ZONE TECH

Best Institute For Assistant & Junior Engineer

# Civil Engineering

## Test - 4

## RSSB (JE) Diploma Test Series - 2024

## Answer key & Detailed Solution

Test ID : 904 | Date:- 13/10/2024

Duration : 80 Minutes | Maximum Marks : 80

1. (a)
2. (b)
3. (b)
4. (c)
5. (d)
6. (b)
7. (a)
8. (b)
9. (b)
10. (b)
11. (c)
12. (b)
13. (a)
14. (d)
15. (a)
16. (c)
17. (b)
18. (b)
19. (c)
20. (a)
21. (a)
22. (b)
23. (b)
24. (c)
25. (b)
26. (d)
27. (a)
28. (d)
29. (d)
30. (a)
31. (a)

Maximum strain in an extreme fibre of concrete = 0.0035

Maximum strain in tension reinforcement (Fe-415 and $E_S$ = 200 kN/mm²) = $\frac{0.87f_y}{E_S} + 0.002$

$$= \frac{0.87 \times 415}{200 \times 10^3} + 0.002$$

$$= 0.0038$$

32. (b)

As per IS 456 : 2000 clause 10.2.2, the accuracy of measuring equipment shall be within ± 2% of quantity of cement being measured & within ± 3% of quantity of aggregate, admixture & water being measured.

33. (d)

| Quantity of Concrete (m³) | Number of Samples |
|---|---|
| 1-5 | 1 |
| 6-15 | 2 |
| 16-30 | 3 |
| 31-50 | 4 |
| 51 & above | 4 + 1 additional sample for each additional 50 m³ or its part |

Hence, for 101 $m^3$ of concrete work

Number of samples = 4 + 1 + 1 = 6

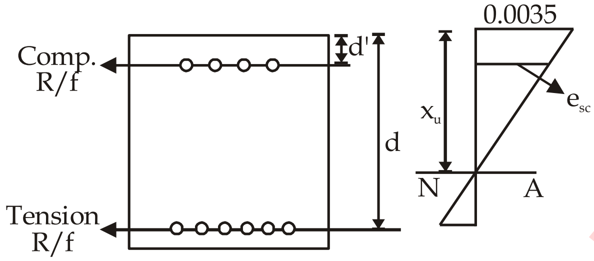
**34. (c)**

As per IS : 456-2000

(i) Clause 26.2.3.1, for curtailment, reinforcement shall extend beyond the point at which it is no longer required to resist flexure for a distance equal to the effective depth of the member or 12 times the bar diameter whichever is greater except at simple supports or ends of cantilever.

(ii) Clause 26.2.3.2, the shear at cut off point does not exceed two-thirds that permitted including the shear strength of web reinforcement provided.

**35. (b)**




$$\frac{0.0035}{x_u} = \frac{e_{sc}}{x_u - d'}$$

$e_{sc}$ = Maximaum strain in concrete at the level of com. R/f

$$e_{sc} = 0.0035\left(1 - \frac{d'}{x_u}\right)$$

**36. (b)**

The target mean strength ($f_t$) is taken as

$$f_t = f_{ck} + 1.65\,\sigma$$

where,

$f_{ck}$ = Characteristic compressive strength
$\sigma$ = Standard deviation

The standard deviation for different grade of concrete as per Clause 9.2.4.2 IS:456-2000.

| Grade of Concrete | Assumed Standard Deviation (N/mm²) |
|---|---|
| M10, M15 | 3.5 |
| M20, M25 | 4.0 |
| M30, M35, M40, M45, M50 | 5.0 |

**37. (d)**

$$\text{Development length } (L_d) = \frac{\phi \sigma_s}{4\tau_{bd}}$$

Where, $\sigma_s$ = Stress in bar at section considered at design load

$\tau_{bd}$ = Design bond stress

$\phi$ = Diameter of bar

**38. (b)**

$$B_f = \frac{lo}{\frac{lo}{b} + 4} + b_w$$

$$\Rightarrow \frac{7000}{\frac{7000}{1500} + 4} + 250$$

$$\Rightarrow 1057.75\,\text{mm.}$$

**39. (d)**

In under-reinforced RCC beam, steel will yield first.

