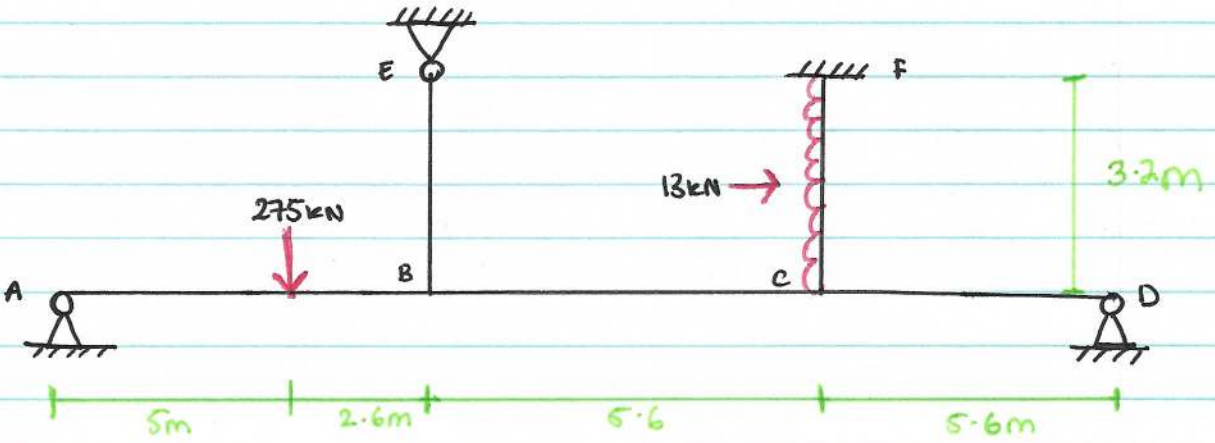
AW Etask report 4 - High Distinction Mark

Structural Analysis (University of Technology Sydney)

Aimee Williams etask 4



$EI = 160\ kNm^2$
$EA = \infty$

Determine rotation stiffness & DF

JOINT B.

$K_{BA} = \frac{3EI}{L} = \frac{3 \times 160}{7.6} = 63.15\ kNm/rad$

$K_{BE} = \frac{3EI}{L} = \frac{3 \times 160}{3.2} = 150\ kNm/rad$

$K_{BC} = \frac{4EI}{L} = \frac{4 \times 160}{5.6} = 114.29\ kNm/rad$

$\Sigma K_B = 63.15 + 150 + 114.29$
$\Sigma K_B = 327.44\ kNm/rad$

Distribution Factor

$DF_{KBA} = 63.15 / 327.44 = 0.1928$
$DF_{KBE} = 150 / 327.44 = 0.458$
$DF_{KBC} = 114.29 / 327.44 = 0.349$
$\Sigma DF_B = 1.0$

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JOINT C

$K_{CB} = \frac{4EL}{L} = \frac{4 \times 160}{5.6} = 114.29$ kNm/rad

$K_{CF} = \frac{4EL}{L} = \frac{4 \times 160}{3.2} = 200$ kNm/rad

$K_{CD} = \frac{3EL}{L} = \frac{3 \times 160}{5.6} = 85.71$ kNm/rad

$\Sigma K_C = 114.29 + 200 + 85.71$

$\Sigma K_C = 400$

Distribution Factor

$K_{CB}\ DF_{CB} = 114.29 / 400 = 0.286$

$DF_{CF} = 200 / 400 = 0.5$

$DF_{CD} = 85.71 / 400 = 0.214$

$\Sigma DF_C = 1.0$

$DF_F = 1.0$ $DF_C = 1.0$ ✓ OK.

