8
CHAPTER

Plate Girder

Q.1 In case of web crippling, the dispersion of load from bearing plate takes place at
(a) 30° (b) 60°
(c) 45° (d) 10°

Q.2 As per IS : 800, in case of a plate girder with vertical and horizontal stiffeners, the greater and lesser unsupported clear dimension of a web panel in terms of web thickness 't_w' should be
(a) 180 t_w and 85 t_w
(b) 270 t_w and 220 t_w
(c) 270 t_w and 180 t_w
(d) 400 t_w and 250 t_w

Q.3 Effective flange area in tension of a plate girder is equal to
(a) A_f (b) $A_f + \frac{Aw}{2}$
(c) $A_f + \frac{Aw}{8}$ (d) $A_f + \frac{Aw}{6}$

Q.4 Economical depth of a plate girder corresponds to
(a) Minimum weight
(b) Minimum depth
(c) Maximum weight
(d) Minimum thickness of web

Q.5 Minimum thickness of web in plate girder, when plate is accessible and also exposed to weather, is
(a) 5 mm (b) 6 mm
(c) 8 mm (d) 10 mm

Q.6 Web crippling due to excessive bearing stress can be avoided by
(a) increasing web thickness
(b) providing suitable stiffeners
(c) increasing the length of bearing plates
(d) none of these

Q.7 As per IS : 800, for compression flange, the outstand of flange plates should not exceed
(a) 12t (b) 16t
(c) 20t (d) 25t

Q.8 Forces acting on the web splice of a plate girder are
(a) axial forces
(b) shear and axial forces
(c) shear and bending forces
(d) axial and bending forces

Q.9 Rivets connecting flange angles to cover plates in a plate girder are subjected to
(a) horizontal shear only
(b) vertical shear only
(c) both (a) and (b)
(d) none of these

Q.10 Intermediate vertical stiffeners are provided in plate girders to
(a) eliminate web buckling
(b) eliminate local buckling
(c) transfer concentrated loads
(d) prevent excessive deflection

Q.11 The thickness of web for unstiffened plate girder with clear distance 'd' between the flanges shall not be less than
(a) $\frac{d}{200}$ (b) $\frac{d}{85}$
(c) $\frac{d}{100}$ (d) $\frac{d}{160}$

Q.12 In a plate girder, web plate is connected to the flange plates by fillet welding. The size of the fillet weld is designed to safely resist
(a) bending stresses in the flanges
(b) vertical shear force at the section
(c) horizontal shear force between the flanges and the web plate
(d) forces causing buckling in the web

Q.13 In plate girders
(a) a large number of cover plates are provided over flange angles so that curtailed flanges matches the bending moment diagram exactly
(b) atleast one cover plate should extend over the entire span so that rain water may not enter and corrode the connections
(c) a minimum of one third of flange area should be provided in flange angles and balance in flange cover plates for stability
(d) All of these

Q.14 A steel welded plate girder is subjected to a maximum bending moment of 150 t-m. If maximum permissible bending stress is 1650 kg/cm^2 and width is 8 mm, then most economical depth of the girder will be
(a) 107 cm (b) 118 cm
(c) 100 cm (d) 80 cm

Q.15 Buckling of web occurs due to
(a) diagonal compression due to shear
(b) longitudinal compression (triangular distribution from the neutral axis) due to bending
(c) vertical compression due to concentrated loads
(d) All of the above

Q.16 The moment of inertia of the pair of vertical stiffeners about the centre line of the web should not be less than
(a) 1.5 d^3t^2/C (b) 1.5 d^2t^3/C
(c) 1.5 d^3t^3/C^2 (d) 1.5 d^2t^4/C^3
where, 't' is the minimum required thickness of the web and 'C' is the maximum permitted clear distance between vertical stiffener for thickness 't'.

