Q. P. Code :- 50330

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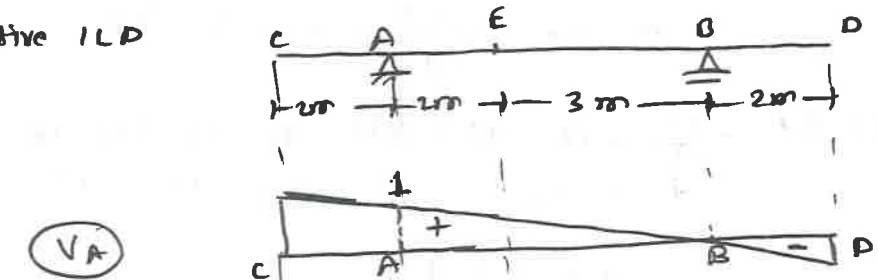
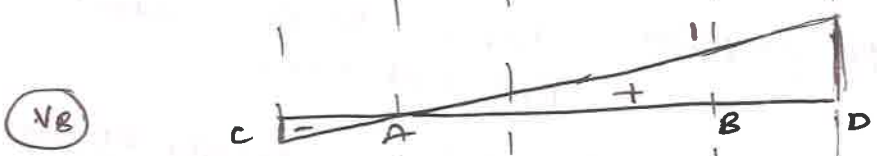
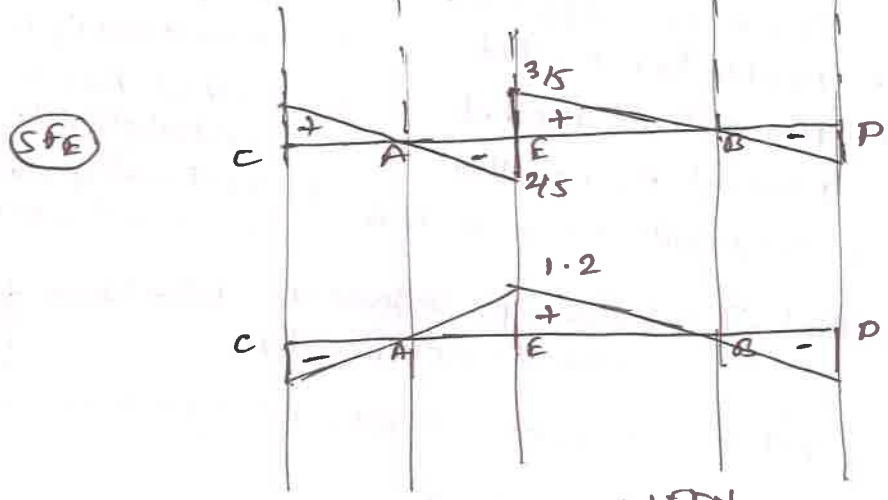
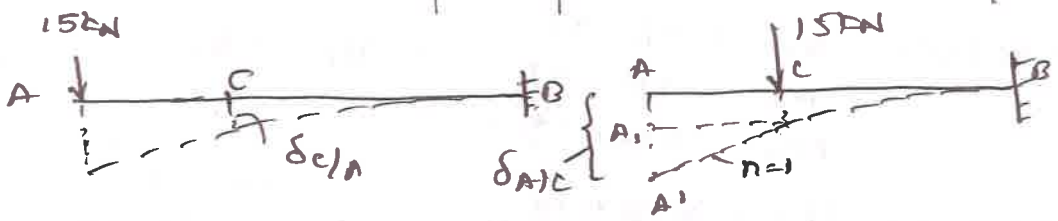
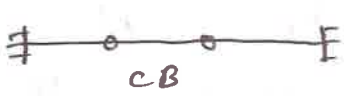
Q.	ANSWER KEY	MARKS
1	Compulsory (Any five) 4×5 = 20	
(a)	Qualitative ILD	
	V_A 	1
	V_B 	1
	$S.F_E$ 	1
		1
(b)		1
	$\delta_{C/A} = \delta_{AC} = AA_1 + A_1A_1 = \frac{15\times3^3}{3EI} + \frac{15\times3^2}{2EI}\times1$	2
	$= \frac{202.5}{EI}$	1
	$\boxed{\delta_{C/A} = \frac{202.5}{EI}}$	
(c)	$(Slope)_{Real} = (SF)_{Conj}$ & $(Deflection)_{Real} = (BM)_{Conj}$	2
	(i)  (ii) 	2

