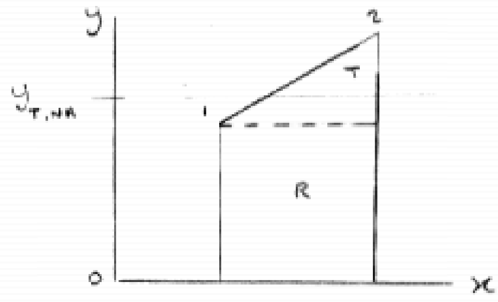
BAS007.1

2ND Moment & Area by Nodes Method



$$y_{T.NA} = y_1 + (y_2 - y_1)/3$$
$$A_T = (y_2-y_1)(x_2-x_1)/2$$
$$I_{T.NA} = (x_2-x_1)(y_2-y_1)^3/36$$

T suffix: triangle
R : rectangle

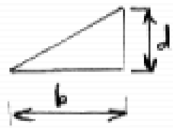
$$I_{T(y=0)} = (x_2-x_1)(y_2-y_1)^3/36 + A_T \, . \, y_{T.NA}^2$$

$$y_R = y_1/2$$
$$A_R = y_1 (x_2-x_1)$$
$$I_{R(y=0)} = (x_2-x_1)\, y_1^3/3$$
$$\bar{y} = \Sigma (A_T y_T + A_R y_R) / \Sigma (A_T + A_R)$$

$$I_{(y=0)} = I_{T(y=0)} + I_{R(y=0)}$$

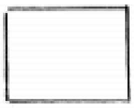
$$I_{NA} = I_{(y=0)} - \Sigma (A_T y_T + A_R y_R) \, . \, \bar{y}$$

Principal Axes and Properties



product of inertia,

$$H_{cm} = b^2 d^2 / 72$$



$$H_{cm} = \emptyset$$

$$H_{xy} = H_{cm} + A \cdot \bar{x} \cdot \bar{y}$$

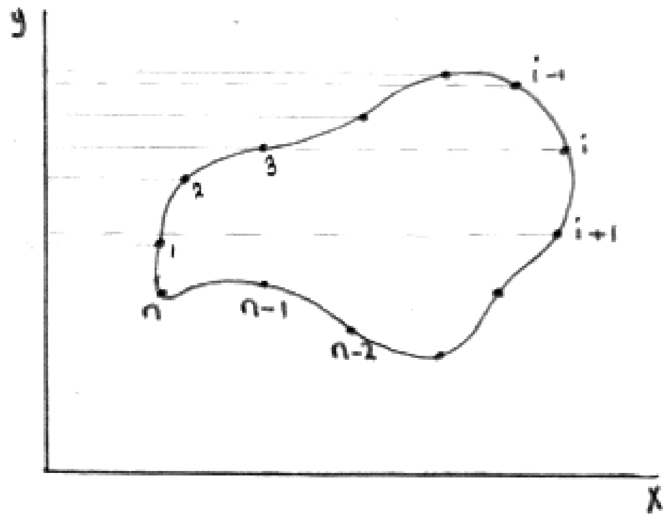
$$I_{1,2} = \frac{1}{2}\left(I_x + I_y\right) \pm \sqrt{\frac{1}{4}\left(I_y - I_x\right)^2 + H_{xy}^2}$$

