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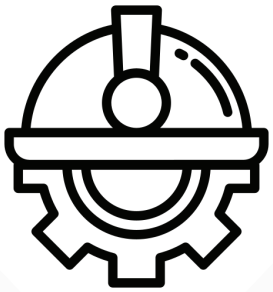
BUILDING MATERIALS

SECTION 1

SYLLABUS

STONE, LIME, GLASS, PLASTICS, STEEL, FRP, CERAMICS, ALUMINUM, FLY ASH, BASIC ADMIXTURES, TIMBER, BRICKS AND AGGREGATES: CLASSIFICATION, PROPERTIES AND SELECTION CRITERIA;

CEMENT: TYPES, COMPOSITION, PROPERTIES, USES, SPECIFICATIONS AND VARIOUS TESTS; LIME & CEMENT MORTARS AND CONCRETE: PROPERTIES AND VARIOUS TESTS; DESIGN OF CONCRETE MIXES: PROPORTIONING OF AGGREGATES AND METHODS OF MIX DESIGN.



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ESE CIVIL: NUMBER OF QUESTIONS ASKED IN PREVIOUS EXAMS (2001-2025)

BUILDING MATERIALS		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1.1	Stones, Brickes & Brick Masonry	5	4	1	2	1	3	4	5	2	3	3	2	2	6	4
1.2	Timber (Properties, Treatment & Uses)	3	7	5	3	5	3	5	4	4	4	2	8	5	3	4
1.3	General Building Materials	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-
1.4	Cement (Type, Composition & Testing)	5	7	5	2	2	4	3	3	2	3	2	5	2	5	4
1.5	Lime & Mortar (Properties, Composition & Uses)	3	-	3	2	1	-	2	3	-	-	2	2	-	4	2
1.6	Concrete (Property, Tests & Mix Design)	5	3	5	10	6	5	7	10	7	9	3	7	11	7	5

BUILDING MATERIALS		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1.1	Stones, Brickes & Brick Masonry	4	2	1	1	2	1	-	2	2	1
1.2	Timber (Properties, Treatment & Uses)	6	1	1	-	-	3	1	3	2	2
1.3	General Building Materials	1	-	1	1	-	4	3	1	2	-
1.4	Cement (Type, Composition & Testing)	3	-	2	3	4	3	1	3	1	2
1.5	Lime & Mortar (Properties, Composition & Uses)	2	1	1	-	2	1	3	3	2	4
1.6	Concrete (Property, Tests & Mix Design)	8	4	2	7	5	3	4	1	7	-

CHAPTER-1 BUILDING MATERIALS

Unit 1.1: Stones, Bricks & Brick Masonry

Previous Year Exam Questions

[ESE: 2001]

1. Which one of the following procedure is applied to determine the soundness of bricks?

(a) Immersing the brick under water for 16 hours and determining the quantity of water absorbed by the brick.

(b) Immersing the brick under water for 24 hours and determining its expansion using Le Chatelier apparatus.

(c) Taking two bricks, hitting one against the other and observing whether they break or not and the type of sound produced while hitting.

(d) Scratching the brick by finger nail and noting whether any impression is made or not.

[ESE: 2001]

2. The number of bricks required per cubic metre of brick masonry is

(a) 400 (b) 450

(c) 500 (d) 550

[ESE: 2001]

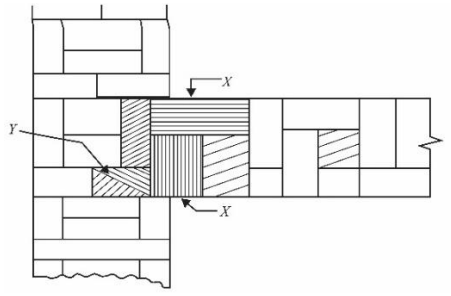
3. The bricks which are extensively used for basic refractories in furnaces are

(a) Chrome bricks (b) Sillimanite bricks

(c) Magnesite bricks (d) Fosterite bricks

[ESE: 2001]

4. The given figure shows the Tee junction in brick masonry which is known as



(a) English bond

(b) English cross-bond

(c) Flemish bond

(d) Double Flemish bond

[ESE: 2001]

5. The minimum compressive strength of first class bricks should be

(a) $5\ \text{N/mm}^2$ (b) $7.5\ \text{N/mm}^2$

(c) $9\ \text{N/mm}^2$ (d) $10\ \text{N/mm}^2$

[ESE: 2002]

6. Assertion (A): More uniformly burnt bricks are obtained from a downward draught kiln.
Reason (R): The bricks are laid in a circular form in this kiln.

(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

[ESE: 2002]

7. Match List-I (Constituents of bricks) with List-II (Corresponding influence) and select the correct answer using the codes given below the lists:

List-I	List-II
A. Alumina	1. Colour of brick
B. Silica	2. Plasticity recovery for moulding
C. Magnesia	3. Reacts with silica during burning and causes particles to unite together and development of strength
D. Limestone	4. Preserves the form of brick at high temperature and prevents shrinkage

Codes:

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

[ESE: 2002]

8. In some brick masonry walls, patches of whitish crystals were found on the exposed surfaces, also chipping and spalling of bricks took place from the same walls. Which among the following are the causes of these defects?

(1) Settlement of foundation

(2) Over-loading of the walls

(3) Sulphate attack

(4) Efflorescence

Select the correct answer from the codes given below:

(a) 1 and 2 (b) 2 and 3

(c) 2 and 4 (d) 3 and 4

[ESE: 2002]

9. Consider the following stages in the manufacturing of bricks:
(1) Weathering
(2) Moulding
(3) Tempering
The correct sequence of these stages in the manufacturing of the bricks, is
(a) 1, 2, 3 (b) 2, 3, 1
(c) 1,3,2 (d) 3,2,1

[ESE: 2003]

10. Consider the following statements:
Bricks are soaked in water before use in masonry work
(1) to remove dust
(2) to remove air voids
(3) so that they do not absorb water from cement mortar
Which of these statements is/are correct?
(a) 1,2 and 3 (b) 1 only
(c) 2 and 3 (d) 3 only

[ESE: 2004]

11. Consider the following characteristics with respect to brick:
(1) Minimum compressive strength $= 175$ (Standard units)
(2) Minimum absorption in 24 hours, (in % of dry weight) = 12
(3) Very little efflorescence
(4) Tolerance in dimensions $= \pm 8\%$
As per Indian Standards classification, a brick with the characteristics given above is termed as
(a) $\mathrm{H-I}$ (b) F-II
(c) L-II (d) $\mathrm{H-II}$

[ESE: 2004]

12. Match List-I (Test) with List-II (Procedure) and select the correct answer using the codes given below the lists:

List-I	List-II
A. Absorption	1. A brick is to be broken for the test
B. Hardness	2. Two bricks are taken and they can be struck with each other without breaking
C. Soundness	3. A scratch is easily made on brick surface with the help of a finger nail
D. Structure	4. Difference in weight between the brick immersed in water for 16 hours and its dry weight

Codes:

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

[ESE: 2005]

13. Refractory bricks resist
(a) high temperature (b) chemical action
(c) dampness (d) all of the above

[ESE: 2006]

14. Assertion (A): The strength of brick masonry is purely dependent upon the type of mortar used.
Reason (R): Mortar is the binding material in masonry.
(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

[ESE: 2006]

15. When a first class brick is immersed in cold water for 24 hours, it should not absorb water by weight more than
(a) 15% (b) 20%
(c) 25% (d) 30%

[ESE: 2006]

16. The temperature at which the bricks are burnt in kiln varies from
(a) 500° to $800^\circ\mathrm{C}$ (b) 800° to $1000^\circ\mathrm{C}$
(c) 1000° to $1200^\circ\mathrm{C}$ (d) 1200° to $1500^\circ\mathrm{C}$

[ESE: 2007]

17. For ornamental work, which type(s) of bricks is/ are preferred?
(1) Silica bricks
(2) Silica lime bricks
(3) Bricks produced in autoclaves
Select the correct answer using the codes given below:
(a) 1 and 3 only (b) 2 and 3 only
(c) 1 only (d) 2 only

[ESE: 2007]

18. Which one of the following is the nominal size of standard modular brick?
(a) $25\ \mathrm{cm} \times 13\ \mathrm{cm} \times 8\ \mathrm{cm}$
(b) $25\ \mathrm{cm} \times 10\ \mathrm{cm} \times 8\ \mathrm{cm}$
(c) $20\ \mathrm{cm} \times 10\ \mathrm{cm} \times 10\ \mathrm{cm}$
(d) $20\ \mathrm{cm} \times 15\ \mathrm{cm} \times 10\ \mathrm{cm}$

[ESE: 2007]

19. Why are bricks soaked in water before using the brick masonry?

(a) For removing dust
(b) For reducing air voids
(c) For preventing depletion of moisture from mortar
(d) For reducing efflorescence

[ESE: 2007]

20. Which type of brick masonry bond is provided for heavy loads on masonry?
(a) English bond
(b) Zigzag bond
(c) Single Flemish bond
(d) Double Flemish bond

[ESE: 2008]

21. For flatly laid single brick soling, what is the number of bricks required of nominal size 20 cm $\times$ 10 cm $\times$ 10 cm, with 1.2 cm wide cement mortar all around and with allowing up to 1% wastage for 10 m^2 area?
(a) 400 (b) 410
(c) 425 (d) 440

[ESE: 2008]

22. Consider the following statements:
(1) Soil containing mage than 30% of calcium hydroxide is used for manufacture of sand lime brick.
(2) Carbon brick is made from crushed coke bonded with tar.

