

$$K_s = 46 \frac{W}{m \cdot ^\circ C}$$

$$K_c = 390 \frac{W}{m \cdot ^\circ C}$$

$$R = 5.0 \text{ cm.}$$

$$L = 4.0 \text{ cm.}$$

Q SAME HEAT FLOWS THROUGH BOTH CYLINDERS

$$\therefore Q_s = Q_c \quad \text{OR} \quad \frac{Q_s}{Q_c} = 1$$

$$Q_s = K_s A \frac{\Delta T_s}{\Delta X_s} \cdot \Delta t$$

$$Q_c = K_c A \frac{\Delta T_c}{\Delta X_c} \cdot \Delta t$$

$$\Delta T_s = 95 - T_m$$

$$\Delta T_c = T_m - 15$$

$$\Delta X_s = \Delta X_c = 4.0 \text{ cm}$$

$$\frac{Q_s}{Q_c} = \frac{K_s A \frac{\Delta T_s}{\Delta X_s} \cdot \Delta t}{K_c A \frac{\Delta T_c}{\Delta X_c} \cdot \Delta t} = \frac{K_s}{K_c} \frac{\Delta T_s}{\Delta T_c} = \frac{K_s}{K_c} \frac{(95 - T_m)}{T_m - 15} = 1$$

$$K_s (95 - T_m) = K_c (T_m - 15)$$

$$K_s 95 - K_s T_m = K_c T_m - 15 K_c$$

$$K_s 95 + 15 K_c = (K_c + K_s) T_m$$

$$\frac{95 K_s + 15 K_c}{K_s + K_c} = T_m$$

$$\frac{95 + 15 \frac{K_c}{K_s}}{1 + \frac{K_c}{K_s}} = T_m$$

$$\frac{K_c}{K_s} = \frac{390}{46} = 8.48$$

$$T_m = \frac{95 + 15(8.48)}{1 + 8.48}$$

$$T_m = 23.4^\circ C$$

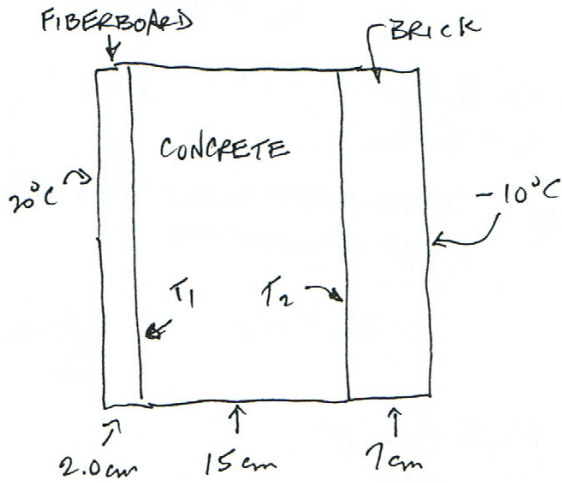
$$Q_s = K_s A \frac{\Delta T_s}{\Delta X_s} \Delta t$$

$$= \frac{46 \cdot \pi \cdot (0.05)^2 (95 - 23.4) 90 \cdot 60}{0.04}$$

$$Q_s = \frac{46(3.14) 25 \times 10^{-4} (71.6)(1200)}{0.04}$$

$$Q_s = 7.76 \times 10^5 \text{ J}$$

CHAP 11 #78 - ANOTHER APPROACH



AREA = 3.5m x 5.0m.

$k_F = 0.059 \frac{W}{m \cdot ^\circ C}$

$k_C = 1.3 \frac{W}{m \cdot ^\circ C}$

$k_B = 0.71 \frac{W}{m \cdot ^\circ C}$

QUES:  
 $\Delta Q$  in 1hr = ?

