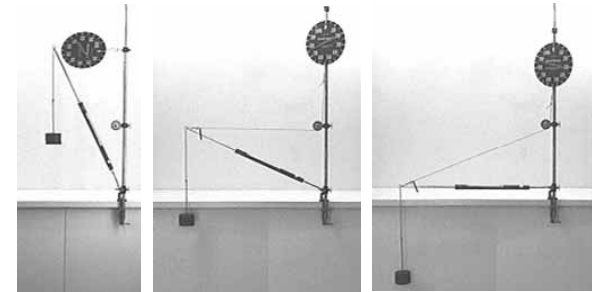




Moments

- forces have the tendency to make a body rotate about an axis



– same translation but different rotation

Moments

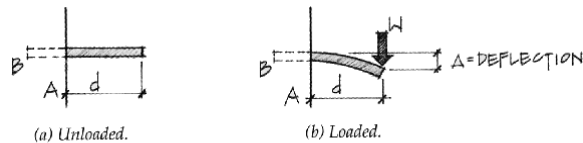


Figure 2.33 Moment on a cantilever beam.

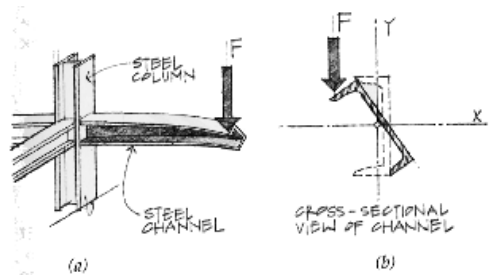
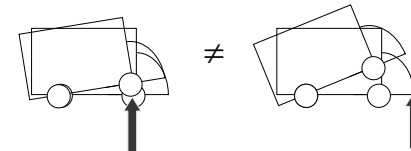


Figure 2.34 An example of torsion on a cantilever beam.

Moments

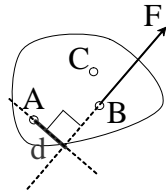
- a force acting at a different point causes a different moment:



Moments

- defined by magnitude and direction
- units: $N \cdot m$, $k \cdot ft$
- direction:
 - + ccw (right hand rule)
 - cw
- value found from F and \perp distance

$$M = F \cdot d$$
- d also called “lever” or “moment” arm



Moments 10

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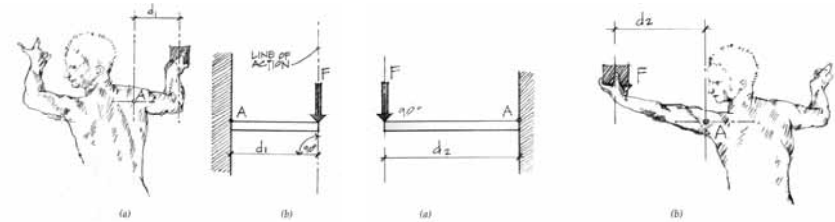
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Moments

- with same F :

$$M_A = F \cdot d_1 < M_A = F \cdot d_2$$

(bigger)



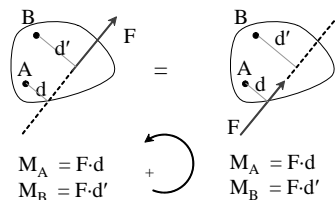
Moments 11

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Moments

- additive with sign convention
- can still move the force along the line of action



Moments 12

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Moments

- Varignon's Theorem
 - resolve a force into components at a point and finding perpendicular distances
 - calculate sum of moments
 - equivalent to original moment
- makes life easier!
 - geometry
 - when component runs through point, $d=0$

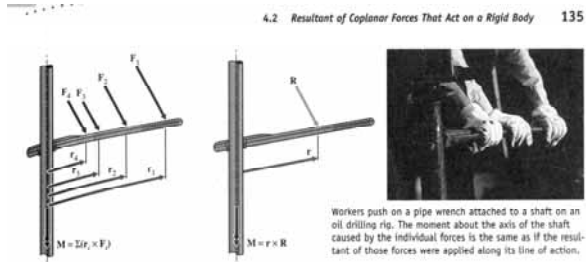
Moments 13

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Physics & Moments of a Force

- moments of a force
 - introduced in Physics as “Torque Acting on a Particle”
 - and used to satisfy rotational equilibrium