Which of these statements is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

[ESE: 2008]

23. What is the number of traditional bricks required for 10 m^3 of brickwork with standard thickness of cement mortar (: 3 to 1: 5, as the case may be)?
(a) 4750 (b) 4850
(c) 4950 (d) 5050

[ESE: 2008]

24. For high class brick masonry, which are the proper bricks?
(a) Refractory bricks (b) Jhumb bricks
(c) Bull nose bricks (d) Modular bricks

[ESE: 2008]

25. Assertion (A): The volume of mortar needed for plastering on both faces of a one-brick wall is more than that for the same area on both faces together of any other thickness of brick wall.
Reason (R): More water evaporates from the wetted bricks in case of a one-brick wall and also the joints have to be more commonly raked.
(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

[ESE: 2009]

26. Modular bricks are of nominal size 20 $\times$ 10 $\times$ 10 cm and 20% of the volume is lost in mortar between joints. Then what is the number of modular bricks required per cubic meter of brickwork?
(a) 520 (b) 500
(c) 485 (d) 470

[ESE: 2009]

27. In order to achieve a safe compressive strength of 20 kg/cm^2 in a brick masonry, what should be the suitable range of crushing strength of bricks?
(a) 35 kg/cm^2 to 70 kg/cm^2
(b) 70 kg/cm^2 to 105 kg/cm^2
(c) 105 kg/cm^2 to 125 kg/cm^2
(d) More than 125 kg/cm^2

[ESE: 2010]

28. Consider the following statements:
(1) Strength of brick masonry is influenced by type of mortar.
(2) Brick masonry with lime mortar achieves full strength earlier than cement mortar masonry.
(3) Mortar strength decides the strength of masonry.

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

[ESE: 2010]

29. The average compressive strength of a burnt clay brick is less than .5 N/mm^2. The allowable rating of efflorescence is
(a) moderate (b) serious
(c) heavy (d) zero

[ESE: 2010]

30. Consider the following statements:
(1) Bricks lose their strength by 25% when soaked in water.
(2) Minimum crushing strength of brick in buildings should be 3.5 kg/cm^2.
(3) The size of modular type bricks is 20 cm $\times$ 10 cm $\times$ 10 cm including mortar thickness.

Which of these statements are correct?
(a) 1,2 and 3 (b) 1 and 2 only
(c) 1 and 3 only (d) 2 and 3 only

[ESE: 2011]

31. The minimum wall thickness of any load bearing wall in case of public building built with mortar, as per IS code, should be not less than
(a) $\frac{1}{2}$ brick (b) 1 brick
(c) $1\frac{1}{2}$ brick (d) 2 brick

[ESE: 2011]

32. Maximum slenderness ratio for load-bearing masonry wall built in cement mortar, as per IS code, shall not exceed

(a) 13 (b) 20

(c) 27 (d) 30

[ESE: 2011]

33. If the effective length, effective height and effective thickness of a masonry wall are l, h and t respectively, then the slenderness ratio of the wall shall be

(a) $\frac{l}{t}$ (b) $\frac{h}{t}$

(c) Larger of $\frac{l}{t}$ and $\frac{h}{t}$ (d) Smaller of $\frac{l}{t}$ and $\frac{h}{t}$

[ESE: 2012]

34. Consider the following statements:

Perforated bricks are preferred in construction since

(1) They are lighter

(2) they are stronger than class 1 bricks

(3) they have heat-insulating properties

(4) they are cheaper and need less mortar

Which of these statements are correct?

(a) 1,2,3 and 4 (b) 2 and 3 only

(c) 1 and 3 only (d) 3 and 4 only

[ESE: 2012]

35. The standard size of a brick is

(a) $20\text{ cm} \times 10\text{ cm} \times 10\text{ cm}$

(b) $19\text{ cm} \times 9\text{ cm} \times 9\text{ cm}$

(c) $18\text{ cm} \times 9\text{ cm} \times 9\text{ cm}$

(d) $18\text{ cm} \times 10\text{ cm} \times 10\text{ cm}$

36. As per IS classification, the minimum compressive strength of a first class brick should be

(a) 75 kg/cm^2 (b) 100 kg/cm^2

(c) 125 kg/cm^2 (d) 150 kg/cm^2

[ESE: 2013]

37. When provided with alternating courses of (a) all headers and (b) all stretchers, the front elevation of such brick masonry is designated as

(a) English bond (b) Single Flemish bond

(c) Double Flemish bond (d) Rat-trap bond

[ESE: 2013]

38. I.S. Code specifies that the compressive strength of brick shall be determined by keeping the brick:

1. On edge
2. On bed
3. After soaking in water for 2 hrs
4. After soaking in water for 24 hrs

(a) 1 and 2 (b) 2 and 3

(c) 3 and 4 (d) 2 and 4

[ESE: 2014]

39. Consider the following statements: A good soil for making bricks should contain

(1) 30% alumina

(2) 10% lime nodules

(3) Only small quantity of iron oxides

(4) 15% magnesia

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3

(c) 1, 2 and 4 (d) 2, 3 and 4

[ESE: 2014]

40. Which of the following is an ODD one as regards 'requirements of good brick-earth?

(a) It must be free from lumps of lime

(b) It should not be mixed with salty water

(c) It must be non-homogeneous

(d) It should not contain vegetable and organic matter

[ESE: 2014]

41. The compressive strength of heavy-duty bricks, as per IS: 2980-1962, should be not less than

(a) 440 kg/cm^2 (b) 175 kg/cm^2

(c) 100 kg/cm^2 (d) 75 kg/cm^2

Directions: Each of the next items consists of two statements, one labelled as 'Statement (I)' and the other as 'Statement (II)'. You are to examine these two statements and select the answers to these items using the code given below.

Codes:

(a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).

(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I).

(c) Statement (I) is true but Statement (II) is false.

(d) Statement (I) is false but Statement (II) is true

[ESE: 2014]

42. Statement (I): Bricks are soaked in water before using in brick masonry for removing dirt and dust.

Statement (II): Bricks are soaked in water before using in brick masonry so that bricks do not absorb moisture from the bonding cement mortar.

[ESE: 2014]

43. Statement (I): Brick masonry in mud mortar is weak in strength.

Statement (II): Cement mortar enhances the strength of the bricks relative to mud mortar.

[ESE: 2014]

44. Consider the following statements:

(1) Brickwork will have high water tightness.

(2) Brickwork is preferred for monument structures.
(3) Bricks resist fire better than stones.
(4) Bricks of good quality shall have thin mortar bonds.

Which of the above statements are correct?

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

[ESE: 2015]

45. Consider the following statements related to autoclave bricks:
(1) Less water absorption compared to other bricks.
(2) Noise reduction.
(3) It is cheap compared to other types of bricks.
(4) Requirement of bulk volume of mortar in joints being relatively less compared to other types of brick masonry.
(5) Not recommended for outer walls.

Which of the above statements are relevant to the use of 'autoclave' bricks?

(a) 1,2 and 4 (b) 1, 3 and 5
(c) 2, 3 and 4 (d) 2, 4 and 5

[ESE: 2015]

46. As per IS 3102-1965, for F1 class bricks, the percentage water absorption after 24 hrs of immersion in cold water shall not exceed

(a) 20% (b) 12%
(c) 25% (d) 5%

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

[ESE: 2015]

47. Assertion (A): Strength of brick wall is dependent on the type of bricks and the mortar used.
Reason (R): Slenderness ratio of masonry decides the strength of the wall, and also mortar type to be used.

[ESE: 2015]

48. Assertion (A): Fly ash bricks are used in construction as alternatives to burnt clay bricks.
Reason (R): Fly ash bricks are lighter in weight and are stronger than burnt clay bricks.

[ESE: 2016]

49. Efflorescence of bricks is due to
(a) Excessive burning of bricks
(b) High silt content in brick clay
(c) High porosity of bricks
(d) Soluble salts present in parent clay

[ESE: 2016]

50. Disintegration of brick masonry walls is primarily due to
(1) Efflorescence
(2) Magnesium sulphate in bricks
(3) Calcined clay admixtures
(4) Kankar nodules

Which of the above statements are correct?