Fixed end moments

$\Sigma M_A = \frac{F a b^2}{2L^3} (2L + b)$

$0 = \frac{275 \times 5 \times (2.6)^2}{2 \times 7.6^3} (2 \times 7.6 + 5)$

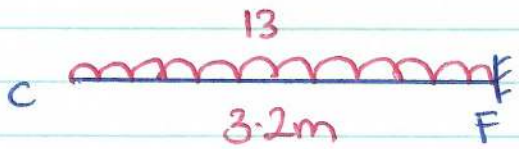
$\Sigma M_A = 213.86$ kN.m ANT CLOCKWISE

$$\Sigma M_B = \frac{Fab}{2L^2}\ (L \times a)$$

$$0 = \frac{275 \times 5 \times 2.6}{2 \times 7.6^2} \times (7.6 * 5)$$

$\Sigma M_B = 389.93$ kNm CLOCKWISE

ΣM_F



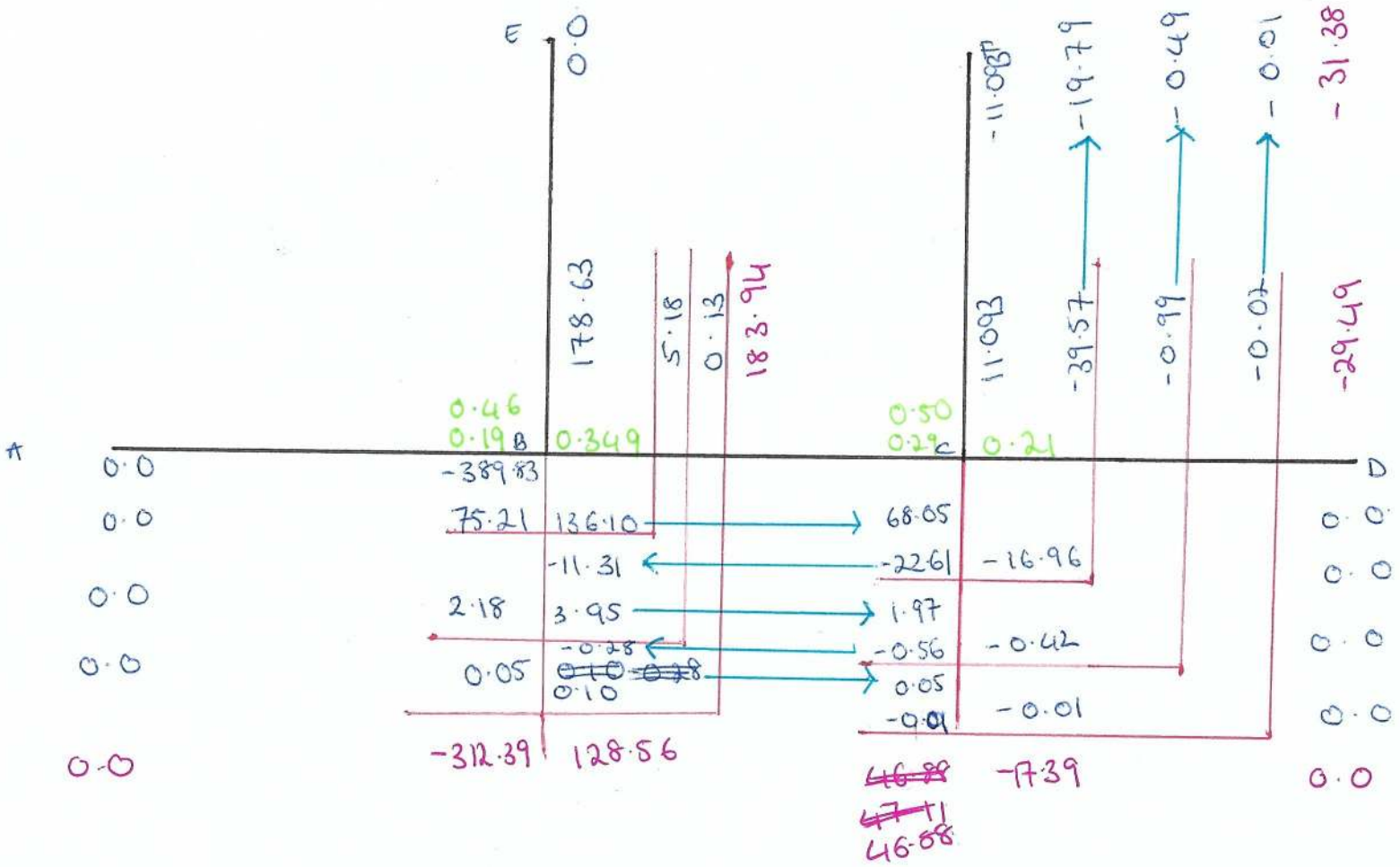
$$\Sigma M_F = \frac{WL^2}{12} = \frac{13 \times 3.2^2}{12}$$

