2 CHAPTER

ILD and Rolling Loads

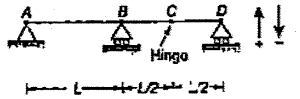
Q.1 The ordinates of influence line diagram for bending moment have dimensions of
(a) length (b) force
(c) length/force (d) none of these

Q.2 A uniformly distributed load longer than the span of a girder moves from left to right. The maximum bending moment at the centre of the span occurs when the uniformly distributed load occupies
(a) whole span of the girder
(b) right half span of the girder
(c) left half span of the girder
(d) none of these

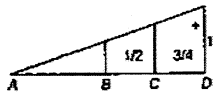
Q.3 A three hinged parabolic arch is carrying a uniformly distributed load over its entire span. Any section of the arch is subjected to
1. Normal thrust
2. Shear force and normal thrust
3. Bending moment

Which of these statements is/are correct?
(a) Only 1 (b) Only 2
(c) Both 1 and 3 (d) None of these

Q.4 For the continuous beam shown in figure, the influence line diagram for support reaction at *D* is best represented as



(a)



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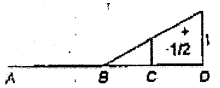
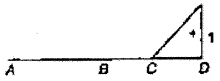


(c)



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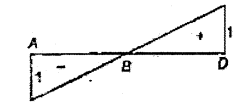
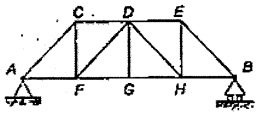
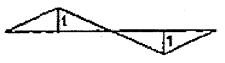


Q.5 Which one of the following diagrams represents the influence line for force in the member *DG*?

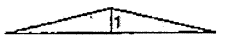


(a)

(b)



(c)

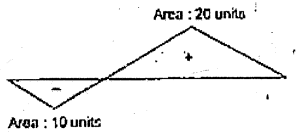


(d)

Q.6 A uniformly distributed live load of 60 kN per metre run of length 5 meters moves on a girder of span 16 metres. What is the maximum positive shear force at a section 6 metres from the left end.
(a) 140.625 kN (b) 65.625 kN
(c) 90.625 kN (d) 45.625 kN

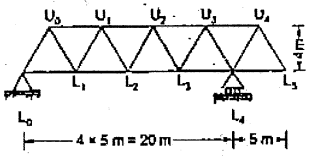
Q.7 The wheel loads 200 kN and 80 kN spaced 2 meter apart move on a girder of span 16 metres. What is the maximum bending moment that will occur at a section 6 metres from the left end?
(a) 990 kNm (b) 1020 kNm
(c) 900 kNm (d) 1000 kNm

Q.8 Influence line diagram for a truss member is shown in the figure.

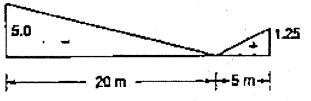


Positive values indicate tension. Dead load of the truss is 20 kN/m and the live load is 10 kN/m. Live load is longer than the span. Maximum tensile force in the member is:
(a) 600 kN (b) 400 kN
(c) 300 kN (d) 200 kN

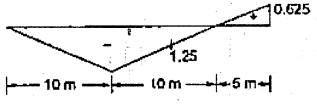
Q.9 A Warren truss is supported as shown in the given figure. Which one of the following diagrams represents the influence line for the force in member U_3U_4?



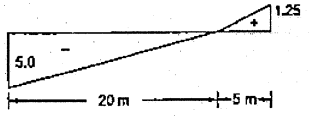
(a)



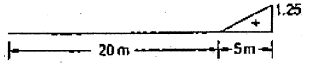
(b)



(c)

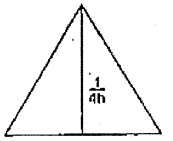


(d)

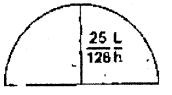


Q.10 The influence line for horizontal thrust of a two-hinged parabolic arch of span '*l*' and rise '*h*' will be as shown in

(a)



(b)



(c)

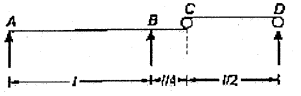
(d) None of the above

Q.11 Three wheel loads 10*t*, 26*t* and 24*t* spaced 2 m apart roll on a girder from left to right with the 10*t* load leading. The girder has a span of 20 meter. For the condition of maximum bending moment at a section 8 meter from the left end,
(a) the 10*t* load should be placed at the section.
(b) the 26*t* load should be placed at the section.
(c) the 24*t* load should be placed at the section.
(d) either the 26*t* load or the 24*t* load should be placed at the section.