Q.17 Consider the following statements in respect of design of web and flange splices:
1. Flange splice shall be designed for actual BM at the section.
2. Flange splice shall be designed to resist the actual shear at the section.
3. Web splice shall be designed to resist the actual shear at the section.
4. Web splice shall be designed for actual BM.
Which of these statements are correct?
(a) 1 and 3 (b) 1 and 4
(c) 2 and 4 (d) 1, 3 and 4

Q.18 Consider the following statements with reference to plate girder when horizontal stiffeners are used in addition to vertical stiffeners:
1. One horizontal stiffener shall be placed on the web at a distance from the compression flange equal to 2/5 of the distance of NA from the compression flange.
2. Horizontal stiffeners should not be provided in pairs.
3. Second horizontal stiffener shall be placed at the neutral axis of the girder.
Which of these statements are correct?
(a) Both 2 and 3 (b) Both 1 and 3
(c) Both 1 and 2 (d) 1, 2 and 3

Q.19 Bearing stiffeners are provided at
1. the mid span
2. where maximum bending moment occurs
3. the support
4. the point of application of concentrated load
Which of these statements are correct?
(a) Both 3 and 4 (b) Both 1 and 4
(c) 1, 2 and 4 (d) 1, 2, 3 and 4

Q.20 Web splices are of following types:
1. Rational splice
2. Shear splice
3. Moment splice
Which of these statements are correct?
(a) Both 1 and 2 (b) Both 2 and 3
(c) Both 1 and 3 (d) 1, 2 and 3

Q.21 If W and L are the total superimposed load and the span of a plate girder in metres, the approximate self weight (M) of the girder, is taken as
(a) $M = \frac{WL}{100}$ (b) $M = \frac{WL}{200}$
(c) $M = \frac{WL}{300}$ (d) $M = \frac{WL}{400}$

Q.22 Length of an outstanding leg of a vertical stiffener, may be taken equal to
(a) 1/15th of clear depth of the girder plus 15 mm
(b) 1/20th of clear depth of the girder plus 20 mm
(c) 1/15th of clear depth of the girder plus 25 mm
(d) 1/30th of clear depth of the girder plus 50 mm

Q.23 According to IS 800 : 1984, the minimum thickness of a vertically stiffened web plate, shall not be less than
(a) $\frac{d}{85}$ (b) $\frac{d}{200}$
(c) $\frac{d}{225}$ (d) $\frac{d}{250}$

Q.24 If d is the distance between the flange angles, the vertical stiffeners in plate girders are spaced not greater than
(a) d (b) $1.25\,d$
(c) $1.5\,d$ (d) $1.75\,d$

Q.25 If R is the reaction on the bearing plate, the minimum moment of inertia of the bearing stiffener provided at the support of a plate girder of overall depth D, maximum thickness of the compression flange T, carrying total load W, is
(a) $\frac{D^2T}{250} \times \frac{R}{W}$ (b) $\frac{D^3T}{250} \times \frac{R}{W}$
(c) $\frac{DT}{250} \times \frac{R}{W}$ (d) $\frac{DT}{250} \times \frac{W}{R}$

Q.26 A symmetrical plate girder has been fabricated with three equal plates. If a circular hole of diameter equal to half of its height is centrally cut in the web, then what is the approximate ratio of the strength of this punctured girder to that of the original girder?
(a) 93% (b) 85%
(c) 75% (d) 56%

Q.27 At a section along the span of a welded plate girder, where the web is spliced, the bending moment is M. If the girder has top flange, web and bottom flange plates of equal area, then the share of the bending moment which would be taken by the splice plates would be
(a) M (b) $M/3$
(c) $M/7$ (d) $M/13$

Q.28 According to the Indian Railways Code, in respect of steel girders of single track for Metre/Broad Gauge, the impact factor for a span of 6 m is
(a) 0.5 (b) 0.82
(c) 1 (d) 1.25

Directions: The following items consists of two statements; one labelled as 'Assertion (A)' and the other as 'Reason (R)'. You are to examine these two statements carefully and select the answers to these items using the codes given below:
Codes:
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.29 Assertion (A) : In a plate girder of uniform cross-section, intermediate vertical stiffeners are provided at closer spacing in the middle rather than at the supports.
Reason (R) : Intermediate vertical stiffeners are provided to prevent the web from buckling under a complex and variable stress situation resulting from combined action of shear force and bending moment.

