Reinforced Concrete Beam Program - Rectangular Section - Beta

Release RCB Beta - Version 090722. This version is to be used for testing and product evaluation only.

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Project Identification

Structure Identification
Test Beam

Project Description
Beta Testing Worksheet

Project Notes

Material Properties

Concrete Compressive Strength	5000	psi.
Steel Yield Strength	60000	psi.
Steel Reinforcement Modulus of Elasticity	29000	ksi.
Concrete Unit Weight	140	pcf.
Concrete Modulus of Elasticity	3900	ksi.

$$E_c = 33 w_c^{1.5} \sqrt{f_c'}$$

Beam Width	25	inches
Beam Height	40	inches
Beam Area	1000	inch^2

Gross Moment of Inertia = $I_g = \dfrac{bh^3}{12}$ $I_g =$ 133333 inch^4

	Reinforcement					
	Distance from Bottom (Inches)	Rebar Size	Number Rebar in Row	Rebar Spacing (Inches)	Area Row	A * d
Row 10					0	0
Row 9					0	0
Row 8					0	0
Row 7					0	0
Row 6					0	0
Row 5					0	0
Row 4					0	0
Row 3	6	#5	8	2	2.48	14.88
Row 2	4	#5	6	3	1.86	7.44
Row 1	2	#6	6	3	2.64	5.28
				Summation	6.98	27.6

$$d_{bot} = \frac{\sum_1^N A_{row\,(n)} d_{row\,(n)}}{\sum_1^N A_{row\,(n)}}$$

Rebar Neutral Axis Distance From Bottom of Beam = 3.954154728 inches

$$d = h - d_{bot}$$

d = distance of centroid of reinforcement to the top of beam (extreme fiber in compression)

d = 36.04584527 inches

Solve for Modulus of Rupture

$$f_r = 7.5\sqrt{f_c'}$$

$f_r =$ 530 psi.

$$y_t = \frac{h}{2}$$

$y_t =$ 20 inches

Modular Ratio = $n = \frac{E_s}{E_c}$ rounded to the nearest whole number, but not less than 6. AASHTO 8.15.3.4

Modular Ratio 7

Solve for the Stress Block Depth Factor

$$\beta_1 = \begin{cases} 0.85 & for...0 < f_c' \le 4000\,psi. \\ 0.85 - 0.05\left(\frac{f_c' - 4000}{1000}\right) & for...4000\,psi. < f_c' \le 8000\,psi. \\ 0.65 & for...f_c' > 8000\,psi. \end{cases}$$

AASHTO Equation 8.16.2.7

Beta 1 = 0.8

Solve for Balanced Reinforcement Ratio

$$\rho_b = \frac{0.85\beta_1 f_c'}{f_y}\frac{87{,}000}{87{,}000 + f_y}$$

AASHTO 8.16.3.2.2 Equation 8-18

$\rho_b =$ 0.033537415

Solve for the Maximum Reinforcement Ratio

$$\rho_{max} = 0.75\rho_b$$

AASHTO Equation 8.16.3.1.1

$\rho_{max} =$ 0.025153061

Solve for Distance of Extreme Compression Fiber to Neutral Axis of the Cracked Section

$$\frac{bc^2}{2} + nA_s c - nA_s d = 0$$

Reinforced Concrete - A Fundamental Approach, Eqn 8.7

c = 10.07538285 inches

Solve for the Cracked Moment of Inertia

$$I_{cr} = \frac{bc^3}{3} + nA_s(d-c)^2$$

$I_{cr} =$ 41478 inch^4

Reinforced Concrete - A Fundamental Approach, Eqn 8.7

Solve for Cracking Moment

$$M_{cr} = \frac{f_r I_g}{y_t}$$

$M_{cr} =$ 294.63 Kip*Ft

Solve for Minimum Reinforcement Ratio

where

$$\rho_{min} = \frac{A_{s(\min)}}{bd} \quad where....A_{s(\min)} \quad develops \quad \phi M_n = 1.2 M_{cr}$$

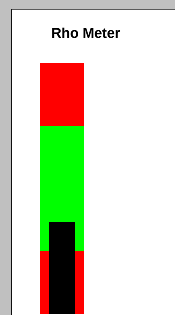
Solve the quadratic equation for $A_{s(\min)}$

$$\frac{A_{s(\min)}^2 f_y^2}{1.7 f_c^{'} b} - \phi f_y d A_{s(\min)} + 1.2 M_{cr} = 0$$

$\phi =$ **0.9** **For Flexure**

$A_{s\,(\min)} =$ 2.222649433 inch^2

$\rho_{\min} =$ 0.0024665



Solve for Tension Reinforcement Ratio

$$\rho = \frac{A_s}{bd}$$

$\rho =$ 0.007745692

Solve for Depth of Equivalent Rectangular Stress Block

$$a = \frac{A_s f_y}{0.85 f_c^{'} b}$$

$a =$ 3.94 inch

Solve for Design Moment

$$\phi M_n = \phi \left[A_s f_y \left(d - \frac{a}{2} \right) \right]$$

AASHTO 8.16.3.2.1

$\phi M_n =$ 1070.30 Kip*Ft.