$\Sigma M_F = 11.093$ kNm CLOCKWISE

$$\Sigma M_C = -\frac{WL^2}{12} = \frac{13 \times 3.2^2}{12}$$

$\Sigma M_C = 11.093$ kNm ANTI CLOCKWISE

NON-SWAY ANALYSIS



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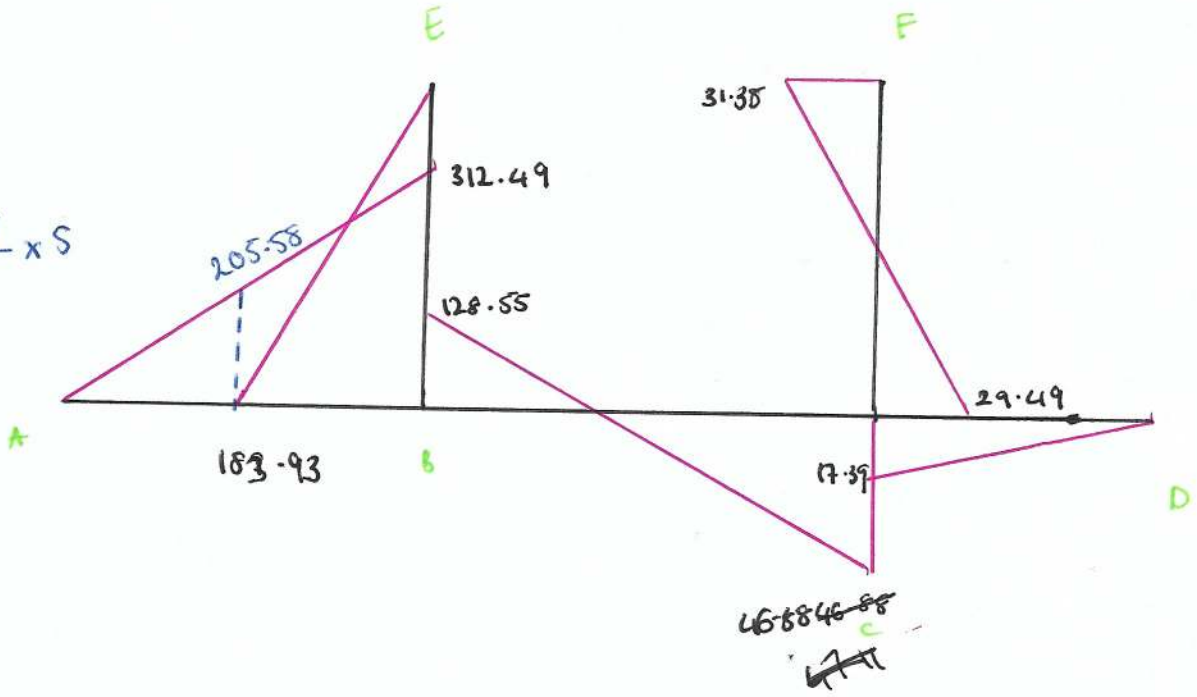
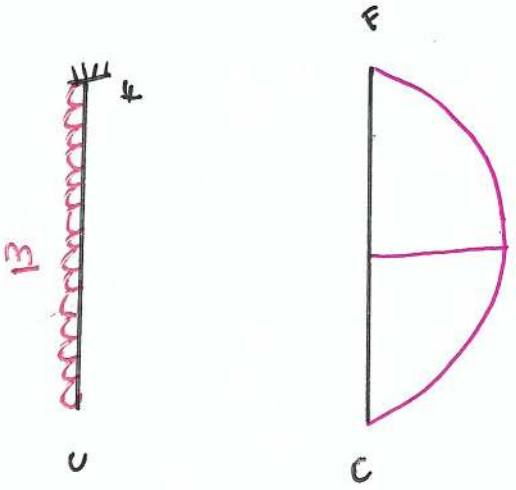
END MOMENT DIAGRAM NON-SWAY