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

Directions: Each of the next items consists of two statements, one labelled as the 'Statement (I)' and the other as 'Statement (II)'. Examine these two statements carefully and select the answers to these items using the codes given below:
Codes:

(a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I)
(c) Statement (I) is true but Statement (II) is false
(d) Statement (I) is false but Statement (II) is true

[ESE: 2016]

51. Statement (I): In general, bricks cannot be used in industrial foundations.
Statement (II): Heavy duty bricks can withstand higher temperatures.

[ESE: 2016]

52. Statement (I): In multi-storeyed constructions, burnt clay perforated bricks are used to reduce the cost of construction.
Statement (II): Perforated bricks are economical and they also provide thermal insulation.

[ESE: 2017]

53. Consider the following statements:
1. IS 3583 refers to Burnt Clay Paving Bricks.
2. IS 5779 refers to Burnt Clay Soling Bricks.
3. IS 3952 refers to Burnt Clay Hollow Bricks.
4. IS 2222 refers to Burnt Clay Lay Bricks.

Which of the above statements are correct?

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

[ESE: 2017]

54. Consider the following statements regarding refractory bricks in furnaces:

1. The furnace is fired at temperatures more than 1700°C.
2. Silica content in the soil should be less than 40%.
3. Water absorption of bricks should not exceed 10%.
4. Chrome bricks are known as basic bricks.

Which of the above statements are correct?

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

[ESE: 2018]

55. Consider the following statements for selecting building stones:

1. Seasoning of stones is essential and is done by soaking in water
2. Specific gravity of stone is to be more than 2.7
3. Porosity of stone affects its durability

Climatic conditions decide the type of stone to be used in construction

Which of the above statements are correct?

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

[ESE: 2019]

56. Which of the following statements are wholly correct regarding broken-brick aggregate useable in concretes?

1. Broken-brick aggregate is obtained by crushing waste bricks; and it has a density varying between $1000\ \text{kg/m}^3 - 1200\ \text{kg/m}^3$.
2. Such aggregate is usable in concrete for foundation in light buildings, floorings and walkways.
3. Such aggregate may also be used in light-weight reinforced concrete floors.

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

[ESE: 2020]

57. When the deposit of efflorescence is more than 10% but less than 50% of the exposed area of the brick, the presence of efflorescence is

(a) Moderate (b) Slight
(c) Heavy (d) Serious

[ESE: 2020]

58. Mohs scale is used for stones to determine

(a) Flakiness index (b) Durability
(c) Strength (d) Hardness

[ESE: 2021]

59. Number of bricks required for 15 cu.m of brickwork is approximately

(a) 6750 (b) 7200
(c) 7500 (d) 6000

[ESE: 2023]

60. Which one of the following statements is NOT correct?

(a) Rustic Brick has a mechanically textured finish, varying in pattern.
(b) Arch Bricks are over-burnt also known as clinker bricks obtained from the inner portion of the kiln.
(c) Pale Bricks are over-burnt bricks obtained from the outer portion of the kiln.
(d) Body Bricks are well burnt bricks occupying central portion of the kiln.

[ESE: 2023]

61. Excess of Silica makes the brick

(a) brittle on burning (b) crack on drying
(c) melt on burning (d) warp

[ESE: 2024]

62. Match the following lists regarding different types of bricks with their applications:

List I (Types of bricks)	List II (Applications)
P. Sand lime bricks	1. Tough, durable
Q. Face bricks	2. Edges and curves to suit the shape
R. Paving bricks	3. Cheaper and used only for backup
S. Sewer bricks	4. Where distinct brickwork finish is intended

Select the correct answer using the code given below:

	P	Q	R	S
(a)	1	2	3	4
(b)	2	3	4	1
(c)	3	4	1	2
(d)	4	1	2	3

[ESE: 2024]

63. How many numbers of bricks are required in 10 m³ of brick work?

(a) 3000 numbers (b) 5000 numbers
(c) 2000 numbers (d) 4000 numbers

[ESE: 2025]

64. The stone masonry construction is superior to brick masonry construction under which of the following circumstances?

(1) Stone masonry construction can be developed aesthetically more sound than brickwork
(2) Stone masonry is more watertight than brick masonry because bricks absorb moisture from the atmosphere
(3) For public buildings and monumental structures, stone masonry provides a solid appearance and is found to be more useful than brick masonry

Select the correct answer.

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

ANSWER KEY									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
(c)	(c)	(c)	(d)	(d)	(b)	(c)	(d)	(c)	(d)
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
(d)	(b)	(d)	(d)	(b)	(c)	(b)	(c)	(c)	(a)
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
(c)	(b)	(c)	(d)	(a)	(d)	(b)	(c)	(a)	(a)
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
(b)	(c)	(d)	(c)	(b)	(b)	(a)	(d)	(b)	(c)
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
(a)	(d)	(c)	(b)	(b)	(a)	(b)	(a)	(d)	(b)
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
(d)	(a)	(a)	(c)	(c)	(c)	(a)	(d)	(c)	(c)
61	**62**	**63**	**64**						
(a)	(c)	(b)	(d)						

EXPLANATIONS

1. Explanation: (c) The soundness of bricks refers to their ability to resist the effects of weathering and remain durable over time.
Striking two bricks together: If they produce a clear ringing sound, the bricks are considered to be of good quality and sound. If the sound is dull, it indicates internal cracks or defects.

2. Explanation: (c)
Nominal brick size $= 0.2\ \text{m} \times 0.1\ \text{m} \times 0.1\ \text{m}$
No. of bricks required $= \frac{1}{0.2 \times 0.1 \times 0.1} = 500$

3. Explanation: (c) Bricks used in basic refractories include magnesite bricks, dolomite bricks, forsterite bricks, and carbon (graphite) bricks, while basic ramming mass is used as a monolithic lining material. Mullite bricks are not basic; they are classified as acidic or neutral refractories.

4. Explanation: (d) The figure illustrates a Double Flemish bond using 1½ bricks, where each course consists of alternating headers and stretchers on both the front (facing) and back (backing) sides.

5. Explanation: (d) The average compressive strength should be at least **75 kg/cm² (7.5 N/mm²)** for **Class-II** bricks and **100 kg/cm² (10 N/mm²)** for **Class-I** bricks.

6. Explanation: (b) The kilns can be either rectangular or circular in shape; however, the actual reason bricks are more uniformly burnt in a downward draught kiln lies in the controlled **downward movement of hot gases**, which ensures even heat distribution throughout the brick layers.

7. Explanation: (c) A small quantity of magnesia in brick earth gives a yellowish tint to the bricks and helps reduce shrinkage. However, an excess amount of magnesia can cause the bricks to decay over time.

8. Explanation: (d) Sulphate salts in bricks react with the alumina in cement (in cement mortar) and with hydraulic lime (in lime mortar), causing an increase in mortar volume. This expansion leads to chipping, spalling of bricks, and efflorescence, which appears as patches of white crystalline deposits on exposed surfaces.

9. Explanation: (c)
The stages in brick manufacturing are as follows:
1. Preparation of Clay
   Unsoiling → Digging → Cleaning → Weathering → Blending → Tempering
2. Moulding
3. Drying
4. Burning

10. Explanation: (d) Bricks are soaked in water before use in masonry work to prevent them from absorbing water from the cement mortar. If dry bricks are used, they draw moisture from the mortar, causing it to dry out prematurely and fail to achieve the desired strength.

11. Explanation: (d) Heavy duty bricks are classified into two classes:
(i) Class-A (or Class-I) bricks, which have a dimensional tolerance of **±3%**, and
(ii) Class-B (or Class-II) bricks, with a dimensional tolerance of **±8%**.
Hence, a brick with Class-B properties would be classified as **H-II**.

12. Explanation: (b)
1. **Absorption** is measured by the difference in weight between a brick soaked in water for 16 hours and its dry weight.
2. **Soundness** is checked by striking two bricks together and listening for a clear ringing sound without breaking them.
3. **Hardness** is tested by scratching the brick surface with a fingernail; no mark should be left on a good-quality brick.

4. **Structure** is tested by breaking the brick and examining the fracture for a uniform, compact, and homogeneous texture.

13. Explanation: (d) Refractory bricks are non-metallic materials used for constructing or lining furnaces that operate at high temperatures. They are classified into three types:
(i) **Acid bricks**
(ii) **Basic bricks**
(iii) **Neutral bricks**
These bricks have a compressive strength ranging from **200 to 220 N/mm²**, and their water absorption typically ranges between **5% and 10%**.
Chrome bricks, a type of neutral refractory, are highly resistant to the corrosive action of slags and gases.

14. Explanation: (d) The strength of masonry depends on the strength of both the **mortar** and the **bricks**, as both work together to resist loads and ensure stability.

