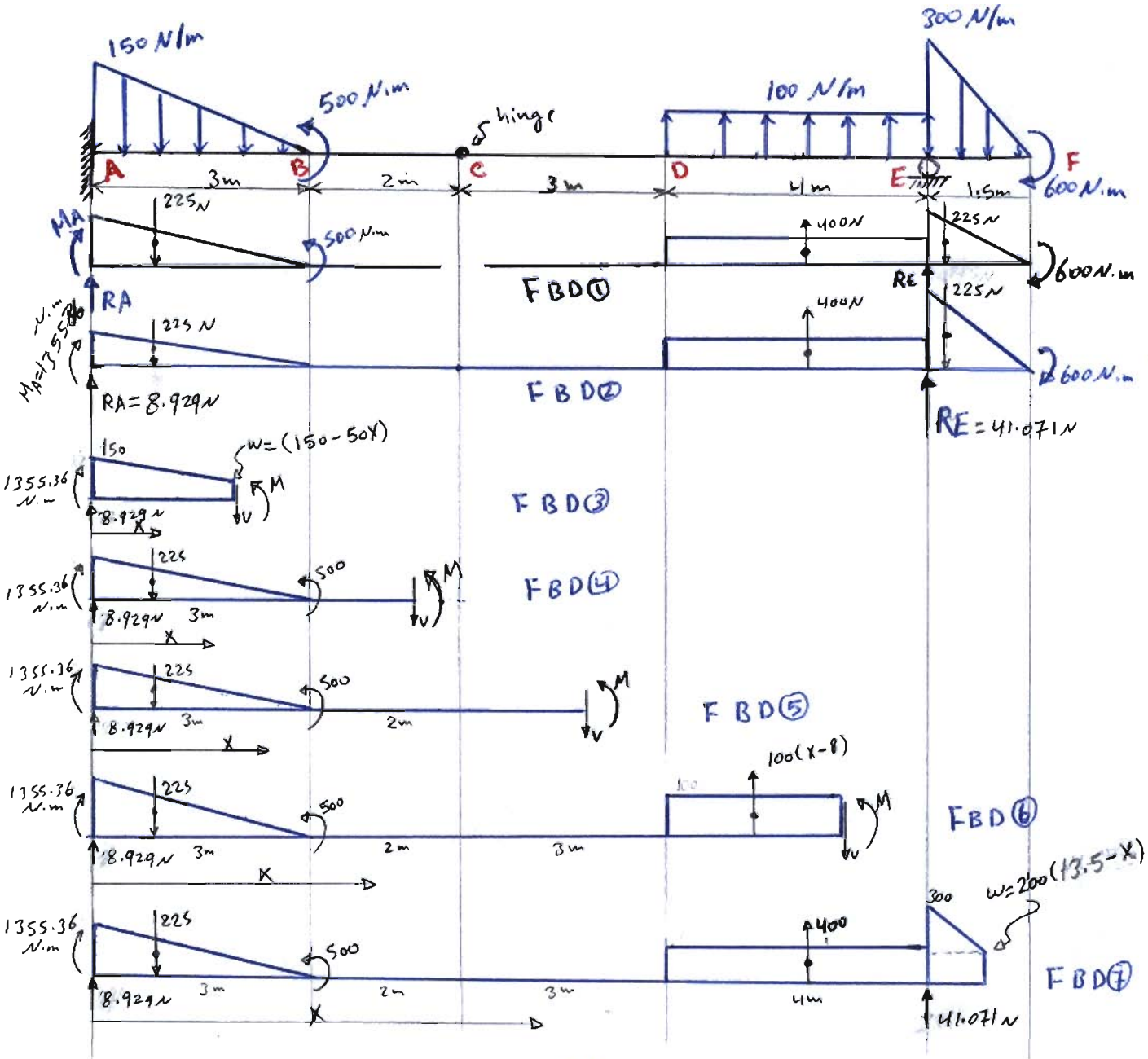
# CE 203-3 [072]
## H.W. # 8 - solution

Problem 1 :-

Given :- Using the "statics" method ( FBD's and Equations), for beam shown in fig.

Req :- Draw shear force diagram (SFD) and the bending moment diagram (BMD)

solution :-



First; find the reactions, from FBD ① right hand side (why ?!).