Once steel is yielded, it does not take any additional stress and total force of tension remains constant.

However, compressive stresses in concrete increase with additional strains.

Thus, neutral axis and the centre of gravity of compressive forces further shift upward to maintain equilibrium.

**40. (d)**

The shear reinforcement in RCC is provided to resist diagonal tension. In RCC beam compressive stress is generated above the neutral axis and tensile stress is generated below the neutral axis

**41. (c)**

If norminal shear stress $(\tau_v)$ exceeds design shear strength of concrete $(\tau_c)$, then shear reinforcement is provided as stirrups for shear stress $\tau = \tau_v - \tau_c$

**42. (d)**

Recommended Value

If $\tau_c < 5kg/cm^2$

than 8 legged is used

and for $\tau_c > 5kg/cm^2$

than 12 legged is used

**43. (c)**

Torsion reinforcement shall be provided at any corners in a two-way slab which is simply supported on both edges meeting at the corner.so provided at both top and bottom.

**44. (b)**

It is a horizontal member that is placed across the openings like doors, windows, etc.

It takes the load coming from the superstructure above it and gives support.

While designing the lintels, it is assumed that the load on the lintel is uniformly distributed if the masonry above it is up to a height of 1.25 times the effective span.

**45. (c)**

Reinforced brickwork is the one in which the brick masonry is strengthened by the provision of mild steel flats, hoop iron, expanded mesh or bars. It is adopted or used in the following circumstances.

- When the brickwork has to bear tensile and shear stresses.
- When it is required to increase the longitudinal bond.
- When the brickwork is supported on soil which is susceptible to large settlement.
- When the brickwork is supposed to act as a beam or lintel over openings.
- When the brickwork is to resist lateral loads, such as in retaining walls etc.
- When the brickwork is to carry heavy compressive loads.
- When the brickwork is to be used in seismic areas, since it can also resist lateral loads.

**46. (a)**

Retaining walls are constructed on the valley side of the hill roadway. These walls are constructed in stone masonry, brick masonry, or cement concrete but are usually made of dry stone masonry as it permits easy drainage of seepage water and also it is economical.

The reasons for providing retaining walls at hill roads are:

- It provides adequate stability to the roadway & slope.
- It resists lateral earth pressure

**47. (c)**

**IS 875 (part 1)-1987:** Indian Standard Codes provides design dead loads (Unit weight of building material and stored materials) for buildings and structures.

**IS 875 (part 2)-1987:** Indian Standard Codes provides conservatively imposed loads for buildings and structures.

**IS 875 (part 3)-1987:** Indian Standard Codes provides design wind loads for buildings and structures.

**IS 875 (part 4)-1987:** Indian Standard Codes provides design snow loads for buildings and structures.

**IS 875 (part 5)-1987:** Indian Standard Codes provides design special loads (load combination) for buildings and structures.

**48. (d)**

As per IS 456 : 2000 clause 26.5.2,

- Minimum flexural reinforcement of Fe250 steel in slabs = 0.15% of gross cross-sectional area.
- Minimum flexural reinforcement of Fe415 steel in slabs = 0.12% of gross cross-sectional area.

