

## Doubly Reinforced Beam by LSM

Q.1 Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I

- Doubly reinforced section
- Limit state design
- Minimum cover
- Span depth ratio

List-II

- Serviceability
- Durability
- Reduction in sectional depth
- Ultimate moment capacity

Codes:

|     | A | B | C | D |
|-----|---|---|---|---|
| (a) | 2 | 1 | 3 | 4 |
| (b) | 4 | 3 | 1 | 2 |
| (c) | 1 | 2 | 3 | 4 |
| (d) | 3 | 4 | 2 | 1 |

Q.2 Consider the following statements:

For an over-reinforced (singly reinforced) rectangular RC section

Answers: Doubly Reinforced Beam by LSM

1. (d) 2. (b) 3. (a)

Explanations: Doubly Reinforced Beam by LSM

2. (b)

Lever arm =  $d - 0.42x_u = l$

$\therefore x_u > x_{u, \text{lim}} (x_{\text{bal}}) \Rightarrow$  over-reinforced section

at 7 days = 2.2

at 28 days = 1.6

3. (a)

$$x_{u, \text{max}} = 0.48 d$$

$$= 0.48 \times 600 = 288 \text{ mm}$$

$\epsilon_{st}$  = strain in steel on tension side

- the lever arm will be less than that for a balanced section
- the maximum stress developed by steel would equal the allowable stress in steel.
- the maximum stress developed by concrete would equal allowable stress in concrete

Which of these statements are correct?

- 1 and 2
- 1 and 3
- 2 and 3
- 1, 2 and 3

Q.3 Consider a doubly reinforced beam of width  $b = 350 \text{ mm}$ ,  $d = 600 \text{ mm}$ ,  $A_{st} = 2945 \text{ mm}^2$  and  $A_{sc} = 1256 \text{ mm}^2$  and  $d' = 60 \text{ mm}$  using M20 and Fe415. Assuming  $E_s = 2 \times 10^5 \text{ N/mm}^2$ , the beam is:

- Over-reinforced having brittle failure
- Under-reinforced, ductile failure
- Over-reinforced, ductile failure
- None of the above

$$= \epsilon_c \left( \frac{d}{x_{u, \text{max}}} - 1 \right) = 0.0035 \left( \frac{600}{288} - 1 \right)$$

$$= 0.00379$$

Yield strain of Fe415,

$$= \frac{f_y}{1.15 E_s} + 0.002 = \frac{415}{1.15 \times 2 \times 10^5} + 0.002$$

$$= 0.0038 > 0.00379$$

Hence, the beam is over-reinforced and having brittle failure.