$+\circlearrowleft \Sigma M=0$ ; $400(5) + RE(7) - 225[(\frac{1.5}{3})+7] - 600 = 0$

$\therefore RE = 41.071\ N$

* From FBD ② :-

$+\uparrow \Sigma F_y = 0$ ;

$RA - 225 + 400 + 41.071 - 225 = 0$

$\therefore RA = 8.929\ N$

$+\circlearrowleft M_A = 0$ ;

$-MA - 225(1) + 500 + 400(10) + 41.071(12) - 225(12.5) - 600 = 0$

$\therefore M_A = 1355.36\ N.m$

AB ( $0 \leq X \leq 3$ ) FBD ③

$+\uparrow \Sigma F_y = 0$ ; $8.929 - (150 - 50X)(X) - \frac{1}{2}(X)(150 - [150 - 50X]) - V = 0$

$8.929 - 150X + 50X^2 - 25X^2 - V = 0$

$\therefore V = 25X^2 - 150X + 8.929$

$+\circlearrowleft \Sigma M = 0$;

$-8.929(X) - 1355.36 + (150 - 50X)(X)(\frac{X}{2}) + 25X^2(\frac{2X}{3}) + M = 0$

$M = 1355.36 + 8.929X - 75X^2 + 25X^3 - 16.67X^3$

$\therefore M = 1355.36 + 8.929X - 75X^2 + 8.333X^3$

BC ( $3 \leq X \leq 5$ ) FBD ④

$+\uparrow \Sigma F_y = 0$ ; $8.929 - 225 - V = 0 \Rightarrow V = -216.071\ N$

$+\circlearrowleft \Sigma M = 0$ ;

$-1355.36 - 8.929(X) + 225(X - \frac{1}{3}*3) + 500 + M = 0$

$M = 855.36 + 8.929X - 225X + 225$

$\therefore M = 1080.36 - 216.071X$

## CD ( $5 \leq x \leq 8$ ) FBD ⑤

$+\uparrow \Sigma F_y = 0$ ; $8.929 - 225 - V = 0$ , $\Rightarrow V = -216.071\ N$

$\therefore M = 1080.36 - 216.071\,x$

## DE ($8 \leq x \leq 12$) FBD ⑥

$+\uparrow \Sigma F_y = 0$; $8.929 - 225 + 100(x-8) - V = 0$

$\therefore V = 100\,x - 1016.071$

$+\circlearrowleft \Sigma M = 0$;

$-1355.36 - 8.929(x) + 225(x-1) + 500 - 100(x-8)\left(\frac{x-8}{2}\right) + M = 0$

$M = 1080.36 - 216.071\,x + 50(x^2 - 16x + 64)$

$\therefore M = 50x^2 - 1016.071\,x + 4280.36$

## EF ( $12 \leq x \leq 13.5$ ) FBD ⑦

$+\uparrow \Sigma F_y = 0$;

