DESIGN OF CONCRETE STRUCTURE-I (CE-385)

Jayed Pasha

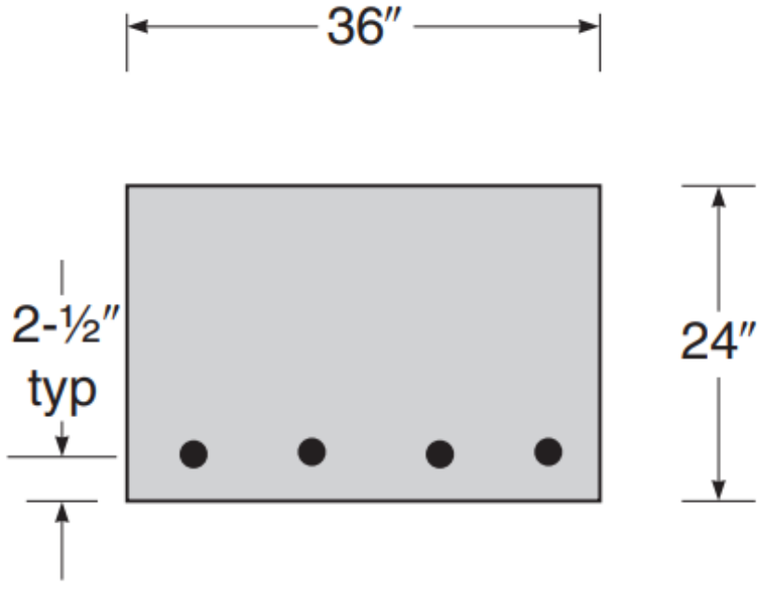
Lecturer

Department of EWCE, MIST

CRACKING MOMENT CALCULATION

Example-1

A rectangular beam has a width of 36” and height of 24” with four No. 11 (#11) bars. It has a concrete tensile capacity of 475 psi. The concrete compressive strength f_C' is 4000 psi and yield point of the steel f_y is 60,000 psi. Compare the cracking moment based on the gross section properties and the transformed section properties



Here,

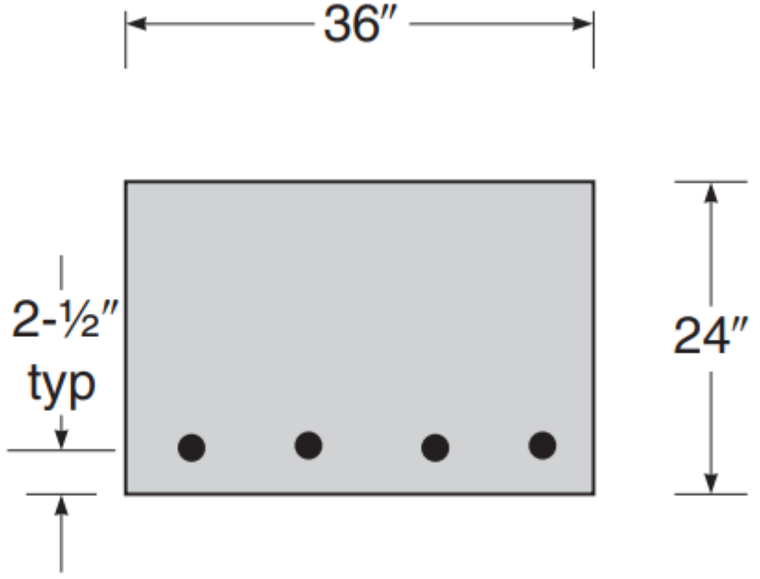
b=36"

h=24"

