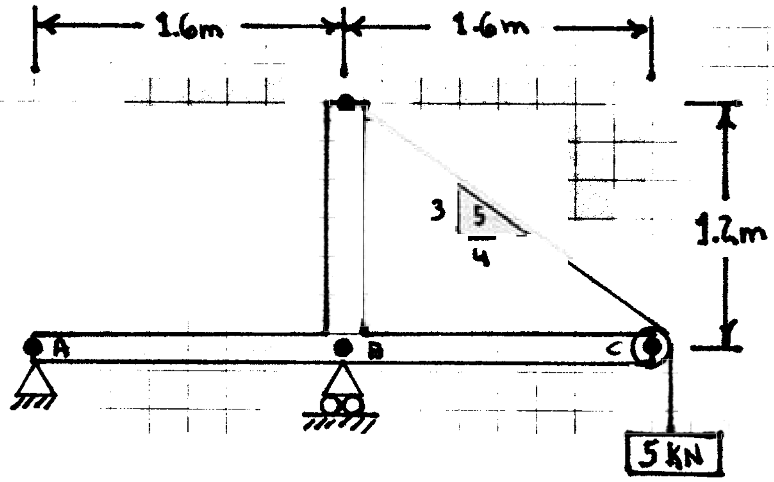
PROBLEM 11 || DETERMINE THE DEFLECTION AND CURVATURE OF POINT C USING THE MOMENT AREA METHOD. COMPARE THESE RESULTS TO YOUR PREVIOUS SOLUTIONS.



GIVEN:

CONSTRAINTS

1. 3.2m LONG BEAM WITH 1.2m VERTICAL EXTENSION AT MID-SPAN
2. SIMPLY SUPPORTED AT ONE END AND AT CENTER SPAN
3. CABLE ATTACHED TO THE TOP OF THE VERTICAL EXTENSION, TRAVELS OVER A FRICTIONLESS ROLLER, AND HOLDS A 5kN MASS.

ASSUMPTIONS

1. GRAVITY ACTS IN THE VERTICAL DIRECTION
2. MATERIAL IS LINEARLY ELASTIC
3. DEFLECTIONS AND STRAINS ARE SMALL

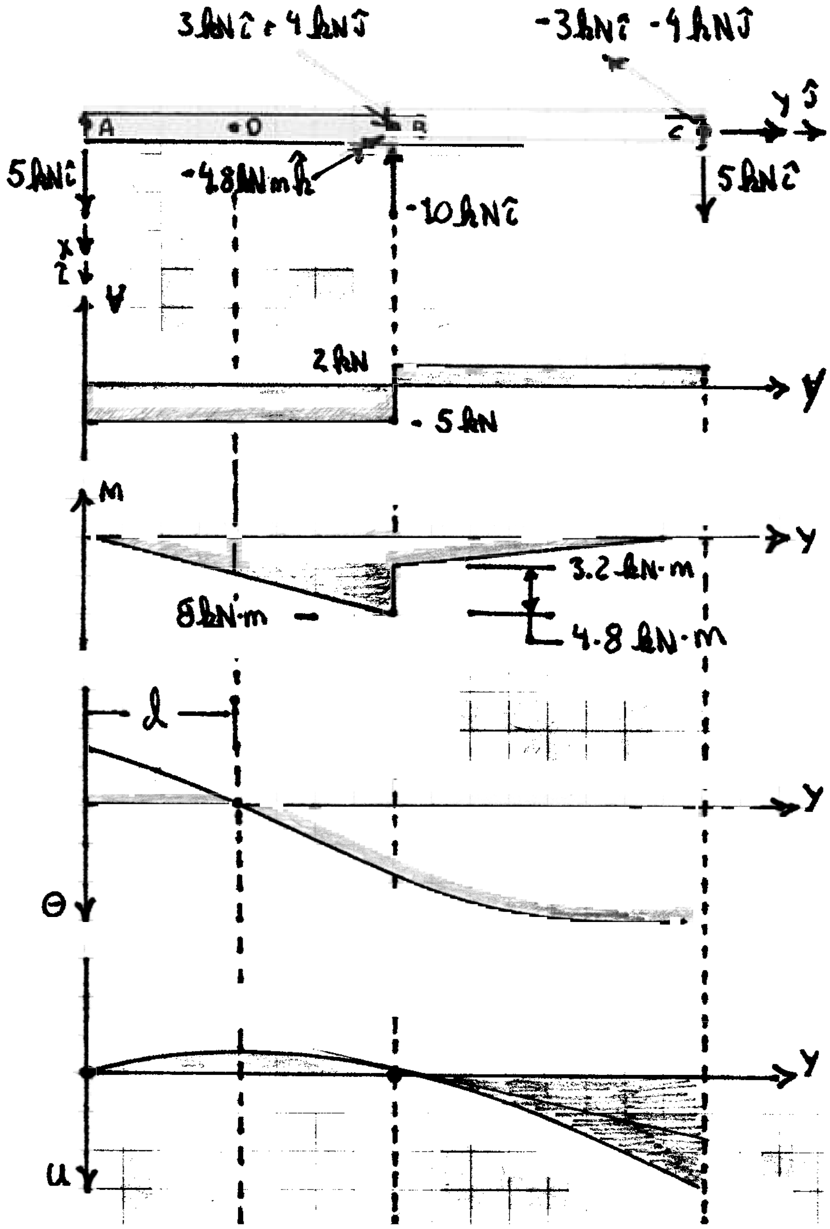
FIND:

1. THE DEFLECTION OF POINT C USING THE MOMENT AREA METHOD

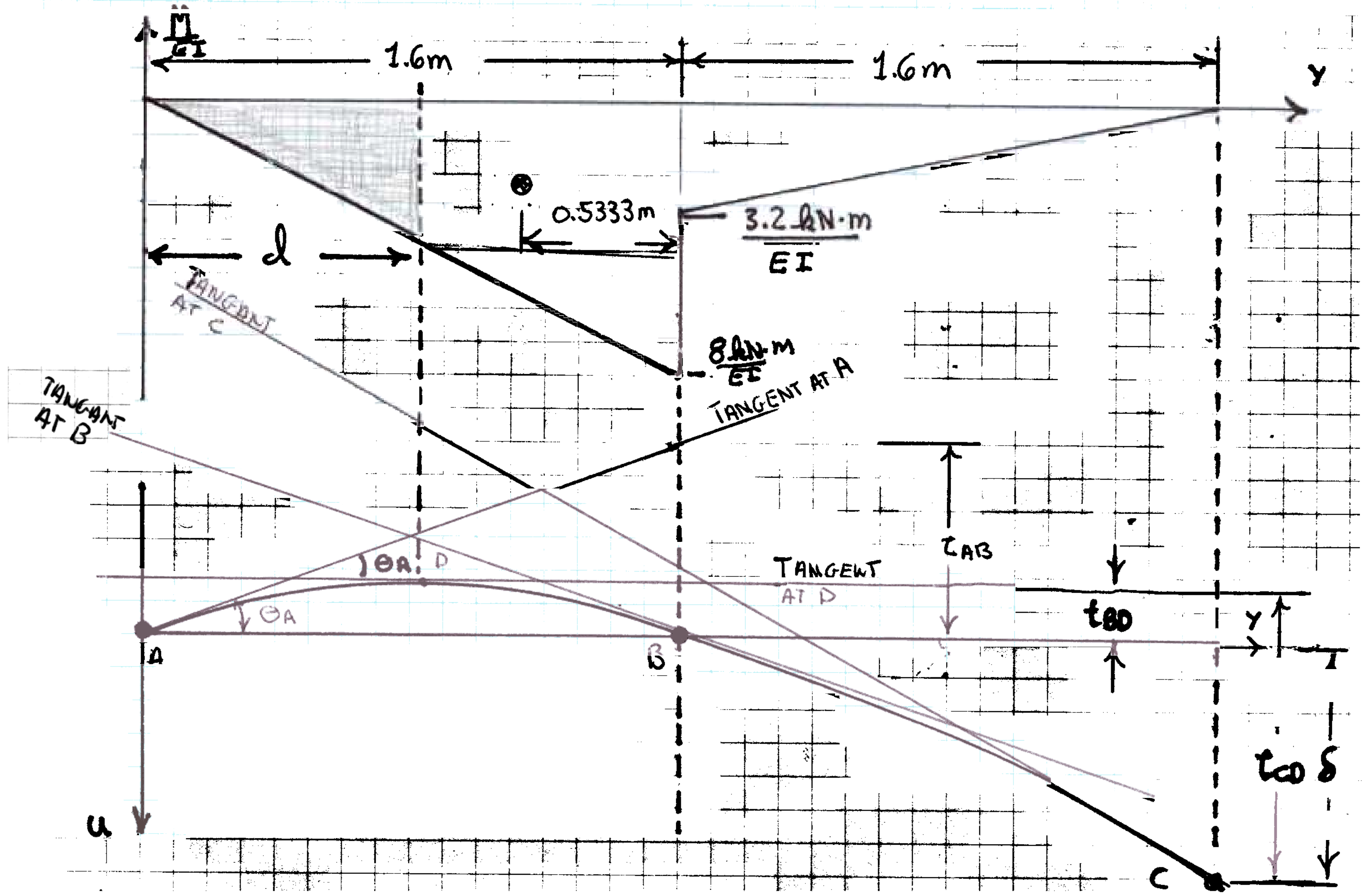
SOLUTION:

THE FIGURES TO THE RIGHT SHOW THE ORIGINAL BEAM, A FREE BODY DIAGRAM OF THE BEAM, THE SHEAR FORCE, BENDING MOMENT, CURVATURE, AND DEFLECTION DIAGRAMS.

THE NORMAL FORCE DIAGRAM HAS NO BEARING ON THE SOLUTION TO THE PROBLEM ASKED AND THEREFORE IS NOT SHOWN.



REDRAWING THE $\frac{M}{EI}$ DIAGRAM AND THE ELASTIC CURVE DIAGRAMS



THE SOLUTION STARTS BY DETERMINING BY DETERMINING θ_A WITH THE USE OF THEOREM II AND THEN USING THEOREM I. THIS IS DONE USING THE ASSUMPTION THAT ALL ANGLES ARE SMALL.

$$\theta_A \cong \tan\theta_A = \frac{t_{AB}}{1.6m} = \frac{1}{1.6m}\left[(1.6m)\cdot\frac{8\,kN\cdot m}{EI}\cdot\frac{1}{2}\cdot(0.5333m)\right] = \frac{2.133\,kN\cdot m^2}{EI} \quad (1)$$

FROM THEOREM I

$$\theta_A = \frac{1}{2}\cdot d\cdot\left(\frac{5\,kN\cdot d}{EI}\right) = \frac{5}{2}\,kN\,\frac{d^2}{EI} \quad (2)$$