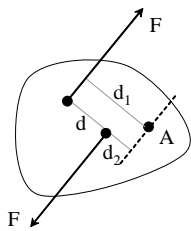
Moments 9
Lecture 3

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Moment Couples

- 2 forces
 - same size
 - opposite direction
 - distance d apart
 - cw or ccw



$$M = F \cdot d$$

- not dependant on point of application

$$M = -F \cdot d = -F \cdot d_1 + F \cdot d_2$$

TOPIC 15

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Physics and Moments of a Force

- my Physics book:

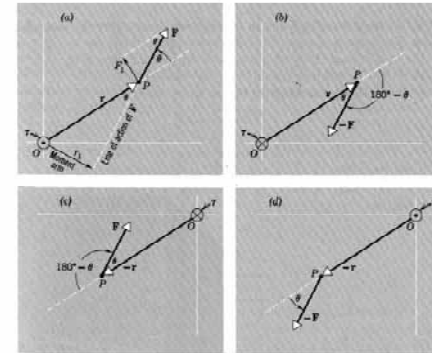


FIGURE 11-2 The plane shown is that defined by τ and F in Fig. 11-1. (a) The magnitude of τ is given by $\tau = rF \sin \theta$ (Eq. 11-2b) or by $\tau = rF_{\perp}$ (Eq. 11-2c). (b) Reversing F reverses the direction of τ . (c) Reversing r reverses the direction of τ . (d) Reversing F and r leaves the direction of τ unchanged. The directions of τ are represented by \odot (perpendicularly out of the figure, the symbol representing the tip of an arrow) and by \otimes (perpendicularly into the figure, the symbol representing the tail of an arrow).

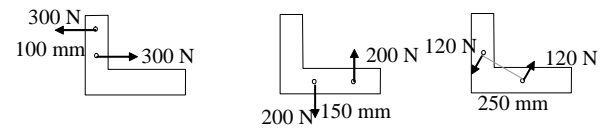
Moments 10
Lecture 3

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Moment Couples

- equivalent couples
 - same magnitude and direction
 - F & d may be different



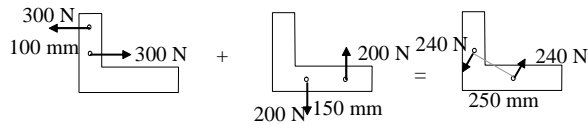
Moments 15

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Moment Couples

- added just like moments caused by one force
- can replace two couples with a single couple



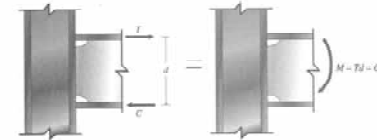
Moments 16

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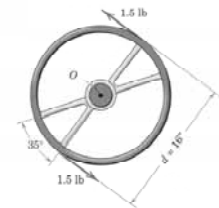
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Moment Couples

- moment couples in structures



The flanges of a steel beam are welded to the flange of a column. Equal and opposite forces T and C in the beam flanges form a couple with moment M that is transferred into the column.



Moments 14
Lecture 3

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Equivalent Force Systems

- two forces at a point is equivalent to the resultant at a point
- resultant is equivalent to two components at a point
- resultant of equal & opposite forces at a point is zero
- put equal & opposite forces at a point (sum to 0)
- transmission of a force along action line

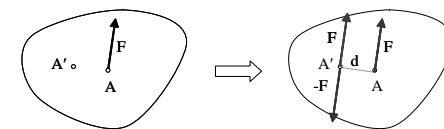
Moments 17

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Force-Moment Systems

- single force causing a moment can be replaced by the same force at a different point by providing the moment that force caused



- moments are shown as arched arrows



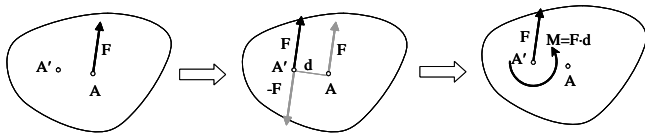
Moments 17

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Force-Moment Systems

- a force-moment pair can be replaced by a force at another point causing the original moment



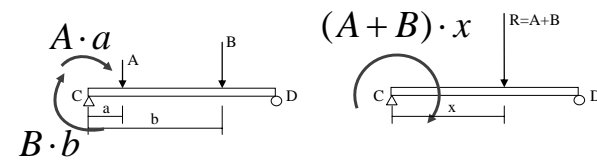
Moments 18

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Parallel Force Systems

- forces are in the same direction
- can find resultant force
- need to find location for equivalent moments



Moments 18
Lecture 3

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