A_s= 4×1.56=6.24 in^2

- For Gross section properties,

$$\bar{y} = 12 \text{ in}$$



Moment of Inertia,

$$I_g = \frac{36 \times 24^3}{12} = 41472 \text{ in}^4$$

We know,

$$f = \frac{Mc}{I}$$

For cracking of concrete, $f_{bottom} = f_r$

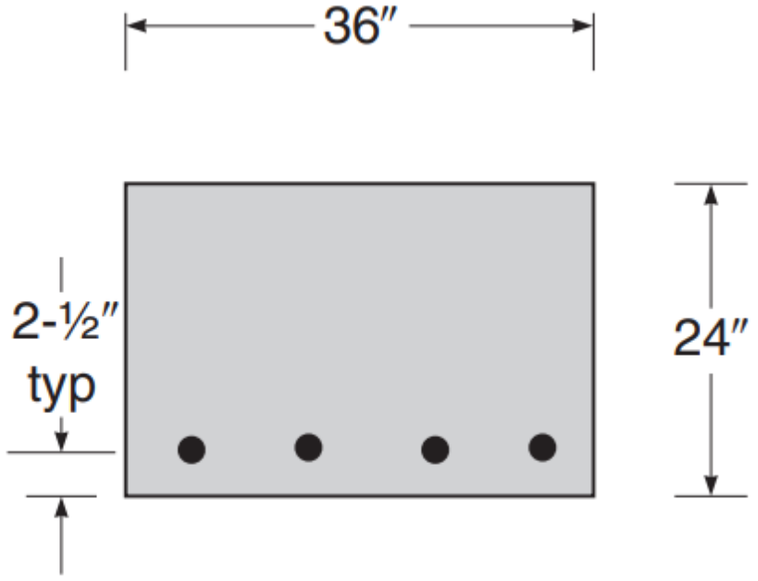
Therefore,

$$f_r = \frac{M_{cr}c}{I}$$

$$\Rightarrow 475 = \frac{M_{cr} \times 12}{41472}$$

$$\Rightarrow M_{cr} = 1641600 \text{ lb-in}$$

$$\Rightarrow M_{cr} = 1641.6 \text{ Kip-in}$$



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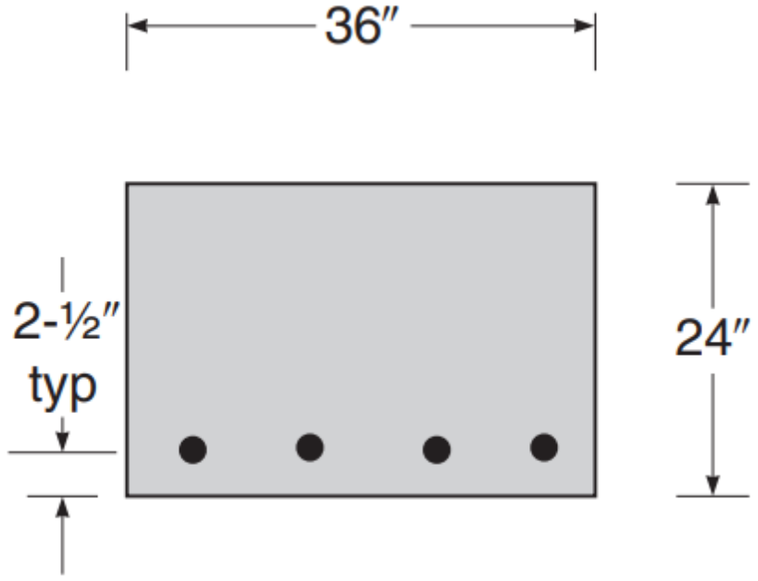
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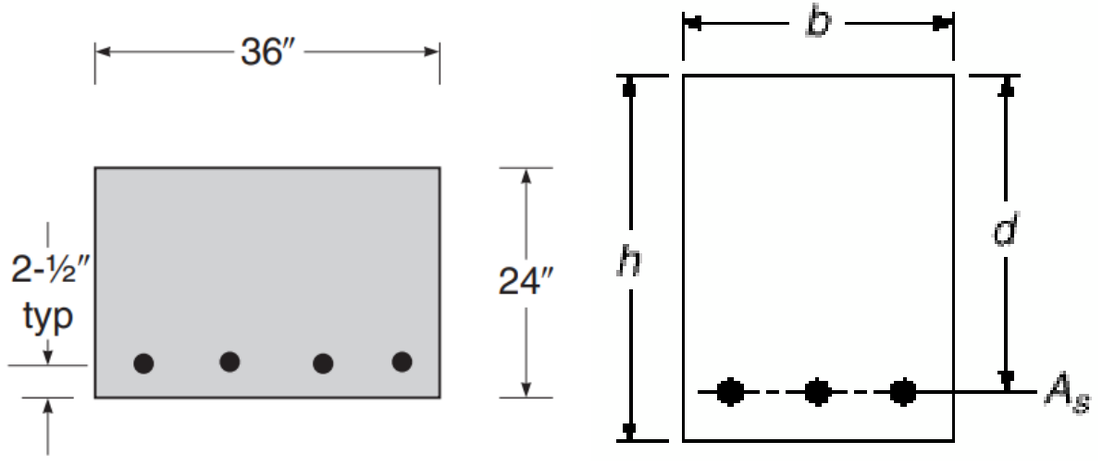