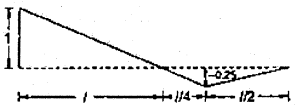
Q.12 The Muller-Breslau principle can be used to
1. determine the shape of the influence line
2. indicate the parts of the structure to be loaded to obtain the maximum effect
3. calculate the ordinates of the influence lines

Which of the these statement is/are correct?
(a) only 1 (b) both 1 and 2
(c) both 2 and 3 (d) 1, 2 and 3

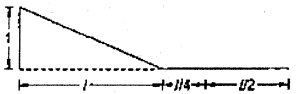
Q.13 A beam with a cantilevered arm *BC* supporting a freely supported end span *CD* is shown in the figure. Which one of the figure represents the influence line diagram for shear force at *A*



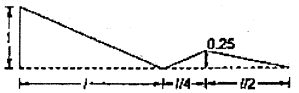
(a)



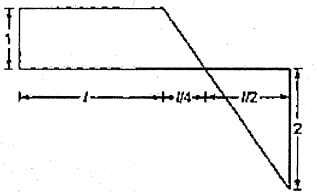
(b)



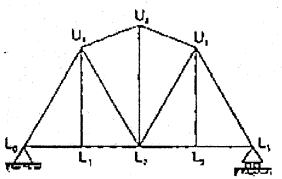
(c)



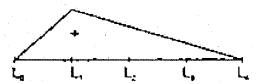
(d)



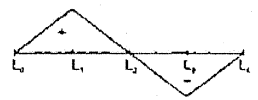
Q.14 Which one of the following is the influence line for the force in the member U_1L_2 of the plane pin-jointed frame shown in the figure given below?



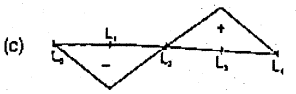
(a)



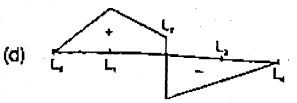
(b)



(c)



(d)



Q.15 The maximum bending moment when a train of point loads crossing a simply supported beam occurs when the load is

(a) at one third span
(b) at mid span
(c) the point load under consideration and the C.G. of train of point loads is equidistant from the mid span
(d) at one quarter span

Q.16 Which of the following statements are CORRECT?

1. Muller-Breslau principle enables the determination of influence line experimentally as well.
2. Influence line of deflection at any point in statically determinate beam is linear
3. The moment distribution, slope displacement and matrix methods can be applied to compute the ordinates of influence line diagram at the required locations.
4. Influence lines cannot be drawn with the help of virtual displacements by making use of the principle of virtual work.

Select the correct answer using the codes given below

(a) 2 and 3 (b) 1 and 3
(c) 1 and 4 (d) 2 and 4

Q.17 Assertion (A): Influence line diagram for S.F. at the fixed end of a cantilever and SFD due to unit load at the free end are same.
Reason (R): ILD for BM at the fixed end of a cantilever and BMD due to unit load at the free end are same.

(a) Both Assertion (A) and Reason (R) are individually true and Reason (R) is the correct explanation of Assertion (A).
(b) Both Assertion (A) and Reason (R) are individually true but Reason (R) is NOT the correct explanation of Assertion (A).
(c) Assertion (A) is true but Reason (R) is false.
(d) Assertion (A) is false but Reason (R) is true.

Q.18 What is the area of influence line diagram for the reaction at the hinged end of a uniform propped cantilever beam of span L?

(a) $\frac{L}{8}$ (b) $\frac{L}{2}$
(c) $\frac{L}{4}$ (d) $\frac{3L}{8}$

Q.19 Consider the following statements and find the correct statement(s) regarding the use of influence lines.

1. To study the effect of moving loads on the structure.
2. To calculate the value of stress function with the critical load condition.
3. To find the position of live load for the maximum value of a particular stress function.