ANS:  
 $3.4 \times 10^6 J$

$Q = KA \frac{\Delta T}{\Delta x} \Delta t$  LET  $Q' \equiv \frac{Q}{A \cdot \Delta t} = K \frac{\Delta T}{\Delta x}$

$Q'_F = Q'_C = Q'_B = Q'$

$\frac{k_F (20 - T_1)}{x_F} = \frac{k_C (T_1 - T_2)}{x_C} = \frac{k_B (T_2 + 10)}{x_B}$

2 EQN = 2 UNKNOWN  
 STD SOLN.

DIFFERENT APPROACH

$\frac{x_F}{k_F} Q' = 20 - T_1$  ;  $\frac{x_C}{k_C} Q' = T_1 - T_2$  ;  $\frac{x_B}{k_B} Q' = T_2 + 10$

$\frac{x_F}{k_F} Q' + \frac{x_C}{k_C} Q' + \frac{x_B}{k_B} Q' = (20 - T_1) + (T_1 - T_2) + (T_2 + 10) = 20 + 10 = 30$

$Q' \left( \frac{x_F}{k_F} + \frac{x_C}{k_C} + \frac{x_B}{k_B} \right) = 30$

$Q' = \frac{30}{\frac{x_F}{k_F} + \frac{x_C}{k_C} + \frac{x_B}{k_B}}$

$Q' = \frac{30}{\frac{0.02}{0.059} + \frac{0.15}{1.3} + \frac{0.07}{0.71}}$

$Q' = \frac{30}{0.339 + 0.115 + 0.099} = \frac{30}{0.533} = 54.2 = \frac{Q}{A \cdot \Delta t} = \frac{W}{m^2 \cdot s}$

$Q = Q' \cdot A \cdot \Delta t = 54.2 (3.5 \times 5) \times 3600$   
 $Q = 3.42 \times 10^6 J$

## EQUIVALENT RESISTANCE (THERMAL)

$$\frac{x_{TOT}}{K_{eff}} = \frac{x_F}{K_F} + \frac{x_C}{K_C} + \frac{x_B}{K_B}$$

$$\frac{1}{K_{eff}} = \frac{1}{K_F} \left( \frac{x_F}{x_{TOT}} \right) + \frac{1}{K_C} \left( \frac{x_C}{x_{TOT}} \right) + \frac{1}{K_B} \left( \frac{x_B}{x_{TOT}} \right)$$

A WEIGHT AVE OF INVERSE THERMAL CONDUCTIVITIES

$$\text{THERMAL RESISTANCE} = \frac{1}{\text{THERMAL CONDUCTIVITY}}$$

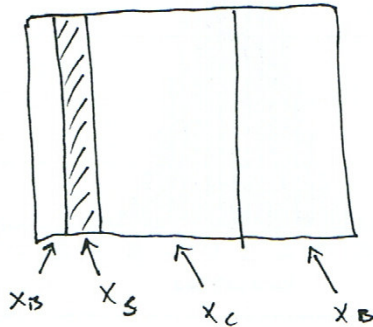
THIS IS THE WAY TO APPROACH MORE COMPLICATED STRUCTURES

CHAP 11 - #79.

ADD S BETWEEN FIBERBOARD → CONCRETE  
TO DROP  $Q$  BY  $1/2$  - WHAT IS  $x_S$ ?

OLD WAY → 4 EQN + 4 UNKNOWN  $Q, T_1, T_2, T_3$

THERMAL RESISTANCE WAY



$x_B = 2.0 \text{ cm}$	$K_B = 0.059 \frac{\text{W}}{\text{m}\cdot\text{C}}$
$x_S = ?$	$K_S = 0.042 \frac{\text{W}}{\text{m}\cdot\text{C}}$
$x_C = 15 \text{ cm}$	$K_C = 1.3 \frac{\text{W}}{\text{m}\cdot\text{C}}$
$x_B = 7 \text{ cm}$	$K_B = 0.71 \frac{\text{W}}{\text{m}\cdot\text{C}}$

$$Q' \rightarrow \frac{Q'}{2} = \frac{54.2}{2} = 27.1 \frac{\text{J}}{\text{m}^2\cdot\text{s}} = \frac{\Delta T}{\frac{x_{TOT}}{K_{eff}}} = \frac{30}{\frac{x_{TOT}}{K_{eff}}} ; \frac{x_{TOT}}{K_{eff}} = \frac{30}{27.1} = 1.11$$

$$\frac{x_{TOT}}{K_{eff}} = \frac{x_F}{K_F} + \frac{x_S}{K_S} + \frac{x_C}{K_C} + \frac{x_B}{K_B}$$

$$x_S = K_S \left( \frac{x_{TOT}}{K_{eff}} - \frac{x_F}{K_F} - \frac{x_C}{K_C} - \frac{x_B}{K_B} \right) = 0.042 (1.11 - 0.533) = 0.024 \text{ m} = 2.4 \text{ cm}$$