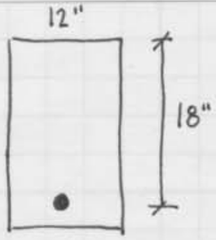
13-1 (A)

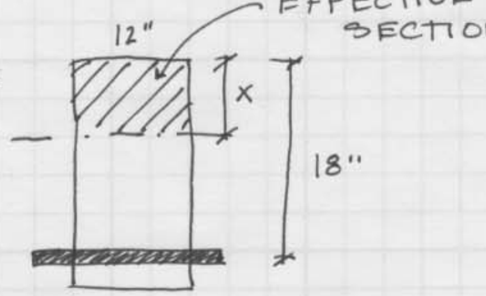


$A_s = 3 in^2$

$E_c = 3625$ ksi ⟶ $n = 8$ (From Data Sheet D-23)

$E_s = 29000$ ksi

First transform section:
(Convert steel into equivalent area of concrete.)



$A_{TR} = 3 in^2 \times 8 = 24 in^2$

(1) Determine Neutral Axis of the Effective Section:

$A_c \bar{x}_c = A_t \bar{x}_t$

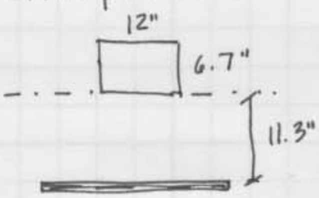
$(12" \times x)\left(\frac{x}{2}\right) = 24 in^2 (18 - x)$

$6x^2 = 432 - 24x$

$x^2 + 4x - 72 = 0$ Use quadratic equation to solve: $x = \frac{-b \pm \sqrt{b^4 - 4ac}}{2a}$

$x = \frac{-4 \pm \sqrt{(4)^2 - (4)(1)(72)}}{(2)(1)} = \boxed{6.7"}$ (Note: ignore negative answer, because we are only interested in a positive value)

(2) Transformed Moment of Inertia



$I = \frac{bd^3}{3} = \frac{(12")(6.7")^3}{3} = 1203 in^4$

$I = Ax^2 = (24 in^2)(11.3")^2 = 3064.56 in^4$

$I_{TR} = \boxed{4267.6 in^4}$

(3) Resisting Capacity of Concrete & Steel

Concrete: $f = 1.8$ ksi

$M = \frac{f I_{TR}}{c} = \frac{(1.8 ksi)(4268 in^4)}{6.7"} = 1146.6$ "k $= 95.5$ 'k

Lower Moment Governs

Steel: $f = 20$ ksi

$M = \frac{f I_{TR}}{cn} = \frac{(20 ksi)(4268 in^4)}{(11.3")(8)} = 944.2$ "k $= \boxed{78.68 'k}$ steel governs.

← Need Modular Ratio!

(4) Actual stress in concrete:

$f = \frac{Mc}{I_{TR}} = \frac{(944.2 "k)(6.7")}{4268 in^4} = \boxed{1.48 ksi}$