15. Explanation: (b)

Characteristics (i) Water absorption	20%	22%	25%
after 24 hrs			
(ii) Efflorescence	Slight	Slight	Moderate

16. Explanation: (c) The temperature in a brick kiln typically ranges from **1000°C to 1200°C** (**1830°F to 2190°F**), which is necessary for proper burning and development of strength and durability in bricks.

17. Explanation: (b) Autoclave bricks and silica bricks are commonly used for **ornamental work**, such as the **façade of a building**, due to their smooth finish, durability, and aesthetic appearance.

18. Explanation: (c) The **actual size** of a modular brick is **19 cm × 9 cm × 9 cm**. When a mortar thickness of 1 cm is added on all sides, the brick size becomes **20 cm × 10 cm × 10 cm**, which is referred to as the **nominal size** of the modular brick.

19. Explanation: (c) If dry bricks are used in masonry, they absorb water from the mortar, causing it to dry out and lose strength. To prevent this, bricks are soaked in water before use so they do not draw moisture from the cement mortar, ensuring proper setting and strength development.

20. Explanation: (a)
English bond is the strongest of all brick bonds.
Double Flemish bond offers a better appearance than English bond but is weaker.
Single Flemish bond combines the strength of the English bond (at the back) with the appearance of the Double Flemish bond (at the front).
Zigzag bond is commonly used for creating ornamental panels in brick flooring.

21. Explanation: (c)
Given,
Wall area = **10 m²** = 10×10^4 cm²
Brick size (nominal, including mortar) = **20 cm × 10 cm**
Mortar thickness = **1.2 cm** (but should be added to both sides)
So number of bricks required for $10\ \text{m}^2$ area,
$$N = \frac{10 \times 10^4}{(21.2 \times 11.2)} = 421.16 \text{ bricks}$$
Also it is given that 1% wastage is allowed. So no. of bricks required
$\text{N} = N \times 1.01 = 421.16 \times 1.01 \simeq 425$ bricks
So option (c) is correct.
But as per question is should be
$$N' = 1.01 \times \frac{10 \times 10^4}{22.4 \times 12.4} \simeq 364 \text{ bricks}$$

22. Explanation: (b) Sand-lime bricks are manufactured by mixing **sand (10%)**, **lime (10%)**, and **fly ash (80%)**, followed by molding and autoclaving.
Carbon bricks are made from **crushed blast furnace coke** or anthracite, **bonded with tar or pitch**, and are known for their excellent resistance to chemical attack and high temperatures.

23. Explanation: (c)
Given:
Volume of brickwork = 10 m³
Nominal size of traditional brick (including mortar) = 20 cm × 10 cm × 10 cm
Volume of one brick (including mortar)
$$= \frac{20 \times 10 \times 10}{10^6} = 0.002 \text{ m}^3$$
$$Number\ of\ bricks\ per\ m^3 = \frac{1}{0.002} = 500\ bricks$$
$$For\ 10\ m^3\ brickwork: 500 \times 10 = 5000\ bricks$$
Considering 1% allowance for mortar and wastage:
$5000 \times 0.99 = 4950$ bricks

24. Explanation: (d) Modular bricks are uniform in size, easy to handle, and ideal for high-class brick masonry due to better finish and minimal mortar wastage.

25. Explanation: (a) One-brick walls have more exposed joints and higher water absorption, requiring more mortar for plastering.
both A and R are true and R is the correct explanation of A.

26. Explanation: (d) Nominal size of modular bricks $= 20\text{ cm} \times 10\text{ cm} \times 10\text{ cm}$
Actual size of modular brick $= 19\text{ cm} \times 9\text{ cm} \times 9\text{ cm}$
Mortar required for 1 m^3 brickwork
$= 1 - \left(\frac{1}{0.2 \times 0.1 \times 0.1} \times 0.19 \times 0.09 \times 0.09\right)$
$= 1 - 0.7695 = 0.2305\text{ m}^3$
Volume of mortar lost between joints $= 20\%$
∴ Volume of set mortar
$= 0.2305 + 0.2305 \times \frac{20}{100} = 0.2766\text{ m}^3$
Actual volume of bricks $= 1 - 0.2766$
$= 0.7234\text{ m}^3$
∴ Number of modular bricks
$= \frac{0.7234}{0.19 \times 0.09 \times 0.09} = 470$

27. Explanation: (b) To safely achieve a **masonry compressive strength of 20 kg/cm²**, the **crushing strength of bricks** should generally be **3 to 5 times** higher than the desired masonry strength to account for material variation and safety.
$20\ kg/cm^2 \times 3.5 \approx 70\ kg/cm^2\ (minimum)$
Thus, the suitable range is **70 to 105 kg/cm²**.

28. Explanation: (c) Brick masonry with cement mortar achieves full strength earlier than lime mortar masonry.

29. Explanation: (a) As per IS:3495–1976, the efflorescence rating for bricks should not be more than **moderate** for bricks up to **Class 12.5**, and should be only **slight** for higher classes.

30. Explanation: (a) As per **IS 1077**, the **minimum crushing strength** for **common building bricks** should be **35 kg/cm²**. The **actual size** of a modular brick is **19 cm × 9 cm × 9 cm**, and with standard mortar thickness, its **nominal size** becomes **20 cm × 10 cm × 10 cm**.

31. Explanation: (b) The thickness of a load-bearing wall must be adequate at all points to ensure that stresses under the worst loading conditions remain within the permissible limits for that wall type. For design purposes, the **actual thickness** of the masonry (not the nominal thickness) should be used. The **minimum thickness** for a load-bearing masonry wall is **1 brick**, which has an **actual thickness of 19 cm** and a **nominal thickness of 20 cm**.

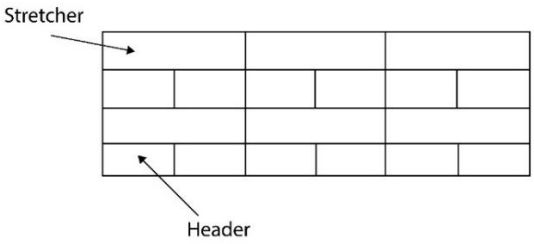
32. Explanation: (c) The limiting value of slenderness ratio is **lower** for masonry built with **lime mortar** compared to that built with **cement mortar**, due to the lower strength of lime-based mortars. As per standards, the **maximum slenderness ratio** is **27** for masonry using **cement mortar** and **20** for masonry using **mortar without cement**.

33. Explanation: (d) For a wall, the slenderness ratio shall be the effective height divided by the effective thickness and stiffening co-efficient (K_h) or the effective length divided by the effective thickness, whichever is less.
Thus, $S_R = \frac{l}{t \times K_n}$ or $\frac{l}{t}$, whichever is less.

34. Explanation: (c) Perforated bricks are preferred over common bricks in construction because they are **lighter in weight** and offer **better thermal insulation**, making them more efficient for both handling and energy performance of buildings.

35. Explanation: (b) The standard dimensions of brick as recommended by Bureau of Indian Standards are length × width × thickness $= 19 \times 9 \times 9$ cm. Including the thickness of mortar the effective size of brick becomes $20 \times 10 \times 10$ cm.

36. Explanation: (b) As per **IS 1077:1992**, the **minimum compressive strength** of a **first-class brick** should be **100 kg/cm²**.

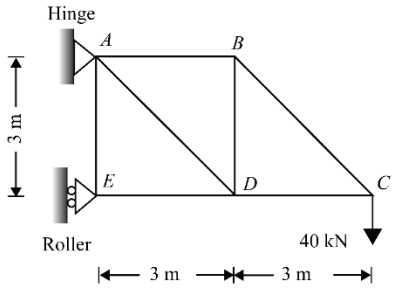


37. Explanation: (a) As per the question, when brick masonry is constructed with alternating courses of all headers and all stretchers, the front elevation is designated as an **English bond**.