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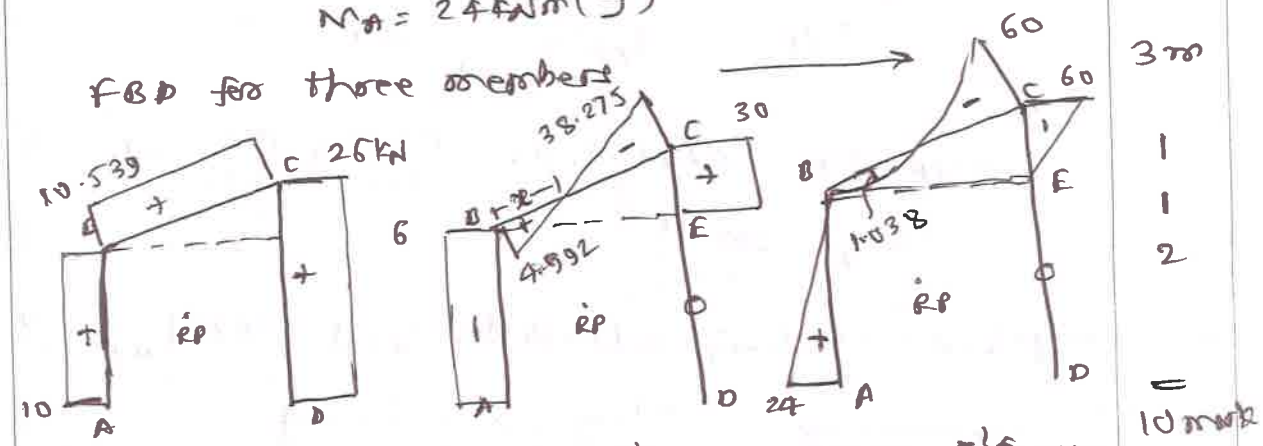
Q.	ANSWER KEY	MARKS
(e)	FBD of A-C $V_A = W l_1 = 284.3$ kN $H = H_A = \frac{W l_1^2}{2d_1} = 457.471$ kN	2m
	FBD of A-D D → H = 457.471, 843 kN; $T_D = 457.173$ kN, $\theta_D = 10.441°$	2m
(d)	Product of inertia (Def.) -- 2 App Important $I_{xy} = 0$ to know about principal axes	2m 2m
(f)	Geometric Approach 1 Double Int. method 2 Macaulay's method 3 Moment Area method 4 Conjugate Beam method Energy Approach 5 strain energy method 6 method based on Castigliano's theorem 7 Unit load method (Virtual work) Method-7 for simple structures having straight axis members Method-6 Curved & Compound structures	3m 1m
Q 2 (a)	Reactions $V_A = 10$ kN (↑) & $V_D = 36$ kN $H_A = 6$ kN (←) $M_A = 24$ kNm (↺)	3m
	FBD for three members	3m
		1 1 2
	AFD Compn +ve SFD 1st +ve BMD 2nd +ve	= 10 marks