As per IS 456 : 2000 clause 26.5.1.1,

- Minimum flexural steel reinforcement in beams is as follows

$$\frac{A_{st,min}}{bd} \geq \frac{0.85}{f_y}$$

**49. (c)**

Table - 16, IS 456 : 2000

| Exposure | Minimum nominal cover (mm) |
|---|---|
| Mild | 20 |
| Moderate | 30 |
| Severe | 45 |
| Very severe | 50 |
| Extreme | 75 |

**50. (b)**

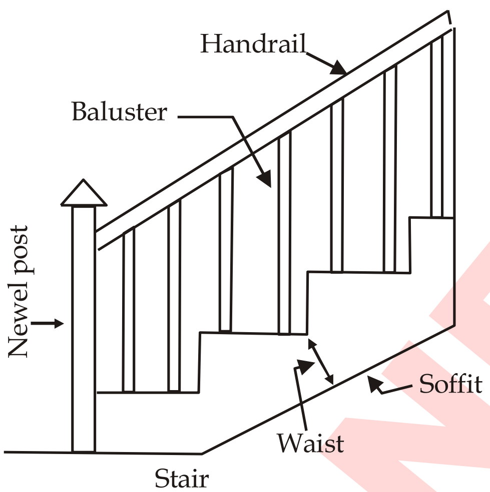
$$\text{design load} = \max^m \begin{cases} 1.5DL + 1.5LL \\ 1.5DL + 1.5SL \\ 1.2DL + 1.2LL + 1.2SL \end{cases}$$

$$\text{design load} = \max^m \begin{cases} 1.5 \times 50 + 1.5 \times 50 \\ 1.5 \times 50 + 1.5 \times 20 \\ 1.2 \times 50 + 1.2 \times 50 + 1.2 \times 20 \end{cases}$$

$$\text{design load} = \max^m \begin{cases} 150\,kNm \\ 105\,kNm \\ 144\,kNm \end{cases}$$

Hence, Design load = 150 kNm

**51. (a)**




**52. (b)**

As per IS456:1978

For longitudinal reinforcement in reinforced concrete, pedestal is defined as a compression member whose effective length does not exceed 3 times the least lateral dimension.

**53. (d)**

As per table-6 of IS 456 : 2000

| Maximum size of Aggregate | Adjustment to minimum cement content (kg/m³) |
|---|---|
| 10 mm | +40 |
| 20 mm | 0 |
| 40 mm | -30 |

Hence, if you are changing maximum size of aggregate from 20 mm to 40 mm, the minimum cement content can be reduced by 30 kg/m$^3$.

**54. (a)**

As per IS 456 : 2000, ANNEX B-5.5.1,

Shear failure at sections of beams and cantilevers without shear r/f will normally occur on plane inclined at an angle 30° to the horizontal.

**55. (b)**

Shrinkage cracks in concrete occur due to change in moisture of concrete.

Concrete and mortar are porous in their structure in the form of inter-molecular space.

They expand when they absorb the moisture and shrink when they dry. This is the main cause of concrete shrinkage cracks on drying.

Also during curing, due to subsequent wetting and drying this shrinkage exceeds and crack is developed in concrete.

In the concrete slab, an increase in temperature will lead to the development of stress and if this stress exceeds its maximum permissible value, then cracks will be developed.

**56. (b)**

Pile foundation is used for isolated or group of columns.

Combined footings are provided when the distance between two columns is small, and bearing capacity of soil is lower, and their footings overlap with each other. When two columns are close together and separate isolated footing would overlap, in such a case, it is better to provide a combined footing than an isolated footing.

Isolated footings, also called Pad or Spread footings, are commonly used in construction for shallow foundations. Their main purpose is to distribute concentrated loads that are generated by columns or pillars.

A raft foundation, also called a mat foundation, is essentially a continuous slab resting on the soil that extends over the entire footprint of the building, thereby supporting the building and transferring its weight to the ground.

**57. (b)**

The moments and the shear forces for a continuous beam and one-way slab can be calculated using moment coefficients and shear force coefficients respectively only when the following conditions are satisfied.

- Continuous spans should be at least three in number.
- Supports should be fairly rigid and should not themselves deflect.
- All the spans should have the same cross sections.
- The effective length of each span should be more or less the same and at any rate, should not differ by more than 15% of the largest effective span.
- The loading on all the spans should be substantially uniformly distributed.
- No redistribution of moments is permitted.