38. Explanation: (d) As per **IS 3495 (Part-1)**, the **compressive strength of a brick** is determined by first immersing the brick in water for **24 hours**. The **frog and all voids** are filled with **1:3 cement mortar**, and the brick is then stored under **damp jute bags for**

[ESE: 2001]

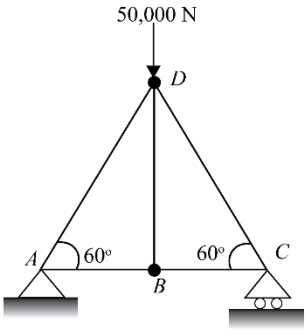
2. The pin-jointed cantilever truss is loaded as shown in the given figure. The force in member ED is



(a) 40 kN (Compressive)
(b) 80 kN (Tensile)
(c) 80 kN (Compressive)
(d) 120 kN (Compressive)

[ESE: 2001]

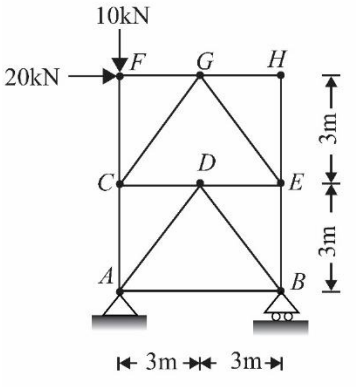
3. In the pin-jointed plane frame shown in the given figure, the force in the member BD is



(a) 50000 N (Tensile)
(b) 50000 N (Compressive)
(c) $50000\sqrt{2}$ N (Tensile)
(d) zero

[ESE: 2001]

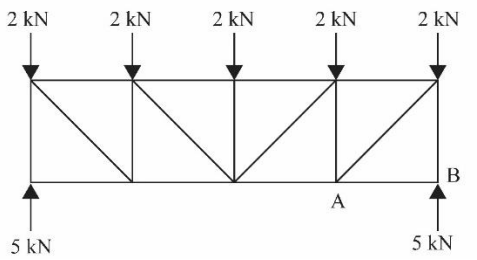
4. A loaded pin-jointed truss is shown in the given figure. The force in member AC is



(a) $10\sqrt{2}$kN (Tensile)
(b) $10\sqrt{2}$kN(Compressive)
(c) zero
(d) 10 kN (Tensile)

[ESE: 2002]

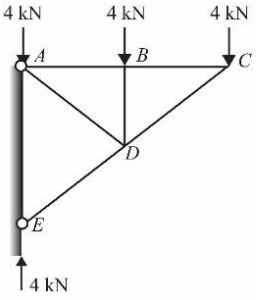
5. The force in member AB is



(a) 5 kN compression
(b) 2 kN compression
(c) zero
(d) 7 kN compression

[ESE: 2002]

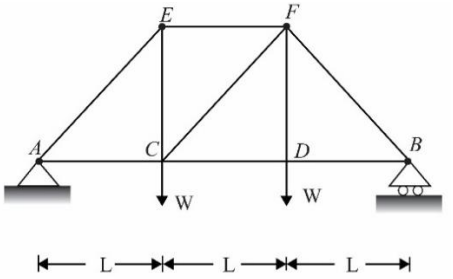
6. The force in the member BD of the truss shown in the figure given below is



(a) 4 kN tensile
(b) 4 kN compressive
(c) zero
(d) 12 kN compressive

[ESE: 2002]

7. In the truss shown in the figure given below, which one of the following members has no force induced in it?



(a) CD
(b) CE
(c) CF
(d) DF

[ESE: 2002]

8. A joint of a roof truss has been isolated and shown in Fig-I The force polygon for the joint is shown in Fig-II. Member ' a ' is in compression, member ' d' is in tension.

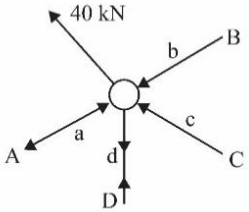


Fig-1
(Free body diagram for joint)

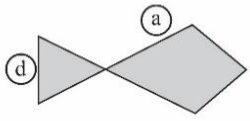
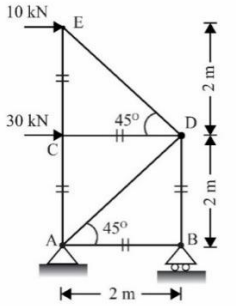


Fig-II
(Force polygon)

Which one of the following is correct?
(a) Both b and c are in tension
(b) Both b and c are in compression
(c) b is in tension; c is in compression
(d) b is compression; c is in tension

[ESE: 2002]

9. A pin-jointed truss is loaded as shown in the figure below. Match List-I (Member) with List-II (Force Induced) and select the correct answer using the codes given below the lists:



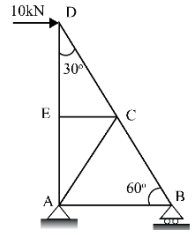
List-I	List-II
A. Member AB	1. 30 kN
B. Member AC	2. 50 kN
C. Member BD	3. zero
D. Member CD	4. 10 kN

Codes:

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

[ESE: 2003]

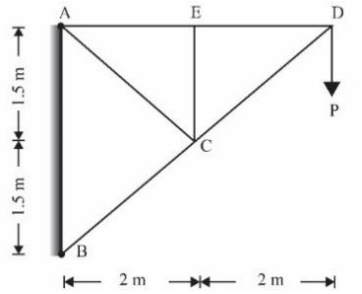
10. Member(s) of the frame shown below which carries/carry zero force is/are



(a) EC only
(b) EC and AB
(c) EC and AC
(d) EC, AC and AB

[ESE: 2003]

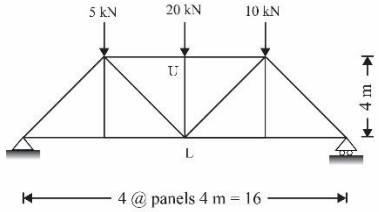
11. What is the force in the member CE of a cantilever truss shown in the adjoining figure?



(a) P(tensile)
(b) P(compression)
(c) $2P$(tensile)
(d) zero

[ESE: 2004]

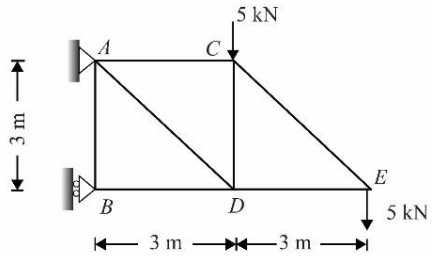
12. The diagram below shows a plane truss. What is the force in vertical member UL of the truss?



(a) 35 kN
(b) 30 kN
(c) 20 kN
(d) 15 kN

[ESE: 2004]

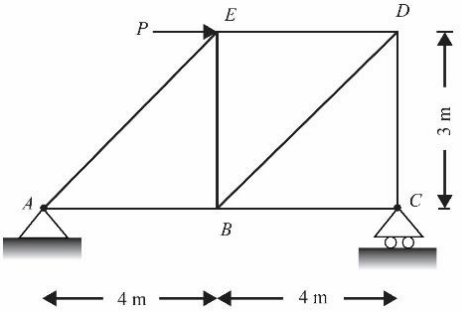
13. The diagram below shows a truss subjected to loading as indicated. What is the force induced in the member?



(a) 5 kN
(b) 10 kN
(c) Zero
(d) $5\sqrt{2}$ kN

[ESE: 2005]

14. What is the ratio of the forces in the members AB, BE and AE of the pin-jointed truss shown in the figure given below?



(a) 5: 4: 3
(b) 4: 3: 5
(c) $\left(\frac{1}{4}\right) \cdot \left(\frac{1}{3}\right) \cdot \left(\frac{1}{5}\right)$
(d) None of these

[ESE: 2006]

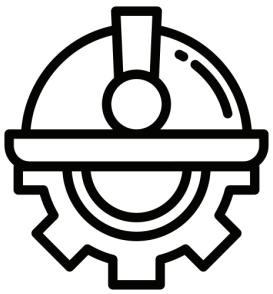
15. Consider the following statements:
Williot-Mohr diagram is used to determine the deflection in
1. an arch
2. a truss
3. a rigid frame
Which of these statements is/are correct?
(a) Only 1
(b) Only 2
(c) Only 3
(d) 1, 2 and 3

DESIGN OF STEEL STRUCTURES

SECTION 4

SYLLABUS

PRINCIPLES OF WORKING STRESS METHODS, DESIGN OF TENSION AND COMPRESSION MEMBERS, DESIGN OF BEAMS AND BEAM COLUMN CONNECTIONS, BUILT-UP SECTIONS, GIRDERS, INDUSTRIAL ROOFS, PRINCIPLES OF ULTIMATE LOAD DESIGN.