D3

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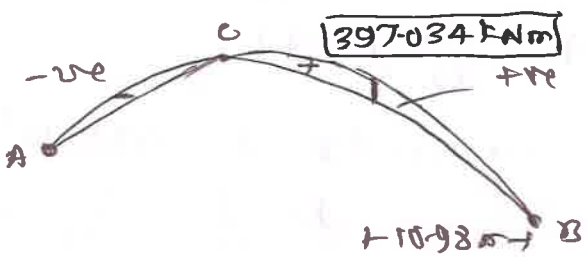
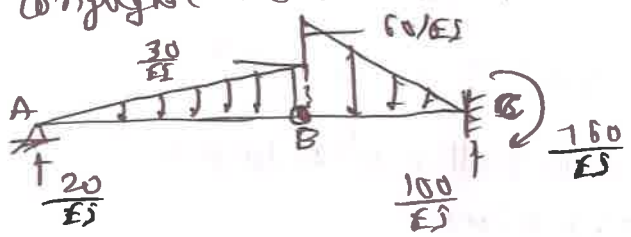
Q.	ANSWER KEY	MARKS
2(b)	$l_1 + l_2 = 40$ $\frac{l_1}{l_2} = \frac{\sqrt{3}}{\sqrt{45}}$ location of hinge 'C' $x_A = 17.978$ m $x_B = 22.022$ m	1m
	Support reactions $H = 615.089$ kN ($\rightarrow \leftarrow$) $V_A = 102.72$ kN (↑) $V_B = 323.679$ kN (↑)	3
	NT & RSF at D i.e $x = 10$ m from A $\theta = 8.424°$ FBD of AD $NT_D = 623.501$ kN ← $RSF_D = 11.503$ kN ↓	2
	location & mag of BM_{max} for BC $x = 10.98$ m from B $BM_{max} = 397.034$ kNm	2
	BMD 	2m
Q3 (a)	Conjugate Beam method 	8m
	$(\theta_C)_R = (SF_C)_{conj} = -100/EI$ $\therefore \theta_C = \frac{100}{EI}$ ↺ $(y_C)_{Real} = (BM_C)_{conj} = -160/EI$ $\therefore y_C = \frac{160}{EI}$ (↓)	2+2

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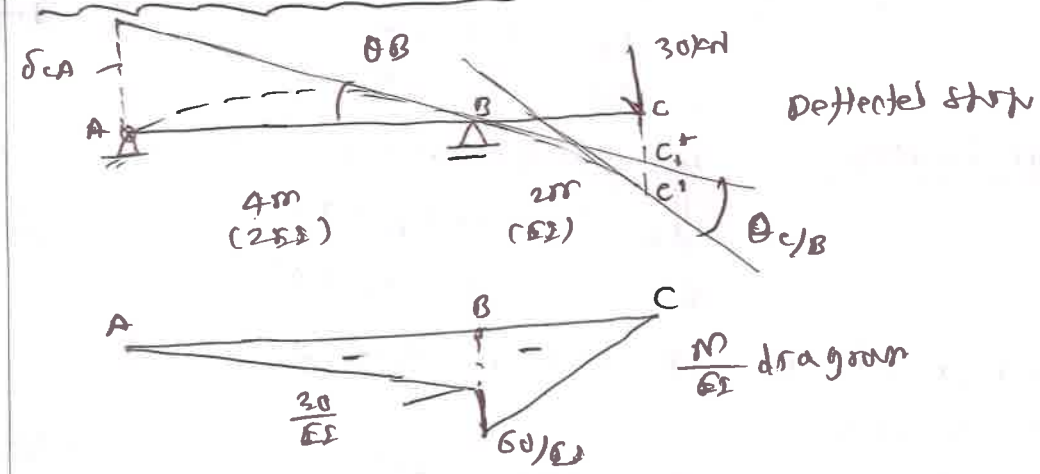
Q.	ANSWER KEY	MARKS
3(a)	Moment Area method	
		
		6m
	$\theta_B = \frac{40}{EI}$ (↻), $\theta_C - \theta_B = \frac{60}{EI}$	
	$\theta_{C/B} = \frac{60}{EI}$ $\therefore \theta_C = \frac{100}{EI}$ rad (↻)	6m
	$\delta_{C/B} = C_1C' = \frac{80}{EI}$ $y_C = CC_1 + C_1C'$ $= \frac{40}{EI} \times 2 + \frac{80}{EI}$	12
	$y_C = \frac{160}{EI}$ m (↓)	
03 (b)	$A = 3500\pi$ $I = 14.76\times10^6\pi$ $Z = 147.6\times10^3\pi$	2
	$P = 150$ kN $e = 40$ mm $l_e = \frac{L}{\sqrt{2}} = \frac{6}{\sqrt{2}} = 4.243$ m	
	$E = 120$ GPa $\sigma_a = \frac{P}{A} = 14.147$ N/mm² (Comp.)	2
	$\theta = \left(\frac{l_e}{2}\sqrt{\frac{P}{EI}}\right)\times\frac{180}{\pi} = 20.612^\circ$	2
	$M = P.e \sec\theta = 6.838\times10^6$ N/mm	2
	$\sigma_b = \pm\frac{M}{Z} = \pm 14.747$ N/mm²	
	$\sigma_{max} = \sigma_a + \sigma_b$ & $\sigma_{min} = \sigma_a - \sigma_b$ $\sigma_{max} = 28.894$ (C) $\sigma_{min} = 0.6$ (T) N/mm²	2 (8 marks)