$$\theta' = \frac{1}{2} \arctan\left(\frac{2H_{xy}}{I_y - I_x}\right)$$

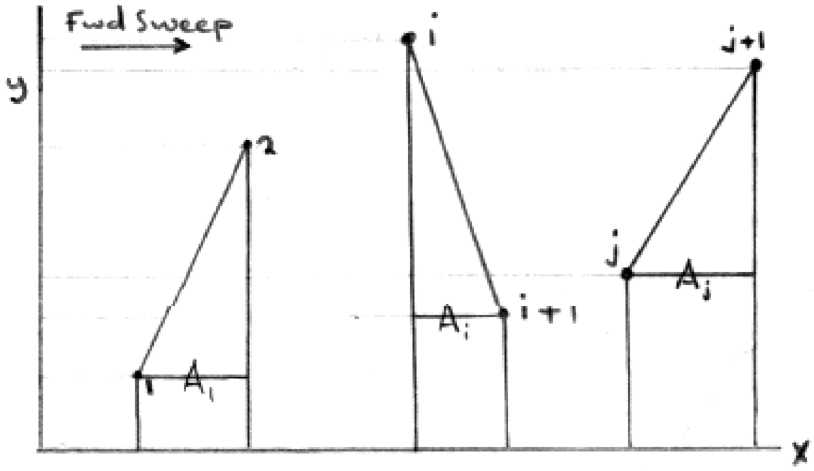
radii of giration about principal axes

$$K_{1,2} = \sqrt{I_{1,2}/A}$$

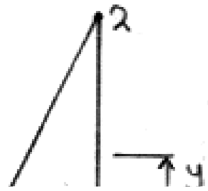
Plastic Bending



Area above assumed Zero Stress Axis



Fwd sweep (
Bwd sweep (



$y < y_1 \rightarrow A_1 = (x_2 - x_1)(y_1 - y) + ($

$y_2 > y > y_1 \rightarrow A_1 = (y_2 - y)^2 (x_2 - x_1) / (2$

that is, $A_1 = (y^2 - 2y_2 y + y_2^2)(x_2 - x$

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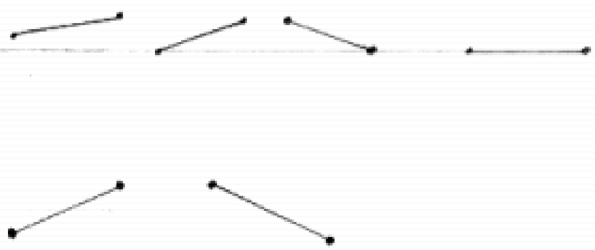
	COEFFICIENTS OF VARIABLE y		
CONDITION	y^2	y^1	y^0
$y_2 > y > y_1$	$\frac{x_2 - x_1}{2(y_2 - y_1)}$	$-2.y_2 \cdot \frac{x_2 - x_1}{2(y_2 - y_1)}$	$y_2^2 \cdot \frac{x_2 - x_1}{2(y_2 - y_1)}$
$y < y_1$		$-1.(x_2 - x_1)$	$y_1(x_2 - x_1) + (x_2 - x_1)(y_2 - y_1)/2$
			$-\frac{A_T}{2}$

roots of equation

are, $y = \dfrac{-b \pm (b^2 - 4ac)^{1/2}}{2a}$



Y_{esa} (assumed)

Zero Stress Axis Position for a Triangle

PlasticBending3

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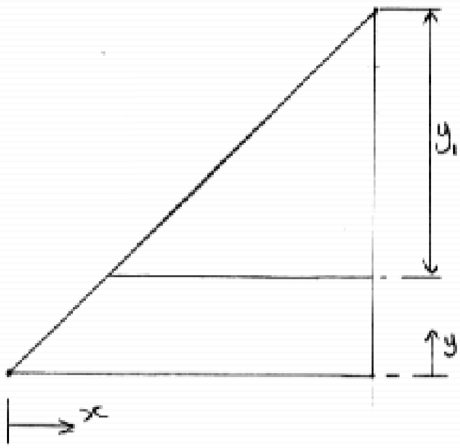


$A = \frac{1}{2} x y$

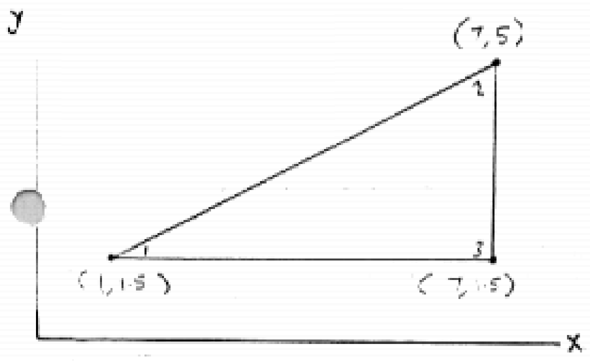
$\frac{A}{2} = \frac{1}{4} x y$

$\frac{1}{4} x y = \frac{1}{2} \cdot y_1 \cdot y_1 \cdot \frac{x}{y}$

$y_1^2 = \frac{2}{4} y^2$, then

$\underline{y_1 = y / \sqrt{2}}$

Theory Check



$\frac{x_2 - x_1}{2(y_2 - y_1)} = (7-1)/(2(5-1.5)) = .8571$

y^2	y^1	y^0
.8571	$-2 \times 5 \times .8571$	$5^2 \times .8571$ $-(5-1.5)(7-1)/(2\times 2)$
$.8571 y^2$	$-8.571 y$	$+16.178$

$= \emptyset$

$y = (8.571 \pm (8.571^2 - 4 \times .8571 \times 16.178)^{1/2})/(2 \times .8571) = 7.475$