**58. (d)**

Design shear stress $(\tau_c)$ is given as:

$$\tau_c = 0.85\sqrt{0.8f_{ck}}\,\frac{\sqrt{1+5\beta}-1}{6\beta}$$

Where, $\beta = \dfrac{0.8f_{ck}}{6.89P_t}$,

$P_i \rightarrow$ % tensile steel reinforcement

So, $\tau_c$ depends on

1. Grade of concrete
2. % tension reinforcement (Only tension reinforcement, compressive reinforcement need not to be considered)

**59. (c)**

The ratio of limiting depth of neutral axis to the effective depth of the beam is given by

$$\frac{x_u}{d} = \frac{\text{Max strain concrete}}{\dfrac{\text{Grade of steel}}{\text{Modulus elasticity of steel} \times \text{F.O.S}} + 0.002 + \text{Max strain concrete}}$$

**Note:**

We know the standard values of the ratio of limiting depth of neutral axis to the effective depth (k) of the beam for different steel sections as following:

$$x_u = k \times d$$

| Grade of steel | Fe 500 | Fe 415 | Fe 250 |
|---|---|---|---|
| 'k' value | 0.46 | 0.48 | 0.53 |

**60. (c)**

0.04bD-Maximum area of tension reinforcement in beams

$\dfrac{250b^2}{d}$ -Slenderness limit for simply supported or continous beam to ensure lateral stability.

$\dfrac{100b^2}{d}$ -Slenderness limit to ensure lateral stability for cantilever

$\dfrac{k_x l_x}{D_x}$ -Column

**61. (a)**

For continuous T-beams, $b_f = \dfrac{l_0}{6} + b_w + 6D_f$

Where

$b_f$ = Effective width of flange

$l_0$ = Distance between points of zero moments in the beam

$b_w$ = Breadth of web

and $D_f$ = thickness of flange

**62. (d)**

**Critical Sections for shear:**

- While designing a concrete member for flexural shear, the critical section has to be located where the shear force reaches its maximum value, and/or where the area of cross-section is the minimum.
- In Flexural members, maximum shear force generally occurs at the face of the support. (CL. 22.6.2 of IS 456:2000).
- In the case of point loads, shear force is very high at locations between the support and the first concentrated load.
- It is quite evident that support reaction gives rise to traverse compression in the end regions of the concrete member.
- This increases the shear strength of this region (i.e. support region) and the inclined cracks do not develop near the face of the support. In such a case, the critical section is located at a distance 'd' from the support faces (CL. 22.6.2.1 of IS 456:2000).

**63. (b)**

If a beam fails in bond, then its bond strength can be increased most economically by using thinner bars but more in number. The actual contact area of a thinner bar increases as compared to contact area based on nominal or thicker diameter bar. Hence, bond strength increases.

Bond strength increases when,

(i) HYSD bars are used instead of plain bars.
(ii) Higher grade concrete is used.
(iii) Increased length of embedment, hooks or bends are provided.
(iv) Mechanical anchorage are employed.
(v) If more number of smaller diameter bars are used for same area of steel.

**64. (d)**

The function of a lintel is just the same as that of arch or beam. However, the lintels are easy and simple in construction. For an arch, special centring or formwork is required.

**65. (b)**

The usual Concrete mix for RCC lintel is 1:2:4 i.e. 1 part of cement, 2 parts of sand and 4 parts of aggregate by volume. The plain concrete lintel can be used up to a span of about 800 mm.

**66. (a)**

In gravity retaining walls, the earth pressure which the backfill exerts, can be resisted by dead weight of the wall. The wall is of masonry or mass concrete.All stresses in the wall are low. These walls are so proportioned that no tension is there. Resultant of forces remains within the middle third of the base.

**67. (d)**

A water tank is a container to store water to tide over the daily requirements. Water tanks are classified under three heads: tanks resting on ground, elevated tanks supported on staging and underground tanks.

Intze Tank : It is used to store large volumes of water at an elevation.

It is a combination of conical dome and bottom spherical dome.