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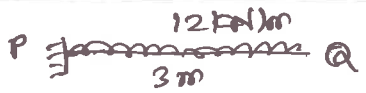
Q.	ANSWER KEY	MARKS
4 (a)		



$M = M_{max} = \frac{12 \times 3^2}{2} = 54$ kNm (Hogging)

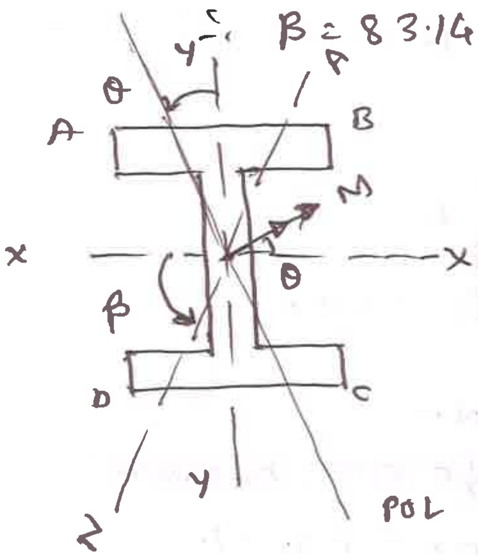
$I_{uu} = I_{xx} = 355.723 \times 10^6$ mm⁴

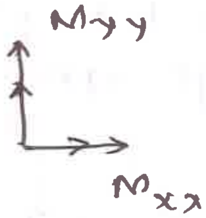
$I_{vv} = I_{yy} = 26.719 \times 10^6$ mm⁴

~~θ = 30~~ $\theta = 32^\circ$ $\tan\beta = \frac{I_{uu}}{I_{vv}} \cdot \tan\theta$

$\beta = 83.141^\circ$

Marks: 4 m





$M_{xx} = 45.795$ kNm T/C

$M_{yy} = 28.612$ kNm T | C

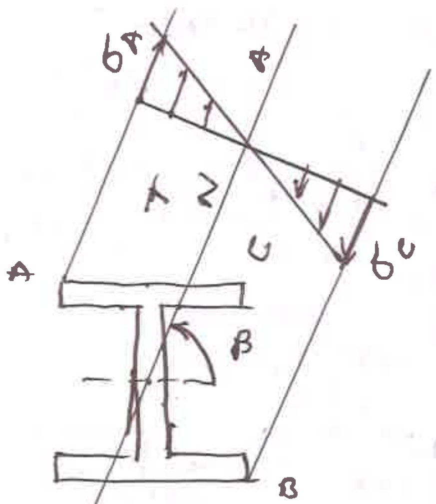
Marks: 2

POL $\sigma_{max} = \frac{M_{uu}}{I_{uu}}(y) + \frac{M_{vv}}{I_{vv}}(x)$

$\sigma_C = \sigma_{max} = 132.833$ N/mm² (comp)

$\sigma_A = \sigma_{max} = 132.833$ N/mm² (tensile)