Q.30 Assertion (A) : The flange area method of design of plate girders is an approximate method.
Reason (R) : Bending stresses in compression and tension flanges are assumed to be linearly distributed.

Q.31 The depth of plate girder for long span is usually
(a) 1/6 of span (b) 1/7 of span
(c) 1/8 of span (d) 1/10 of span

Q.32 When vertical intermediate stiffeners are subjected to bending moments due to eccentricity of vertical loads, their moment of inertia (in cm^4) is increased by
(a) $\frac{125MD^2}{EI}$ (b) $\frac{150MD^2}{EI}$
(c) $\frac{175MD^2}{EI}$ (d) $\frac{225MD^2}{EI}$
Where,
M = the applied bending moment in kN-m
D = overall depth of girder in mm
E = Young's modulus in MPa
I = thickness of web in mm

Q.33 For a welded plate girder with vertical stiffeners, what is the maximum depth of web provisionable in design when the thickness of the web plate is 5 mm?
(a) 425 mm (b) 1000 mm
(c) 1250 mm (d) 2000 mm

Q.34 Minimum spacing of vertical stiffeners is limited to
(a) $d/4$ (b) $d/3$
(c) $d/2$ (d) $2d/3$
where d is the distance between flange angles.

Q.35 Which one of the following is correct?
An intermediate vertical stiffener connected to the web is designed to withstand a shearing force of not less than
(a) $\frac{100t}{h}$ (b) $\frac{150t^2}{h}$
(c) $\frac{125h}{t^2}$ (d) $\frac{125t^2}{h}$
where t is web thickness in mm and h is the outstand of stiffener in mm.

Q.36 Shear buckling of web in plate girder is prevented by using
(a) intermediate vertical stiffner
(b) horizontal stiffner
(c) bearing stiffner
(d) none of the above

Q.37 Horizontal stiffner in a plate girder is provided to safeguard against
(a) shear buckling of web plate
(b) compression buckling of web plate
(c) yielding
(d) all of the above

Q.38 The angle of dispersion of a concentrated load on the flange to the web plate of a steel beam is
(a) 90° with the horizontal
(b) 60° with the vertical
(c) 45° with the horizontal
(d) 30° with the vertical

Q.39 The allowable shear stress in stiffened webs of mild steel beams decreases with
(a) decrease in the spacing of the stiffners
(b) increase in the spacing of the stiffners
(c) decrease in effective depth
(d) increase in effective depth

Q.40 Consider the following statements:
Horizontal stiffener is provided when
1. The depth of web is small.
2. Tendency of web buckling is less.
3. Vertical stiffeners become too close.
4. Only thin plates are available for web.
Which of these statements are correct?
(a) 1 and 2 (b) 3 and 4
(c) 1, 2 and 4 (d) 1, 3 and 4

Q.41 In steel bridges, for span less than 9 m and class AA loading for wheeled vehicles, the impact factor is taken as
(a) 20% (b) 25%
(c) 30% (d) 35%

Q.42 In a plate girder, flange angle should be
(a) Equal angle section
(b) Unequal angle with long leg horizontal
(c) Unequal angle with short leg horizontal
(d) A bulb angle

Q.43 List-I contains some elements in design of a simply supported plate girder and List-II gives some qualitative locations on the girder. Match the items of two lists as per good design practice and relevant codal provisions.
List-I
A. Flange splice
B. Web splice
C. Bearing stiffeners
D. Horizontal stiffener

List-II	Codes:			
1. At supports	A	B	C	D
2. Away from centre of span	(a) 2	3	1	5
3. Away from support	(b) 4	2	1	3
4. In the middle of span	(c) 3	4	2	1
5. Longitudinally somewhere in the compression flange	(d) 1	5	2	3

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Answers Plate Girder

1. (a)	2. (c)	3. (c)	4. (a)	5. (c)	6. (c)	7. (b)	8. (c)	9. (a)	10. (a)
11. (b)	12. (c)	13. (d)	14. (b)	15. (d)	16. (c)	17. (a)	18. (b)	19. (a)	20. (d)
21. (c)	22. (c)	23. (b)	24. (c)	25. (b)	26. (b)	27. (c)	28. (b)	29. (d)	30. (c)
31. (c)	32. (b)	33. (b)	34. (b)	35. (d)	36. (a)	37. (b)	38. (b)	39. (b)	40. (b)
41. (b)	42. (b)	43. (a)							

Explanations Plate Girder

2. (c)

The maximum clear dimension of the panels formed by the intermediate stiffness should not be greater than 270 t and the lesser dimension of panel should not be greater than 180 t where t is thickness of the web.

