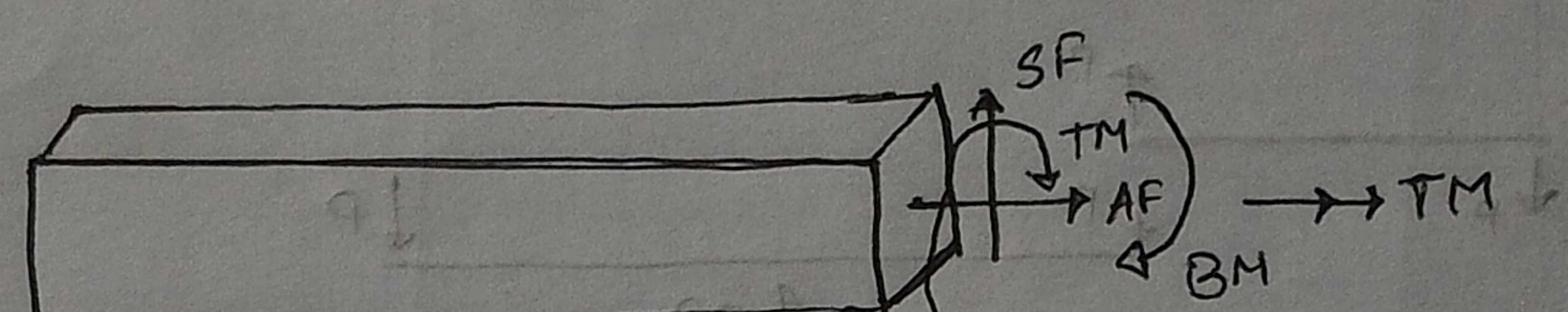
1ST LECTURE

Date: 02-03-2015

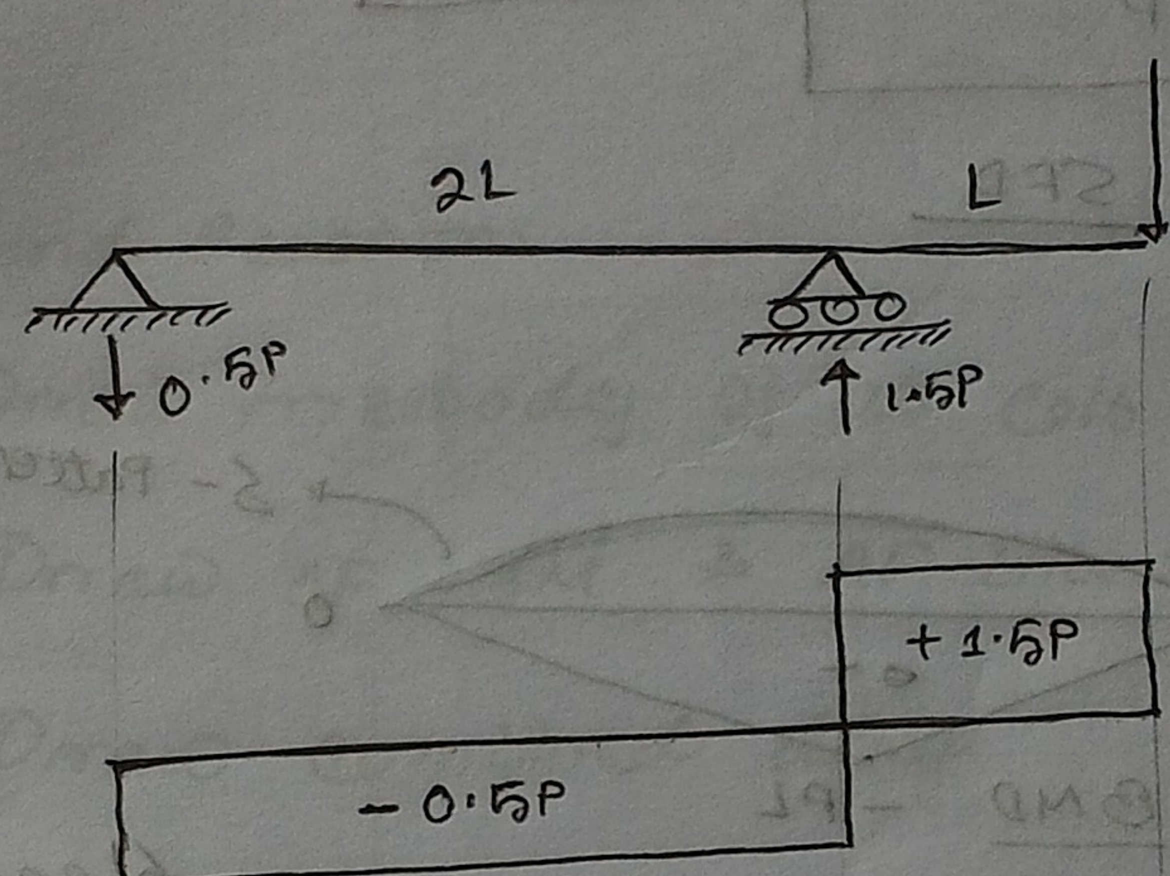
Structural Analysis and Design I

Course Teacher: Prof. Md Abdur Rouf

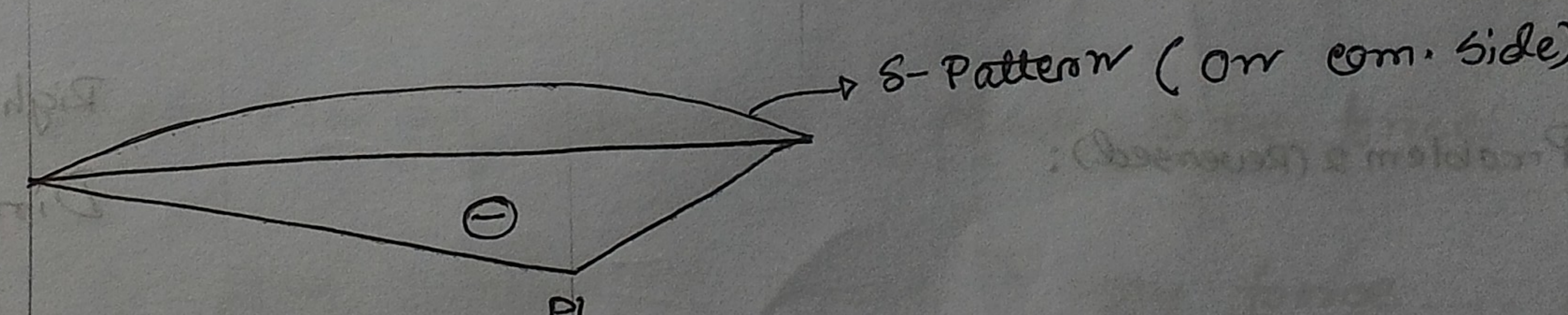
Reference:-
LORRIS WILBER
Seph Boter



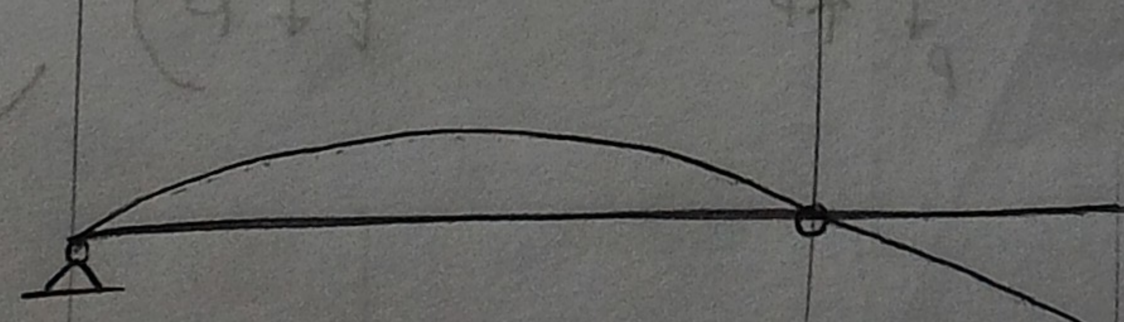
Problem ①



SFD

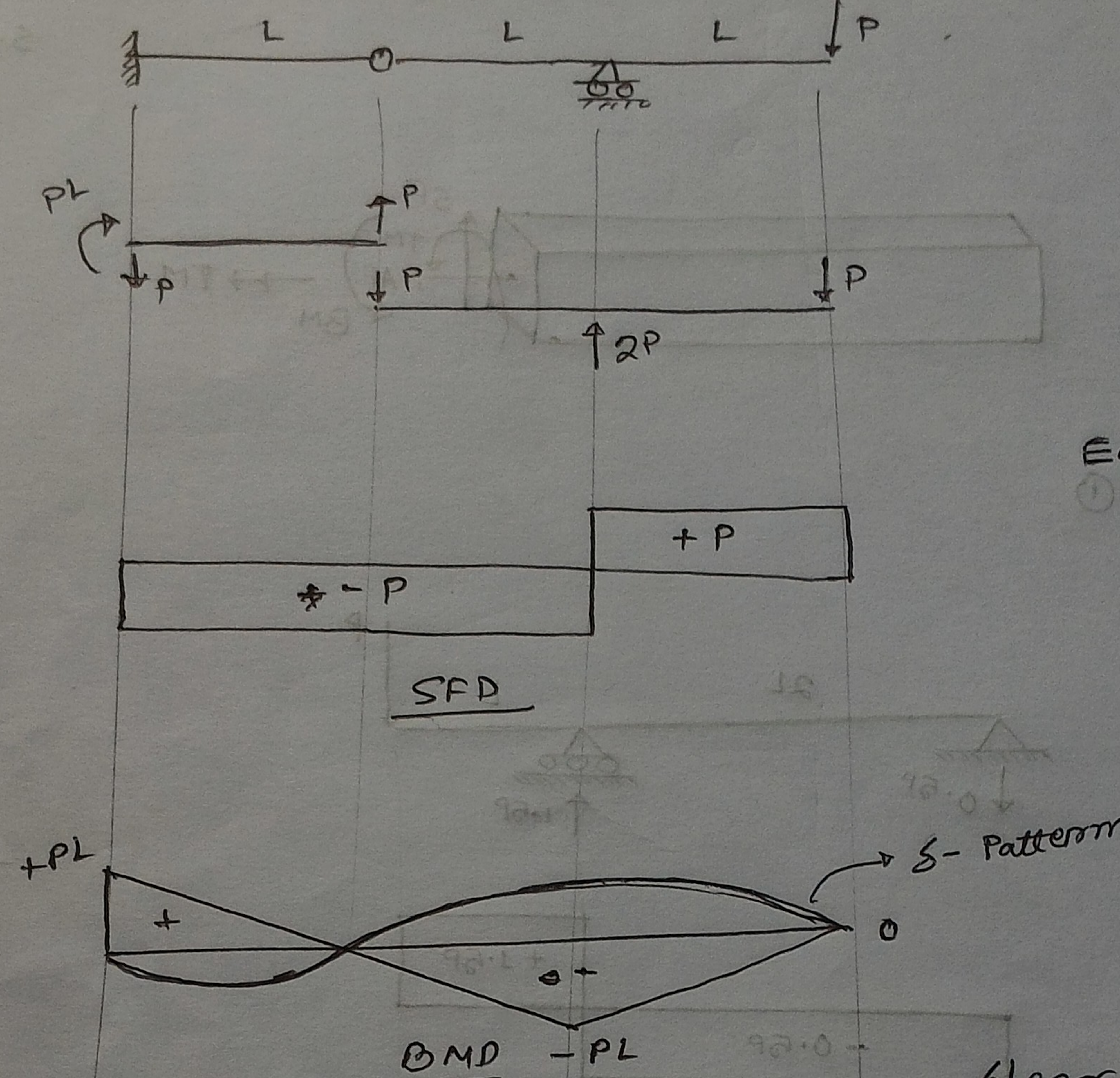


BM Dia.



S-Shape

Prob ②



$-(R_B \times L) + 2PL = 0$

$\therefore R_B = 2P$

Equations of statics:-

$\Sigma F_x = 0$

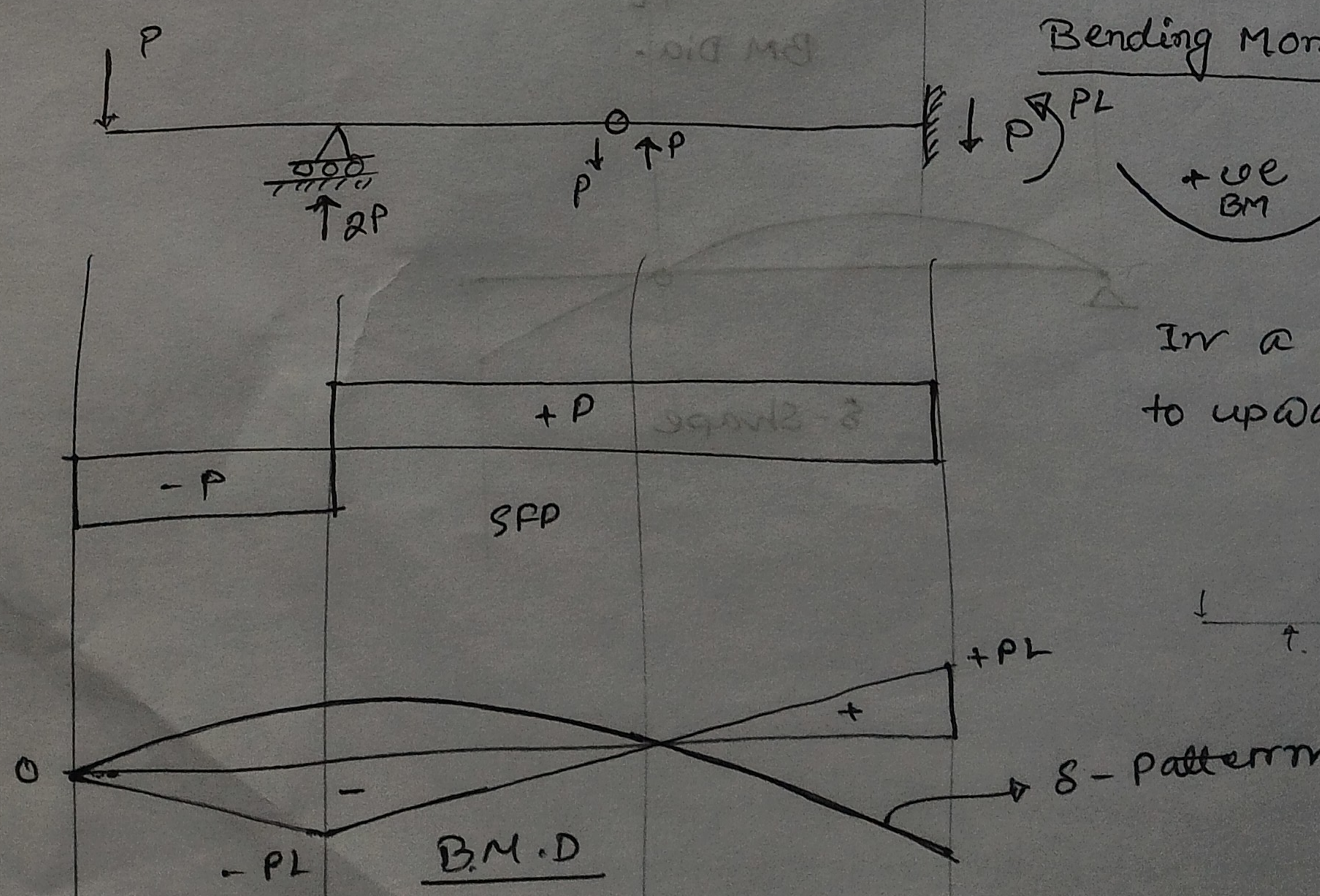
$\Sigma F_y = 0$

$\Sigma M_z = 0$

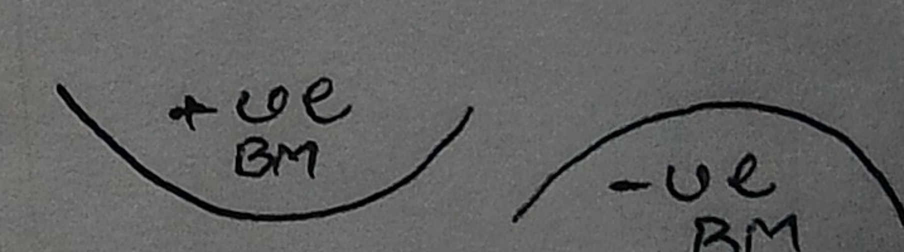
Shear Force Dia:-

Draw From Left to Right & Follow Load's Direction.

Problem 2 (Reversed):



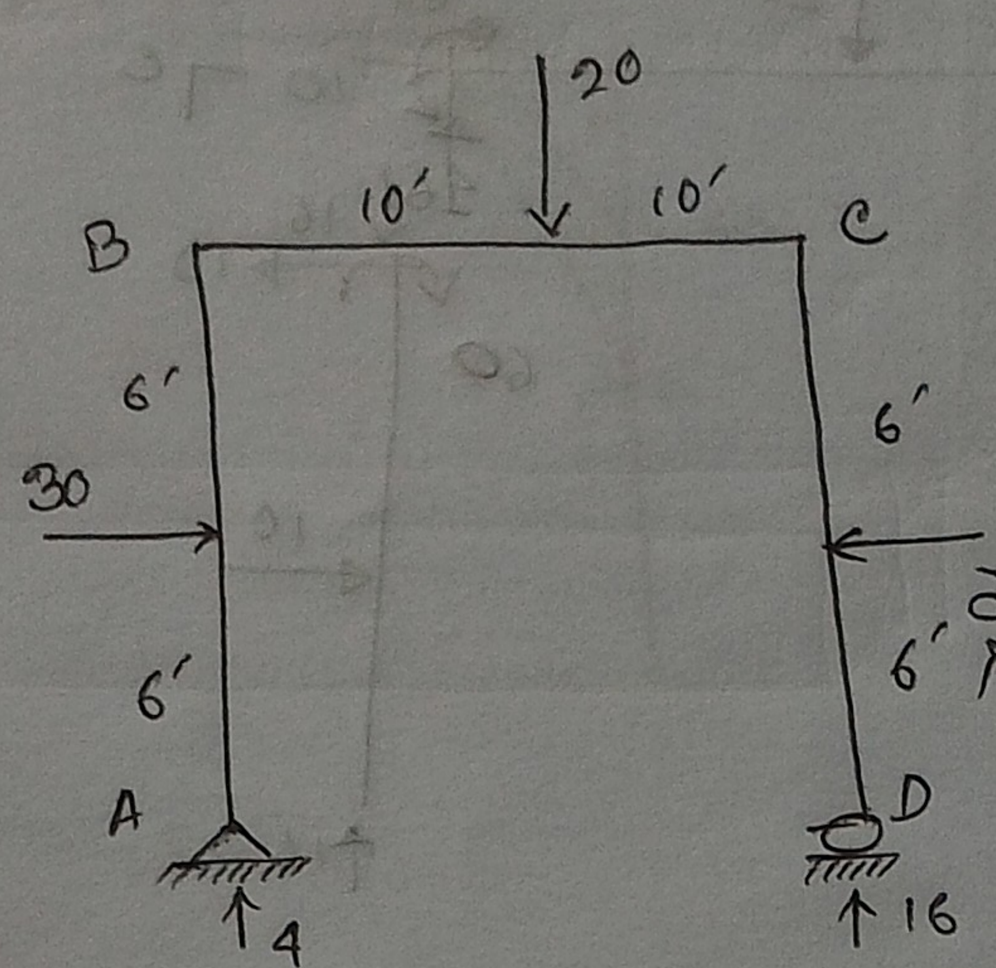
Bending Moment Diagram:-



In a Beam BM Due to upward load is +ve

$(R_A \times y - P \times L$

Analysis of Plane (2D) Frame



Steps:

- Find Reactions
- Draw Freebody of all Cols and Beams and joints - separately
- Draw SF, BM & AF Dia. - Saparately
- Draw combined diag.