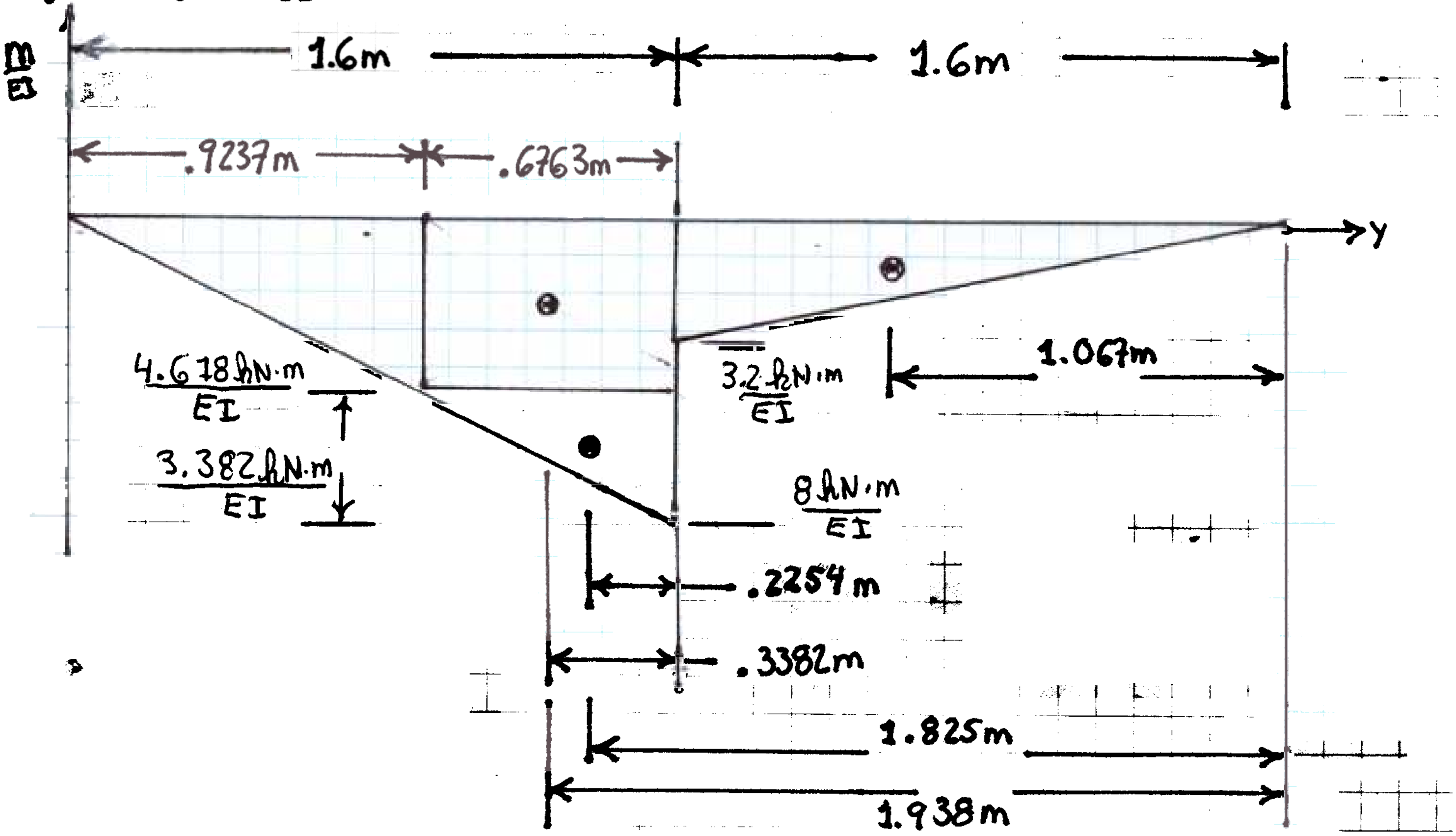
EQUATING (1) AND (2) SINCE THEY MEASURE THE SAME ANGLE

$$\frac{5}{2}\,\cancel{kN}\cdot\frac{d^2}{\cancel{EI}} = \frac{2.133\,\cancel{kN}\cdot m^2}{\cancel{EI}} \Rightarrow d^2 = \frac{2}{5}\cdot 2.133m^2 = .8532m^2$$

$$\Rightarrow \underline{\underline{d = 0.9237m}}$$

FROM THE DIAGRAM THE DEFLECTION OF POINT C CAN BE WRITEN

$$\delta = t_{CD} - t_{BD}$$



$$\delta = \left[(.6763\text{m})\cdot\left(\frac{4.618\ \text{kN}\cdot\text{m}}{EI}\right)(1.938\text{m}) + \tfrac{1}{2}(.6763\text{m})\left(\frac{3.382\ \text{kN}\cdot\text{m}}{EI}\right)(1.825\text{m}) + (1.6\text{m})\left(\frac{3.2\ \text{kN}\cdot\text{m}}{EI}\right)\cdot\tfrac{1}{2}\cdot(1.067\text{m})\right] - \left[(.6763\text{m})\left(\frac{4.618\ \text{kN}\cdot\text{m}}{EI}\right)(.3382\text{m}) + \tfrac{1}{2}(.6763\text{m})\left(\frac{3.382\ \text{kN}\cdot\text{m}}{EI}\right)(.2254\text{m})\right]$$

$$= \boxed{\frac{9.557\ \text{kN}\cdot\text{m}^3}{EI}}$$

SUMMARY:

THE SOLUTION TO THIS PROBLEM REQUIRES THE THE EXTREME VALUES OF THE ELASTIC CURVE BE DETERMINED. THE FIRST STEP IS FINDING θ_B FIRST USING THEOREM II AND THEN THEOREM I. THIS LOCATES THE POSITION OF THE MAXIMUM DEFLECTION BETWEEN "A" AND "B" ON THE ELASTIC CURVE.