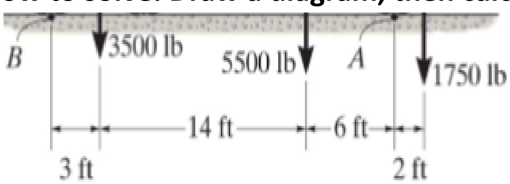
Lecture 8 Note - *Couples and Distributed Loads*

Textbook Chapter 4.8-4.9

Simplifications of Forces & Moments:

- <u>Concurrent ***F*** system (2D/3D)</u>: A group of forces whose lines of action meet at point *O* These forces can be replaced by 1 resultant force (with a line of action through *O*)
- <u>Coplanar ***F*** system (2D):</u> A force group with action-lines in the same plane; <u>not</u> concurrent Can be replaced by 1 resultant force acting in the same plane and by the ∑ of all moments
- <u>Parallel force system</u>: If multiple forces are parallel to one axis, the ∑ of those forces ***(F_R)*** will also be parallel, and the resultant moment ***(M_R)$_o$*** perpendicular (it must be).
- Note that all these situations can be represented either by a single resultant moment & force vector, OR simply by a resultant force vector offset by distance *d* from point *O*.

How to solve: Draw a diagram, then calculate the resultant force, then the resultant moment:



$$\sum M_B = -F_R(d_B)$$
$$\sum M_B = \sum Fd = -(3500 \times 3) - (5500 \times 17) - (1750 \times 25)$$
$$= -147{,}750\ lb \cdot ft$$
$$d_B = \frac{\sum Fd}{-F_R} = -\frac{147{,}750 lbft}{-10{,}750 lb} = 13.7\ ft$$

- $\sum M_B = F_1d_1+F_2d_2+F_3d_3 = \sum Fd_B$, therefore $d_B = \sum M_B / \sum F$ — you can find distance this way.
- If you calculate this from side a, the distances will add up to the total object length (23ft)

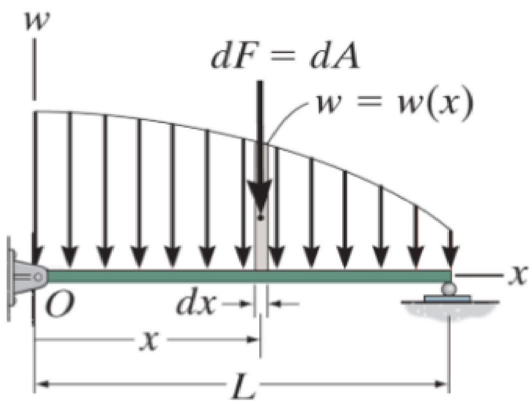
The "Wrench" Simplification: Simplifying objects so they translate & rotate about one axis:

- Most 3D force-and-moment systems can be replaced by a single ***F_R*** and ***M_R***
  - In these cases the resultant couple moment can be broken up into parallel and perpendicular parts relative to ***F_R***'s line of action. Then the perpendicular part can be eliminated by moving ***F_R*** a perpendicular distance *d* from point *O*.
  - The resultant moment's parallel part can be moved around freely.

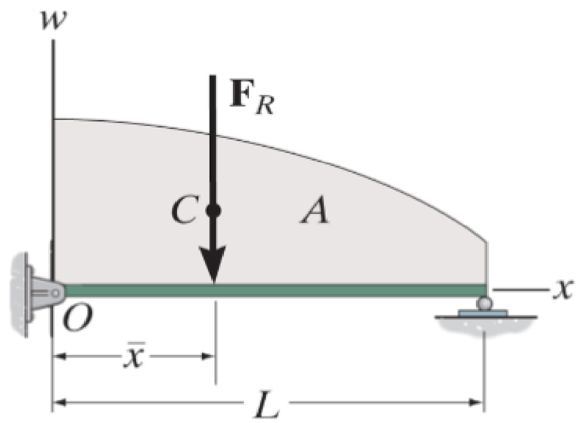
The Distributed Load Simplification (for problems where force is distributed over a surface):

- Force is measured in kN/m. Magnitude is represented by "height" *ω* (a lowercase *Ω*)
- The resultant force of a distributed load equals its area. Height times width.

- The F_R of a distributed load effectively pases through its centroid. To find centroids of complex shapes, split 'em up. Triangle centroids are located ⅓ of the way from the big end.



w
dF = dA
w = w(x)
x
O
dx
x
L



w
F_R
C
A
x
O
x̄
L

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