$\frac{312.49}{7.6} \times 5$

$= 205.58$



INTERNAL MOMENT



$\frac{WL^2}{8} = \frac{13 \times 3.2^2}{8}$

$M_{max} = 16.64$ KNM

Reaction Forces

Member AB

$\Sigma M_B = 0$ ↺ +ve

$= (A_Y \times 7.6) + 312.49 - (189.93 \times 2.6) = 0$

$A_Y = 105.775 \uparrow$ kN

$\Sigma F_Y = 0$

$= 105.775 - 183.93 + B_Y = 0$

~~$B_Y = 84.155$ kN ↑~~ $B_Y = 78.155$ kN ↑

Member BE

$M_E = 0$ ↺ +ve

$= (B_X \times 3.2) + 183.93 = 0$

$B_X = 57.48$ kN ←

$\Sigma F_{XC} = 0$

$B_X = E_{XC} = 57.48$ kN →

Member BC

$\Sigma M_C = 0$ ↻ +ve

$= (B_Y \times 5.6) - 128.55 - 46.88 = 0$

$B_Y = 31.326$ kN ↑

$\Sigma F_X = 0$

$\therefore C_Y = 31.326$ kN ↑

Member CD

$\Sigma M_D = 0$ ↺ +ve

$= (C_D \times 5.6) + 17.39 = 0$

$= -3.105$ kN $\therefore 3.105$ kN ↓

$\Sigma F_Y = 0$

$\therefore D_Y = 3.105$ kN ↑

Member CF

$\Sigma M_F = 0$ ↺ +ve

$= (C_{DC} \times 3.2) + 29.49 + 31.35 - (13 \times 3.2 \times 1.6) = 0$

$C_{DC} = 1.78$ kN ←

$\Sigma F_{DC} = 0$

$= F_{DC} + 1.78 - (13 \times 3.2) = 0$

$F_{DC} = 39.82$ kN ←

~~$\therefore R_{NS} = \Sigma E_X + F_X$~~

$= 39.82 + 19.46$

$=$

$\therefore R_{NS} = 59.26$

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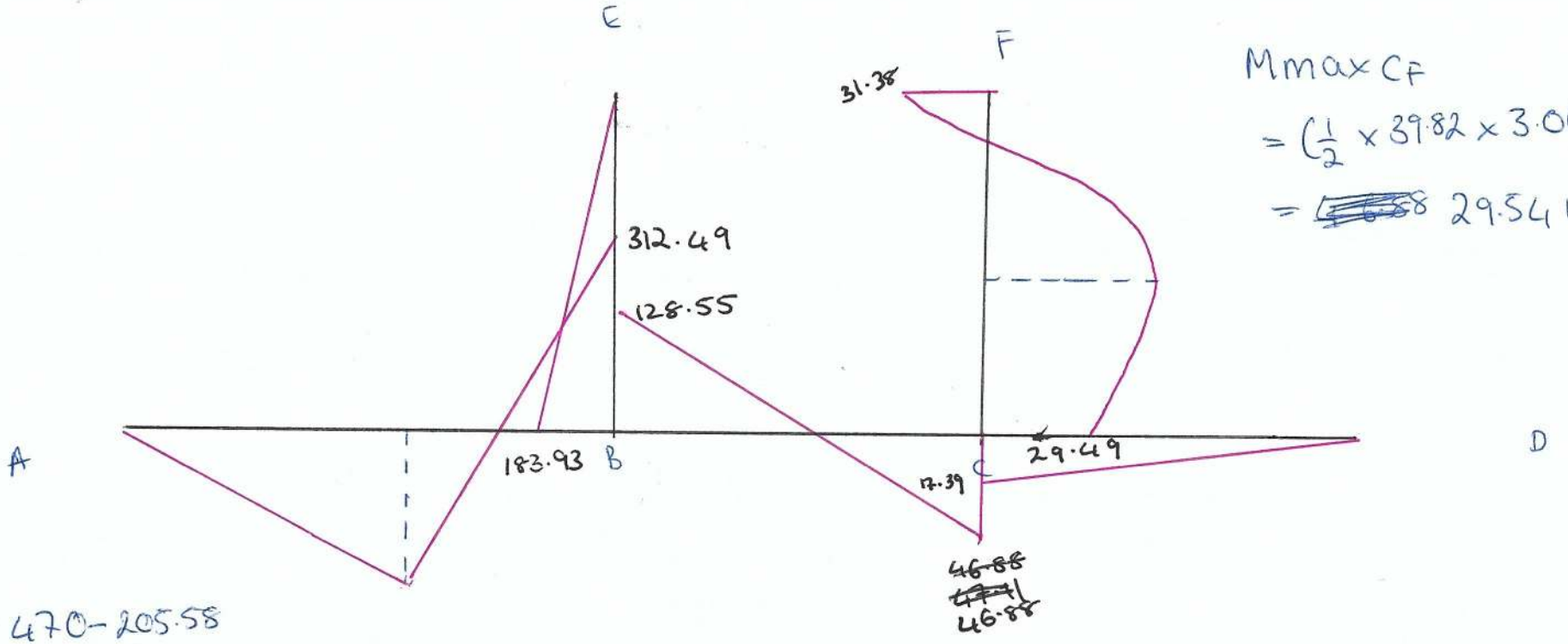
Superposition