$8.929 - 225 + 400 + 41.071 - 200(13.5-x)(x-12)$

$-\frac{1}{2}(x-12)[300 - 200(13.5-x)] - V = 0$

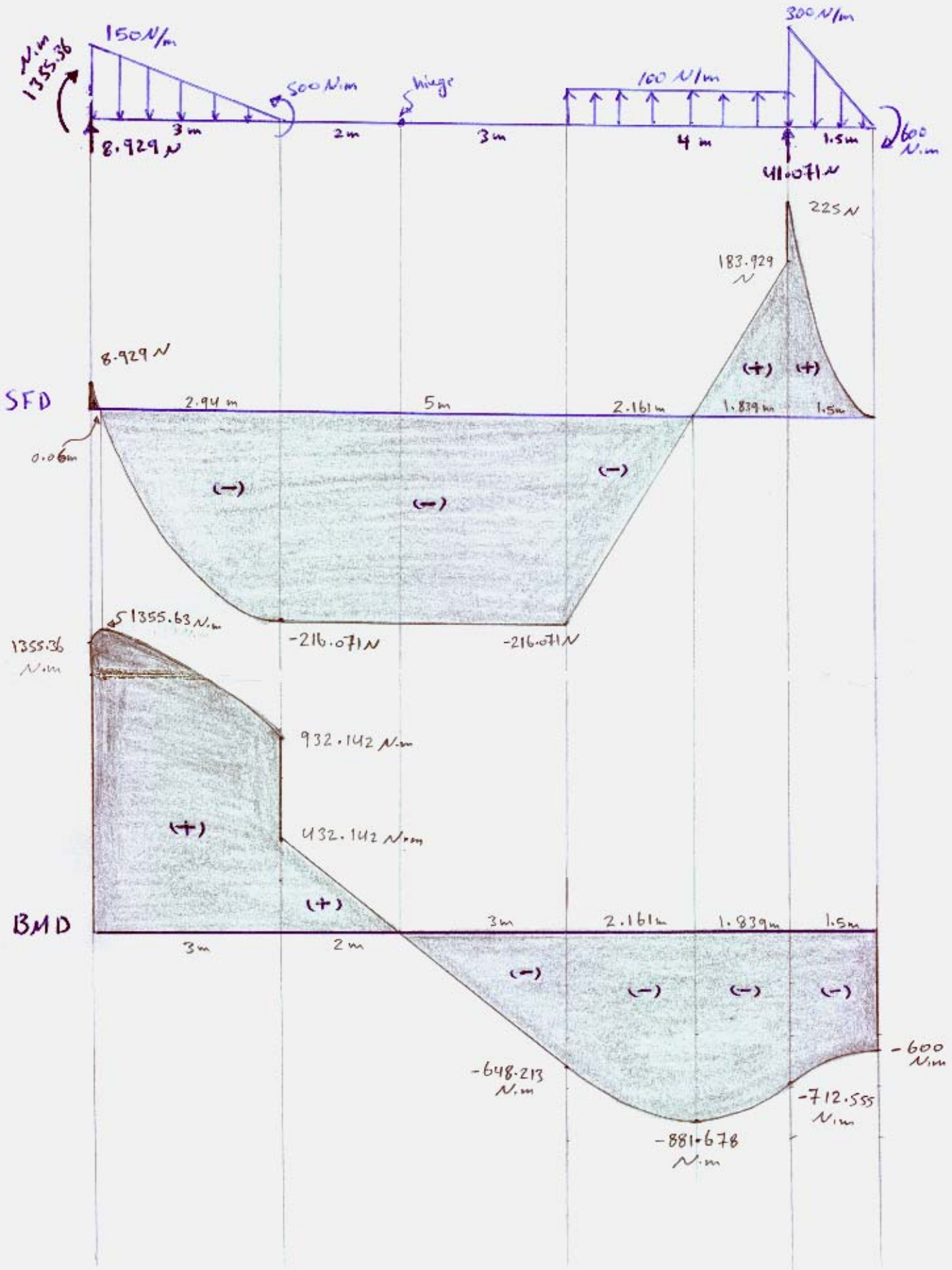
$225 - 200[13.5x - 162 - x^2 + 12x] - 150(x-12)$

