + \frac{8}{3} \frac{h^2}{L^2} - \frac{32}{5} \frac{h^4}{L^4} \right)$$