$M_{max\ CF} = \left(\frac{1}{2} \times 39.82 \times 3.06\right) - 31.3$

$= 29.54\ kNm$

$M_{max\ AB} = 470 - 205.58$

$= 264.42\ kNm$

$x = 3.2\left(\frac{1.78 \times 3.2}{39.82 + 1.78}\right)$

$x = 3.06$

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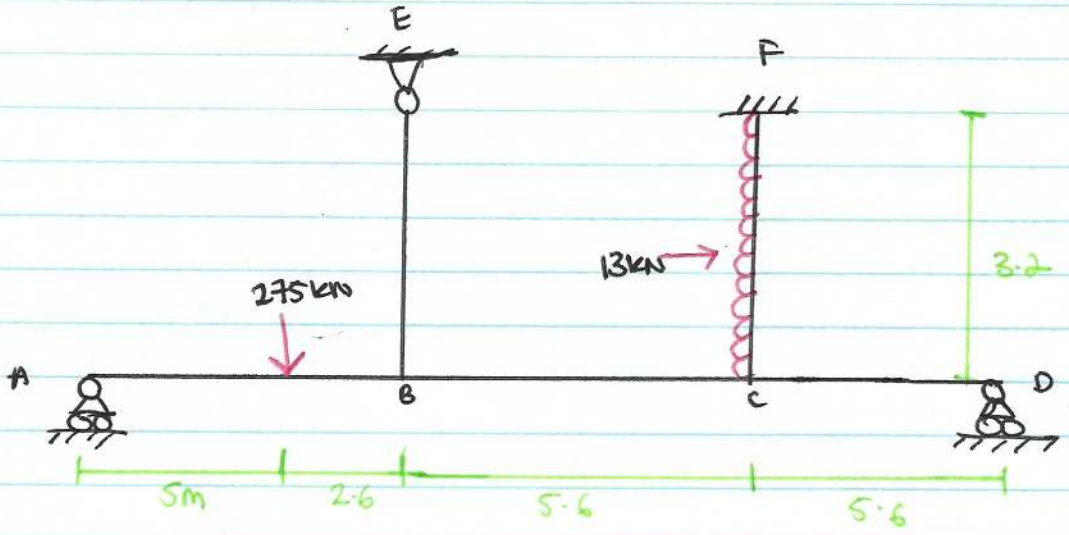


As worked in 4.1

JOINT B

K_{BA} = 63.15 kN.m/rad	DF_{BA} = 0.1928
K_{BE} = 150 kNm/rad	DF_{BE} = 0.458
K_{BC} = 114.29 kNm/rad	DF_{BC} = 0.349
ΣK_B = 327.44 kNm/rad	ΣDF_B = 0.9998 ≈ 1.0