$+ 100[13.5x - 162 - x^2 + 12x] - V = 0$

$225 - 150(x-12) - 100[13.5x - 162 - x^2 + 12x] = V$

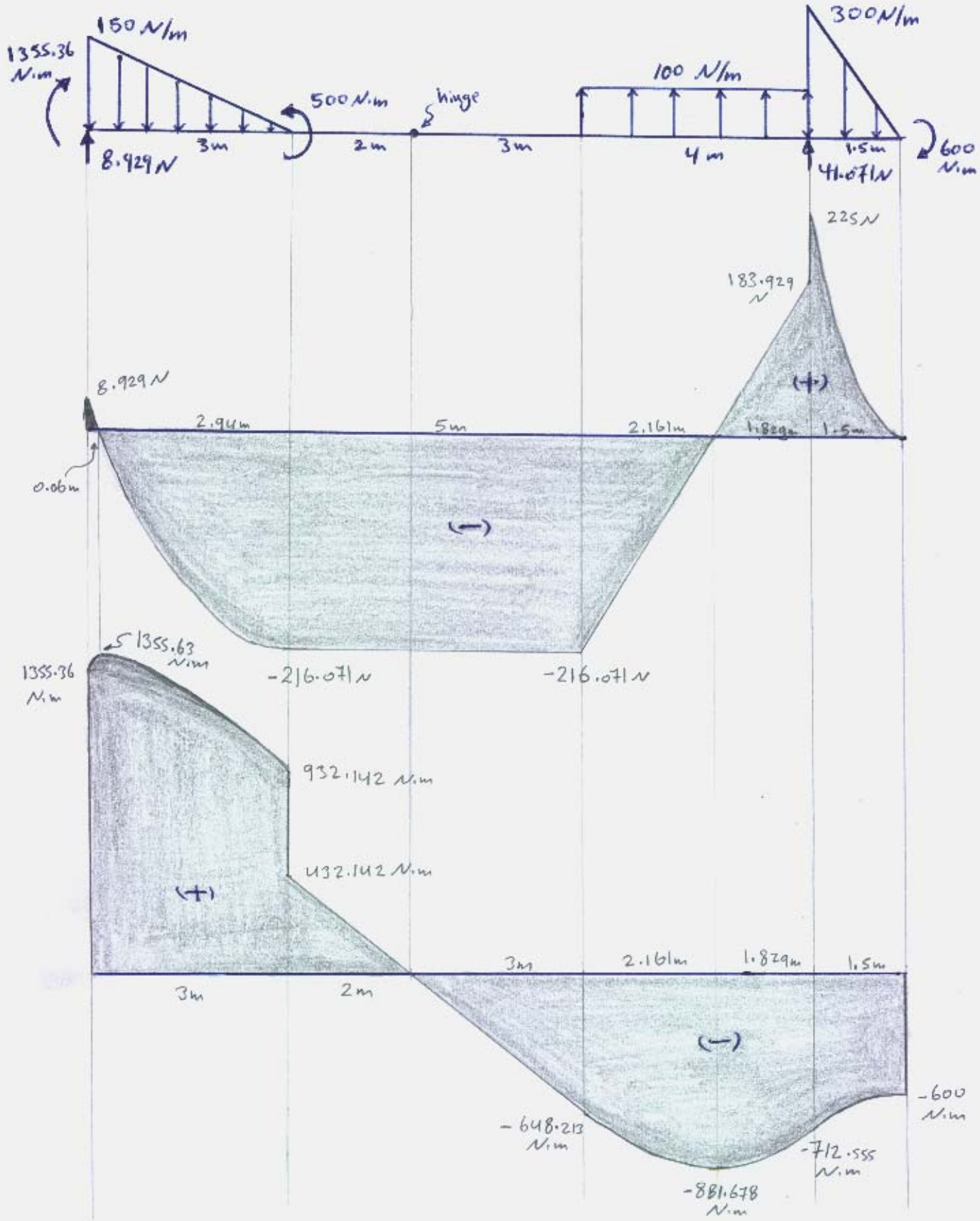
$\therefore V = 18225 - 2700x + 100x^2$

$\therefore M = 33.333x^3 - 1350x^2 + 18225x - 82611.68$


150 N/m
1355.36 N.m
500 N.m
hinge
100 N/m
300 N/m
600 N.m
8.929 N
411.071 N
3m
2m
3m
4m
1.5m
225 N
183.929 N
8.929 N
SFD
2.94 m
5m
2.161 m
1.839 m
1.5m
0.06m
(+)
(+)
(−)
(−)
(−)
1355.63 N.m
1355.36 N.m
-216.071 N
-216.071 N
932.142 N.m
432.142 N.m
BMD
(+)
(+)
3m
2m
3m
2.161m
1.839m
1.5m
(−)
(−)
(−)
(−)
-600 N.m
-648.213 N.m
-712.555 N.m
-881.678 N.m

Problem 2:-

Req:- Re work problem (1), but using the summation (area) method. compare and discuss.