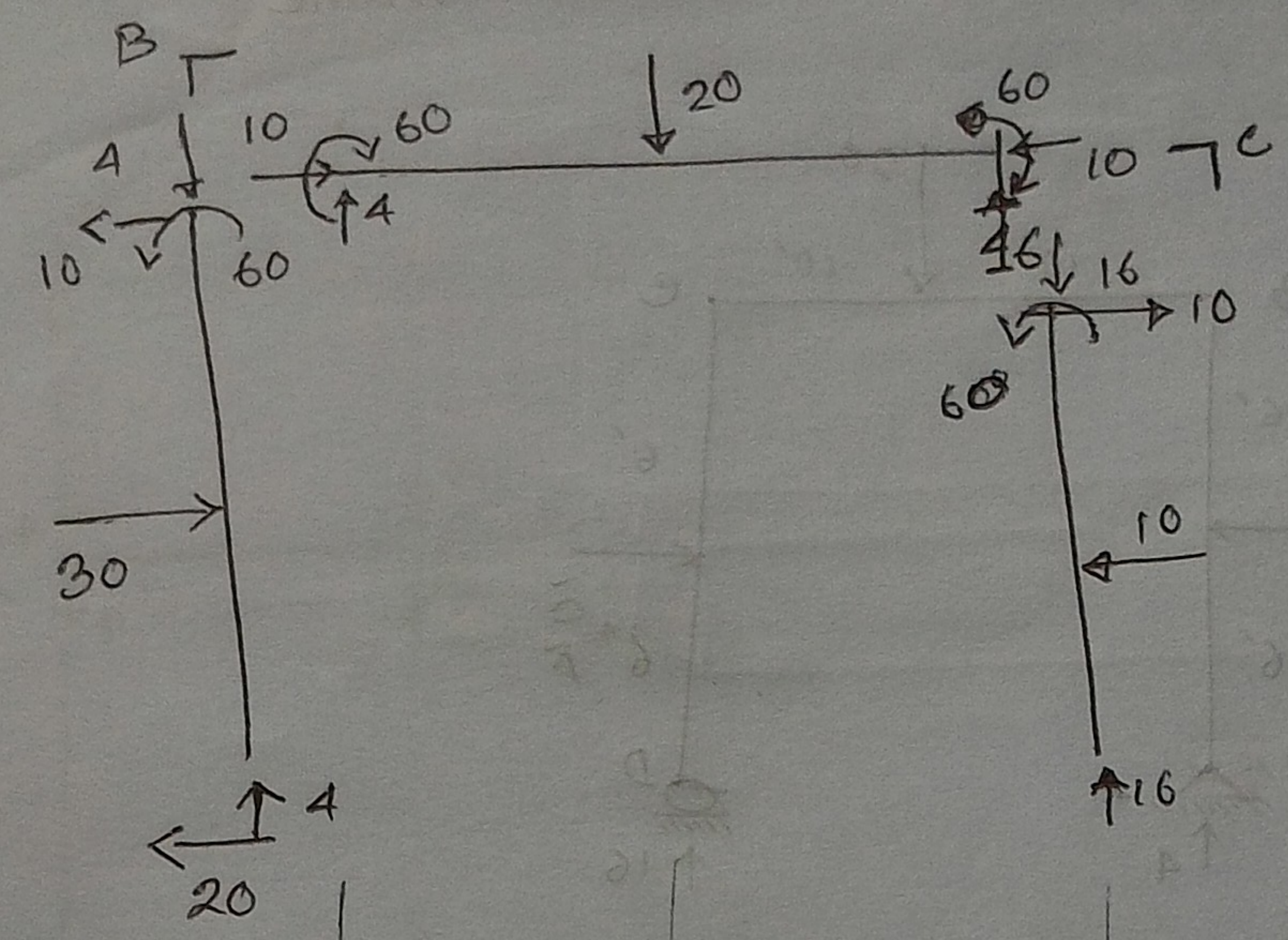
Note:

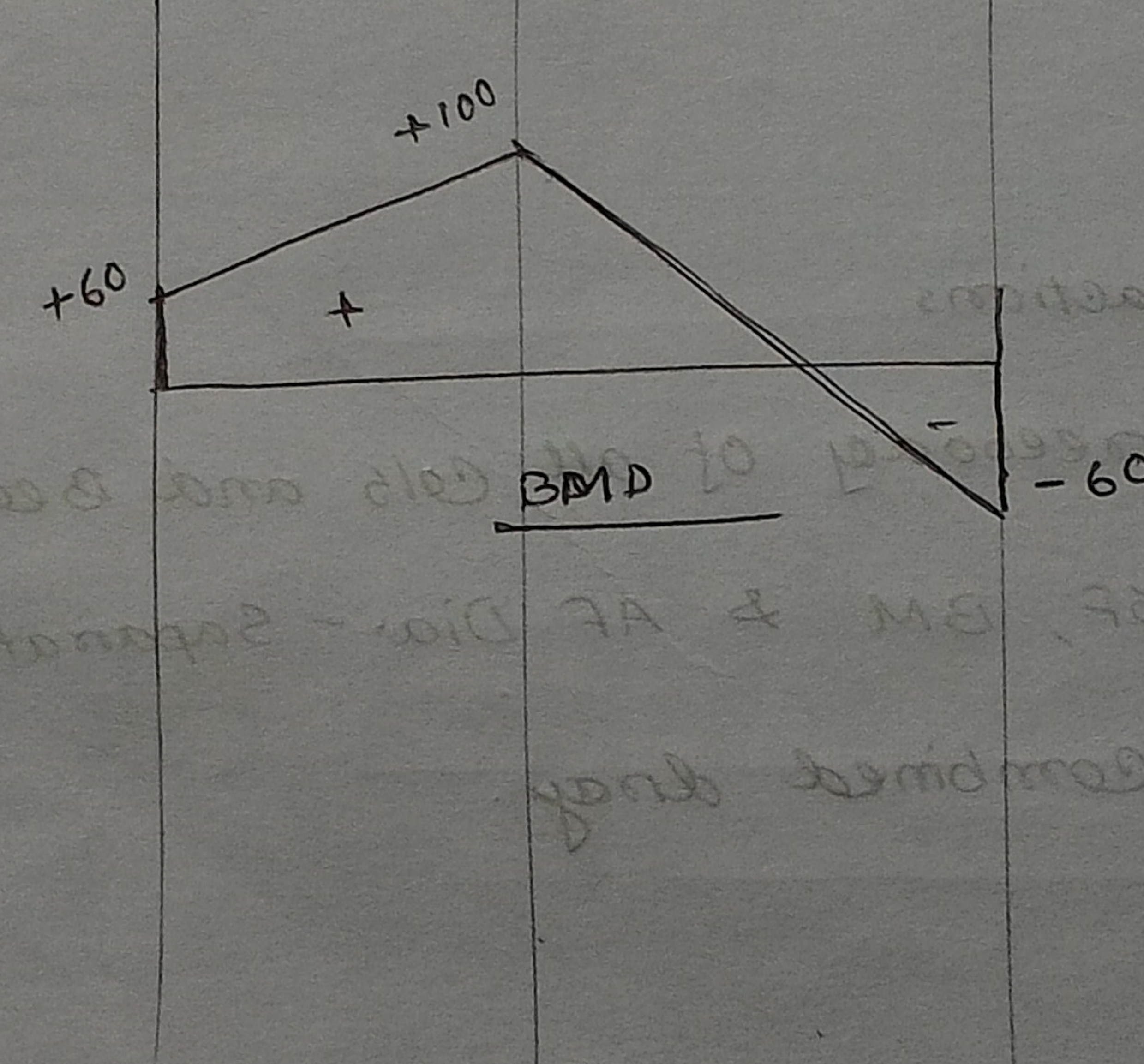
- Joints can be ignored if there is no force
- Consider joint(s) if there is any force --- at least for the type of load (Horz, vertical, Mom) present in the joints.

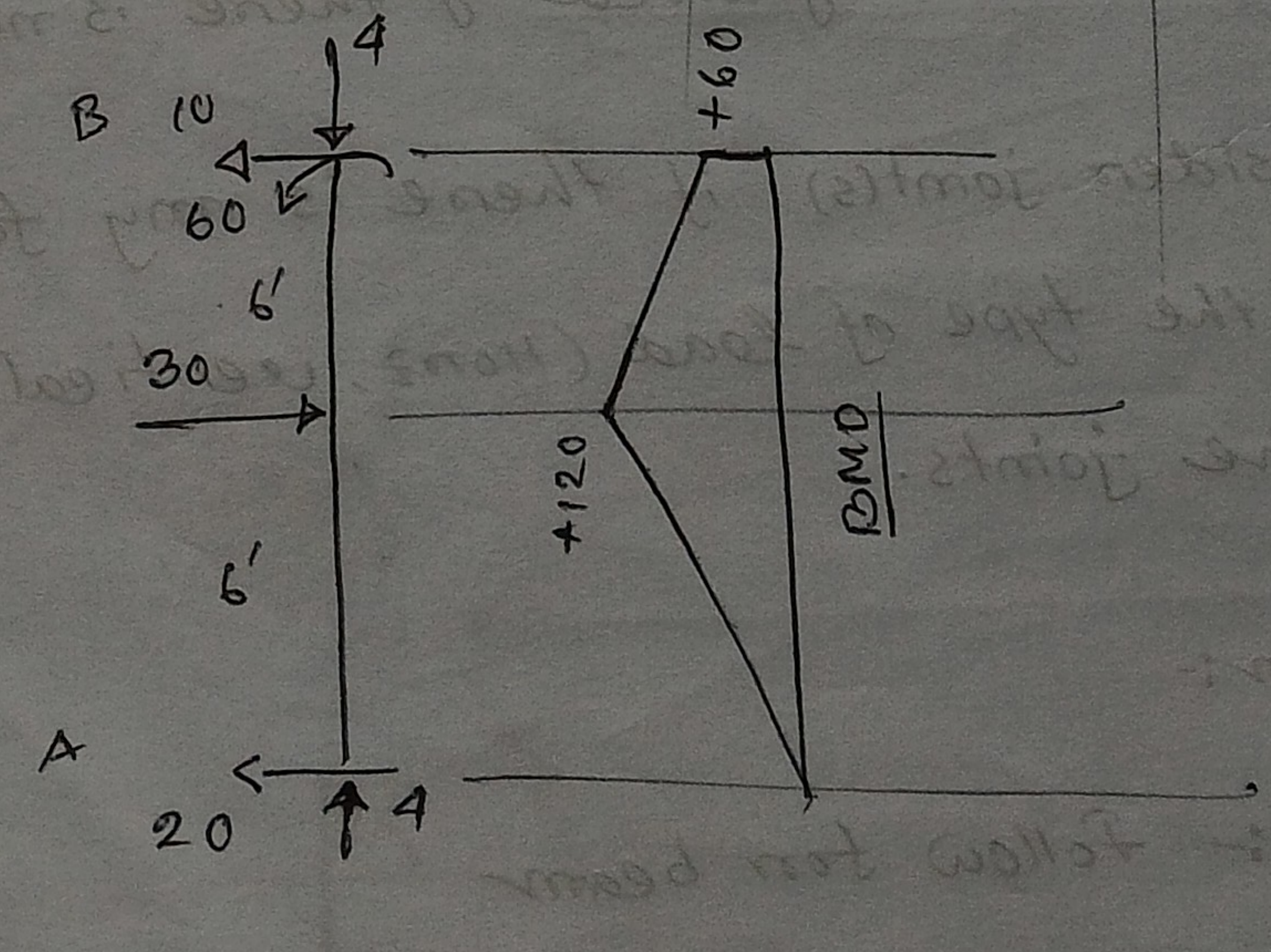
Sign convention:-

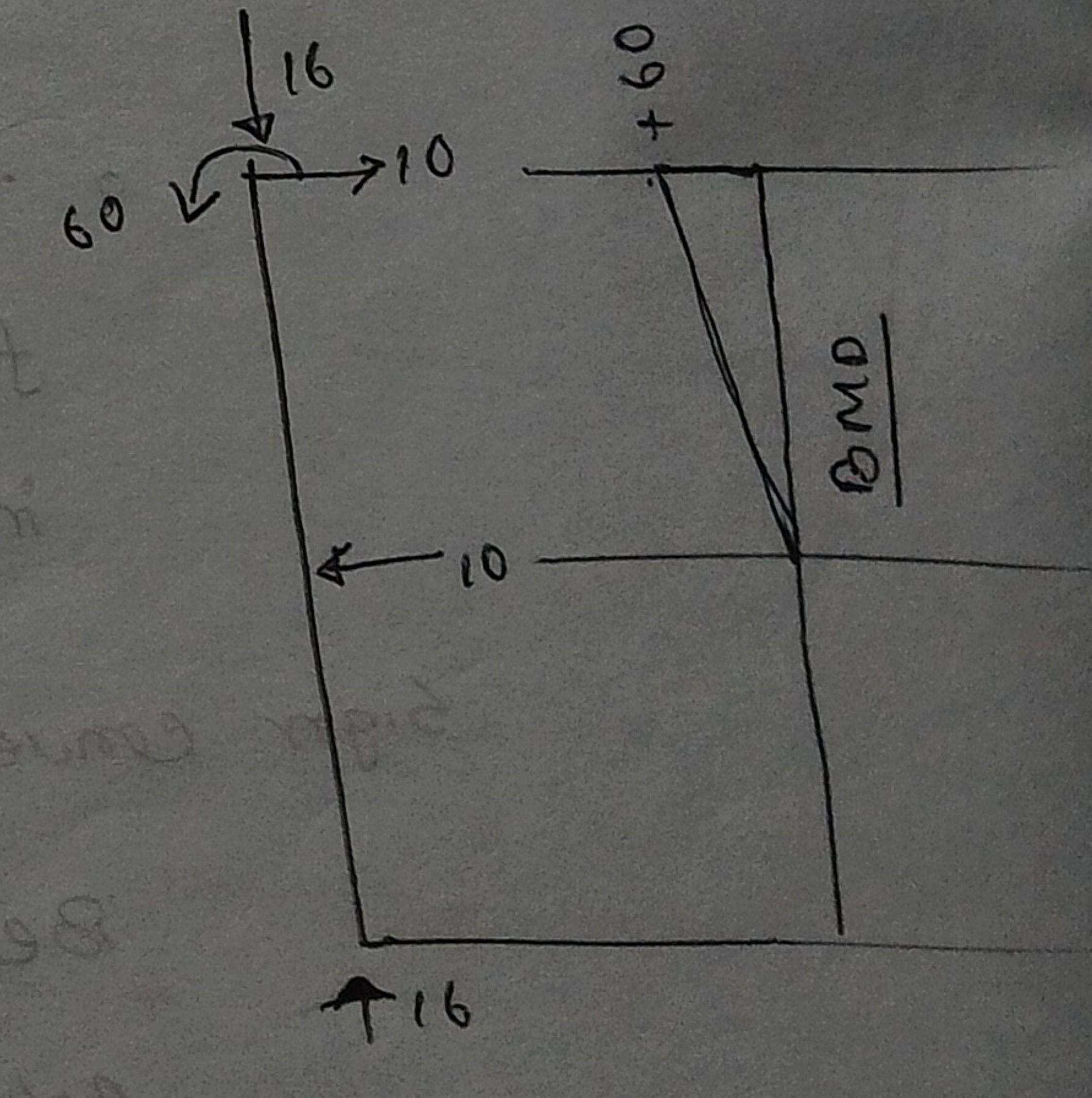
Beam :- Follow for beam

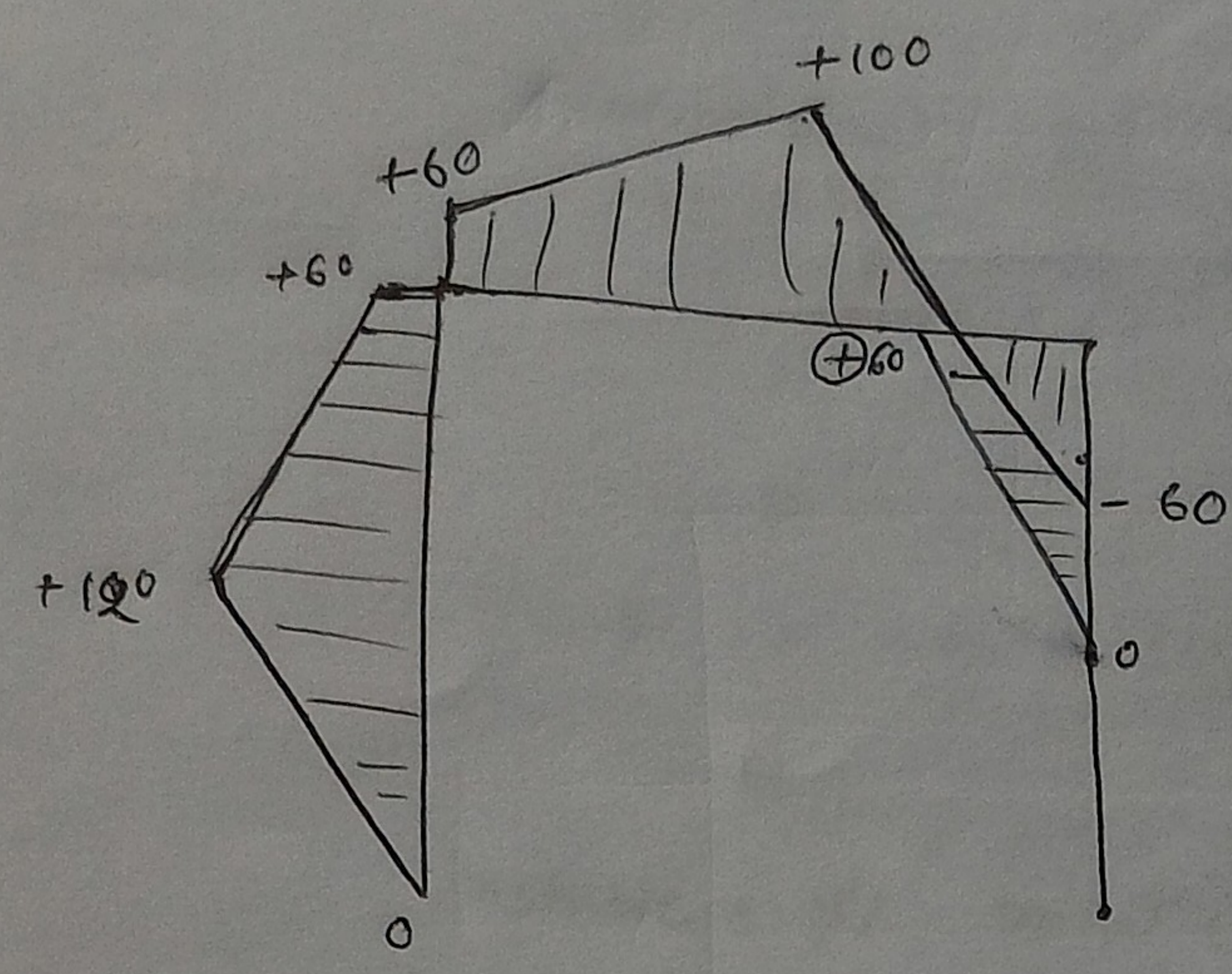
Column :- Rotate the column so that low end at the left side.


