2.2 INFLUENCE LINE FOR SHEARING FORCE, BENDING MOMENT AND SUPPORT REACTION COMPONENTS OF PROPPED CANTILEVER

Influence line for bending moment at any point in propped cantilever beam

Let us consider a point ‘C’ at a distance ‘b’ from the propped end. In order to get the influence line for bending moment at ‘C’ by assuming that the beam is simply supported, a hinge is introduced and displacement is provided at ‘CC’ such that unit rotation is produced at ‘C’ The slope are A and B are –b/l and a/l respectively.

The indirect model analysis is based on the Muller Breslau principle.

Muller Breslau principle has lead to a simple method of using models of structures to get the influence lines for force quantities like bending moments, support moments, reactions, internal shears, thrusts, etc.

To get the influence line for any force quantity,

(i) remove the resistant due to the force,

(ii) apply a unit displacement in the direction of the

(iii) plot the resulting displacement diagram. This diagram is the influence line for the force.

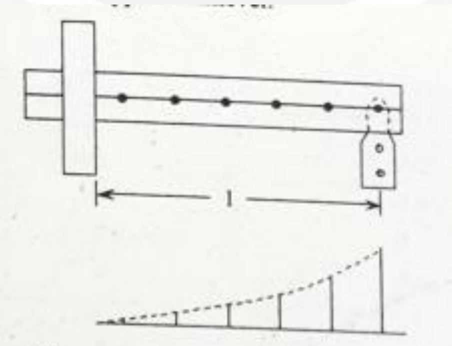

Figure : Model of Propped Cantilever

Fig. 2.2.1 Propped Cantilever

Maximum shear force diagram

Due to a given system of rolling loads the maximum shear force for every section of the girder can be worked out by placing the loads in appropriate positions. When these are plotted for all the sections of the girder, the diagram that we obtain is the maximum shear force diagram. This diagram yields the 'design shear' for each cross section.

Bending moment diagram

Bending moment diagram represents variation of bending moment. Bending moment diagrams are drawn for only bending moments. If span longer than UDL for a maximum BM, the load on left side is equal to the load on right side in case of bending moment diagram.

Location of maximum shear force

In a simple beam with any kind of load, the maximum positive shear force occurs at the left hand support and maximum negative shear force occurs at right hand support.

Influence lines

An influence line is a graph showing, for any given frame or truss, the variation of any force or displacement quantity (such as shear force, bending moment, tension, deflection) for all positions of a moving unit load as it crosses the structure from one end to the other.

Uses of influence line diagrams

(i) Influence lines are very useful in the quick determination of reactions, shear force, bending moment or similar functions at a given section under any given system of moving loads and

(ii) Influence lines are useful in determining the load position to cause maximum value of a given function in a structure on which load positions can vary.

Example:

Draw the influence line for reaction at B and for the support moment MA at A for the propped cantilever as shown in fig, computes the IL ordinate at 1.5 m intervals

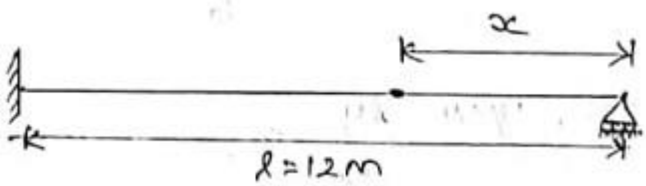

Fig. 2.2.2

Solution :

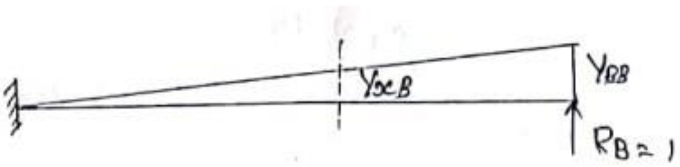

Fig. 2.2.3

when RB = 1

YxB is displacement at x section

due to unit load applied at B

$Mx \quad = EI\, d^2y/dx^2$

$RBx \quad = -EI\, d^2y/dx^2$

$1\, x \quad = -EI\, d^2y/dx^2$

$EI\, d^2y/dx^2 \quad = -x$

Integrating on both sides

$EI\, dy/dx \quad = -x^2/2 + C1$ ______(1)

Again integrating on both sides

$EI\ Y = -x^3/6 + C1x + C2$ ____(2)

Sub at x= 12 dy/dx = 0

$EI\ dy/dx = -x^2/2 + C1$

$0 = -12^2/2 + C\ 1$

$C1 = 72$

sub x=12 Y=0 in 2

$EI\ Y = -x^3/6 + C1x + C2$

$0 = -12^3/6 + (72\times12) + C2$

$C2 = -576$

apply C1 and C2 in 2

$EI\ Y = -x^3/6 + C1x + C2$

$YxB = 1/EI\ [-x^3/6 + 72x - 576]$

At x=0

$YBB = 1/EI\ [-0^3/6 + 72x0 - 576]$

$YBB = -576/EI$

ILO for RB at x

X =YxB/YBB

$=[1/EI\ \ [\ -x^3/6 + 72x - 576]]/(-576/EI\ )$

$=[\ -x^3/6 + 72x - 576]\ /(-576)$

Ordinate of ILD for RB at 1.5m interval

x(m)	0	1.5	3	4.5	6	7.5	9	10.5	12	
RB	1	0.814	0.632	0.463	0.312	0.184	0.085	0.022	0.0	