**68. (d)**

The chajja slab is an example of one-way slab. Remaining flat plates, flat slabs, waffle slabs are example of two-way slab.

**69. (b)**

If the actual N.A. is above the critical N.A., the section is under-reinforced. Here the stress in steel reaches its maximum permissible value first then the stress in concrete is found. If the actual N.A. falls at or below the critical N.A., the section is over-reinforced.

**70. (a)**

Working Stress method is based on linear elastic theory which is used for reinforced concrete and structural steel.

**71. (b)**

Limit state method of design, this average bond stress is referred to as design bond stress, $(\tau_{bd})$ as per Cl. 26.2.1.1 of IS 456:2000.

The value of bond stress is increased by 60% for deformed bars in tension and a further increase of 25% is made for bars in compression.

**Design Bond Stress for Different Grade of Concrete $\left(\text{in N / mm}^2\right)$**

| Concrete Grade | M15 | M20 | M25 | M30 | M35 | M40 | M45 | M50 |
|---|---|---|---|---|---|---|---|---|
| LSM (Cl. 26.2.1.1 of IS : 456) | – | 1.2 | 1.4 | 1.5 | 1.7 | 1.9 | 1.9 | 1.9 |
| WSM (Table 21 of IS : 456) | 0.6 | 0.8 | 0.9 | 1 | 1.1 | 1.2 | 1.3 | 1.4 |

**72. (d)**

Shear cracks form near the supports of members and are inclined at between about 30° and 45° to the axis of the beam, from the tension face of the member back towards the support. As with flexural cracks, they will be widest at the tension face, reducing in width with distance from the face. Shear cracks are also called as Diagonal tension.

**73. (d)**

If lateral support is given to one or both directions of a column, the column is called the braced column. Bracings totally bear the lateral loads like wind load etc. Therefore, the side sway is not allowed in this column. The column is not subjected to lateral movement.

**74. (c)**

The Concrete inside the core is subjected to tri-axial compression. It is confined by hoop stresses in spiral reinforcement and axial load along the longitudinal direction. Uniaxial compression acts only if plain short column loaded axially. Bending and compression acts when reinforced short column is loaded unilateral eccentricity or bilateral eccentricity. Biaxial compression acts when the short column is reinforced with vertical stirrups (ties) and loaded axially.

**75. (c)**

A cantilever beam is a member with one end projecting beyond the point of support, free to move in a vertical plane under the influence of vertical loads placed between the free end and the support.

**76. (a)**

The working stress method can be expressed by the equation as:

$$\mu R > L$$

Here,

$\mu$ = Inverse of factor of safety which is less than unity,

R = Resistance of the structural elements

L = Working loads on the structural elements.

**77. (c)**

The structure may be rendered unfit for its intended purpose due to various serviceability limit states being reached, there are six factors which effect the limit states and the different failures of the members are also considered in this factors in case of limit states.

**78. (d)**

Shear reinforcement shall be provided in any of the following forms:

- Vertical stirrups
- The bent-up bar along with stirrups
- Inclined stirrups

Shear reinforcement shall be provided to carry a shear force equal to $(Vu - \tau c \times bd)$

Note that, the shear reinforcement increases as the spacing among the stirrups decreases and vice versa.

As shear strength requirement is more at the supports than the center, the spacing of stirrups increases towards the center of the beam.

**79. (c)**

The lintel is projected by a minimum of 150mm on either side of the opening into the wall so as to transfer the imposed loads on to the jambs of the openings. This projection ensures that the weight and pressure from the loads are evenly distributed and supported by the jambs, preventing any structural damage or failure. A smaller projection could result in inadequate support, while a larger projection may not be necessary and could lead to unnecessary material and construction costs.

**80. (c)**

The code also specifies the standard staircase dimensions for the individual steps or treads and the risers.

The tread depth is typically between 250-300 millimeters (10-12 inches).

The riser height is generally kept between 150-200 millimeters (6-8 inches). These dimensions ensure comfortable and safe climbing of stairs.