B
C
20
60
10
4
60
10
60
16
16
10
60
30
10
4
16
20


+100
+60
+
-
-60
BMD


4
B
10
60
6'
30
6'
A
20
4
+60
+120
BMD


16
60
10
10
16
+60
BMD



2.5 Stability :-

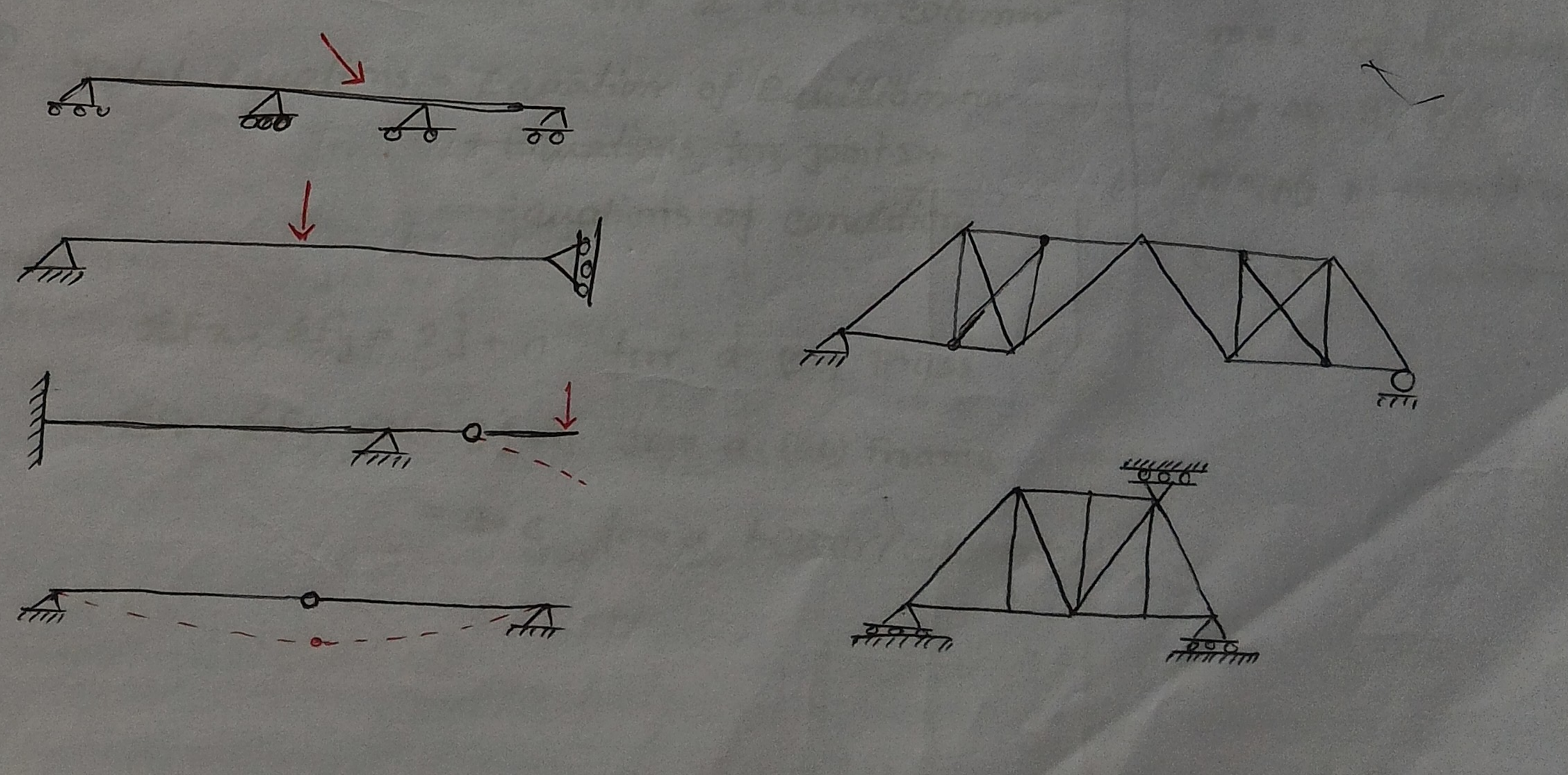
A structure :-

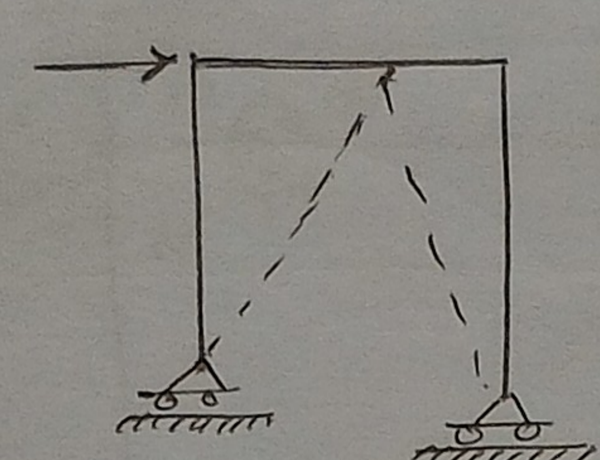
1. Statically unstable

   If total Equation > Total Unknown

2. Geometrically Unstable

   If geometrical arrangement of reactions and members are not properly made.





3rd LECTURE

Date : 23·03·2015

Structural Stability -
Determinancy and Indeterminancy

ⓐ A structure is statically :-

i) Unstable : If Total Unknown forces < Total equations.

ii) Stable and Determinate : If total unknown forces = Total equations

iii) Indeterminate : If total Unknown forces > Total equations

D° of indeteminance = (Total unknown forces) - (Total equations)

ⓑ Total Unknown forces = Member forces + Reactions.

AF = 1b + r for a (2D) Truss

(AF, SF, BM) = 3m + r for a (2D) ~~Truss~~ Frame

= r for a beam/column

ⓒ Total equations = Equation of Equilibrium ~~+ Equations~~ for joints + Equations of condition

$\Sigma Fx, \Sigma Fy = 2j + 0$ for a (2D) Truss

$\Sigma Fx, \Sigma Fy, \Sigma M = 3j + c$ for a (2D) Frame

$= 3 + c$ for a beam/column

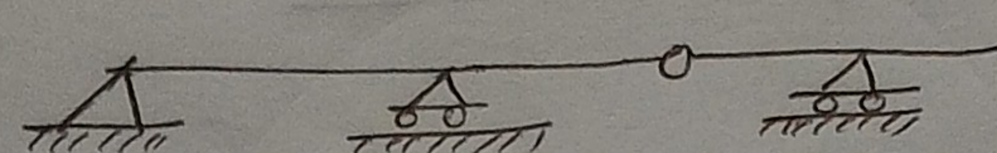
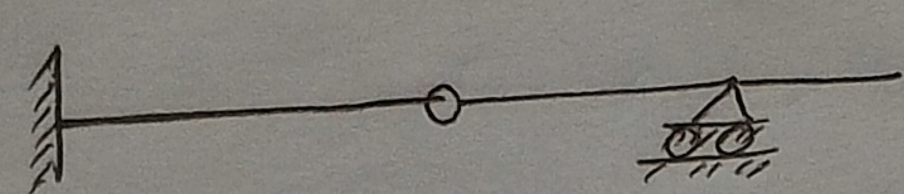
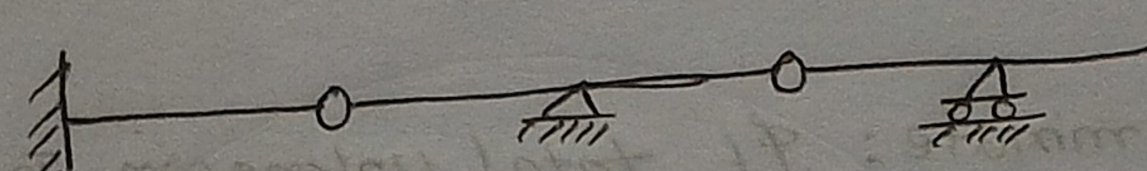
b = No of bars

m = " of members

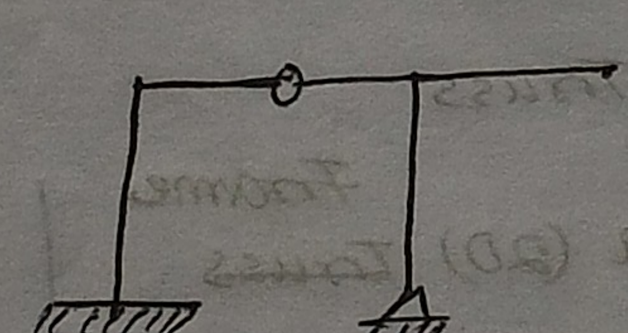
J = No. of Jts

r = No of reaction

c = No of conditions

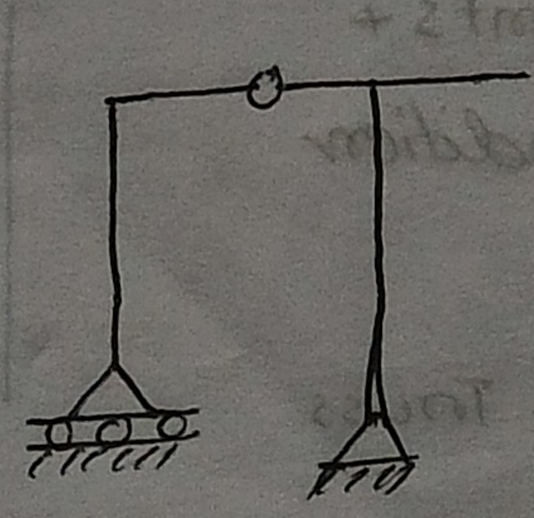
Beams	Unknown Forces	Equations	D° of Indet.
	4	3+1	0
	4	3+1	0
	6	3+2	1

Plane (2D) Frame:



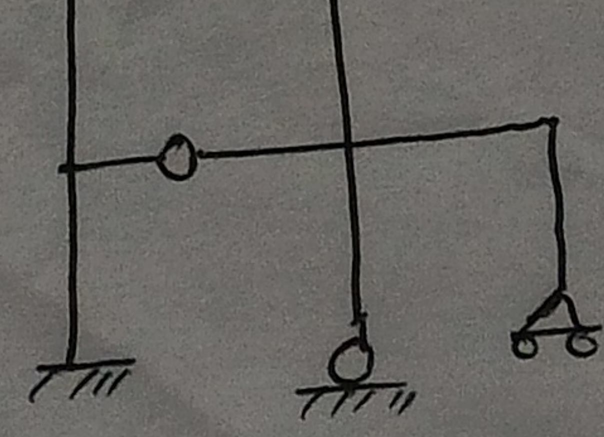
$m = 4$
$r = 5$
$J = 5$
$e = 1$

$3m + r = 17$
$3j + e = 16$ > 1°D = statically stable and Indeterminate



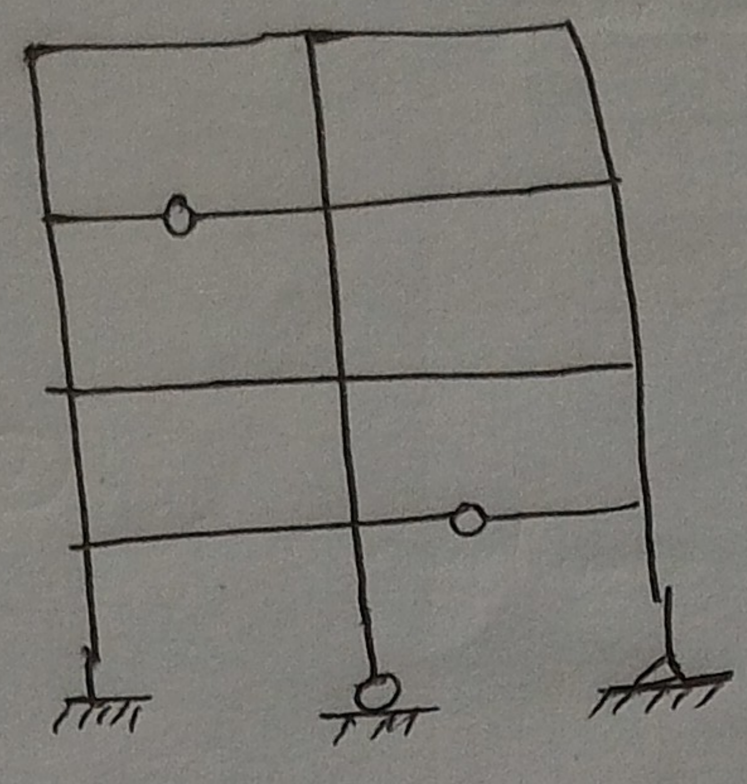
$m = 4$
$r = 3$
$J = 5$
$e = 1$

$3m + 4 = 15$
$3j + e = 16$ > −1°D = statically Unstable



$m = 8$
$r = 6$
$j = 8$
$e = 1$

$3m + R = 30$
$3j + e = 5$ > 5°D



$m = 20$

$r = 6$

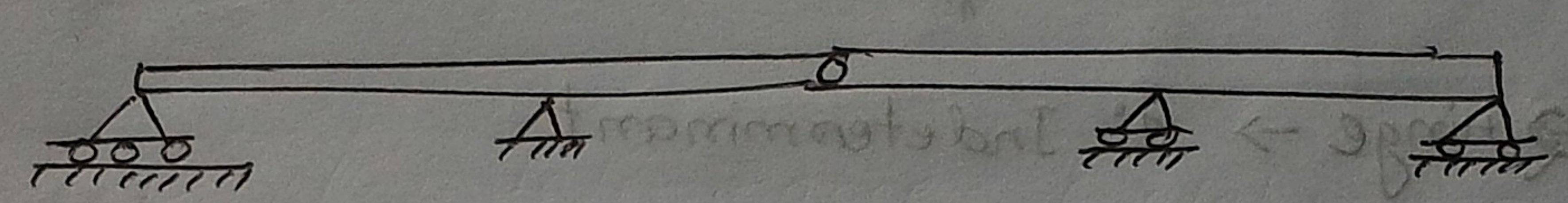
$j = 15$

$c = 2$

$3m + r = 66$

$3j + c = 47$ > 19° D

Lorrris willber → page 132



$r = 5$

$3 + c = 4$ > 1° D

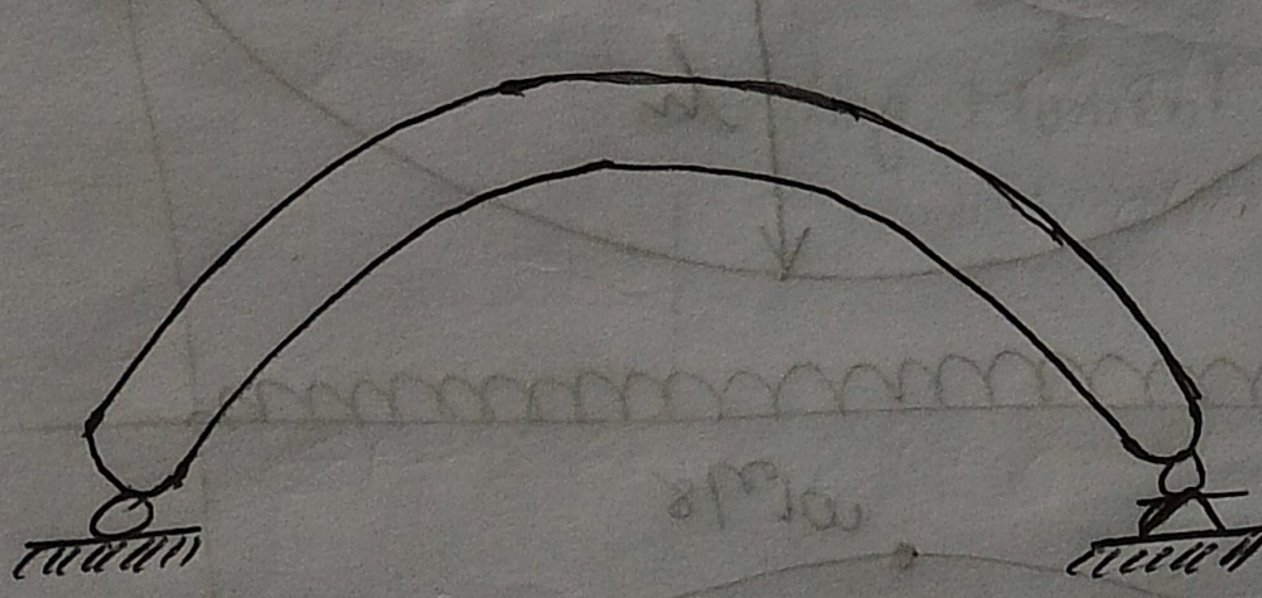
o Truss (কে Always A Triangle হতে হবে।

Class Test

Frame Analysis

Next: Monday

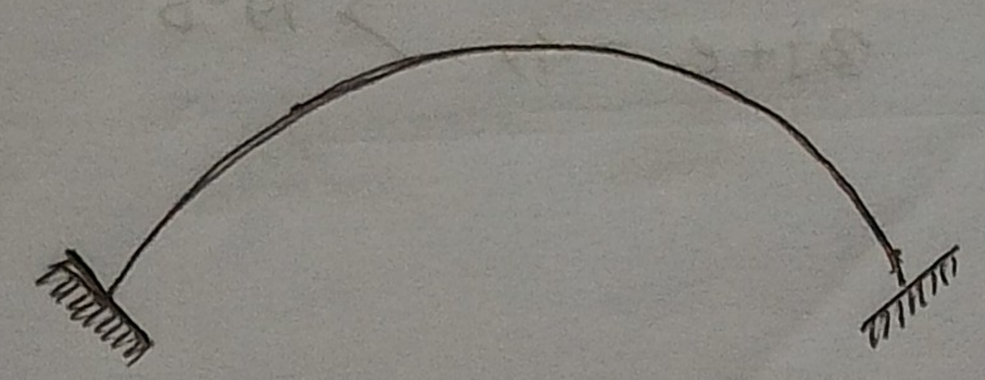
Analysis of Arch:



Can be Circular/ Parabolic / Elliptical

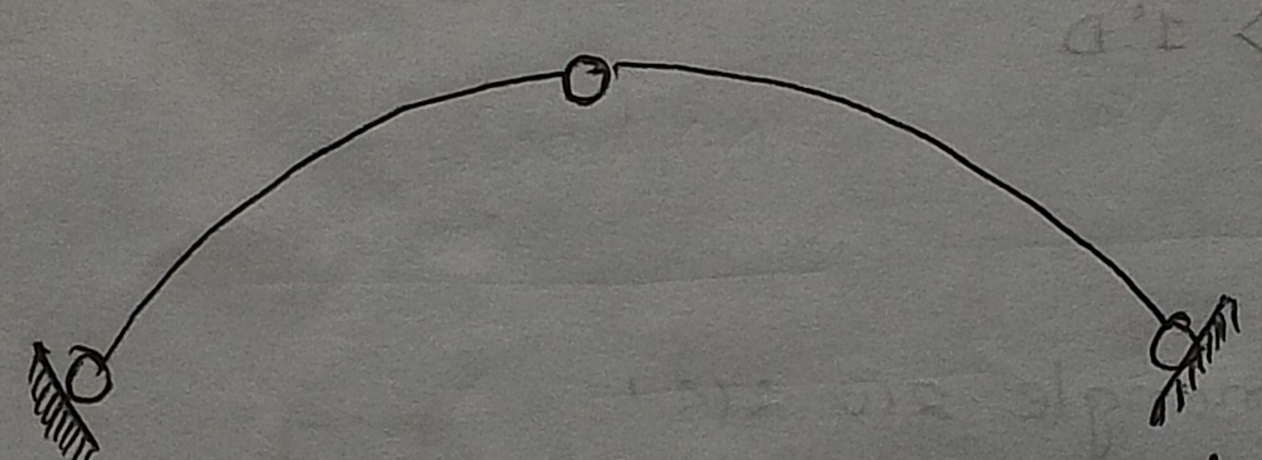
Or Geometry

On support



Fixed -> 3° InDeterminant

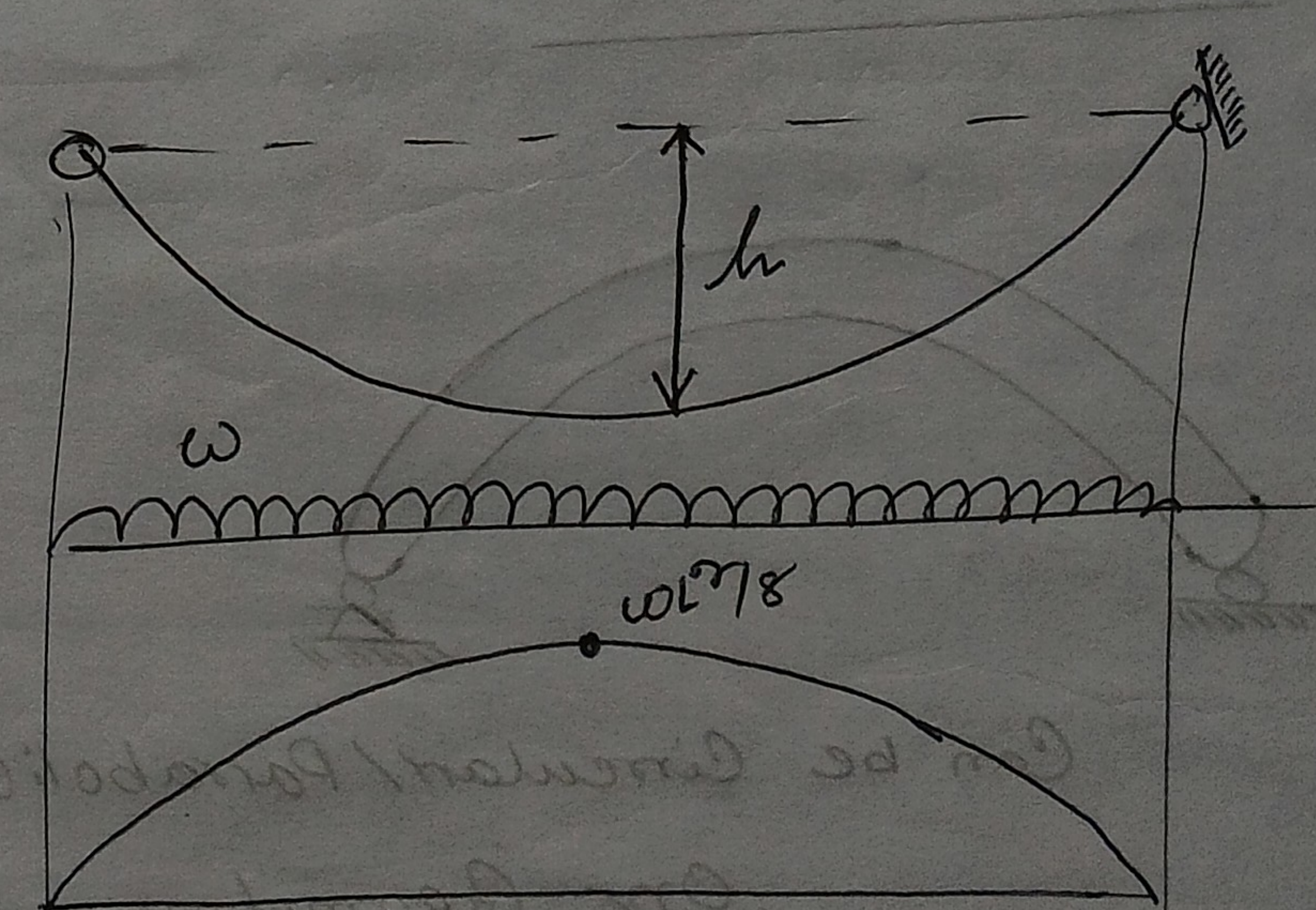
2 Hinge -> 1° Indeterminant



3 Hinge -> Determinant

$H = \frac{\omega L^2}{8h}$

Cable:-



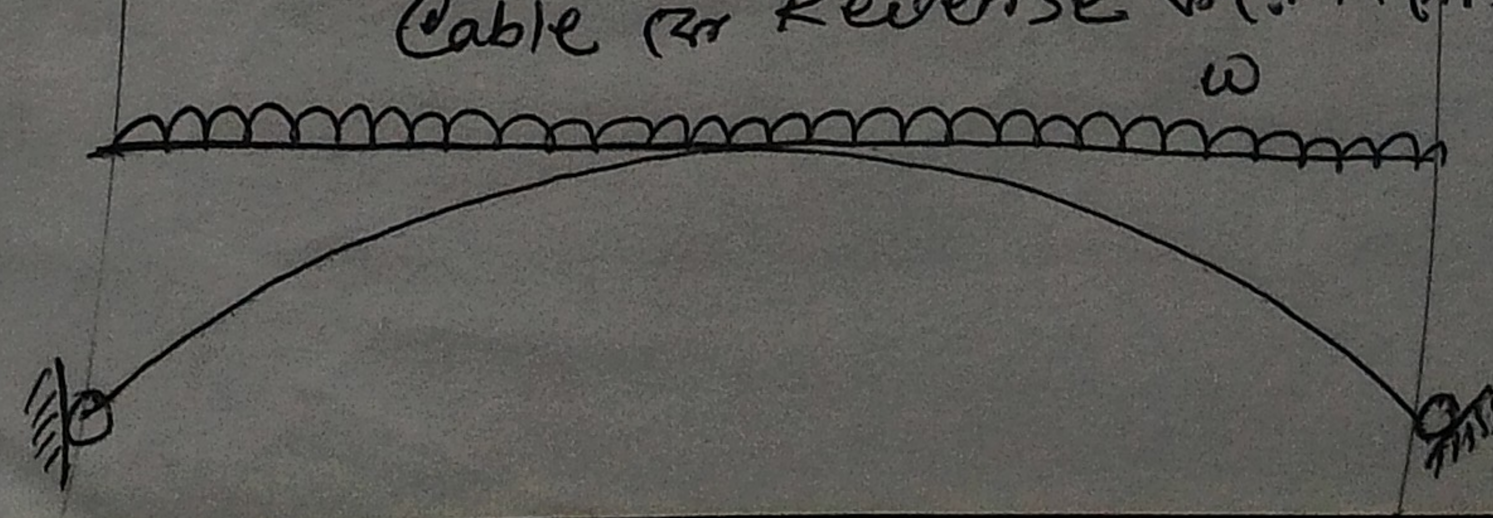
BMD

At Ct,

$H = \frac{BM}{h}$

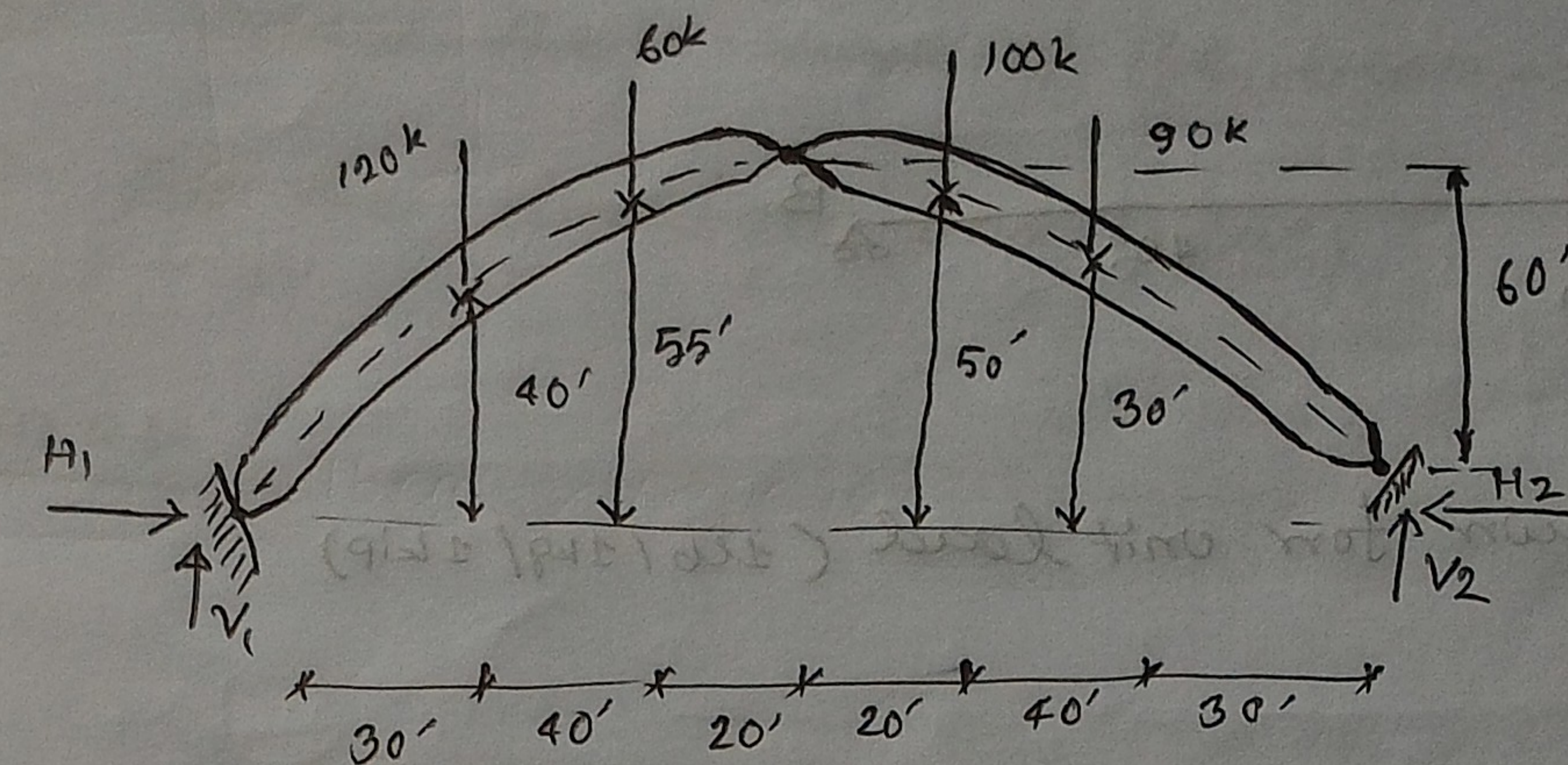
$\therefore H = \frac{\omega L^2}{8}$

Cable কে Reverse করে দিলে,



Shedd- Vawter page 46 :-

3 Hinge ARCH 1



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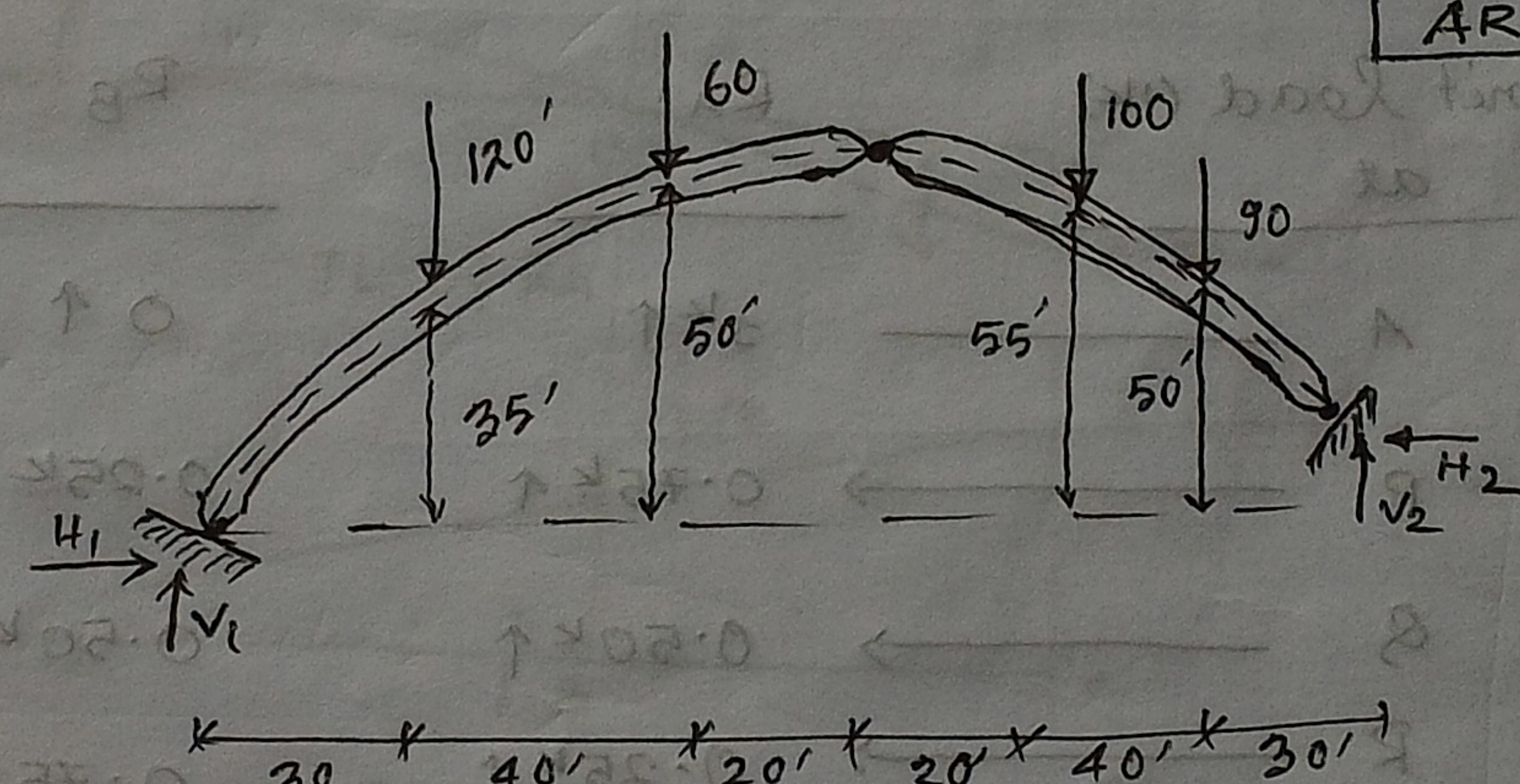
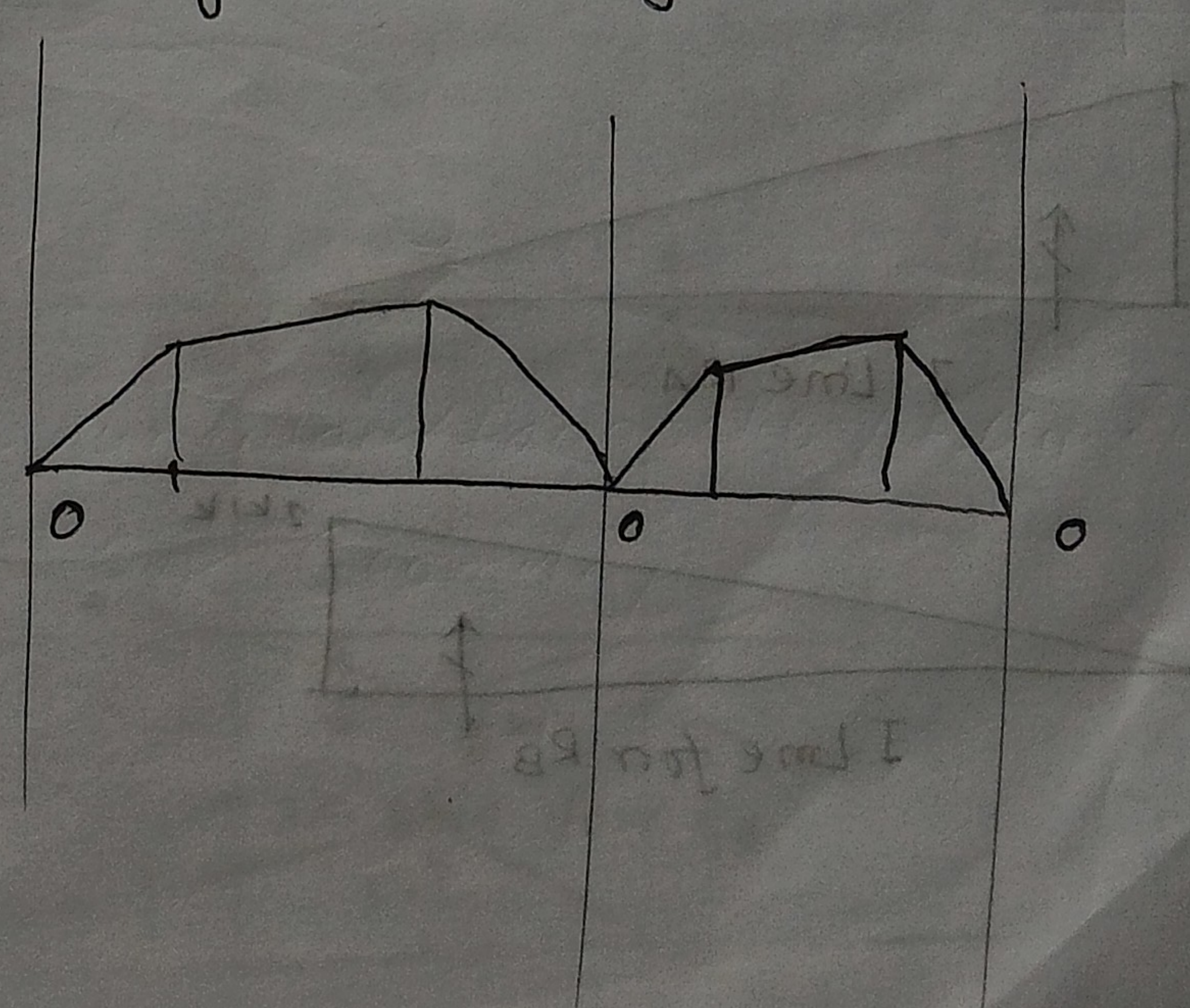
ARCH 2

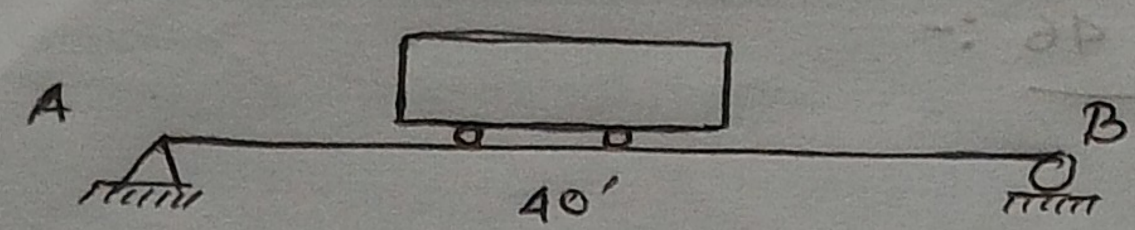


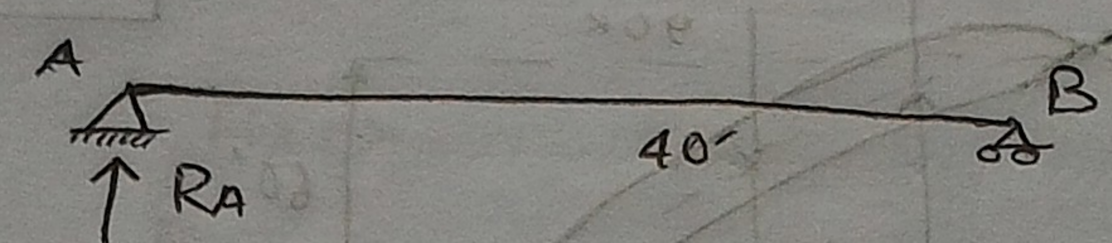
Draw
↓
Bending Moment Diagram



Date : 27-04-2015

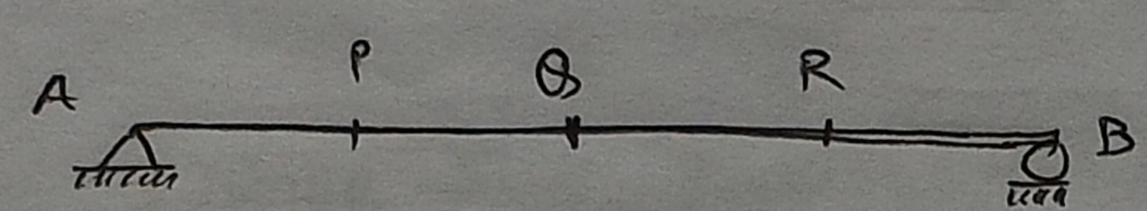
Structural Analysis and Design





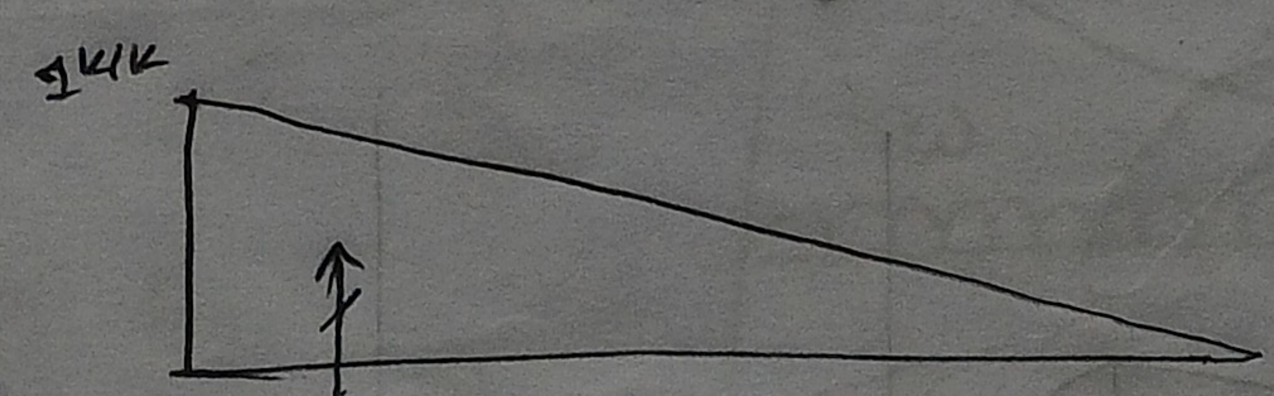
is drawn for unit load (1lb / 1kg / 1kip)

Beam 1:

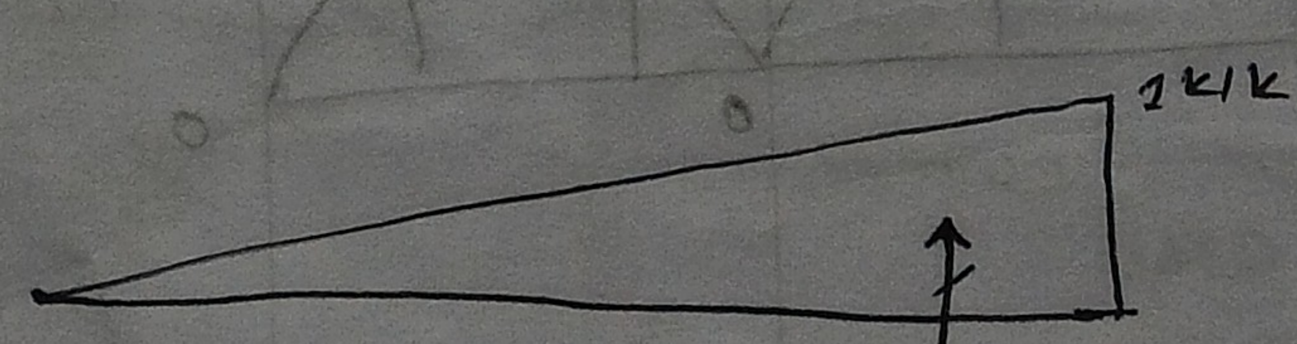


4 @ 10' = 40'

Unit load (1k) at	R_A	R_B
A	1^k ↑	0 ↑
P	0.75^k ↑	0.25^k ↑
Q	0.50^k ↑	0.50^k ↑
R	0.25^k ↑	0.75^k ↑
B	0^k	1^k ↑



I Line RA



I Line for RB

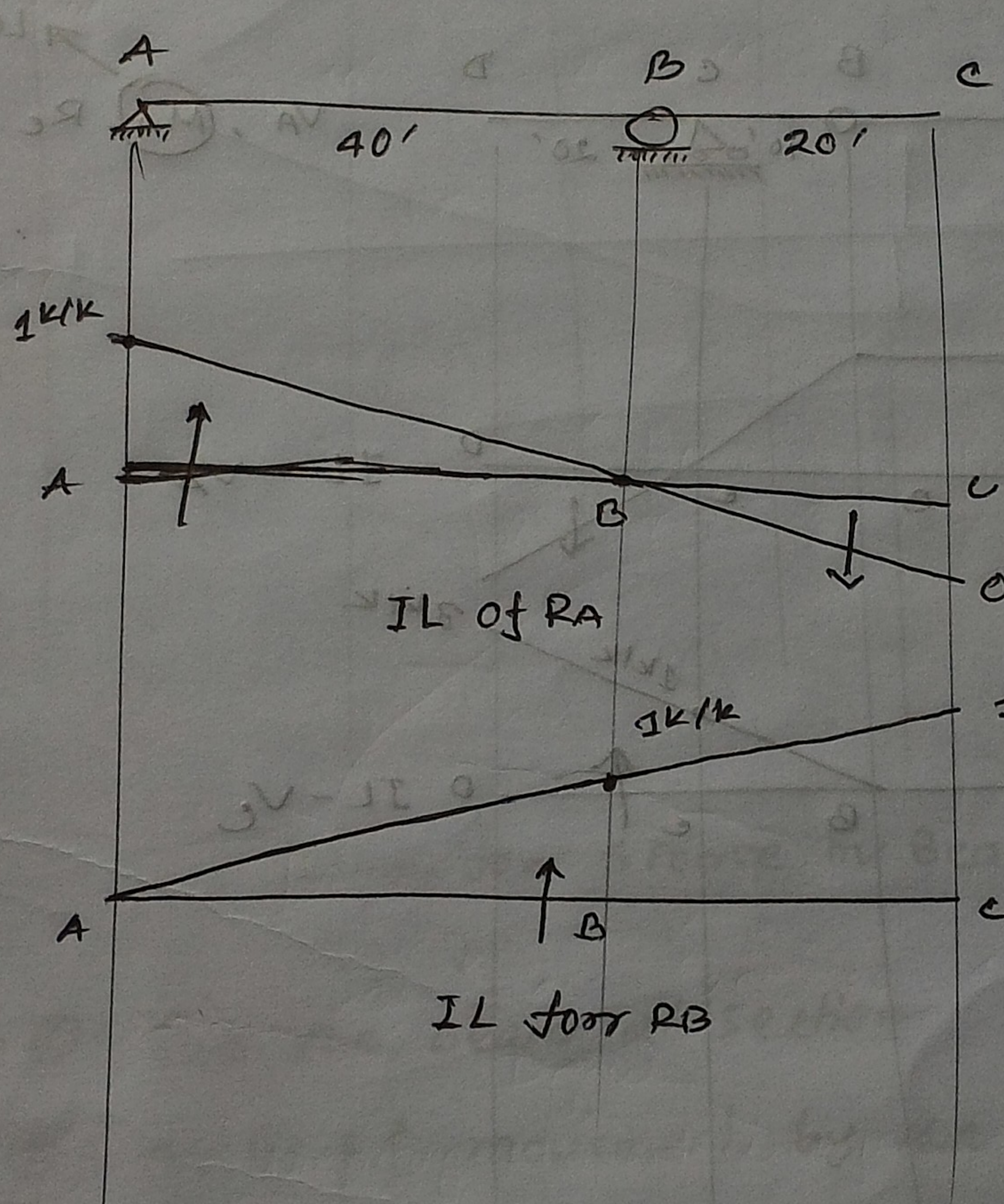
Drawing of I Lines for Rections:

Step 1: Push up the support of Reaction by 1

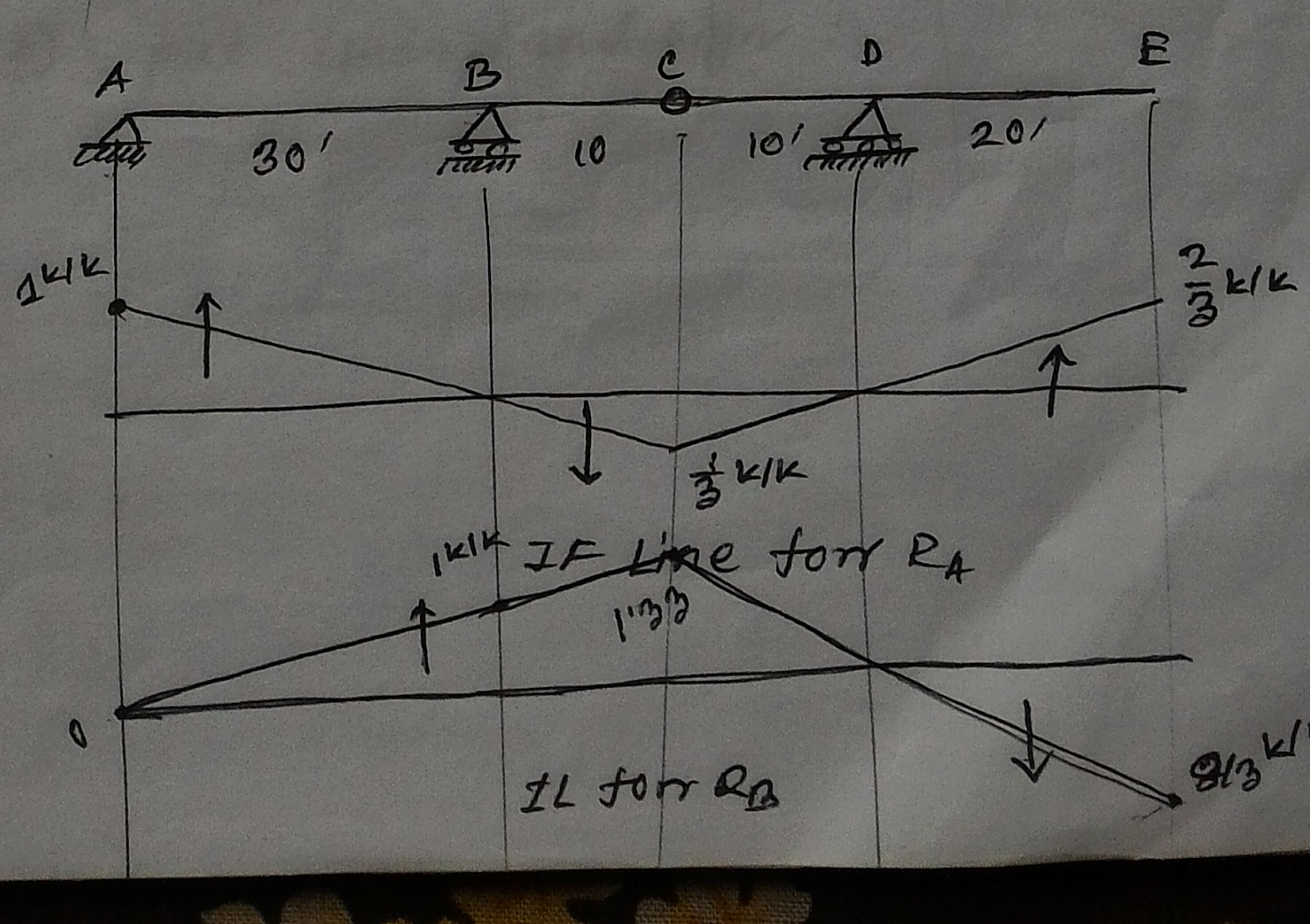
②: Draw the δ-Shape of the beam → I Line

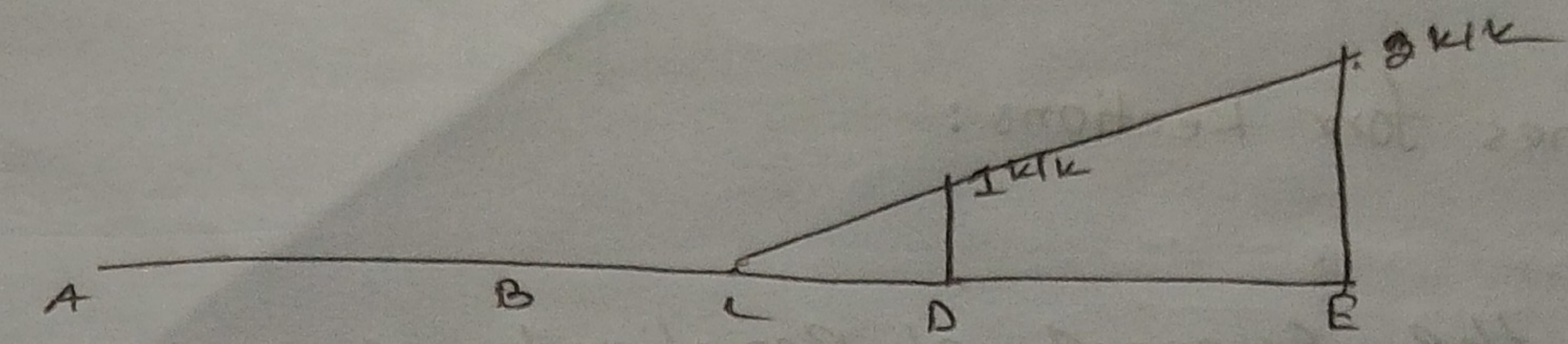
③: Put the directions and values

Beam 2:-



Beam 3





IL for R_D

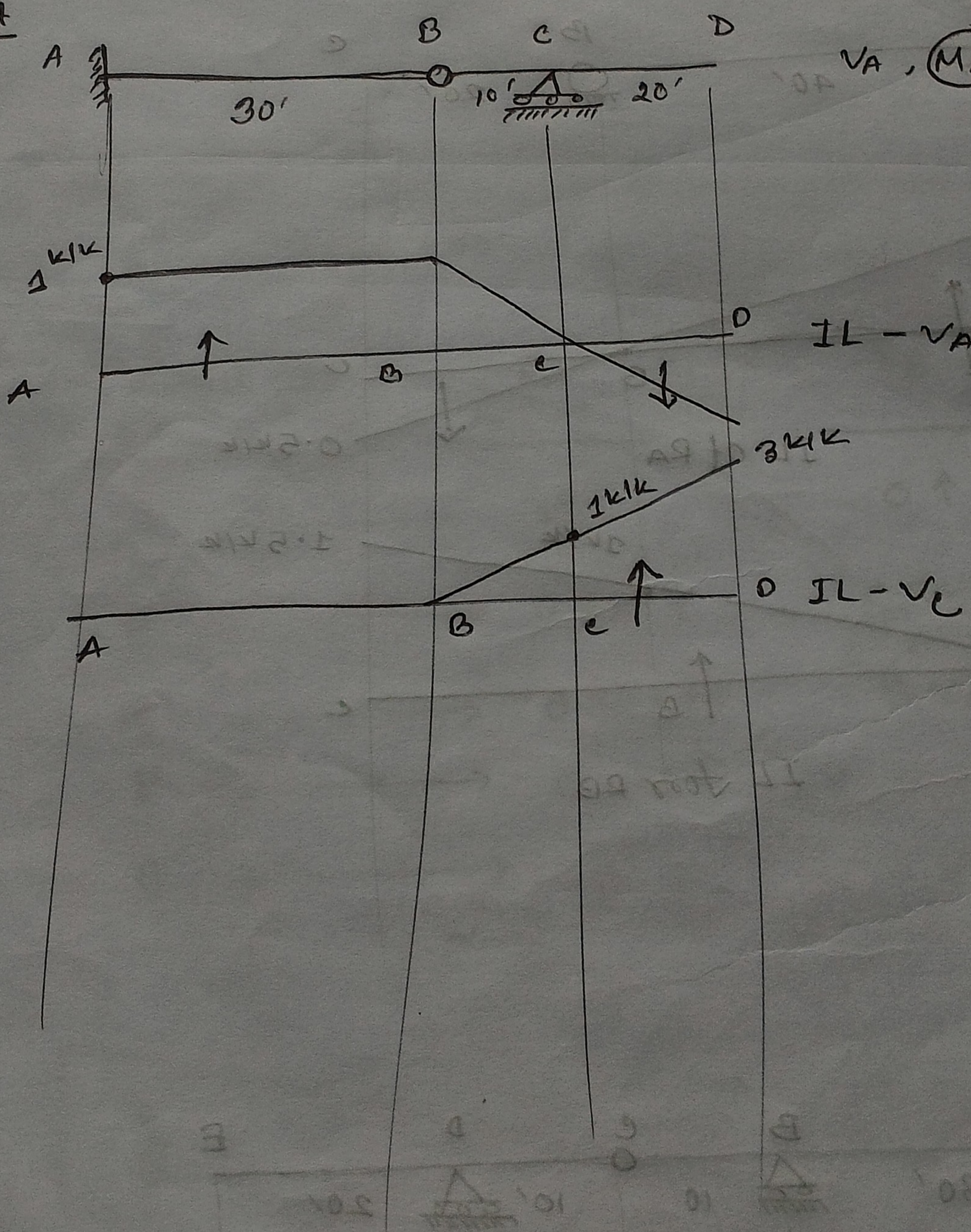
Value of a function

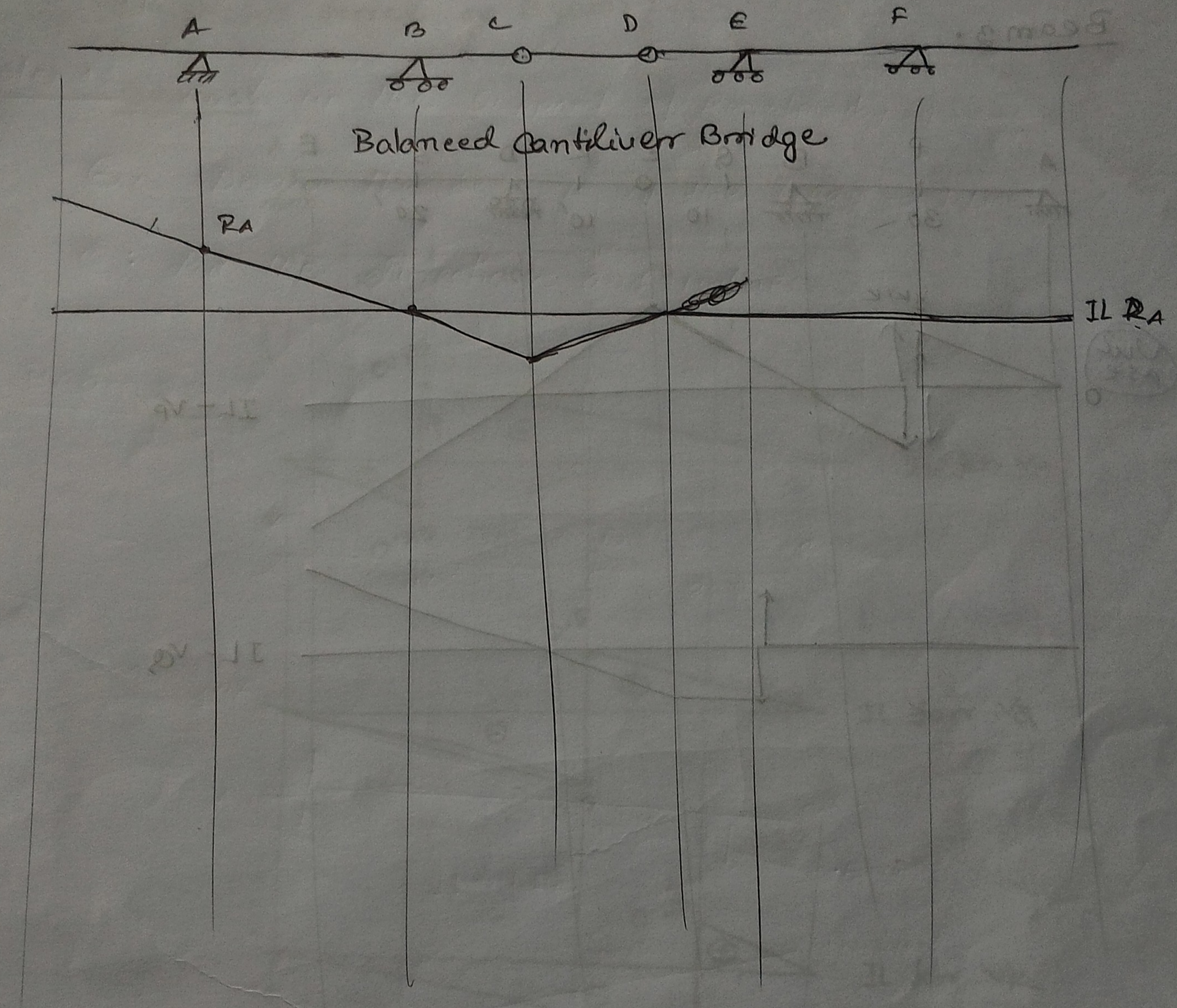
= Ordinate of IL × Load → for Point Load