6. (c)

$$\sigma_b = \frac{P}{\left(b+2h\sqrt{3}\right)t}$$

$$\Rightarrow \sigma_b \propto \frac{1}{b(\text{bearing plate length})}$$

7. (b)

For tension flange, it is 20 t.

14. (b)

Most economical depth of the girder is given by

$$d = 1.1\sqrt{\frac{M}{f_b \cdot t_w}}$$

$M = 150\ t.m = 150 \times 10^7 \times 100$ kg-cm

$f_b = 1650$ kg/cm^2

$t_w = 8$ mm $= 0.8$ cm

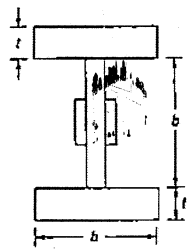
$$\therefore \quad d = 1.1\sqrt{\frac{150\times10^3\times100}{1650\times0.8}}$$

$= 117.26$ cm $\simeq 118$ cm.

18. (b)

The first horizontal stiffener is provided at one fifth of distance from compression flange to the tension flange if required another stiffener is provided at the neutral axis.

27. (c)



Bending moment taken by web,

$$M_w = M \times \frac{I_w}{I}$$

$$I_w = \frac{tb^3}{12}$$

Moment of inertia of whole section,

$$I = \frac{tb^3}{12} + 2bl \times \left(\frac{b}{2}\right)^2$$

Neglecting moment of inertia of flanges.

$$I = \frac{7tb^3}{12}$$

$$\therefore \quad M_w = M \times \frac{\frac{tb^3}{12}}{\frac{7tb^3}{12}} = \frac{M}{7}$$

28. (b)

For broad and metre gauge with single track,

$$\text{impact factor} = 0.15 + \frac{8}{6+L}$$

Subjected to maximum of 1

For, $L = 6$ m

$$\text{Impact factor} = 0.15 + \frac{8}{12}$$

$$= 0.15 + 0.67 = 0.82$$

30. (c)

In the flange area method, the bending stress distribution in the tension and compression flange is assumed to be uniform

$$M = Td_1 = A_f\sigma_{bf}d_1$$

$$\therefore \quad A_f' = \frac{M}{\sigma_{bf}d_1}$$

31. (c)

The depth of plate girder usually varies from 1/8th to 1/12th of its span

33. (b)

Vertical stiffeners are required in a welded plate girders when

$$\frac{d}{t_w} > 85 \text{ and } \frac{d}{t_w} \le 200$$

$$\therefore \quad d_{min} > 85 \times 5 = 425 \text{ mm}$$

$$d_{max} \le 200 \times 5 = 1000 \text{ mm}$$

34. (b)

Vertical stiffeners are provided at the spacing of 0.33 d to 1.5 d where d is the distance between the flanges ignoring fillets and if horizontal stiffeners are also provided d is the maximum clear depth of the web. Spacing can be reduced near the supports where the shear force is large compared to the centre of the girder.

35. (b)

As per clause 6.7.4.6 of IS 800:1984, intermediate horizontal stiffeners not subjected to external loads shall be connected to web by rivets or welds, so as to withstand a shearing force, between each component of the stiffener and the web of not less than

$$\frac{125t^2}{h} \text{ kN/m}$$

38. (b)

As per IS : 800, where a load is directly applied to a top flange, it shall be considered as dispersed uniformly at an angle of 30° to the horizontal, i.e., 60° with the vertical.

42. (b)

Unequal flange angles with long horizontal legs are provided to serve the following purposes:

1. To increase the moment of inertia of the section, and
2. A large length is available for making the connection with the flange plate.

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