ARCHITECTURAL STRUCTURES I:

STATICS AND STRENGTH OF MATERIALS

DR. ANNE NICHOLS

FALL 2007

lecture



centers of gravity- centroids

Lecture 11

ENDS 231

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Center of Gravity

• "average" x & y from moment

$$\begin{array}{c|c} z & y & \sum \Delta W \\ \Delta W_4 & \Delta W_1 \\ \Delta W_{13} & \Delta W_2 \\ \hline \end{array}$$

$$\sum M_{y} = \sum_{i=1}^{n} x_{i} \Delta W_{i} = \overline{x} \mathbf{W} \implies \overline{x} = \frac{\sum (x \Delta W)}{\mathbf{W}}$$

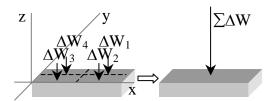
$$\sum M_{x} = \sum_{i=1}^{n} y_{i} \Delta W_{i} = \overline{y} \mathbf{W} \implies \overline{y} = \frac{\sum (y \Delta W)}{\mathbf{W}}$$

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Center of Gravity

- location of equivalent weight
- determined with calculus



• sum element weights

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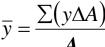
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Centroid

- "average" x & y of an area
- for a volume of constant thickness
 - where γ is weight/volume $-\Delta W = \gamma t \Delta A$
 - center of gravity = centroid of area

$$\bar{x} = \frac{\sum (x \Delta A)}{A}$$





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Centroid

• for a line, sum up length

$$\overline{x} = \frac{\sum (x\Delta L)}{L}$$

$$\overline{y} = \frac{\sum (y\Delta L)}{L}$$





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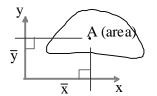
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1st Moment Area

- math concept
- the moment of an <u>area</u> about an axis

$$Q_x = \overline{y}A$$

$$Q_y = \overline{x}A$$



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Symmetric Areas

- symmetric about an axis

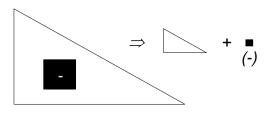
 symmetric about a center point

mirrored symmetry

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Composite Areas

- made up of basic shapes
- areas can be <u>negative</u>
- (centroids can be negative for any area)



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Basic Procedure

- 1. Draw reference origin (if not given)
- 2. Divide into basic shapes (+/-)
- 3. Label shapes
- 4. Draw table

5. Fill in table

Component	Area	\overline{x}	$\overline{x}A$	\overline{y}	$\overline{y}A$
Σ					

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- 6. Sum necessary columns
- 7. Calculate \hat{x} and \hat{y}

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Area Centroids

• Table 7.1 – pg. 242

Shape	Name of the second seco	X	У
Triangular area		$\frac{b}{3}$ right triangle only	<i>h</i> 3
Quarter-circular area	9	$\frac{4r}{3\pi}$	$\frac{4r}{3\pi}$
Semicircular area		0	$\frac{4r}{3\pi}$
Semiparabolic area	C C / 1	3 <i>a</i> 8	3h 5
Parabolic area		0	3h 5

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