= Area Under I Line × ω → for UDL

Beam 4

V_A, M_A (→ Later), R_C





I Line for S Force in Beams

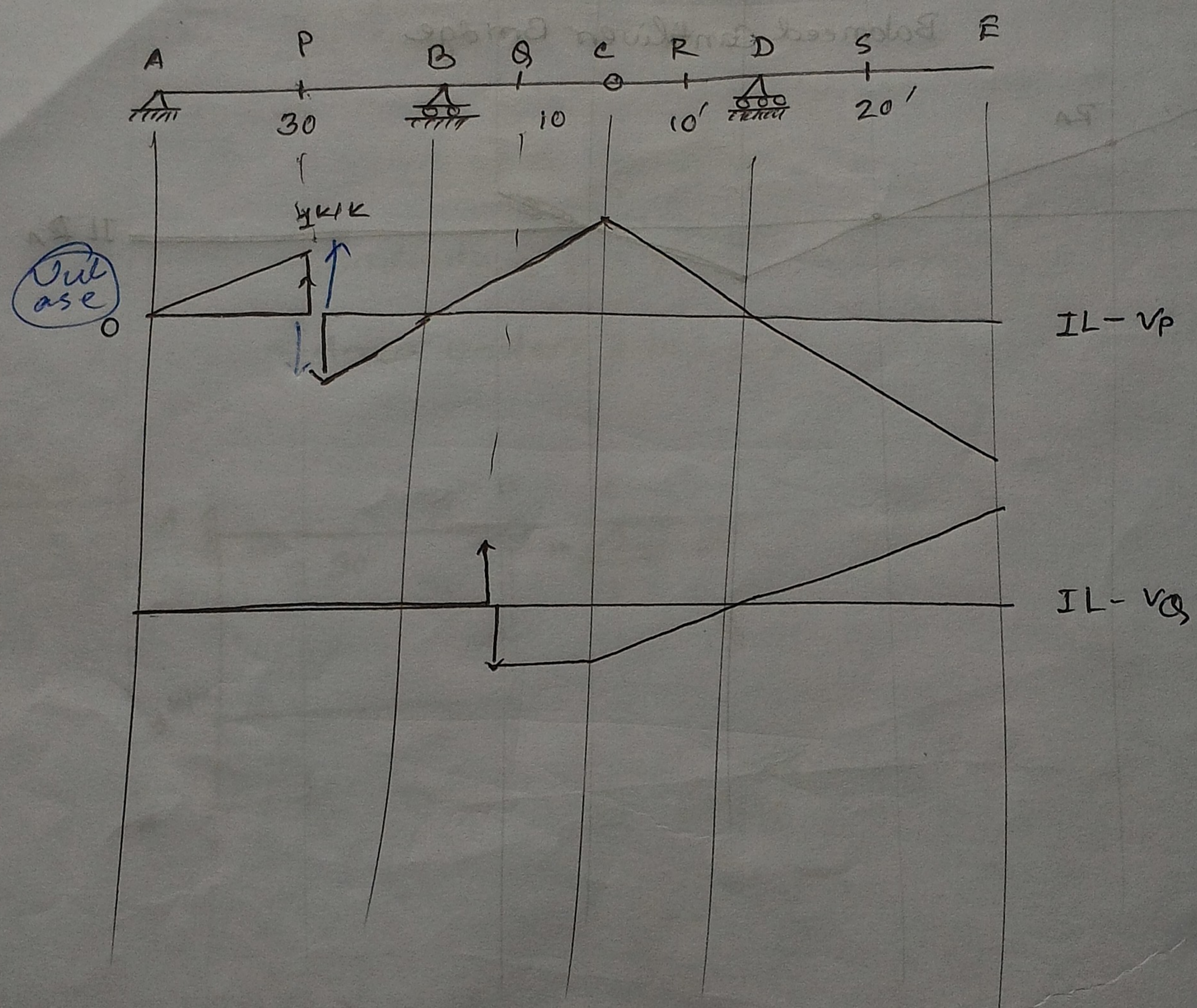
Step ①: Cut the beam at section

②: Apply ↑↓ movement by the side of the section

③: Draw the S-shape ⟶ I Line for SF

④: put value and sign

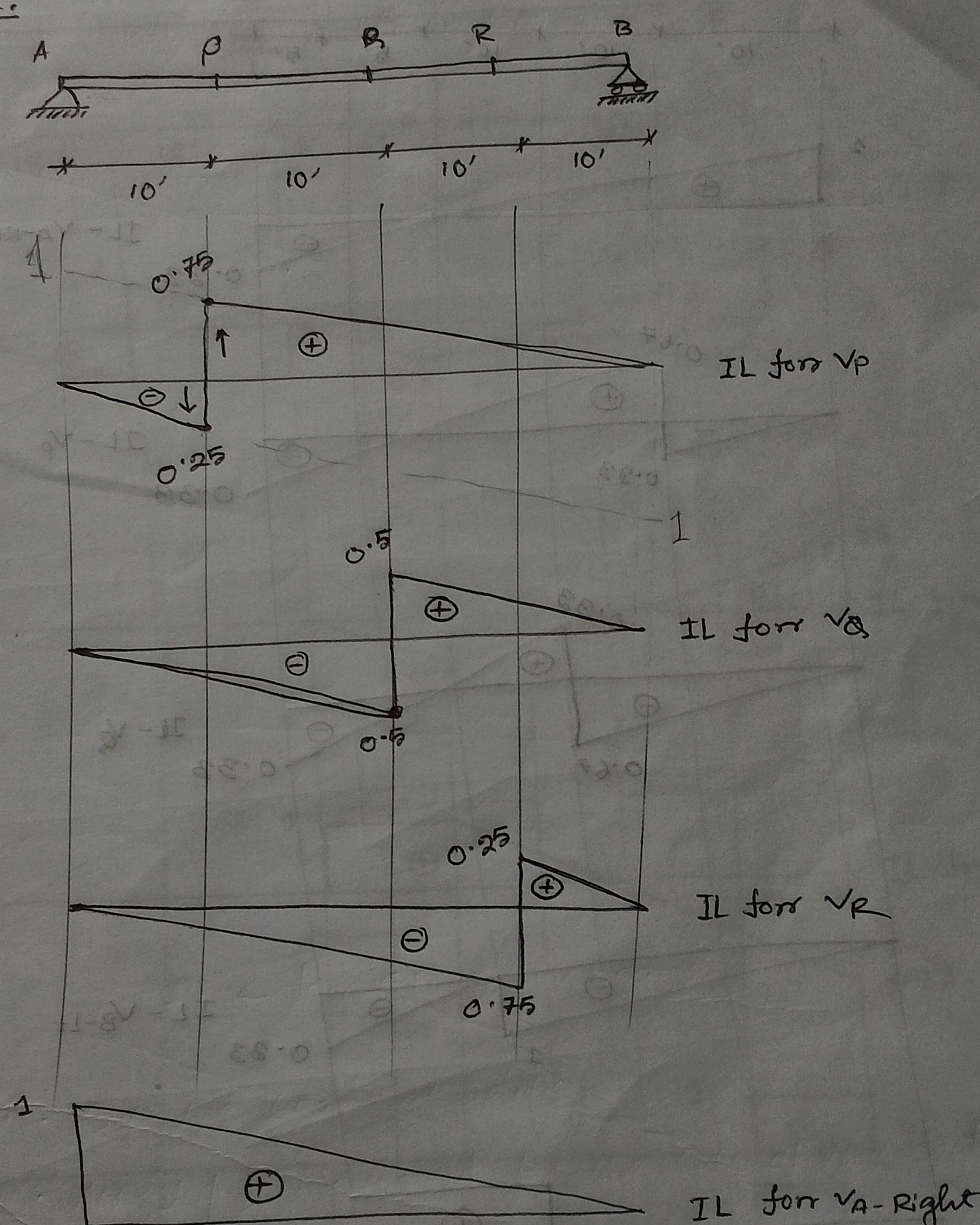
Beam 3:



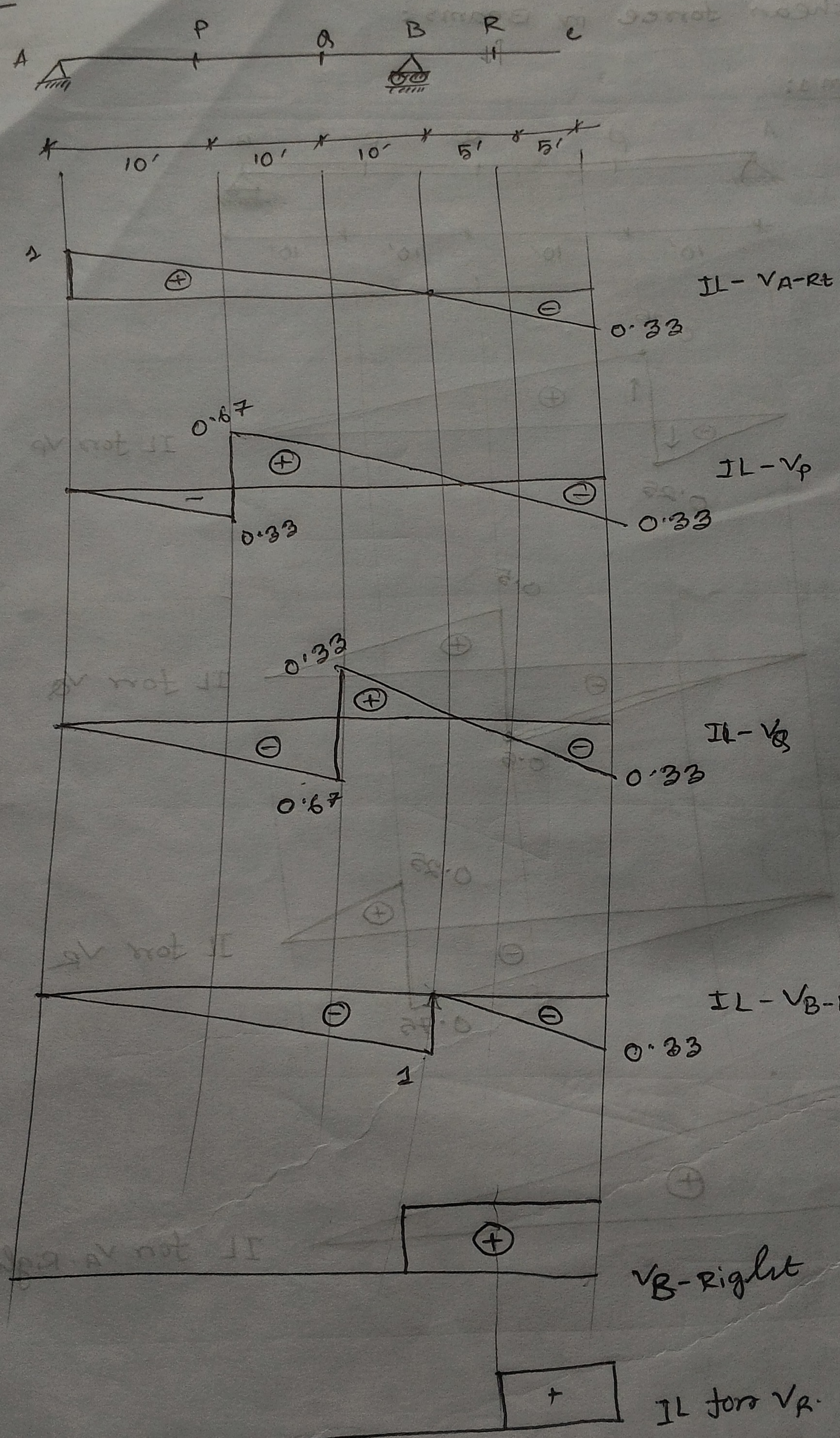
Structural Design

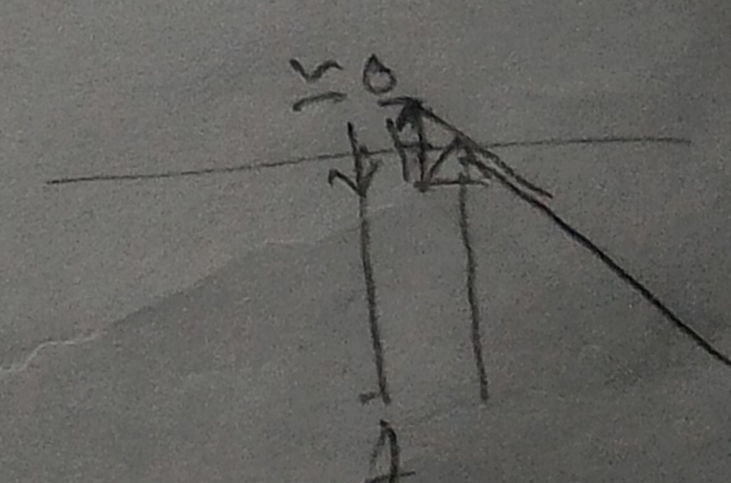
IL for shear force in Beams :

Beam 1:

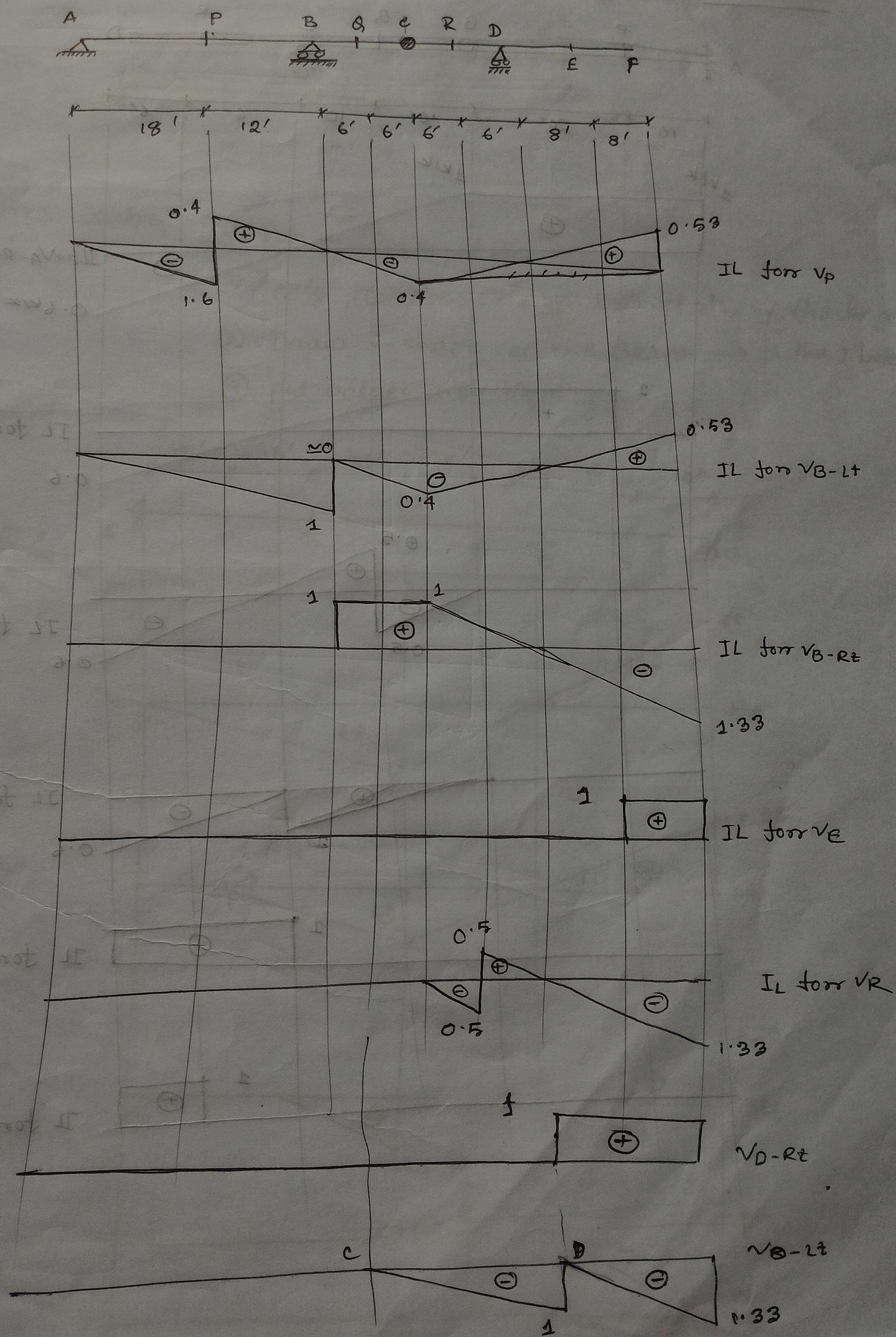


Beam 2:-


A
P
Q
B
R
C
10'
10'
10'
5'
5'
1
IL- VA-Rt
0·33
0·67
IL- VP
0·33
0·33
0·33
IL- VQ
0·67
0·33
IL- VB-Lt
1
0·33
VB-Right
IL for VR.

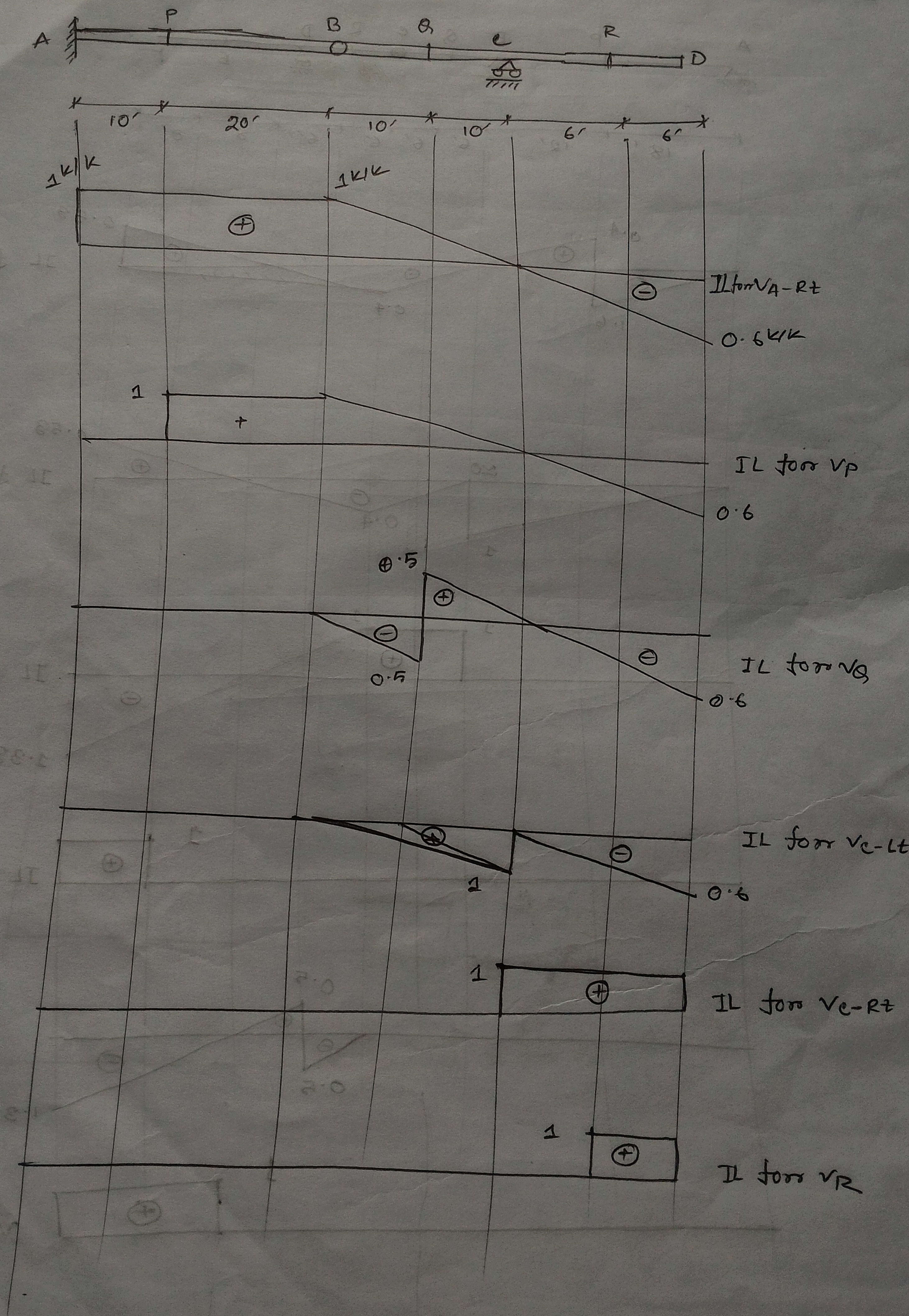


Beam ③:



A
P
B
Q
C
R
D
E
F
18'
12'
6'
6'
6'
6'
8'
8'
0.4
1.6
0.4
0.53
IL for Vp
≃0
1
0.4
0.53
IL for VB-Lt
1
1
1.33
IL for VB-Rt
1
IL for VE
0.5
0.5
1.33
IL for VR
1
VD-Rt
C
D
1
1.33
VD-Lt

Beam 4:



A
P
B
Q
C
R
D
10'
20'
10'
10'
6'
6'
1k/k
1k/k
0.6k/k
IL for VA-Rt
1
0.6
IL for VP
0.5
0.5
0.6
IL for VQ
1
0.6
IL for VC-Lt
1
IL for VC-Rt
1
IL for VR