$= \underline{\underline{2.525}}$

Check

$y_{zsa} = ((5-1.5) - (5-1.5)/\sqrt{2}) + 1.5 = 2.525$ ✓

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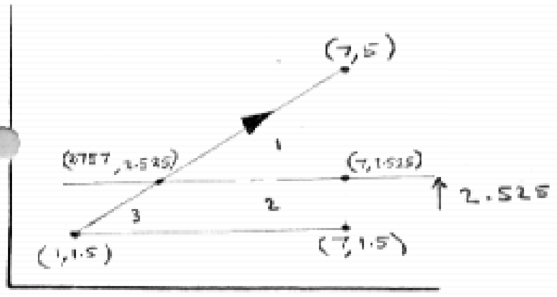
$\Sigma A.y$ check

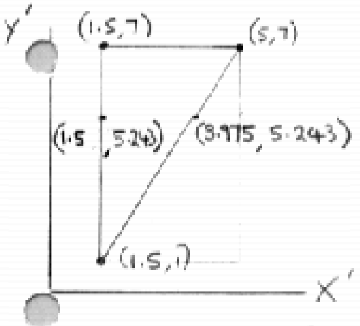
x_{zsa}	5.243	✓
AX	12.3	✓
y_{zsa}	2.525	✓
AY	7.176	✓



$$\Sigma A.Y = (7-2.757)(5-2.525)^2/(2\times 3)$$
$$+ (7-2.757)(2.525-1.5)^2/2$$
$$+ (2.757-1)(2.525-1.5)^2\,2/(3\times 2)$$
$$= 7.176$$

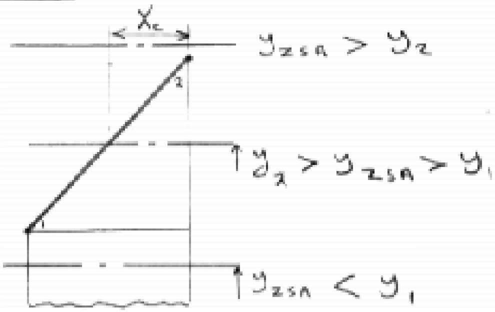
$$X_{zsa} = 1.0 + (7-1)/\sqrt{2} \qquad = 5.243$$

$\Sigma A.X$ check



$$\Sigma A.X = (3.975-1.5)(5.243-1)^2/(2\times 3)$$
$$+ (3.975-1.5)(7-5.243)^2/2$$
$$+ (5-3.975)(7-5.243)^2\,2/(3\times 2)$$
$$= 12.30$$

Σ A y



$y_{zsa} < y_1$

$$A.y = (x_2 - x_1)\,y_{zsa}^2/2 + (x_2 - x_1)(y_1 - y_{zsa})^2/2$$
$$+ (x_2 - x_1)(y_2 - y_1)\big((y_2 - y_1)/3 + y_1 - y_{zsa}\big)/2$$

$y_2 > y_{zsa} > y_1$

$A = \frac{d}{2}(b + c)$

$y_t = \frac{d}{3}\,\frac{2b + c}{b + c}$

$$X_c = (y_2 - y_{zsa})(X_2 - X_1)/(y_2 - y_1)$$
$$A.y = X_c\,(y_2 - y_{zsa})^2/(2 \times 3)$$
$$+ (x_2 - x_1)\,y_1\,(y_1/2 + y_{zsa} - y_1)$$
$$+ \big((y_{zsa} - y_1)(X_2 - X_1 + X_c)/2\big)$$
$$\cdot (y_{zsa} - y_1)(2(X_2 - X_1) + X_c)/((X_2 - X_1 + X_c)3)$$

$y_{zsa} > y_2$

$$A.y = (x_2 - x_1)\,y_1\,(y_1/2 + y_{zsa} - y_1)$$
$$+ (x_2 - x_1)(y_2 - y_1)\big((y_2 - y_1)2/3 + y_{zsa} - y_2\big)/2$$

$y_1 > y_{zsa} > y_2$

$$X_c = (y_1 - y_{zsa})(X_2 - X_1)/(y_2 - y_1)$$
$$A.y = X_c\,(y_1 - y_{zsa})^2/(2 \times 3)$$
$$+ (X_2 - X_1)\,y_2\,(y_2/2 + y_{zsa} - y_2)$$
$$+ \big((y_{zsa} - y_2)(X_2 - X_1 + X_c)/2\big)$$
$$\cdot (y_{zsa} - y_2)(2(X_2 - X_1) + X_c)/((X_2 - X_1 + X_c)3)$$