3 CHAPTER
Working Stress Method

Q.1 The neutral axis factor for a singly reinforced rectangular balanced section made of M15 grade of concrete and Fe 415 steel is
(a) 0.29 (b) 0.40
(c) 0.32 (d) 0.20

Q.2 The depth of the neutral axis of a singly reinforced rectangular section in working stress method, depends on
1. permissible compressive stress due to bending in concrete
2. permissible stress in steel in tension
3. cross-section of the section
Which of these statements is/are correct?
(a) Both 1 and 3 (b) Both 1 and 2
(c) Both 2 and 3 (d) Only 2

Q.3 By making a balanced section as over reinforced, the moment of resistance cannot be increased by
(a) 25% (b) 50%
(c) 40% (d) 15%

Q.4 The ratio of the permissible bearing stress in working stress method of design and limit state method of design is
(a) 9 : 5 (b) 5 : 9
(c) 6 : 5 (d) 5 : 6

Q.5 The diameter of the polygonal links or lateral ties shall neither be less than the one-fourth of diameter of the largest bar nor less than
(a) 8 mm (b) 6 mm
(c) 5 mm (d) none these

Q.6 The ratio of the modular ratio for M15 grade and M20 grade of concrete is
(a) 7 : 5 (b) 5 : 7
(c) 3 : 5 (d) 5 : 3

Q.7 Consider the following statements regarding the working stress design of under reinforced RC sections.
1. The neutral axis depth will be greater than that of a balanced section.
2. The stress in steel in tension will reach its maximum permissible value first.
3. The moment of resistance will be less than that of the balanced section.
4. The concrete on the tension side is also to be considered for calculating the moment of resistance of the section.
Which of these statements are correct?
(a) 1 and 2 (b) 1 and 4
(c) 3 and 4 (d) 2 and 3

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.8 Assertion (A) : In the working stress design method, the internal stress at a section of member are computed for factored load.
Reason (R) : In the working stress design method it is ensured that the internal stresses due to working loads are less than the allowable stresses.

Q.9 The load carrying capacity of a column designed by working stress method is 500 kN. The collapse load of the column is
(a) 500.0 kN (b) 662.5 kN
(c) 750.0 kN (d) 1100.0 kN

Q.10 Beam sections designed in accordance with LSM as compared to sections designed in accordance with WSM will have
(a) larger depth and smaller amount of reinforcement.
(b) same depth and same reinforcement.
(c) smaller depth and more reinforcement.
(d) same depth as that of a deep beam.

Q.11 If σ_{cbc} is permissible compressive stress in flexural compression in N/mm² under service load conditions, then the modular ratio is of the order of
(a) $\frac{280}{3\sigma_{cbc}}$ (b) $\frac{280}{4\sigma_{cbc}}$
(c) 19 (d) 13

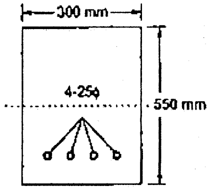
Q.12 As compared to working stress method of design, the limit state method takes concrete to
(a) higher stress level.
(b) lower stress level.
(c) same stress level.
(d) sometime higher but generally lower.

Q.13 If the depth of neutral axis for a singly reinforced balanced section is represented by *kd* in working stress design, then the value of *k*
(a) depends on σ_{st} only
(b) depends on σ_{cbc} only
(c) both (a) and (b)
(d) none of the above

Q.14 A beam of width *b* and effective depth d has neutral axis located at a depth *x* from top. Area of steel in compression and tension are A_{sc} and A_{st} respectively. The equivalent concrete area in compression by WSM of analysis is
(a) $bx + 1.5\ m\ A_{sc}$
(b) $bx - A_{sc} + 1.5\ m\ A_{sc}$
(c) $bx - A_{sc}$
(d) $bx + A_{sc} + 1.5\ m\ A_{st}$

Q.15 For a rectangular beam (600 × 300 mm) with effective cover of 50 mm is singly reinforced with 4 – 25ϕ bar. Considering M20 grade concrete, the depth of neutral axis from extreme compression fibre is; consider uncracked section of concrete.
(a) 219.8 mm (b) 369.6 mm
(c) 329.6 mm (d) 289.8 mm

Q.16 Consider the beam section under service load moment of 140 kNm.



Assuming M20 grade concrete and Fe 415 grade steel and concrete section cracked. The maximum concrete stress is:
(a) 6.34 MPa (b) 8.43 MPa
(c) 7.43 MPa (d) 9.43 MPa

■■■■

Answers Working Stress Method

1. (a) 2. (d) 3. (a) 4. (b) 5. (b) 6. (a) 7. (d) 8. (d) 9. (c) 10. (c)
11. (a) 12. (a) 13. (a) 14. (b) 15. (c) 16. (b)

Explanations : **Working Stress Method**

1. (a)

Neutral axis factor

$$k = \frac{1}{1 + \frac{\sigma_{st}}{m\sigma_{cbc}}}$$

where, $m = \frac{280}{3\sigma_{cbc}}$

$$k = \frac{1}{1 + \frac{3\sigma_{st}}{280}}$$

For Fe 250 $k = 0.40$

Fe 415 $k = 0.29$

4. (b)

As per IS : 456-2000

For working stress, Bearing stress = 0.25 f_{ck}

For limit stress, Bearing stress = 0.45 f_{ck}

$$\text{Ratio} = \frac{0.25}{0.45} = \frac{5}{9}$$

5. (b)

According to clause 26.5.3.2 of IS 456 : 2000.

6. (a)

$$m = \frac{280}{3\sigma_{cbc}}$$

σ_{cbc} for M20 = 7

σ_{cbc} for M15 = 5

$$\text{Ratio} = \frac{1/5}{1/7} = \frac{7}{5}$$

13. (a)

$$k = \frac{1}{1 + \frac{3\sigma_{st}}{280}}$$

15. (c)

Equating moment of areas of transformed section about top fibre.

$$A_T\bar{y} = BD \times \frac{D}{2} + (m-1)A_{st}(d)$$

and $A_{st} = 4 \times \frac{\pi(25)^2}{4} = 1963 \text{ mm}^2$

$A_T = BD + (m-1)A_{st}$

For M20, $m = 13.33$

$$\therefore \bar{y} = \frac{(300 \times 600)300 + (13.33 - 1) \times 1963 \times 550}{(300 \times 600) + (12.33 \times 1963)}$$

= 329.6 mm

16. (b)

$$A_{st} = 4 \times \frac{\pi}{4}(25)^2 = 1963 \text{ mm}^2$$

Transformed steel area = mA_{st}

= 13.33 × 1963 = 26167 mm²

Equating moments of areas about neutral axis,

$$\frac{300(kd)^2}{2} = 26167(550 - kd)$$

$\Rightarrow$ $kd = 234.6$ mm

$\Rightarrow$ $k = \frac{234.6}{550} = 0.4265$

$\Rightarrow$ Lever arm, $jd = d - \frac{kd}{3} = 471.8$ mm

Maximum concrete stress

$$M = \frac{1}{2}f_c \times b(kd)(jd)$$

$\Rightarrow$ $f_c = \frac{140 \times 10^6}{0.5 \times 300 \times 234.6 \times 471.8}$

= 8.43 MPa