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ESE CIVIL: NUMBER OF QUESTIONS ASKED IN PREVIOUS EXAMS (2001-2025)

DESIGN OF STEEL STRUCTURE		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
4.1	Principles of working stress method and structural Fasterners	3	-	4	4	1	2	2	2	3	3	4	3	1	2	7
4.2	Design of Tension Member	2	1	4	3	3	2	2	4	2	2	-	2	-	2	-
4.3	Design of Compression Members	1	5	7	4	9	6	4	3	3	4	3	6	3	6	1
4.4	Design of beam and beam-column connections	3	3	-	3	1	1	-	2	3	1	4	2	1	2	-
4.5	Built – up Sections, Plate Girders and Industrial Roofs	4	4	1	4	6	5	8	3	3	4	5	5	6	6	6
4.6	Principal of ultimate load design and plastic analysis	5	5	6	6	4	6	7	6	7	9	9	-	-	4	1

DESIGN OF STEEL STRUCTURE		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
4.1	Principles of working stress method and structural Fasterners	1	1	1	-	-	3	1	6	4	2
4.2	Design of Tension Member	1	-	1	-	2	2	4	1	-	1
4.3	Design of Compression Members	3	-	2	2	1	4	1	4	5	2
4.4	Design of beam and beam-column connections	-	-	-	-	3	-	2	1	2	2
4.5	Built – up Sections, Plate Girders and Industrial Roofs	1	4	2	5	1	1	1	-	3	1
4.6	Principal of ultimate load design and plastic analysis	3	1	1	4	2	-	-	-	-	-

CHAPTER-4 DESIGN OF STELL STRUCTURES

Unit 4.1: Principles of working stress method and structural Fasteners

Previous Year Exam Questions

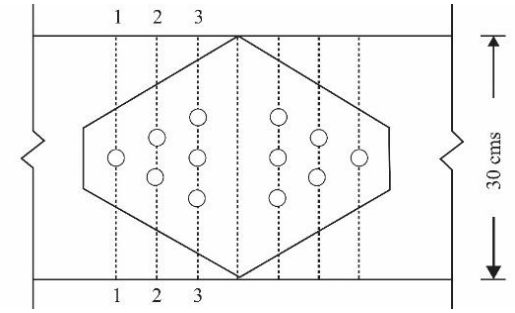
[ESE: 2001]

1. Which one of the following is the mode of failure in a fillet weld material?

(a) Tension (b) Shear
(c) Bearing (d) Crushing

[ESE: 2001]

2. Load on connection is not eccentric for



(a) lap joint
(b) single cover butt joint
(c) double cover butt joint
(d) all the joints mentioned in (a), (b) and (c) of the question

[ESE: 2001]

3. Two steel plates each of 12 mm thickness are connected by a double cover butt joint by rivets shown in the given figure. If the rivet diameter is 22 mm with rivet force value of 53150 N and permissible stress in tension of plate is $\mathbf{N/mm^2}$, which one of the following sections is the most critical section?

(a) Section 1-1
(b) Section 2-2
(c) Section 3-3
(d) Both section 1-1 and section 2-2

[ESE: 2003]

4. The order of elongation which a specimen of mild steel undergoes before fracture is

(a) 0.1% (b) 1%
(c) 10% (d) 100%

[ESE: 2003]

5. Match List-I (Failure mode) with List-II (Reason) and select the correct answer using the codes given below the lists:

List-I	List-II
A. Shear failure of plates	1. Insufficient edge distance
B. Bearing failure of plates	2. Strength of plate is less than that of the rivets
C. Tearing failure of plates	
D. Splitting failure of plates	

Codes:

	A	B	C	D
(a)	1	1	2	1
(b)	2	1	2	1
(c)	1	2	2	1
(d)	1	1	1	2

[ESE: 2003]

6. Which of the following does not describe a weld type?

(a) Butt (b) Plug
(c) Zig-Zag (d) Lap

[ESE: 2003]

7. A plate used for connecting two or more structural members intersecting each other is termed as

(a) Template (b) Base plate
(c) Gusset plate (d) Shoe plate

[ESE: 2003]

8. In a riveted joint, failure will occur due to which one of the following?

(a) Shear failure of rivet
(b) Bearing failure of rivet
(c) Tearing failure of plate
(d) Minimum load value of shearing, bearing or tearing failure

[ESE: 2004]

9. The stress strain diagram for mild steel subjected to tensile load is given below. Now consider the following statements:

(1) The diagram represents average stress strain diagram.
(2) The diagram represents actual stress strain diagram.
(3) A represents upper yield point.
(4) B represents lower yield point.

Which of these statements are correct?

(a) 1,2 and 4 (b) 1,3 and 4

(c) 2, 3 and 4 (d) 1,2 and 3

[ESE: 2004]

10. When the effect of wind or earthquake load is considered in the design of rivets and bolts for steel structures, by what percentage the permissible stresses may be exceeded?

(a) 15% (b) 25%

(c) 33.33% (d) 50%

[ESE: 2004]

11. A 6 mm thick mild steel plate is connected to an 8 mm thick plate by 16 mm diameter shop rivets. What is the number of rivets required to carry an 80 kN load?

(a) 2 (b) 3

(c) 4 (d) 6

[ESE: 2004]

12. Consider the following statements:

(1) The gross area of a rivet is taken as the cross sectional area of the rivet hole.

(2) The distance between the centres of the rivets should not be less than 2.5 times the gross diameter of the rivet.

(3) In no case shall fewer than two bolts or rivets be used for attaching the lug angle to the gusset.

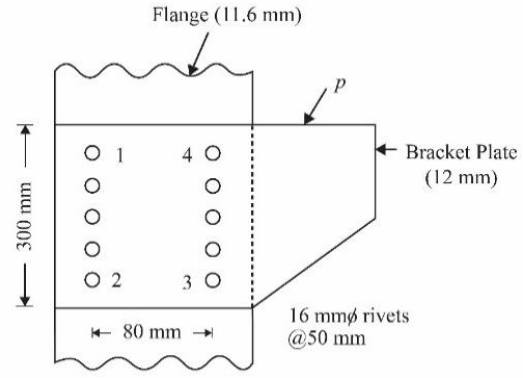
Which of these statements are correct?

(a) 1 and 2 (b) 1 and 3

(c) 2 and 3 (d) 1,2 and 3

[ESE: 2005]

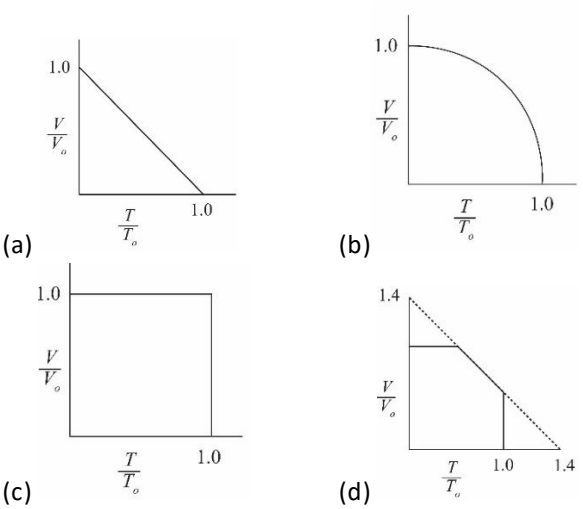
13. Which one of the following is the most critical rivet in the joint shown in the figure given below?



(a) No. 1 (b) No. 2

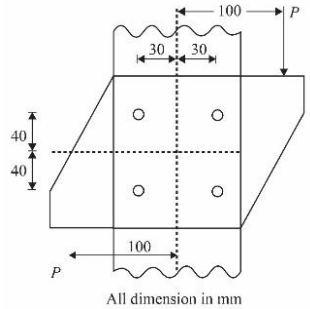
(c) No. 3 (d) No. 4

14. A bolt is subjected to shear force V and tension T. The capacity of the bolt in resisting shear and tension respectively are V_0 and T_0. Which one of the following diagrams represents interaction relations?



[ESE: 2006]

15. A bracket has been attached to flange of a column as shown in the figure. What is the maximum force in the bolt?



(a) $P/4$ (b) $P/2$

(c) P (d) 2 P

[ESE: 2006]

16. Assertion (A): Deflection of a beam with bolted connections is greater than that of a beam with riveted connections.

Reason (R): Bolted connections allow greater slip between components than riveted connections.

(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

[ESE: 2007]

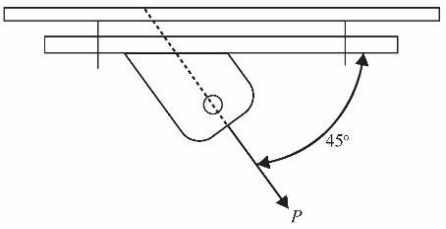
17. What is the ratio of the yield stress in power driven shop rivets relative to the permissible bearing stress of mild steel?

(a) 1.0 (b) 0.8

(c) 0.6 (d) 0.4

18. Four bolts share the load P as shown in the figure below. The shear strength of bolts is 30 kN and tension strength of bolt is 40 kN.

Which one of the following is the value of P?