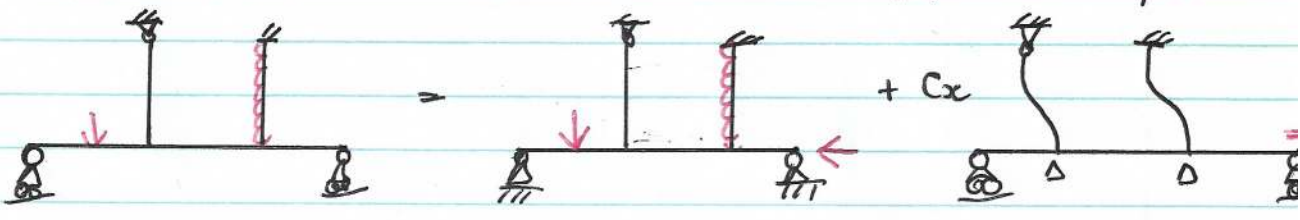
JOINT C

K_{CB} = 114.29 kNm/rad	DF_{CB} = 0.286
K_{CF} = 200 kNm/rad	DF_{CF} = 0.5
K_{CD} = 85.71 kNm/rad	DF_{CD} = 0.214
ΣK_C = 400 kNm/rad	ΣDF_C = 1.0

DF_B = 1.0 DF_C = 1.0 ✓ OK!