❑ For Transformed section,

$n = E_s/E_c = 29{,}000{,}000 / 3{,}600{,}000 = 8$

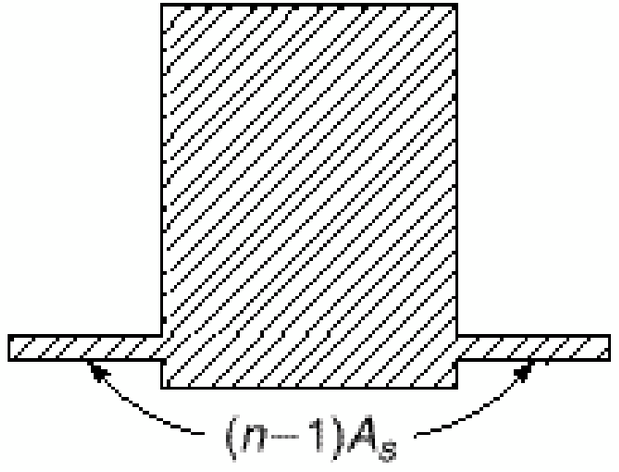
$A_s = (4 \times 1.56)\ in^2$

$(n-1)As = (8-1) \times (4 \times 1.56) = 43.68\ in^2$



Distance of Neutral axis from top,

$$\bar{y} = \frac{36 \times 24 \times 12 + 43.68 \times 21.5}{36 \times 24 + 43.68} = 12.46\ \text{in}$$



Distance of Neutral axis from bottom = 24-12.46=11.54 in

Moment of Inertia,

$$I_{tr} = \frac{36 \times 24^3}{12} + 36 \times 24 \times (12.46 - 12)^2 + 43.68 \times (21.5 - 12.46)^2 = 45224.42\ \text{in}^4$$

We know,

$$f = \frac{Mc}{I}$$

For cracking of concrete, $f_{bottom} = f_r$

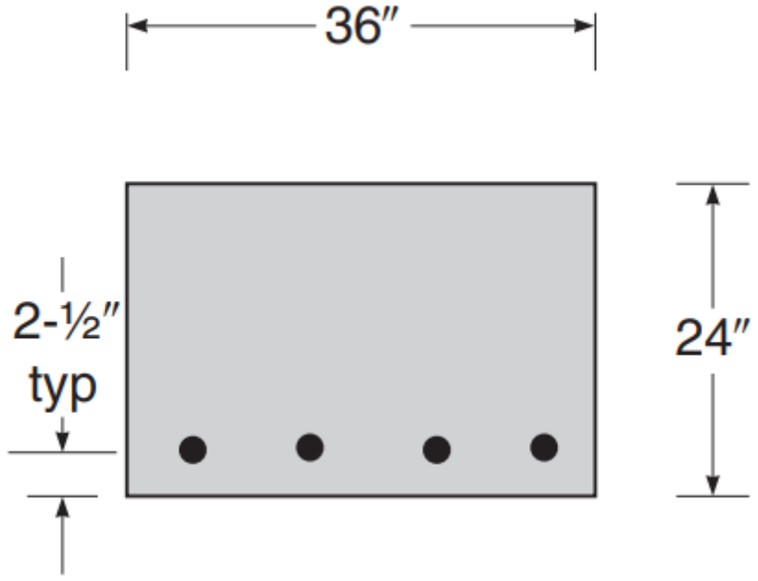
Therefore,

$$f_r = \frac{M_{cr}c}{I}$$

$$\Rightarrow 475 = \frac{M_{cr} \times 11.54}{45224.42}$$

$$\Rightarrow M_{cr} = 1861490.4 \quad \text{lb-in}$$

$$\Rightarrow M_{cr} = 1861.5 \quad \text{Kip-in}$$



- For gross section, M_{cr} =1641.6 kip-in
- For transformed section, M_{cr} =1861.5 kip-in

The ratio of cracking moment based on transformed section properties to gross section properties is

$$\frac{1861.5}{1641.6} = 1.13$$