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Appendix

To illustrate the theory stated in Chapter 2, samples of calculation of mid-span deflection of B1 are presented here.

Details of test beam, B1, are as follow; cross section 10.2x18.6 cm., effective depth 17.1 cm., area of reinforcement 0.89 cm^2., gross sectional moment of inertia (neglect areaof reinforcement) 5470 cm^4, uncracked moment of inertia 5682 cm^4., cracked moment of inertia 969 cm^4., cylindrical compressive strength 694 ksc, concrete tensile strength 49 ksc, modulus of elasticity of concrete 3.978×10^5 ksc and n = 5.

a) <u>For the curve abbreviated as I_{inst}</u>.

As the applied load was increased up to cracking load, 868 kg., equivalent to bending moment 290 kg-m. shown in Table 4.2, moment of inertia of the critical section was constant and equal to 5682 cm^4. Hence the increment of mid-span deflection obtained from equation 2.26 should be

$$\Delta y = -0+ \frac{23- x(210)^3 x868}{(36)^2 3.978x10^5 x5682}$$

$$= 0.063 \quad cm. \qquad ....(1)$$

As the applied load was greater, the neutral axis moved forward. The depth of observed neutral axis was 4.61 cm. from the extreme compressive fiber at the load 1000 kg. Substituting properties of B1 into equation 2.6 yields cracked moment of inertia at the state of load 1000 kg.

$$I_{cr} = \frac{1.012}{3}(4.61)^3 + 5x0.89x(17.1-4.61)^2$$

$$= 1027 \quad cm^4. \qquad ....(2)$$

Again by using equation 2.26, the increment of mid-span deflection between the applied load 868 and 1000 kg. was obtained as

$$\Delta y = \frac{-23 \quad x(210)^3 x868x(1027-5682)}{(36)^2 x3.978x10^5 \; x(5682)^2} + \frac{23 \quad x(210)^3 x1000-868)}{(36)^2 x3.978x10^5 x5682}$$

$$= +0.052+0.009$$

$$= 0.061 \quad cm. \qquad ....(3)$$

Hence the mid-span deflection at the load 868 kg was 0.063 cm. and that of the load 1000 kg was 0.063 plus 0.061 which was equal to 0.124 cm. Other points of load-deflection curve could be obtained in the same way.

b) <u>For the curve obreviated as I_{eff}</u>

In this method, moment of inertia was propose in 1977 ACI Code as effective moment of inertia which included the degree of loading in term of bending moment as

$$I_{ef} = (\frac{M_{cr}}{M_{max}})^3 \; Ig + |1-(\frac{M_{cr}}{M_{max}})^3| I_{cr} \qquad ....(4)$$

As the applied load was increased up to cracking load, 868 kg, moment of inertia of critical section was constant at 5470 cm^4.

Hence the mid-span deflection, obtained from equation (2.24) should be

$$y = \frac{23 \times (210)^3 \times 868}{(36)^2 \times 3.978 \times 10^5 \times 5470}$$

$$= 0.065 \quad \text{cm.} \qquad ....(5)$$

As the applied load was greater as 2400 kg, equivalent to bending moment 840 kg-m, moment of inertia was reduced and could be obtained from equation 4 as

$$I_{ef} = \left(\frac{304}{840}\right)^3 \times 5470 + \left|1-\left(\frac{304}{840}\right)^3\right| 969$$

$$= 1179 \quad \text{cm}^4 \qquad ....(6)$$

Then the mid-span deflection, obtained from equation 2.24 should be

$$y = \frac{23 \times (210)^3 \times 2400}{(36)^2 \times 3.978 \times 10^5 \times 1179}$$

$$= 0.841 \quad \text{cm.} \qquad ....(7)$$

Hence the mid-span deflection at the load 868 kg. was 0.065 cm. and that of the load 2400 kg. was 0.841 cm.

c) <u>For the curve abbreviated as Para</u>

By assuming the depth of neutral axis, curvature and parabolic compressive stress distribution compression force could be obtained and with strain distribution tension force could be determined. Several trial might be performed until internal equilibrium was achieved then the resisting bending moment could be found. The resisting bending moment could be transformed to equivalent applied load by multiplied by 6/L.

The further step in calculating mid-span deflection was the same as stated previously in a) Above the cracking load, 868 kg, compressive stress distribution was assumed in parabolic shape. At the load of 1131 kg. the calculated depth of neutral axis was 3.5 cm. Hence moment of inertia of critical section at this state was

$$I_{cr} = \frac{10.2}{3} x(3.5)^3 + 5x0.89x(17.1-3.5)^2$$

$$= 969 \quad cm^4. \qquad \text{.........(8)}$$

The increment of mid-span deflection between the applied load 868 and 1131 kg. was obtained as

$$\Delta y = \frac{-23x868x(969-5682)}{(36)^2x3.978x10^5x(5682)^2} + \frac{23x(210)^3x(1131-868)}{(36)^2x3.978x10^5x5682}$$

$$= 0.050+0.019$$

$$= 0.069 \quad cm. \qquad \text{.........(9)}$$

Hence the mid-span deflection at the load 868 kg. was 0.063 cm. and that of the load 1131 kg. was 0.063 plus 0.069 which was equal to 0.132 cm.

d) <u>For the curve obbreviated as Tri</u>

The mid-span deflection was obtained in the same way as that stated before in Para except that compressive stres distribution was assumed in triangular shape. At the load of 1131 kg. the calculated depth of neutral axis was 3.5 cm. Hence the mid-span deflections at the mid-span deflections at the load 868 and 1131 kg. were the same those obtained in Para.

e) <u>For the curve obreviated as Straight</u>

In this method moment of inertia of critical section was considered at before and after cracking state. The mid-span deflection could be obtained by using equation (2.24) with proper moment of inertia.

As the applied load was increased up to cracking load, 868 kg., the mid-span deflection was increased linearly and at cracking load the deflection was

$$y = \frac{23 x (210)^3 x 868}{(36)^2 x 3.978 x 10^5 x 5682}$$

$$= 0.063 \quad cm. \qquad ....(10)$$

At further state of loading up to the ultimate load the critical section was considered to be cracked section. Hence the mid-span deflection at cracking load, 868 kg., was

$$y = \frac{23 x 868 x (210)^3}{(36)^2 x 3.978 x 10^5 x 969}$$

$$= 0.370 \quad cm. \qquad ....(11)$$

And the deflection at ultimate load, 7590 kg., was

$$y = \frac{23 x 7590 x (210)^3}{(36)^2 x 3.978 x 10^5 x 969}$$

$$= 3.236 \quad cm. \qquad ....(12)$$

VITA

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