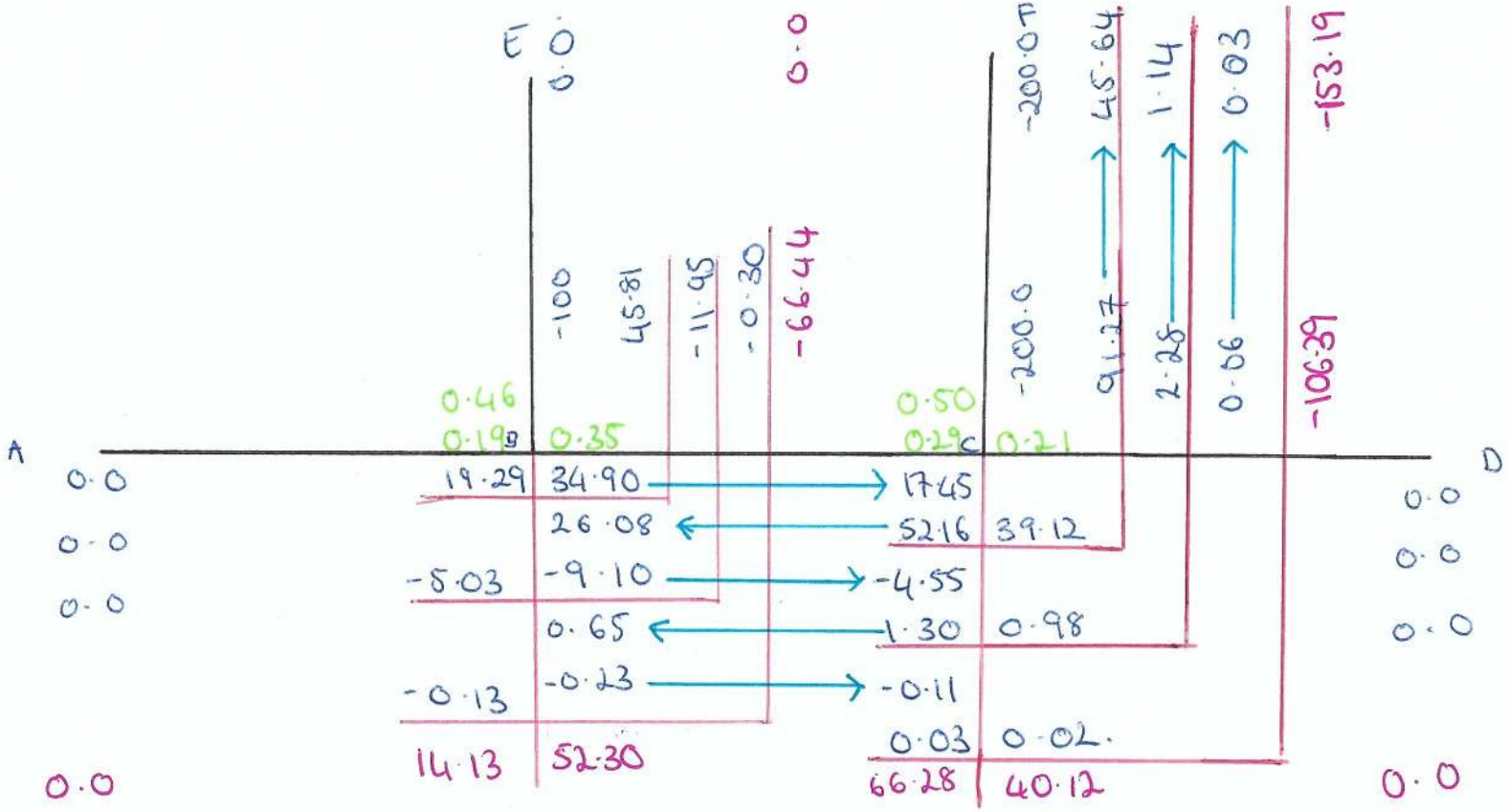
~~WORK~~ SWAY ANALYSIS

Complete ~~sol~~ solution = non sway solution + sway factor × sway solution



B & C are now fixed joints

SWAY DISTRIBUTION



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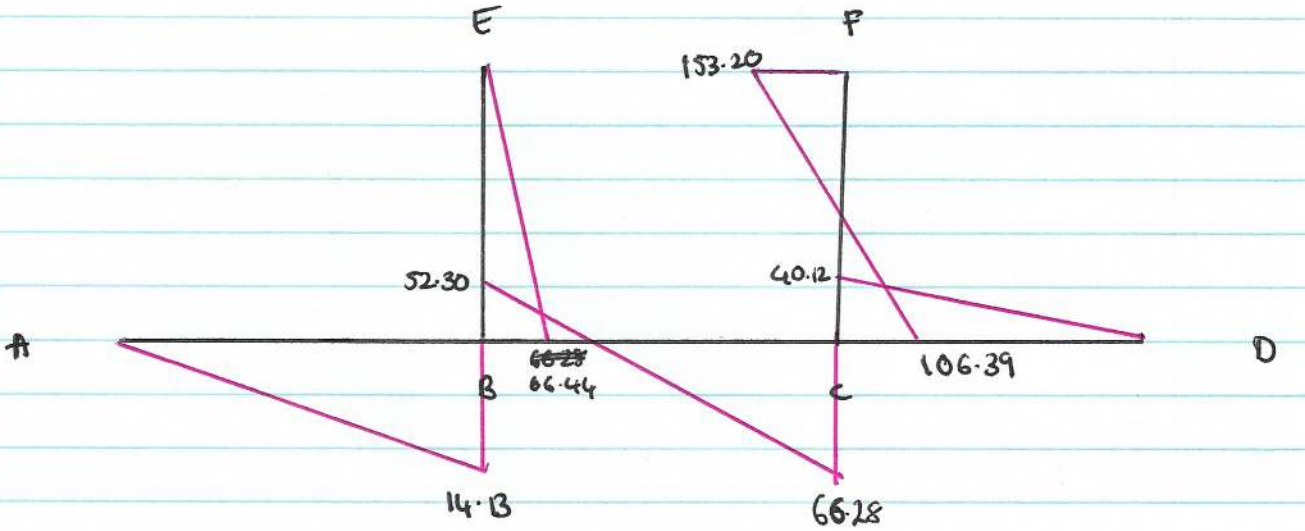
END MOMENT DIAGRAM