Marks: 2



Marks: 2

Total: 10

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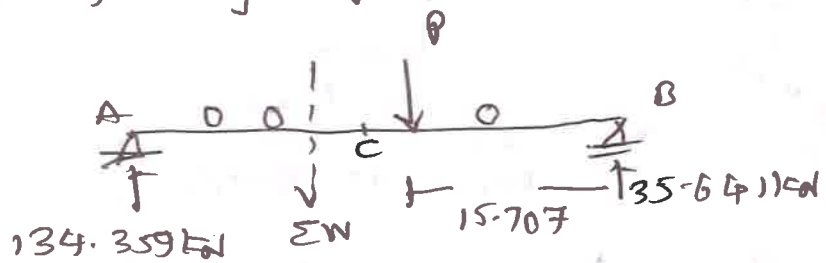
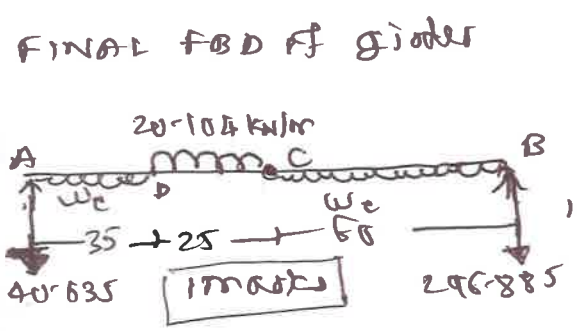
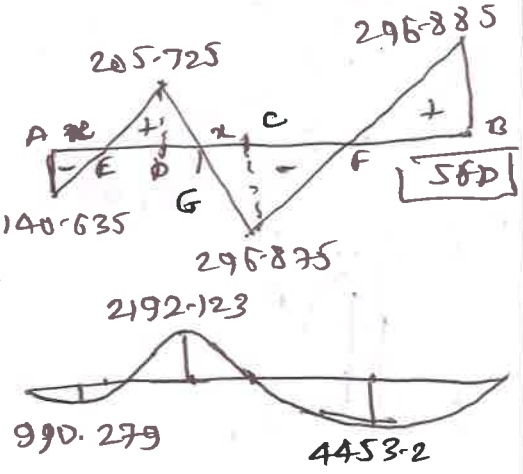
Q.	ANSWER KEY	MARKS
4 (b)	$\Sigma W = 70$ kN $\bar{x}_1 = 4.914$ m $\bar{x}_R = 4.586$ m P = 24 kN at $x_1 = 5.5$ m $\therefore d = 5.5 - 4.914$	2
	$d = 0.586$ m $x = \frac{d}{2} = 0.293$ P = 24 kN to be placed at $15 + 0.293 = 15.293$ m from left support	2
		3
	$BM_{24} = 495.813$ kN m — Ans	1
	YES – It is absolute max^m BM., because 24 kN load will cause max^m BM at centre of span	2
		10
5 (a)	Consider FBD of stiffening girder with w_e EUDL for $BM_C = 0$ for girder $w_e = 9.896$ kN/m	5
	FINAL FBD of girder 	1
		3 3
		12

07

SAE MAY 2018

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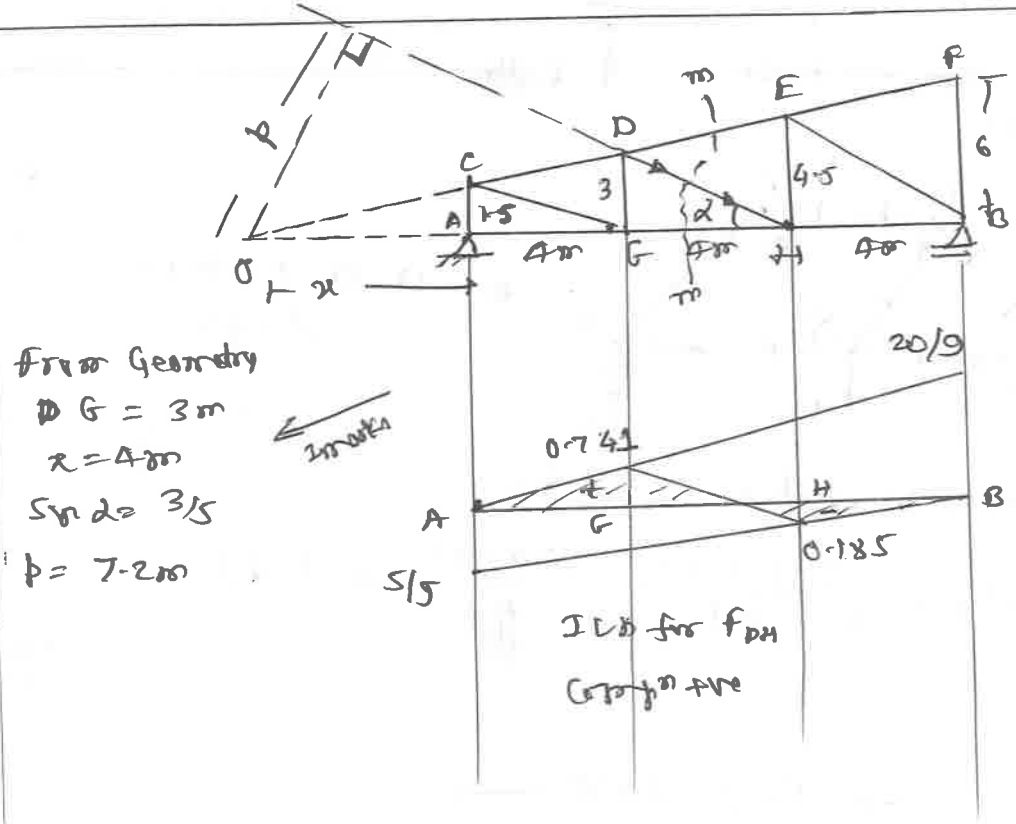
Q.	ANSWER KEY	MARKS
5 (b)	M-diagram $V_A = 36$ kN ↑ $H_A = 20$ kN ← $M_A = 60$ kN m ↺ $V_D = 36$ kN (↑)	1
	m-diagram $H_A = 1$ kN (←) $H_D = 1$ kN (→) $V_A = 0.5$ kN (↑) $V_D = 0.5$ kN (↓) $M_A = 3$ kN m (↺)	2
	Virtual (unit load) at D in (→)	1
	$\Delta_{DX} = \int \frac{M m\, dx}{EI}$	3
	Prepare table	1
	$\Delta_{DX} = \frac{90}{EI} + 0 + \frac{324}{EI} = \frac{414}{EI}$ m (→) (AB) (DC) (CB)	1
		8
6 (a)		2
	From Geometry ID G = 3m x = 4m $\sin\alpha = 3/5$ $\beta = 7.20°$	2
	ILD for f_{DH} Ordinates +ve	