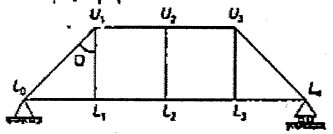
(a) 1, 2 and 3 (b) 1 and 2
(c) 1 and 3 (d) 1 only

Q.20 Four wheel loads 3 kN, 4 kN, 5 kN, 6 kN spaced 2 m, 3 m, 3 m apart are moving on a simply supported beam of span 24 m with 3 kN load leading from left to right. To find maximum. BM at 18 m from left support, the load that must be placed at the section is

(a) 3 kN (b) 4 kN
(c) 5 kN (d) 6 kN

Q.21 Consider the following statements:
For the N-girder shown in the given figure, ILD for force in the member L_0U_1 is obtained by

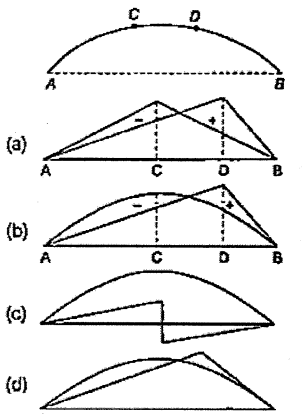
1. multiplying the ordinate of ILD for shear in the panel L_0L_1 by sec θ.
2. dividing the ordinate of ILD for moment at L_1 by L_0L_1.cos θ.
3. dividing the ordinate of ILD for moment at L_1 by L_1U_1



Of these statements,

(a) only 3 is correct
(b) 1 and 3 are correct
(c) 1 and 2 are correct
(d) 1, 2 and 3 are correct

Q.22 Shape of influence line diagram for bending moment at D in a symmetrical two hinged arch as shown below is

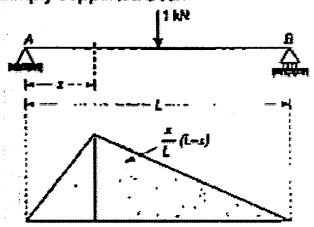


Answers **ILD and Rolling Loads**

1. (a)	2. (a)	3. (a)	4. (c)	5. (d)	6. (a)	7. (a)	8. (b)	9. (d)	10. (b)
11. (b)	12. (d)	13. (a)	14. (b)	15. (c)	16. (b)	17. (c)	18. (d)	19. (a)	20. (b)
21. (c)	22. (b)								

1. (a)

Simply Supported Beam



$$M_x = \frac{x}{L}\times[L-x]$$

So dimensions of M_x is length

3. (a)

Three hinged parabolic arch having UDL on entire span carries zero moment at any section. Hence rate of change of BM is also zero i.e. SF is also zero. Thus it is only designed for normal thrust.

4. (c)

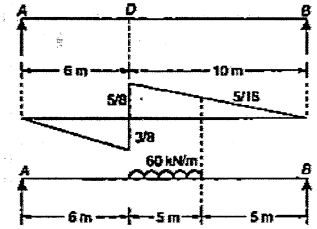
The ILD for support reaction at D can be obtained by giving unit displacement in the direction of reaction. The deflected shape of beam will represent ILD as in figure (c)

5. (d)

Member DG will develop tensile force only when the load is on span FG and GH. The maximum force in the member is induced when the load is at G. Thus ILD is given by figure (d).

6. (a)

We must first draw the influence line diagram for the SF at the section-D.



For maximum positive SF at D, the loading should be applied as shown in the figure.

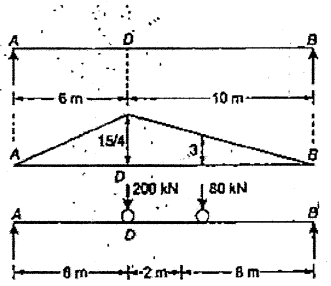
Maximum positive = load x area of ILD covered by load.

SF at D

$$= 60\times\frac{5}{2}\left(\frac{5}{8}+\frac{5}{16}\right)\text{kN}$$

$$= \frac{1125}{8}\text{kN} = 140.625\text{ kN}$$

7. (a)



Ordinate of ILD = $\frac{6\times10}{16} = \frac{15}{4}$ units

By seeing the ILD, it is clear that for the BM at D to be maximum the heavier load i.e., the 200 kN load should be placed at D. The other load i.e., the 80 kN load should be placed at 2 m on the right side of D.

∴ Maximum BM at D

$$= 200\times\frac{15}{4} + 80\times3$$

$$= 990\text{ kNm}$$

8. (b)

Tensile force due to D.L.

$= (20 - 10)\times20 = 200$ kN

Maximum Tensile force due to L.L.