End Forces

~~Member CF~~
~~$\Sigma M_C = 0$ ↺ +ve~~
↻

$Ex = 66.44 / 3.2 = 20.765_{KN}$ ←

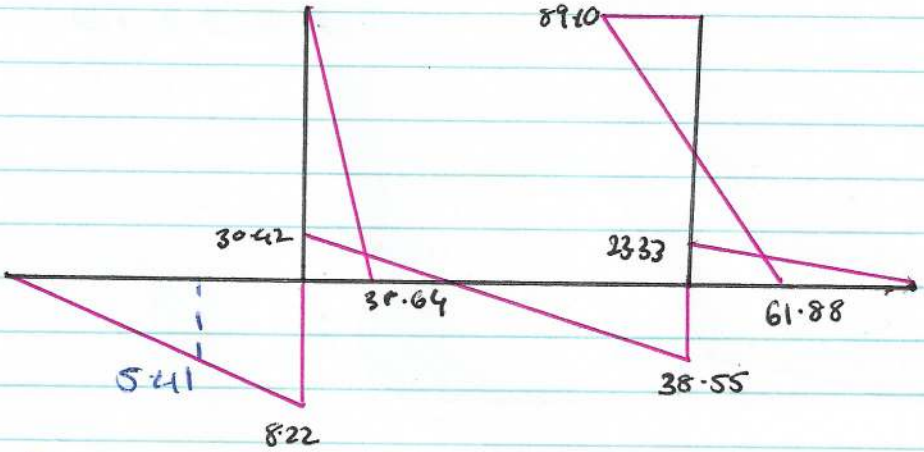
$Fx = (153.20 + 106.39) / 3.2 = 81.12$ KN ←

$Rs = 20.76 + 81.12 = 101.886$ KN ←

Sway Factor

$$C = \frac{RNS}{RS} = \frac{59.26}{101.886} = 0.5816$$

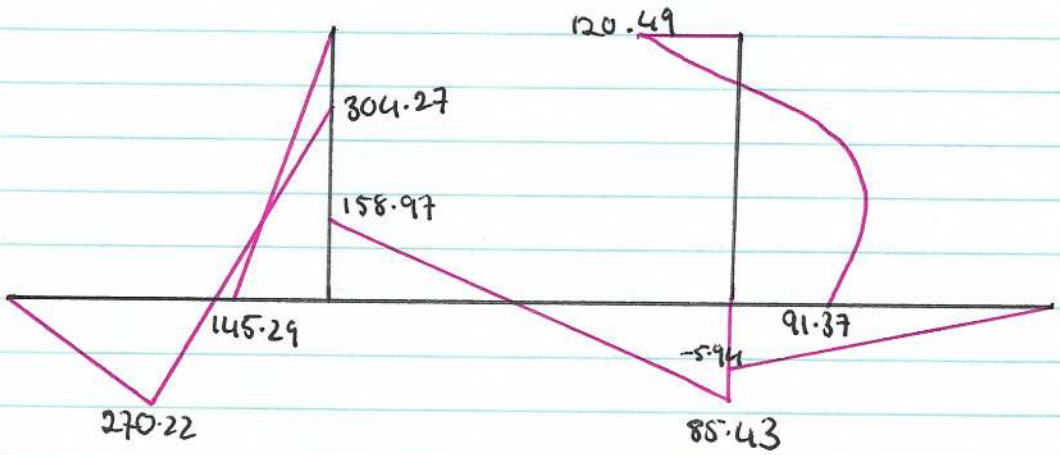
SWAY & C



$\frac{7.6 \times 5}{8.22}$ L

$= 5.41$

SUPERPOSITION FINAL



$\Sigma M_C = 0$ ↺ +ve

$= 13 \times 3.2 \times 1.6 + 120.49 + 91.37 - 3.2 F_x = 0$

$F_x = 87.006$ kN ←

$\Sigma M_B = 0$ ↺ +ve

$= 304.27 + 275 \times 2.2 + 7.6 \times A_y = 0$

$= 39.56$ ↑ kN

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$$A_Y = \frac{((F \times b) - M_{RA})}{(a+b)}$$

$$= \frac{((275 \times 2.6) - 304.27)}{7.6}$$

$$= 54.04\,kN \uparrow$$