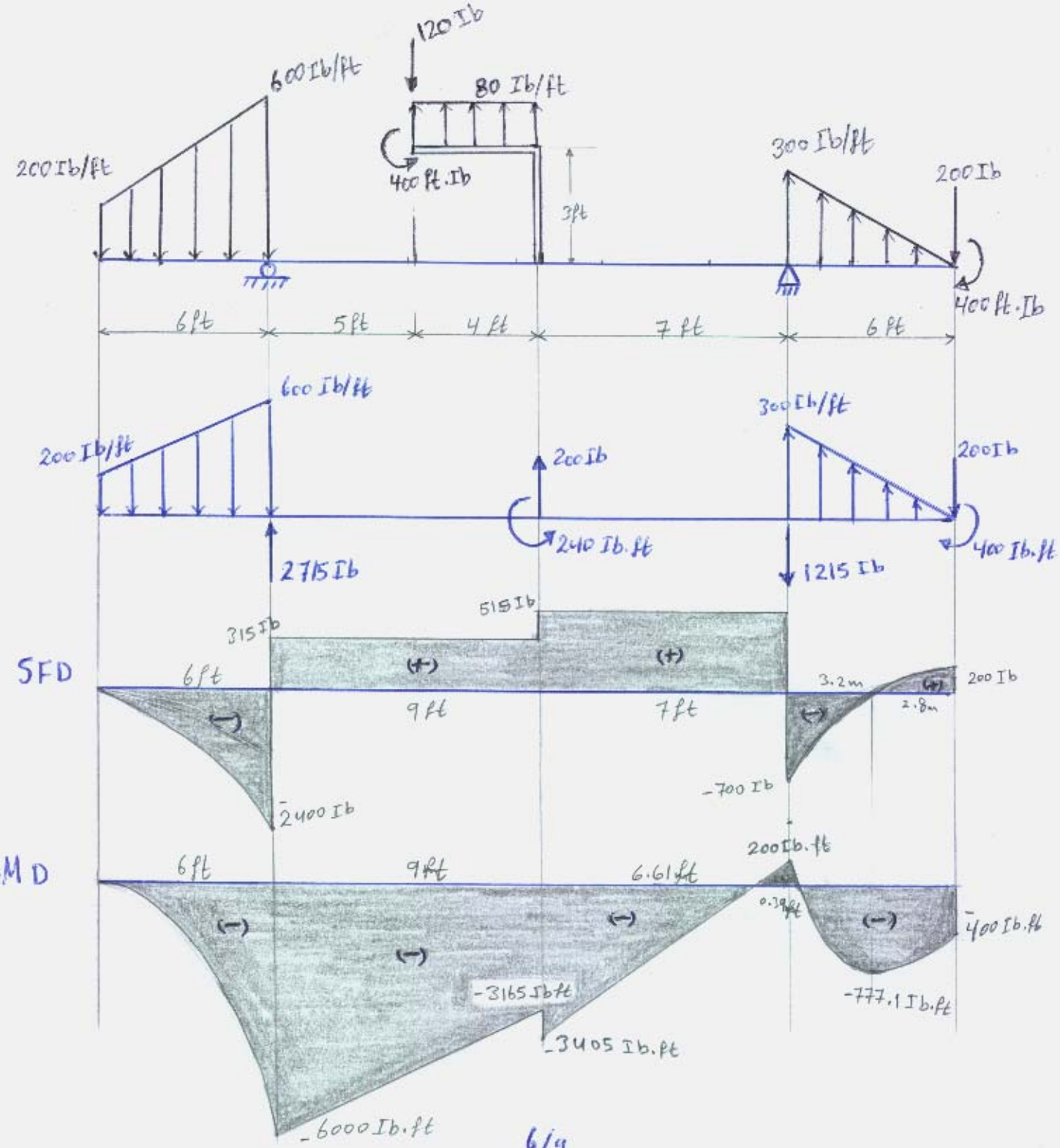


Problem 3

Given :- The Fig. p3, use the summation method.

Req :- Draw the SFD and BMD for the beam shown.

Solution :- The reactions have been calculated as well as the distances.