$= 20\times10 = 200$ kN

Thus maximum tensile force

$= 200 + 200 = 400$ kN

9. (d)

Introduce a cut through U_3U_4, U_3L_4 and L_3L_4. The member forces of L_3L_4 and U_3L_4 pass through support at L_4. So when load is at L_0, L_1, L_2, L_3 and L_4, the total moment of all the force except force in U_3U_4 on the right part of cut section is zero. So from moment equilibrium the force in U_3U_4 will remain zero when load is between L_0 and L_4. When load is at L_5, the force in member U_3U_4

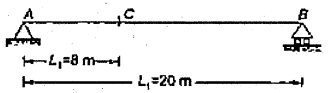
$$= \frac{L\times5}{4} = 1.25$$

10. (b)

Figure (a) is the ILD of horizontal thrust for three hinged arch.

11. (b)

Maximum bending moment at a section occurs when a particular load is on the section which changes the ratio $R_1/L_1 > R/L$ to $R_1/L_1 < R/L$ as the load passes over the section.



where R_1 is the resultant of load on left side of section.

Resultant of all loads (R)

$= 10 + 26 + 24 = 60t$

$$\frac{R}{L} = \frac{60}{20} = 3t/\text{m}$$

When 10t load crosses section C.

$R_1 = 26 + 24 = 50t$

$$\frac{R_1}{L_1} = \frac{50}{8} = 6.25\ t/\text{m} > R/L$$

When 26t load crosses the section C

$R_1 = 24t$

$$\frac{R_1}{L_1} = \frac{24}{8} = 3\ t/\text{m} = R/L$$

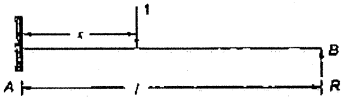
It means that maximum bending moment is obtained when 26 t load is on the section.

15. (c)

Absolute maximum bending moment occurs when position of load train is such that centre of span is mid way between C.G of load system and load under consideration.

18. (d)

Propped Cantilever beam



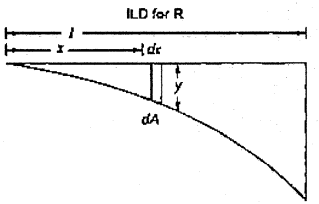
Let unit load at distance x from support A moves from A to B.

Let R be reaction when unit load is at x distance from A.

Using compatibility at support B;

$$\frac{x^3}{3EI} + \frac{x^2}{2EI}(l-x) = \frac{Rl^3}{3EI}$$

$$\Rightarrow \frac{3}{l^3}\left[\frac{x^3}{3} + \frac{lx^2}{2} - \frac{x^3}{2}\right] = R \Rightarrow y$$



Let A be area of ILD for A. Consider an element dx at distance x from A.

$\therefore \quad dA = ydx$

Integrating both sides; we get

$$\int dA = \int ydx = \frac{3}{l^3}\int_0^l\left(\frac{x^3}{3} + \frac{lx^2}{2} - \frac{x^3}{2}\right)dx$$

$$\Rightarrow \frac{3}{l^3}\left[\frac{x^4}{12} + \frac{lx^3}{6} - \frac{x^4}{8}\right] = \frac{3}{l^3}\left[\frac{l^4}{12} + \frac{l^4}{6} - \frac{l^4}{8}\right]$$

$$= 3l\left[\frac{2+4-3}{24}\right]$$

$$A \Rightarrow \frac{3l}{8}$$

20. (b)

	Avg. load on AC	Avg. load on BC
(i) When all loads on AC	$\frac{6+5+4+3}{18} = 1$	0
(ii) When 3 kN crosses section	$\frac{6+5+4}{18} = \frac{15}{18}$	$> \frac{3}{6}$
(iii) When 4 kN crosses section	$\frac{6+5}{18} = \frac{11}{18}$	$< \frac{4+3}{6} = \frac{7}{6}$

21. (c)

The shear in panel will be balanced by vertical component of force in L_0U

$\therefore$ $F\cos\theta$ = Shear

$\Rightarrow$ F = Shear $\times \sec\theta$

Moment at L_1 can be divided by the perpendicular distance at member L_0U_1 to get ILD at for shear force in L_0U_1.

$\therefore$ Ordinate of ILD = $\frac{M_{L_1}}{L_0L_1\cos\theta}$

22. (b)

For two hinged arch, the bending moment influence line due to horizontal thrust will be non-linear and beam bending moment influence line will be linear.

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