Table. 2.2.1 Ordinate of ILD for RB

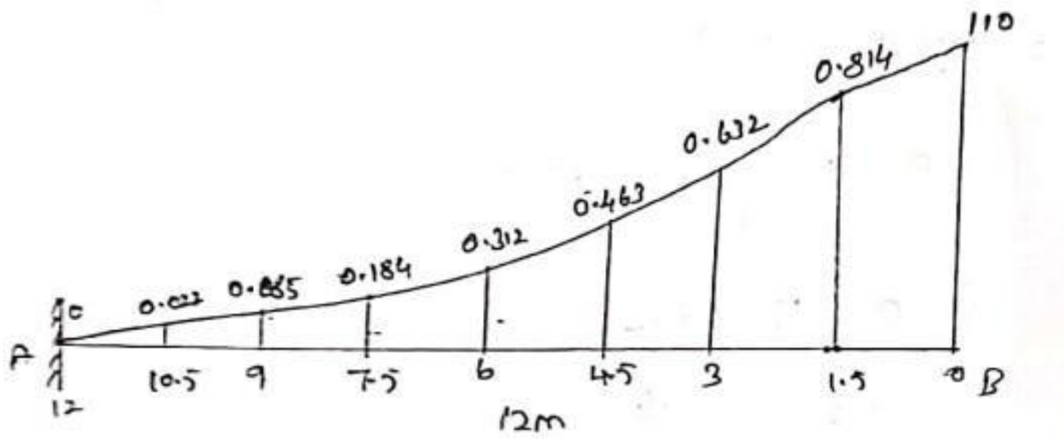

Fig. 2.2.4 ILD for RB

We have to apply a unit rotation at A

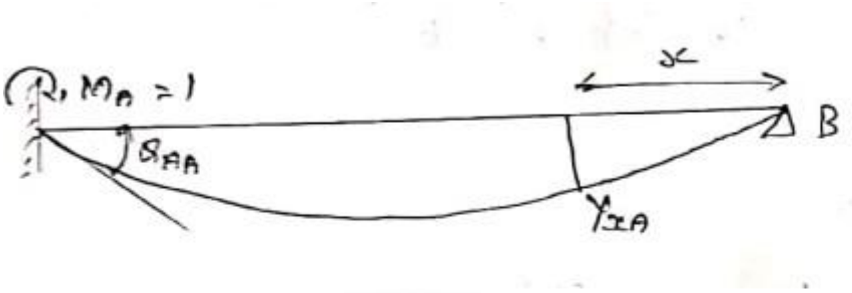

Fig. 2.2.5

$M_A = 1$

$R_B = -R_A = 1/12$

$M_x = -EI\, d^2y/dx^2$

$EI\, d^2y/dx^2 = -X/12$

Integrate on both side

$EI\, dy/dx = -x^2/24 + C1$ ______(1)

Again integrating

$EIY = -x^3/72 + C1x + C2$

At x= 0,y= 0

$EI\, dy/dx = -x^2/24 + C1$

At x=12,y=0

EIY $= -x^3/72 + C1x + C2$

Hence C2= 0, C1 = 2

$Y_{XA} = 1/EI\,[-x^3/72 + 2x]$

$Ø_{AA} = dy/dx$

$= 1/EI\,[-x^2/24 + 2]$

$Ø_{AA}$ at x= 12

$Ø_{AA} = [-12^2/24 + 2]$

$= -4/EI$

when we divide Y_{XA} by $Ø_{AA}$ We get the ILO at X

ILO from MA $= 1/EI\,[-x^2/24 + 2] / -4/EI$

$= [-x^3/72 + 2x] / (-4)$

$= [+x^3/288 - x/2]$

Ordinate of the ILD for MA at 1.5 m

x(m)	0	1.5	3	4.5	6	7.5	9	10.5	12
ILO	0	-0.788	-1.406	-1.934	-2.250	-2.285	-1.069	-1.23	0

Table. 2.2.2 Ordinate of the ILD for MA

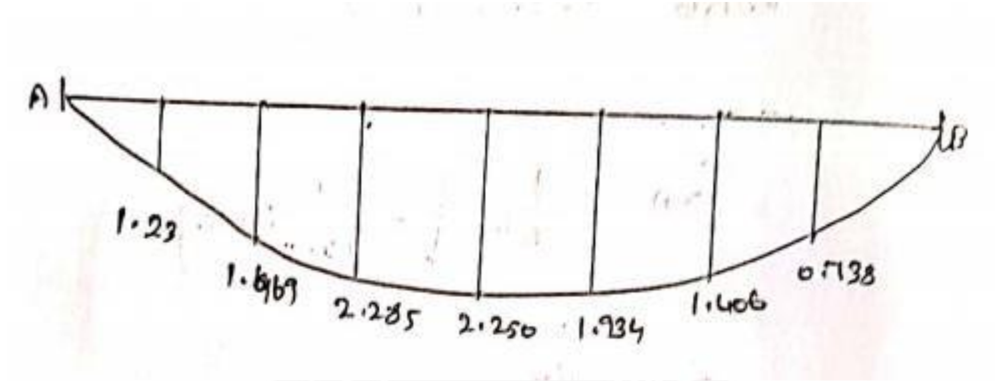

Fig. 2.2.6 Ordinate of the ILD for MA