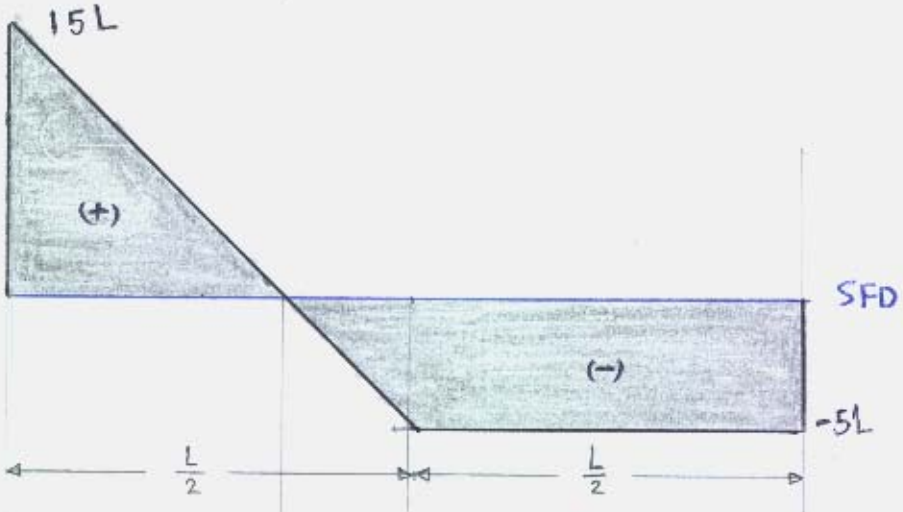


Problem 27:-

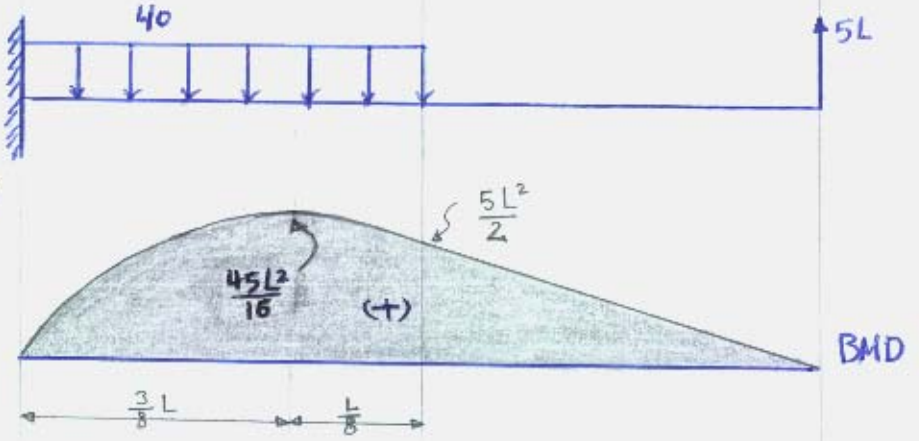
Given :- The shear force diagram for cantilever beam is shown in fig.p4 below.

Req :- Sketch the Loads on the beam, and draw the bending Moment diagram. (How many possibilities).

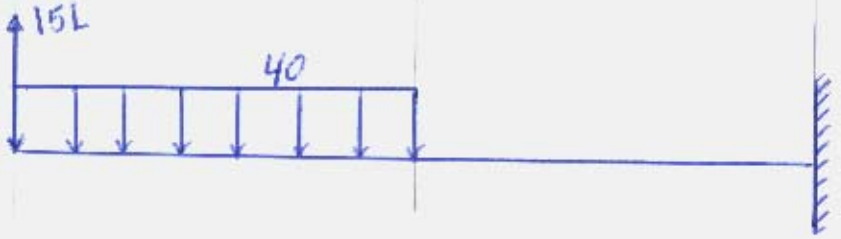
solution:-




The part with Linearly varying Load shear has Uniformly distributed Load as the slope of the Line $\frac{15L + 5L}{L/2} = 40$




Alternatively, if we conceder the fixity to be on the other side the Loading can be Like this.