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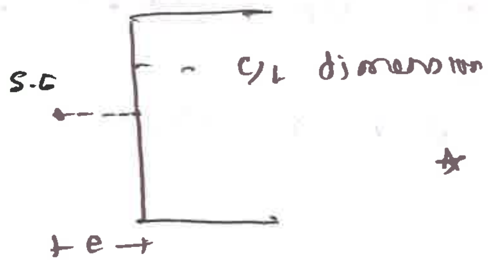
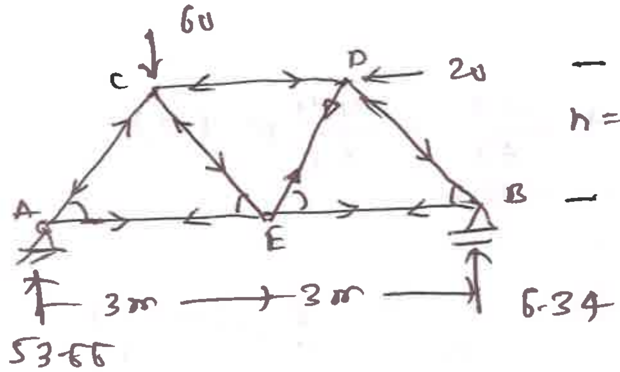
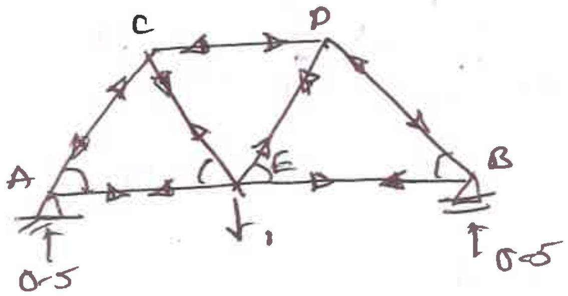
Q.	ANSWER KEY	MARKS
6 (b)	$I_{xx} = I_{NA} = 57.432 \times 10^6\ mm^4$ $e = \frac{b^2 h^2 t}{4 I_{NA}} = \frac{100^2 \times 300^2 \times 10}{4 \times 57.432 \times 10^6} = 39.177\ mm$  ★ correction uniform thickness as 10 mm	6
6 (c)	 $h = 1.5 \tan 60° = 2.598\ m$ ← P-force	3
	 ← u or k force diagram	3
	prepare table →	3
	$\Delta_{EV} = \sum \frac{PKL}{AE} = \frac{179.914}{AE}\ m\ (\downarrow)$	1
		10 marks

— THE END —