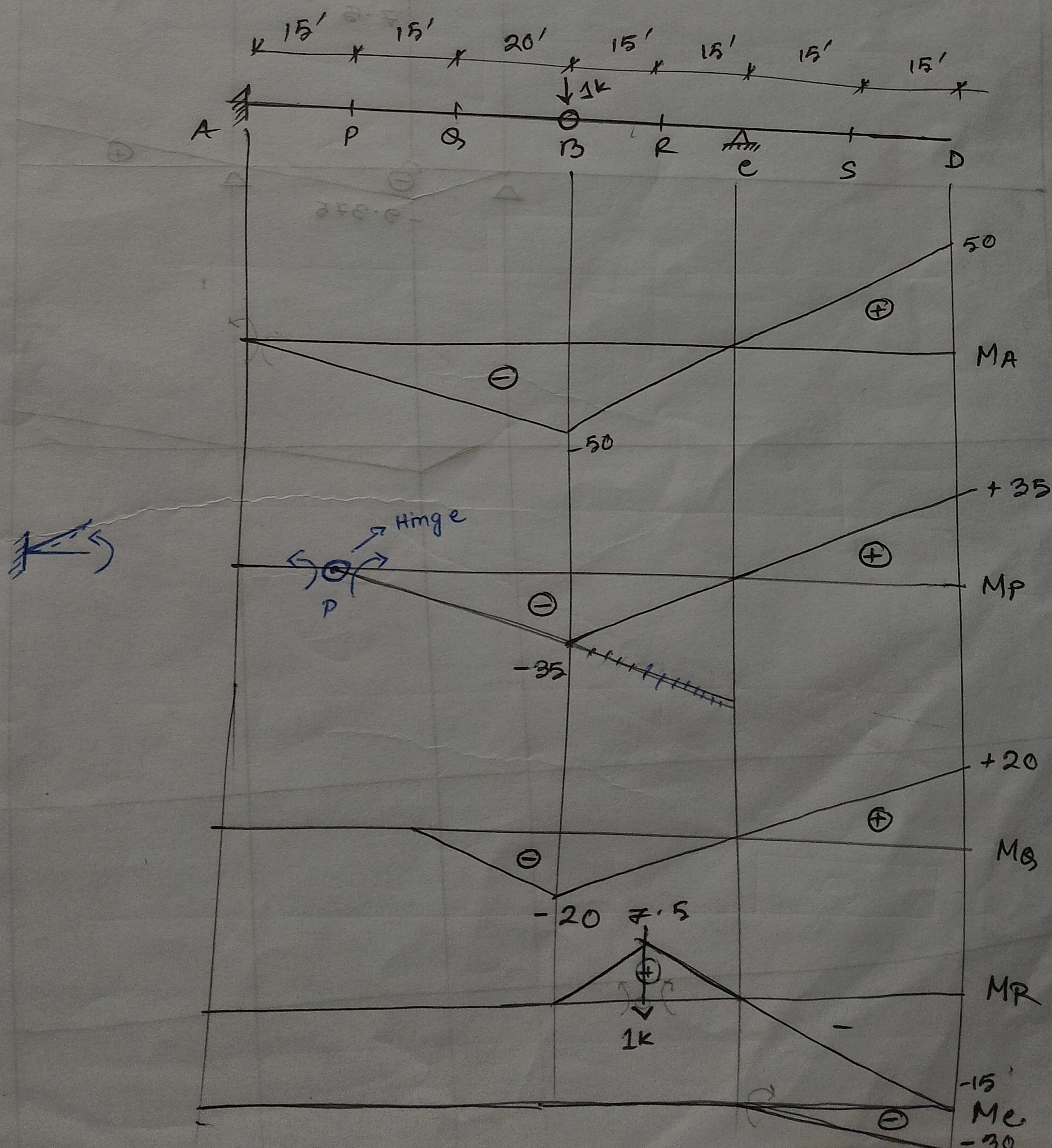
Structural Analysis and Design

Date: 18.05.015

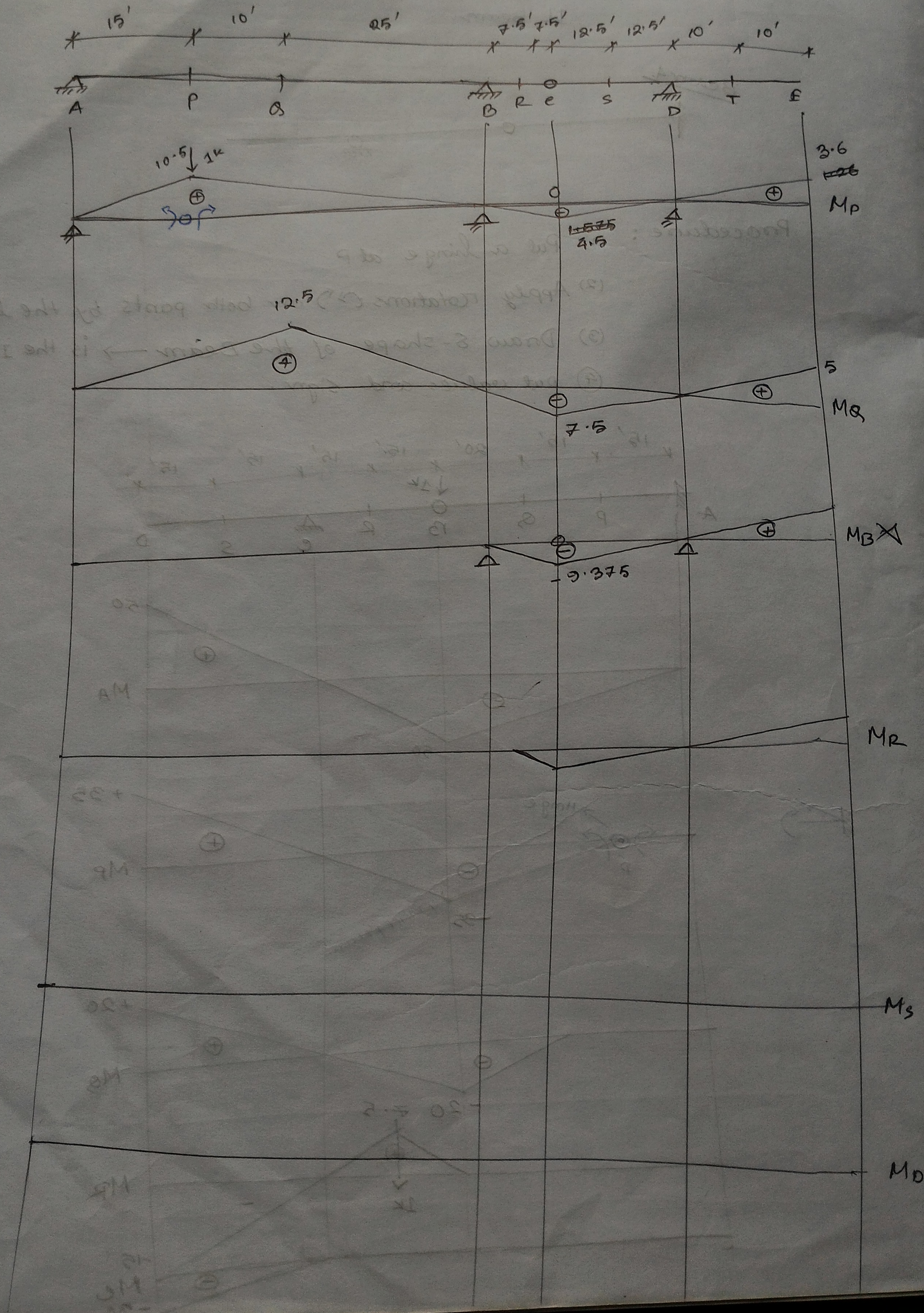
IL Beam

Beam 4

Procedure:
(1) Put a hinge at P
(2) Apply rotations ↶↷ on both parts by the hinge
(3) Draw S-shape of the Beam ⟶ is the I Line
④ put values and sign.

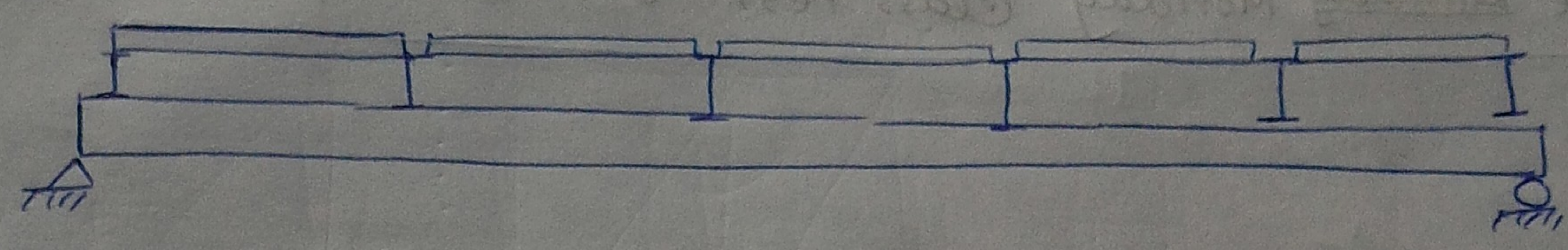


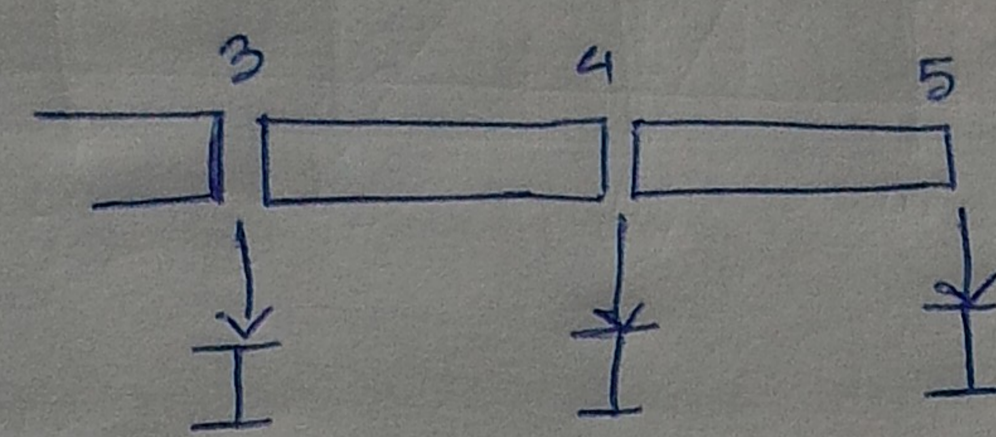
Beam 3



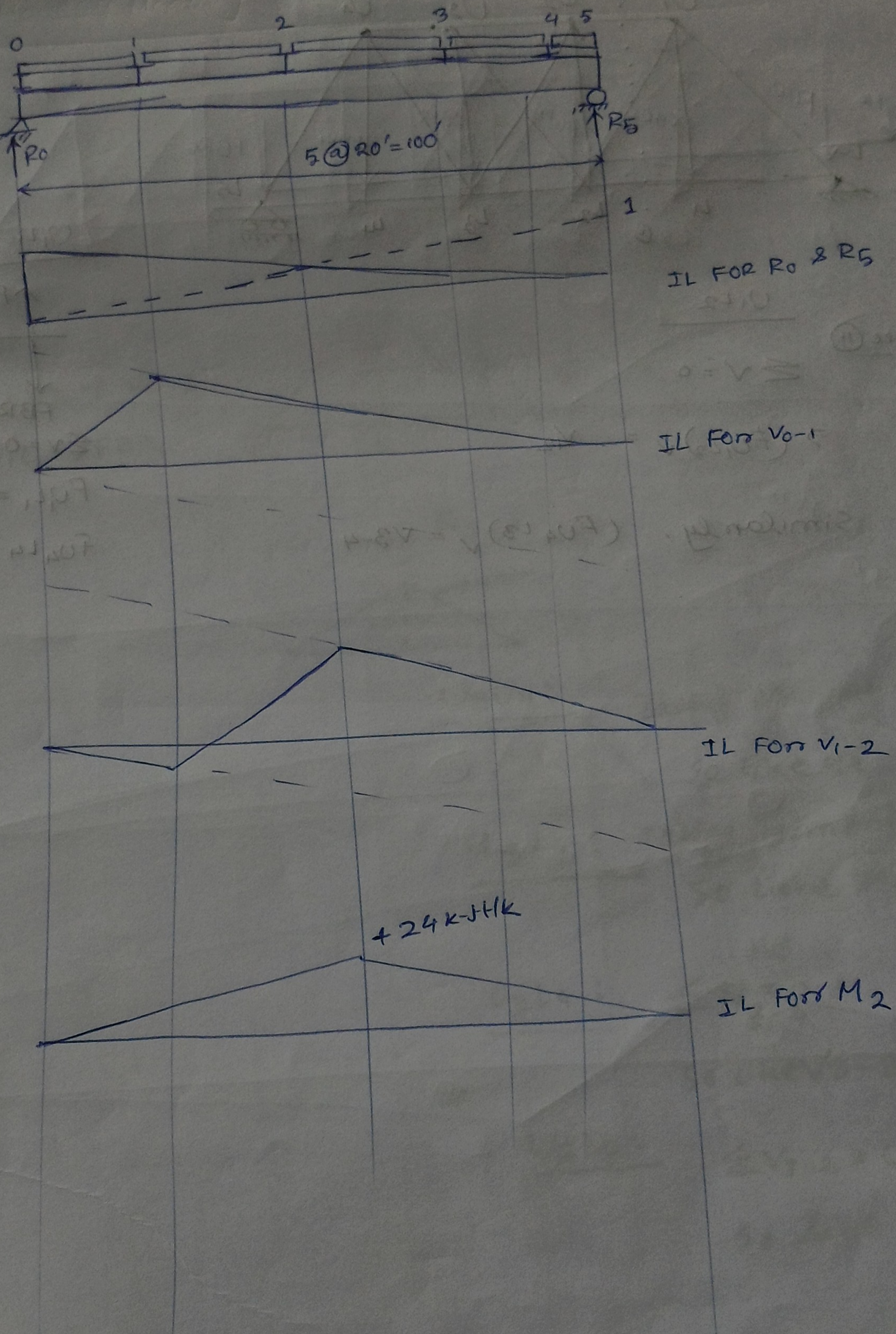
15'
10'
25'
7.5'
7.5'
12.5'
12.5'
10'
10'
A
P
Q
B
R
e
S
D
T
E
10.5
1k
3.6
Mp
4.5
12.5
5
MQ
7.5
MB
-9.375
MR
MS
MD

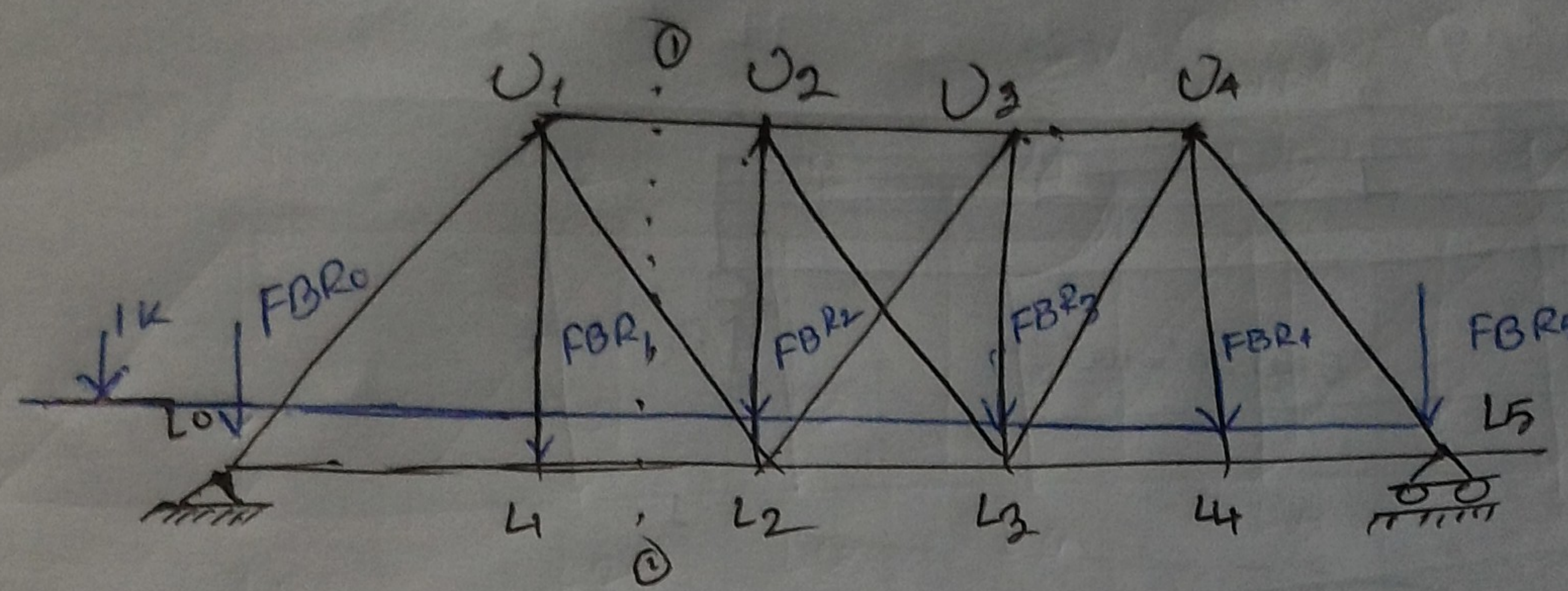
Structural Analysis and Design





Example:-


0
1
2
3
4
5
R0
R5
5 @ 20' = 100'
1
1
IL FOR R0 & R5
IL For V0-1
IL For V1-2
+24 k-ft/k
IL For M2



U_1L_1

$\uparrow F_{U_1L_1}$

FBR1

$\Sigma V = 0$

$F_{U_1L_1} = FBR_1$

$F_{U_4L_4} = FBR_2$

U_1L_2

Sec (II)

$\Sigma V = 0$

$\Rightarrow (F_{U_1L_2})_V = V_{12}$

Similarly, $(F_{U_4L_3})_V = V_{3-4}$

Structural Analysis and Design   Date: 24.08.2015

Page No.: 264 (Shedd & Vawter)

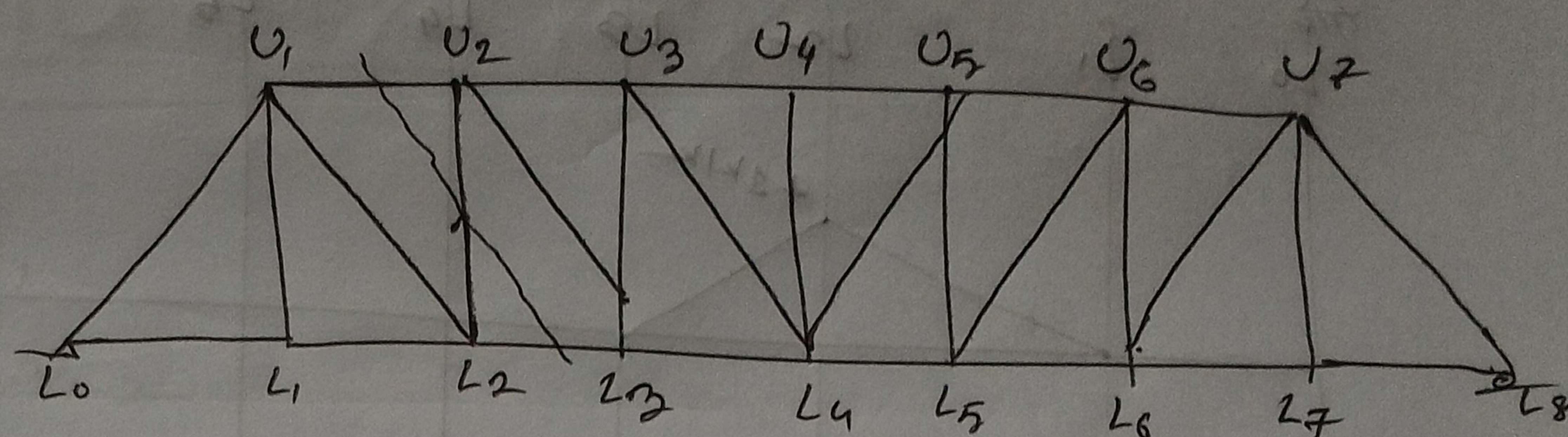
$U_3U_4 \rightarrow M_4$

$L_3L_4 \rightarrow M_3$

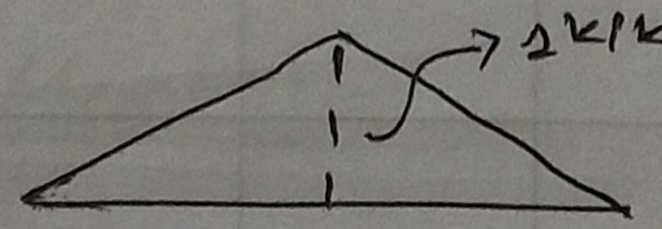
$U_3L_4 \rightarrow V_{3-4}$

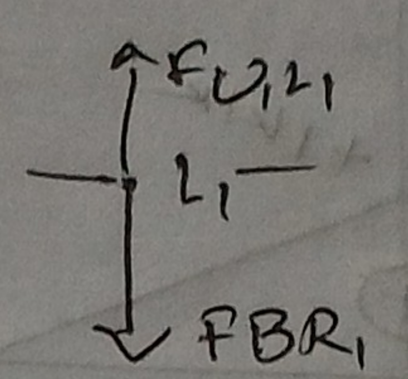
$U_2L_2 \rightarrow V_{2-2}$

$U_1L_1 \rightarrow FBR_1$



For U_1L_1:





U_3U_4: Taking Moment at L_4

So Like M_4

L_3L_4: Taking Moment at U_3

So Like M_3

U_3L_4: $\Sigma V_{3-4} = 0$

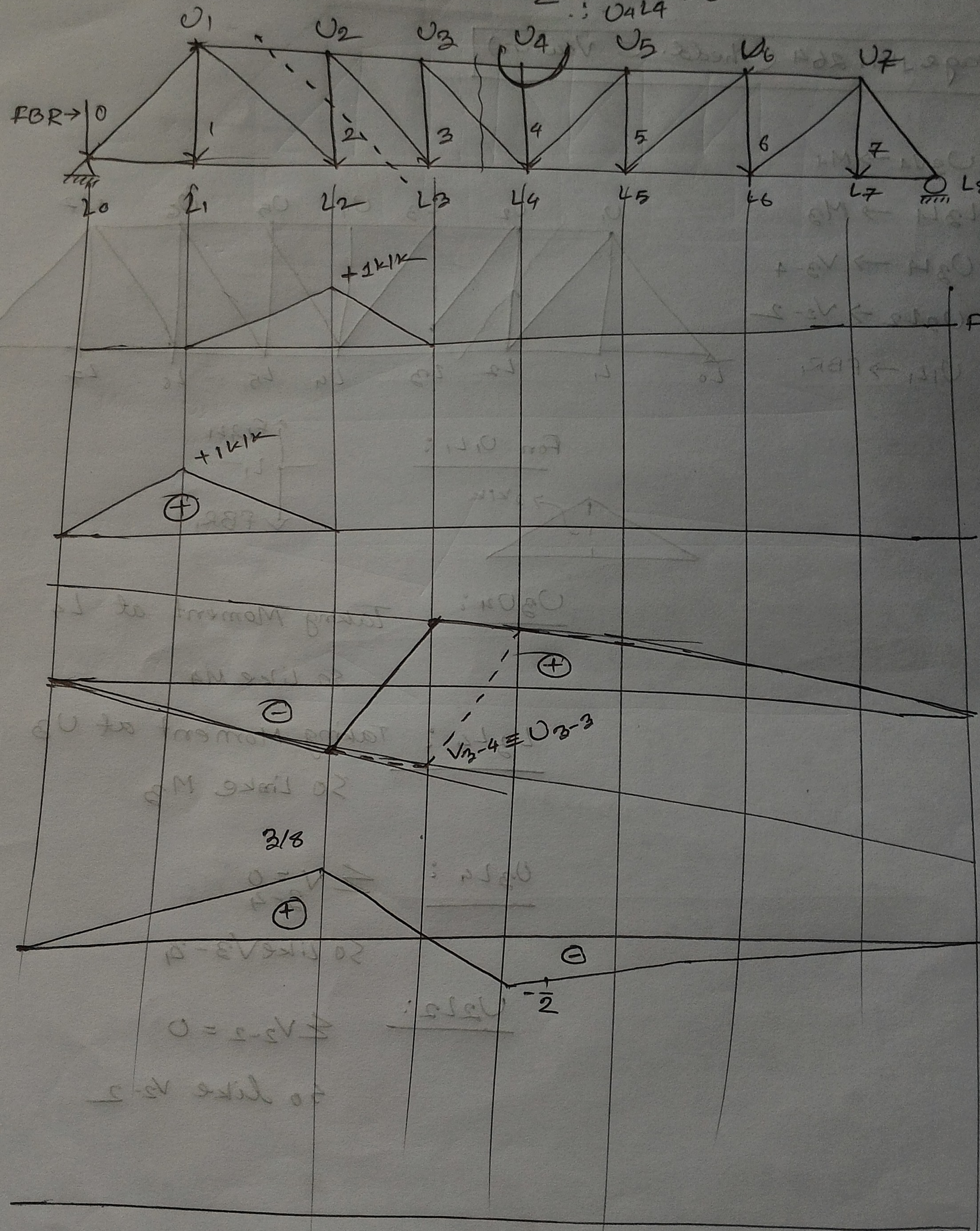
So Like V_{3-4}

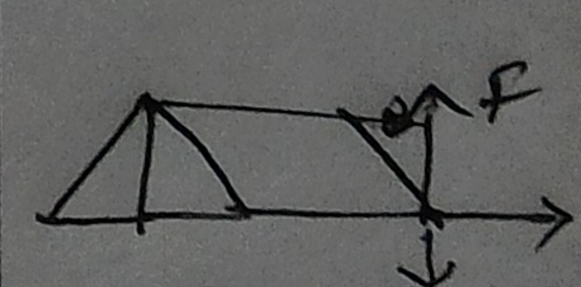
U_2L_2: $\Sigma V_{2-2} = 0$

So like V_{2-2}

$\Sigma V = 0$

$\therefore U_4L_4 = 0$





$\Sigma V = 0$

$\Rightarrow -1 + \frac{5}{8} + f = 0$

$\therefore f = +\frac{3}{8}k$

$U_3L_4 \equiv V_{3-4}$

Inclined web

U_3L_4 By sec 3-4 & $\Sigma V=0$

so, $IL(U_3L_4)_v \equiv V_{3-4}$

$U_1L_0 = V_{0-1}$

~~V_1~~ $U_1L_2 = V_{1-2}$

$U_2L_3 = V_{2-3}$

- I Line for Truss Member:-

T.C. Member

$U_1U_2 \equiv$ By vertical section through 1-2 & $\Sigma M_2 = 0$

$\equiv M_2$

$U_2U_3 \equiv M_3$

$U_3U_4 \equiv M_4$

$U_4U_5 \equiv M_4$

Lower Chord:

$L_0L_1 \equiv M_1$

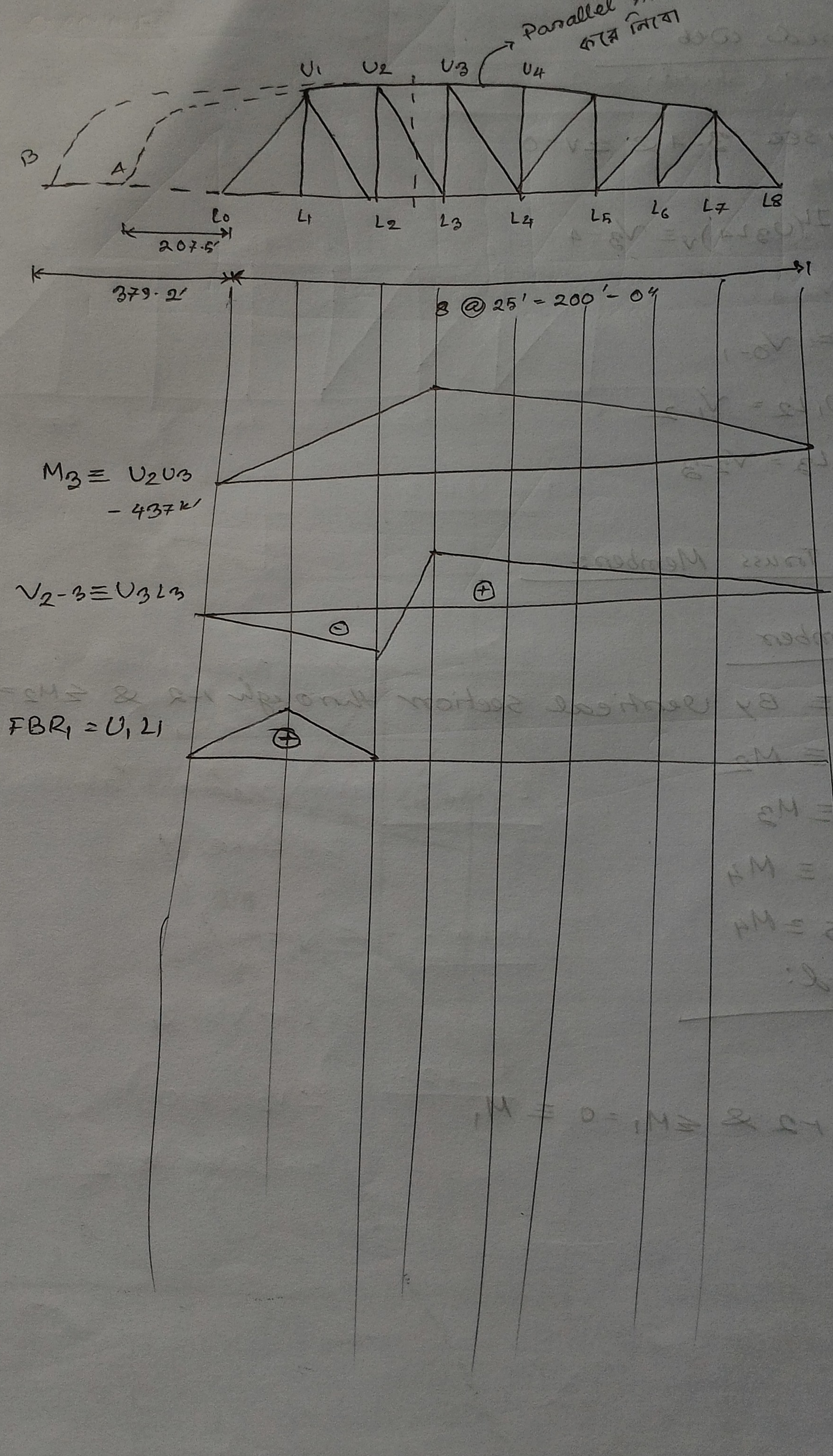
$L_1L_2 \equiv$ sec 1-2 & $\Sigma M_1 = 0 \equiv M_1$

$L_2L_3 \equiv M_2$

$L_3L_4 \equiv M_3$

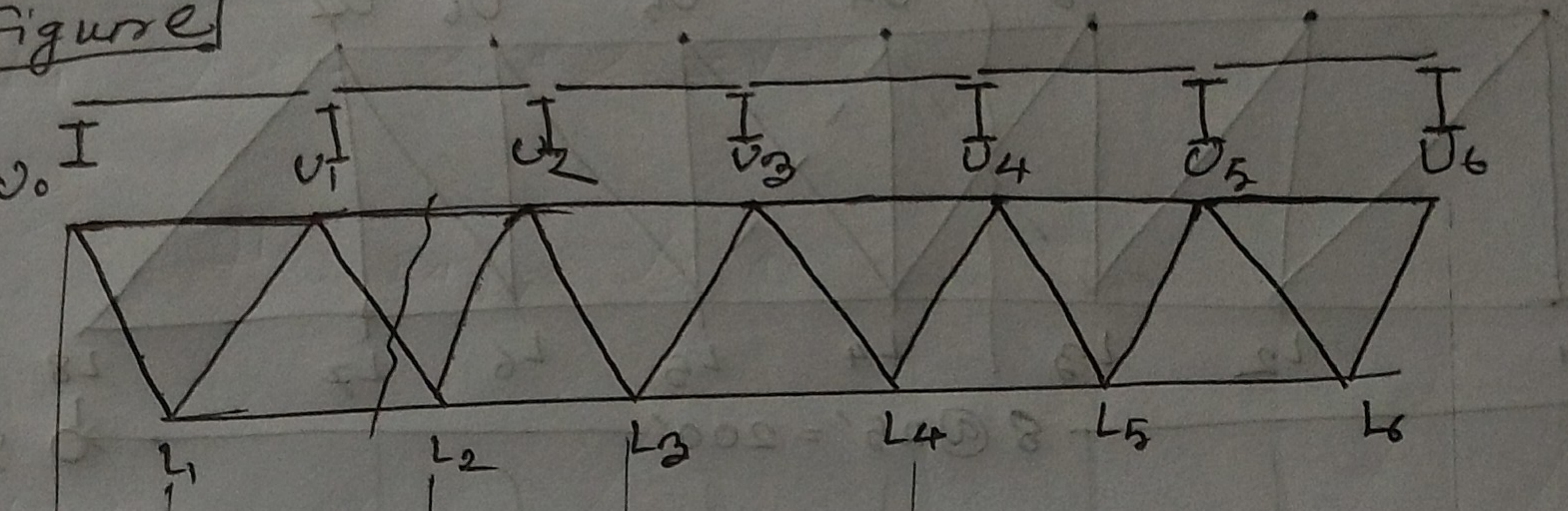
Structural Analysis and Design

Date: 01.06.2015



I-Line - Truss without verticles

[5] figure

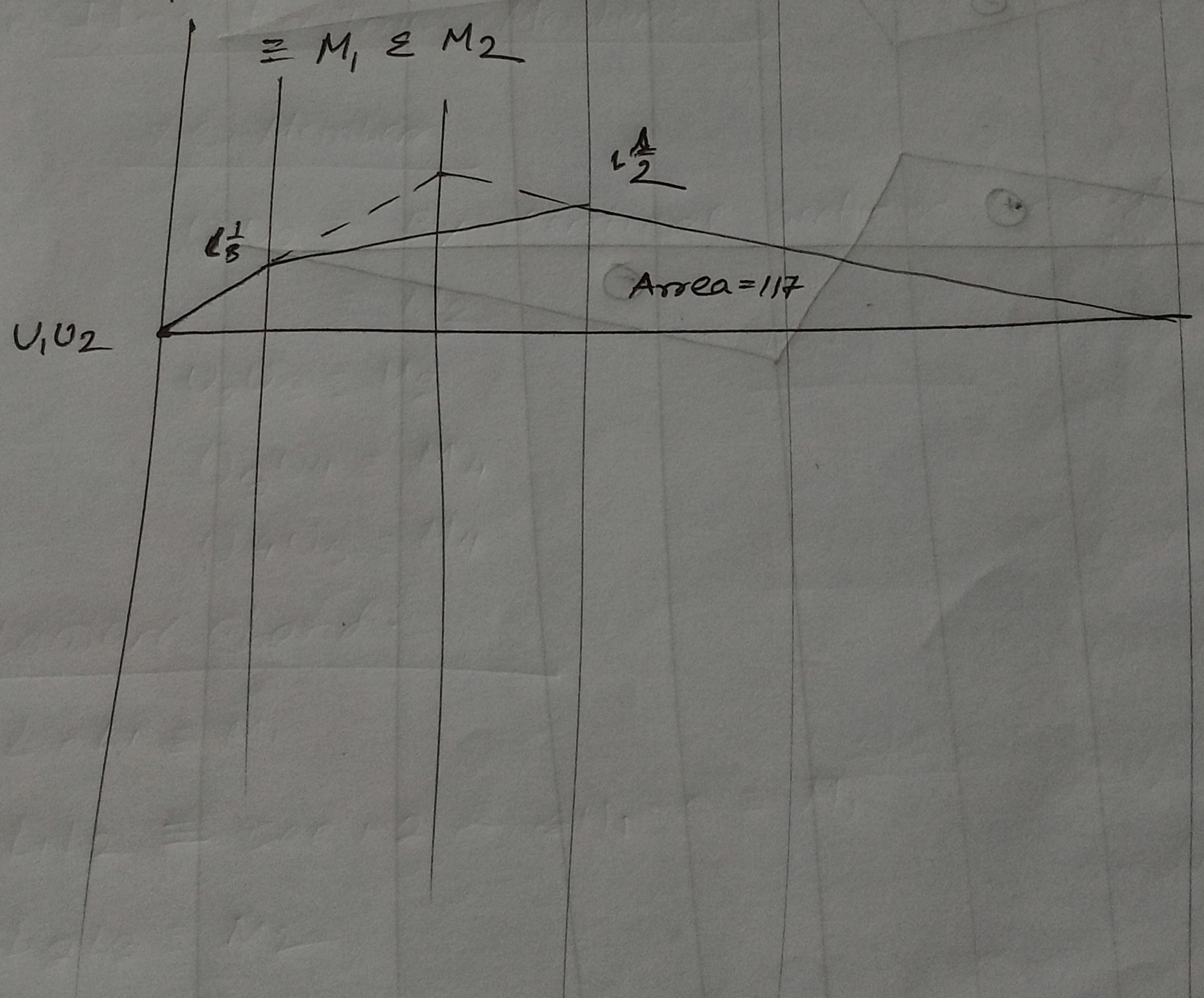


$L_1L_2 \equiv MU_1 \equiv M_1$

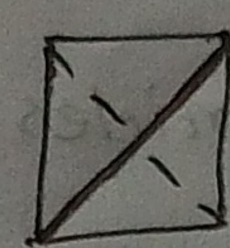
$L_2L_3 \equiv MU_2 \equiv M_2$

$U_1U_2 \equiv M_{L2} \not\equiv M_2$

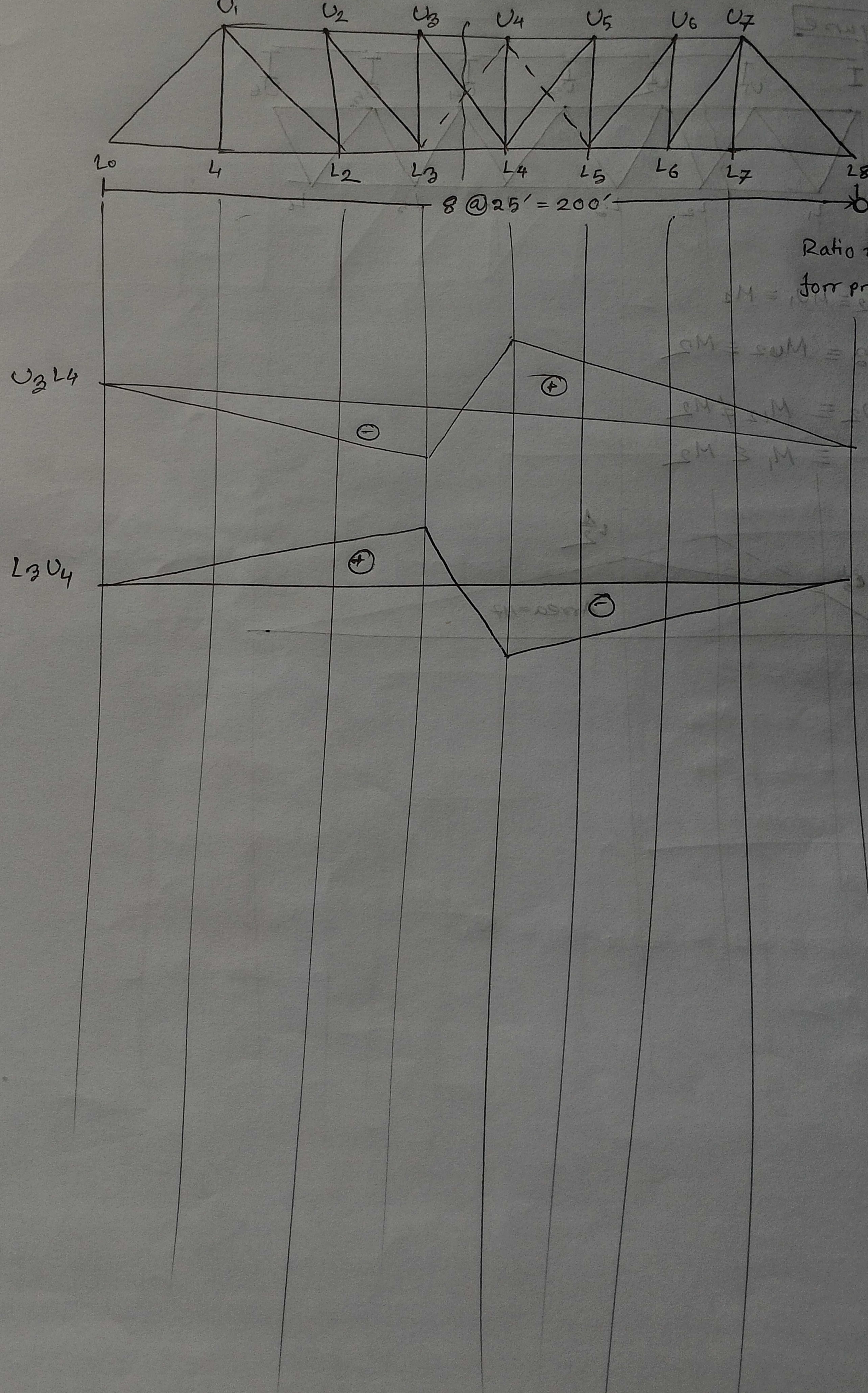
$\equiv M_1$ & M_2



○ COUNTERS:-



Counters



Slanderness Ratio must be below 120 forr primary