(a) 96 kN (b) 105 kN
(c) 117 kN (d) 134 kN

[ESE: 2007]

19. Which one of the following is correct?
Steel structures are ideally suitable for impact loads because they have high
(a) toughness value
(b) elastic modulus
(c) design stress
(d) plastic modulus

[ESE: 2008]

20. Which one of the following is correct?
The permissible stresses in a weld are usually taken as
(a) less than those of the parent body
(b) equal to those of the parent body
(c) more than those of the parent body
(d) any desired value

[ESE: 2008]

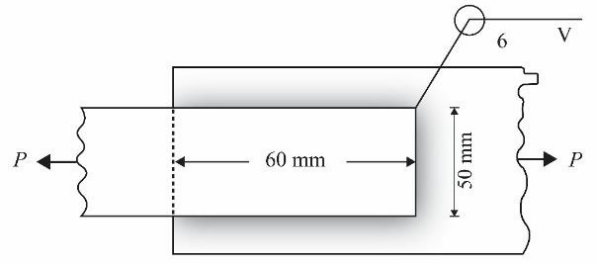
21. For field rivets, the permissible stresses are reduced by what percentage?
(a) 10% (b) 15%
(c) 25% (d) $33\frac{1}{3}\%$

[ESE: 2009]

22. A steel plate is 300 mm wide and 10 mm thick. A rivet of nominal diameter of 16 mm is driven into it. What is the net sectional area of the plate?
(a) $2600\ \text{mm}^2$ (b) $2760\ \text{mm}^2$
(c) $2830\ \text{mm}^2$ (d) $2840\ \text{mm}^2$

[ESE: 2009]

23. What is the safe load P that can be transmitted by the fillet-welded joint shown in figure below if the safe allowable shear stress in the fillet-weld is 108 MPa?



(a) 60 kN (b) 66 kN
(c) 77 kN (d) 81 kN

[ESE: 2009]

24. Consider the following statements:
(1) When wind load is the primary load, no increase in the allowable stresses is provided for in members or fasteners.
(2 Due to wind load acting along with dead and live loads, increase in allowable stress up to 33.33% can be provided for.
(3) Due to wind load acting along with dead load, increase in allowable stress of 25% in foundation bolts can be provided for.
Which of these statements is/are correct?
(a) 1, 2 and 3 (b) 1 only
(c) 2 and 3 (d) 3 only

[ESE: 2010]

25. A bolt designated as Hex bolt M 16×70 NL will have
(a) Diameter of 16 mm
(b) diameter of 70 mm
(c) length of 16 mm
(d) cross-sectional area of $16 \times 70\ \text{cm}^2$

[ESE: 2010]

26. The maximum longitudinal pitch allowed in bolted joints of tension members is
(a) 16 times the diameter of the bolt
(b) 32 times the diameter of the bolt
(c) 16 times the thickness of the plate
(d) 32 times the thickness of the plate

[ESE: 2010]

27. A structural member carrying a pull of 700 kN is connected to a gusset plate using rivets of 20 mm diameter. If the pull required for shearing the rivets, to crush the rivets and to tear the plate per pitch length are $60\text{kN}, 35\text{kN}$ and 70 kN respectively, then the number of rivets required is
(a) 12 (b) 18
(c) 20 (d) 22

[ESE: 2011]

28. The effective length of the fillet weld is
(a) Total length $-2 \times$ throat size
(b) Total length $-2 \times$ weld size
(c) $0.7 \times$ total length
(d) Total length $-\left(\frac{\text{Weld size}}{\sqrt{2}}\right)$

[ESE: 2011]

29. When the distance between centres of two adjacent rivets connecting the members subjected to either compression or tension exceeds the maximum pitch, then the additional rivets which are not subjected to the calculated stresses are known as
(a) Packing rivets (b) Long-grip rivets
(c) Tacking rivets (d) Auxiliary rivets

[ESE: 2011]

30. The maximum longitudinal pitch in bolted joints, subjected to tensile forces, wherein t = thickness of the plate and D = diameter of bolt, is

(a) 32 D (b) 16 D
(c) 32 t (d) 16 t

[ESE: 2011]

31. A tie bar $100\ mm \times 16\ mm$ thick is to be welded to another plate as shown in floure using 8 mm fillet welds. If the tensile stress in plates is $150\ N/mm^2$ and shear stress in weld is $.0\ N/mm^2$, the minimum overlap required will be

(a) 50 mm (b) 75 mm
(c) 100 mm (d) 150 mm

32. For two plates of equal thickness, full strength of square-edged fillet weld can be ensured if its maximum size is limited to

(a) 1.5 mm less than the plate thickness
(b) 67% of the plate thickness
(c) 80% of the plate thickness
(d) Thickness of the plate

[ESE: 2012]

33. When the effect of wind or earthquake load is taken into account in the design of a riveted connection, the permissible stresses in rivets may be exceeded by

(a) 16.66% (b) 33.33%
(c) 25% (d) 30%

[ESE: 2012]

34. A mild steel flat subjected to a tensile force of 840 kN is connected to a gusset plate using rivets. If the permissible forces required per pitch length (i) to shear a single rivet, (ii) to crush the rivet and (iii) to tear the plate are $50kN, 80kN$ and 60 kN respectively, then the number of rivets required is

(a) 12 (b) 14
(c) 16 (d) 17

[ESE: 2012]

35. The effective throat thickness of a fillet weld depends upon

(a) angle between fusion faces
(b) length of weld
(c) permissible shear stress
(d) type of weld

36. When the load line coincides with the centroid of the rivet group, the rivets are subjected to

(a) shear only
(b) tension only
(c) bending only
(d) shear as well as tension

[ESE: 2013]

37. Which of the following statements is/are correct?

(1) A steel structure designer can guarantee the safety of the structure.
(2) Working stress method of design of steel structures offers a safer and economical structure.
(3) Strength and serviceability of a structure cannot be predicted on account of several unforeseen factors

Codes:

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

[ESE: 2014]

38. An angle ISA $50 \times 50 \times 6$ is connected to a gusset plate 5 mm thick, with 16 mm bolts. What is the bearing strength **of the bolt when the hole diameter is 16 mm and the allowable bearing stress is 250 MPa?**

(a) 8 kN (b) 20 kN
(c) 22.5 kN (d) 24 kN

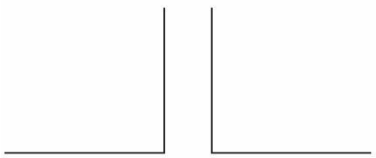
[ESE: 2014]

39. The effective length of a fillet weld is taken as the actual length

(a) plus twice the size of the weld
(b) minus twice the size of the weld
(c) plus the size of the weld
(d) minus the size of the weld

[ESE: 2015]

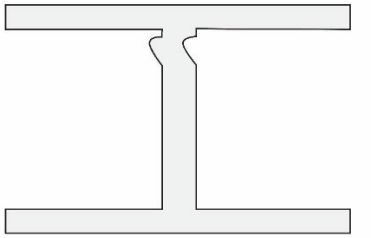
40. For the welded joint shown in the figure, the direct vertical shear stress on the weld is 40 MPa and the bending stress is 120 MPa. For what strength should the weld be designed?



(a) 80 MPa (b) 120 MPa
(c) 132 MPa (d) 160 MPa

[ESE: 2015]

41. A fillet-welded joint is shown in the figure. The size of the weld is 8 mm. Safe stress in the weld is N/mm^2. What is the safe force (to the nearest magnitude) to which the weld can be subjected?



(a) 125 kN (b) 130 kN
(c) 140 kN (d) 135 kN

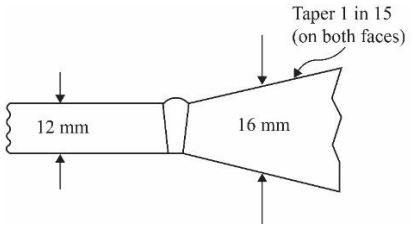
[ESE: 2015]

42. A circular shaft of diameter 120 mm is welded to a rigid plate by a fillet weld of size 6 mm. If a torque of 8 kNm is applied to the shaft, what is the maximum stress in the weld (to the nearest unit)?

(a) $84\ \text{N/mm}^2$ (b) $87\ \text{N/mm}^2$
(c) $90\ \text{N/mm}^2$ (d) $95\ \text{N/mm}^2$

[ESE: 2015]

43. Two plates of dimensions $150\ \text{mm} \times 16\ \text{mm}$ and $150\ \text{mm} \times 12\ \text{mm}$ at their welding edges are joined by butt welding as shown in the figure. What is the maximum tension that this single V-butt weld joint can transmit? The permissible tensile stress in the plates is 150 MPa.



(a) 168.75 kN (b) 270 kN
(c) 218 kN (d) 1350 kN

[ESE: 2015]

44. What is the maximum number of 20 mm diameter bolts that can be accommodated in a single row on a 140 mm wide flat strip used as one of the structural elements involved in the process?

(a) 4 (b) 3
(c) 2 (d) 5

[ESE: 2015]

45. What is the nearest magnitude of strength of a 6 mm fillet weld of 100 mm length made between two flats each 10 mm thick? The allowable shear stress on the weld is 110 MPa.

(a) 23 kN (b) 33 kN
(c) 46 kN (d) 66 kN

[ESE: 2015]

46. Consider the following statements:

(1) When analyzing by the Ultimate Load Method, the eccentrically loaded fastener group rotates about an instantaneous centre.
(2) The rivet which is the farthest from the centre of gravity of the rivet group and may also be the nearest to the applied load line is the most 'critical' one.
(3) The deformation at each rivet is not proportional to its distance from the centre of rotation.