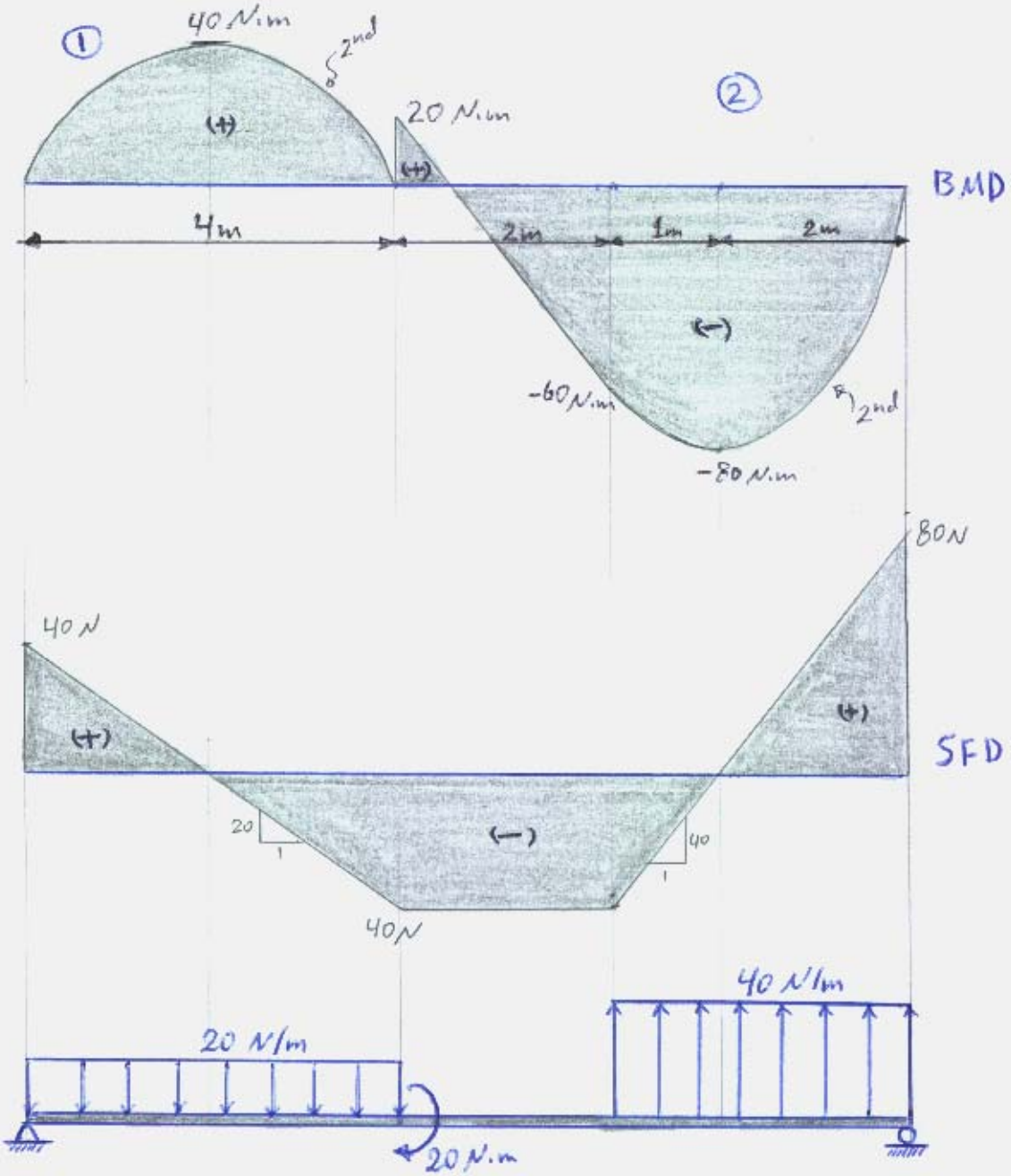


Problem 5 :-

Given :- A simply supported beam has the bending moment diagram drown in Fig. P5 below.

Req :- Draw the shear force diagram and then draw the beam with the Loading.

solution :-



This is an explanation :, how we can find the values of distributed Loads [[This is not required or needed!]]

* Consider curve (1) ;- it has an equation in the following form :-

$$M = ax_1^2 + bx_1 + c$$

at $x_1 = 0$ , $M = 0$ $\Rightarrow$ $c = 0$

at $x_1 = 2$ , $M = 40$ $\Rightarrow$ $4a + 2b = 40$ —(1)

at $x_1 = 4$ , $M = 0$ $\Rightarrow$ $16a + 4b = 0$ —(2)

by solving the two eqs:-

we get $a = -10$ , $b = 40$

$\therefore$ $M = -10x_1^2 + 40x_1$

$$V = \frac{dM}{dx} = -20x_1 + 40$$

at $x_1 = 0$, $\frac{dM}{dx} = 40\ N$

* similarly curve (2) :- $M = ax_2^2 + bx_2 + c$

at $x_2 = 0$ , $M = -60$ $\Rightarrow$ $c = -60$

at $x_2 = 1$ , $M = -80$ $\Rightarrow$ $a + b - 60 = -80$ —(3)

at $x_2 = 3$ , $M = 0$ $\Rightarrow$ $9a + 3b - 60 = 0$ —(4)

$\therefore$ $a = 20$ , $b = -40$

$\therefore$ $M = 20x_2^2 - 40x_2 - 60$

$$V = \frac{dM}{dx} = 40x_2 - 40$$

at $x_2 = 0$, $\frac{dM}{dx} = -40$