Which of the above statements are correct?

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

[ESE: 2015]

47. Which of the following statements are correct in respect of welded connections?

1. Strength of Butt weld is equal to the strength of components joined.
2. Fillet welds carry the loads computed based on the tensile strength characteristic of fusion material.
3. For effective transmission of load by fillet weld, the fusion faces shall subtend an angle between $60°$ and $120°$.

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

[ESE: 2016]

48. The block shear failure of a bolted joint in tension occurs because of

(1) Use of high shear strength bolts
(2) Use of plates with higher bearing strength

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1

[ESE: 2017]

49. The design strength of a tension member is governed by

1. Rupture at a critical section
2. Yielding of gross area
3. Block shear of end region

Select the correct answer using the codes given below:

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

[ESE: 2018]

50. Statement (I): In a bolted joint, all similarly placed bolts share the load equally.
Statement (II): Bolts are placed in holes having slightly larger diameters.

[ESE: 2021]

51. The ultimate tensile strain in steel is in the range of:

(a) 0.012- 0.020 (b) 0.0012 - 0.0020
(c) 0.12 - 0.20 (d) 0.00012 - 0.00020

[ESE: 2021]

52. Consider the following statements related to merits of construction in structural steel:

1. Structural steel has high strength per unit weight as compared to RCC.
2. The steel members are slender or small in size as compared to RCC.
3. The steel structures are useful in construction of tall buildings, long-span bridges and airplane hangars.

Which of the above statements are correct?

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

[ESE: 2021]

53. A beam simply supported over an effective span of 9 m, carries a uniformly distributed load of 60kN/m, inclusive of its own weight. What is the section modulus of the beam, if $f_y = 250\ \text{N/mm}^2$ and $E = 2 \times 10^5\ \text{N/mm}^2$? (Assume width of support is 200 mm)

(a) $2612 \times 10^3\ \text{mm}^3$ (b) $3682 \times 10^3\ \text{mm}^3$
(c) $4682 \times 10^3\ \text{mm}^3$ (d) $5124 \times 10^3\ \text{mm}^3$

[ESE: 2022]

54. If the load is transmitted by bolts or rivets through some but not all the cross-sectional elements of the member, the effective area A_e is computed by using net area A_n and the reduction coefficient U as

(a) $A_e = UA_n$ (b) $A_e = A_n/U$
(c) $A_e = 0.87UA_n$ (d) $A_e = 0.66UA_n$

[ESE: 2023]

55. An 18 mm thick plate is joined to a 16 mm plate by 200 mm long (effective) butt weld. What is the strength of the joint if a double V butt weld is used? (Assume that Fe410 grade plates and shop welds are used)

(a) 605.987 kN (b) 378.742 kN
(c) 467.535 kN (d) 478.348 kN

[ESE: 2023]

56. Consider the following statements related to principles of design of connections:

1. The centre of gravity of bolts should coincide with the centre of gravity of the connected members.
2. The length of connection should be kept as small as possible.

Which of the above statements is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

[ESE: 2023]

57. Nominal shear capacity of a bolt is 82335 N. What is the design capacity of the bolt, if slip resistance is designated at service load?

(a) 82335 N (b) 74850 N
(c) 449.099 N (d) 395.208 N

[ESE: 2023]

58. Which one of the following is an advantage of welded connection?

(a) Noise produced in welding process is relatively less.
(b) Proper welding in field condition is difficult.
(c) The inspection of welded joint requires non-destructive testing.
(d) There is a greater possibility of brittle fracture in welding.

[ESE: 2023]

59. The maximum pitch for tension and compression members respectively are

(a) (12 t or 200 mm, whichever is less) and (16 t or 200 mm, whichever is less)
(b) (12t or 300 mm, whichever is less) and (16 t or 300 mm, whichever is less)
(c) (16 t or 200 mm, whichever is less) and (12 t or 200 mm, whichever is less)
(d) (16t or 300 mm , whichever is less) and (12 t or 300 mm, whichever is less)

[ESE: 2023]

60. The minimum size of fillet weld for 20 mm to 32 mm plate is

(a) 3 mm (b) 5 mm
(c) 6 mm (d) 8 mm

[ESE: 2024]

61. Which one of the following statements is correct under safety provisions of the ACI code?

(a) Design strength is greater than required strength and design moment is greater than required moment
(b) Design strength is greater than required strength and design moment is less than required moment
(c) Design strength is less than required strength and design moment is greater than required moment
(d) Design strength is less than required strength and design moment is less than required moment

[ESE: 2024]

62. Match the following lists:

List I (Sections)	List II (Limiting width to thickness ratio)
P. Rolled section	1. 88:2
Q. Welded section	2. 42:6
R. Circular hollow section	3. 15:7e
S. Hot rolled RHS	4. 13:6e

Select the correct answer using the code given below:

	P	Q	R	S
(a)	2	3	4	1
(b)	3	1	4	2
(c)	3	1	1	4
(d)	2	4	3	1

[ESE: 2024]

63. Match the following lists:

List I (Types of beams with)	List II (Applications)
P. Angles	1. Long spans and heavy loads
Q. Rolled I-sections	2. Roof purlin and sheeting rail

R. Castellated beams	3. Most frequently used as a beam
S. Plate girders	4. Long spans and light loads

Select the correct answer using the code given below:

	P	Q	R	S
(a)	3	4	1	2
(b)	3	1	4	2
(c)	2	3	4	1
(d)	2	4	1	3

[ESE: 2024]

64. What is the minimum load factor for dead load as per IS 800:1984?

(a) 1.3 (b) 1.7
(c) 2.3 (d) 2.7

[ESE: 2025]

65. Which one of the following statements is not correct?

(a) In elastic theory of design, stresses in the structures under working load are less than the allowable working stress.
(b) Theory of elasticity will be best suited for structural analysis at the time of failure.
(c) Elastic method does not provide a uniform overload capacity for all parts of the structures.
(d) The ultimate load design method is more economical than the elastic design method.

[ESE: 2025]

66. The permissible maximum shear stress τ_{vm} for a steel beam should not exceed

(a) $0.36f_y$ (b) $0.45t_y$
(c) $0.65f_y$ (d) $0.87f_y$

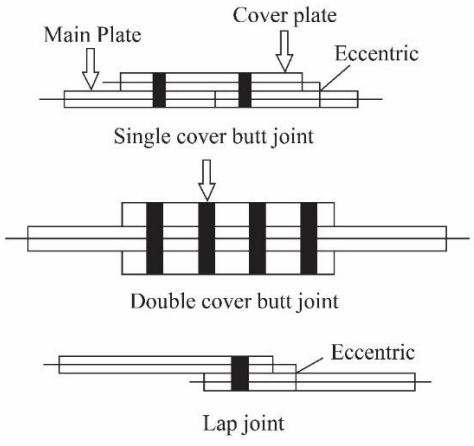
where f_y is the yield stress of steel.

ANSWER KEY									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
(b)	(c)	(a)	(c)	(a)	(c)	(c)	(d)	(b)	(b)
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
(c)	(b)	(c)	(d)	(c)	(*)	(c)	(d)	(a)	(b)
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
(a)	(c)	(c)	(c)	(a)	(c)	(c)	(b)	(c)	(d)
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
(c)	(a)	(c)	(d)	(a)	(a)	(b)	(b)	(b)	(c)
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
(d)	(a)	(a)	(c)	(c)	(c)	(d)	(c)	(d)	(b)
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
(c)	(c)	(b)	(a)	(a)	(c)	(b)	(a)	(c)	(c)
61	**62**	**63**	**64**	**65**	**66**				
(a)	(c)	(c)	(b)	(b)	(b)				

EXPLANATIONS

1. Explanation (b): A fillet weld always fails by shear on its throat, no matter what direction the load is applied.

2. Explanation (c): A double-cover butt (concentric) joint is concentric; a lap joint or single-cover butt joint is eccentric.



3. Explanation (a):

Gross hole diameter

$D_g = 22 + 1.5 = 23.5$ mm

Strength of the main plate

Section	Expression	Value (kN)
1-1	$\sigma_{at}\,(B-d)\,t$	$142\,(300-23.5)\times 12 = 471.156$
2-2	$\sigma_{at}\,(B-2d)\,t + R_V$	$142\,(300-47)\times 12 + 53.150 = 484.262$
3-3	$\sigma_{at}\,(B-3d)\,t + 3R_V$	$142\,(300-70.5)\times 12 + 159.450 = 550.518$

The lowest value occurs at section 1-1, making it the critical section.

4. Explanation (c): For mild steel

Property	Typical range
Proportional limit	$190 - 220$ MPa
Yield strength	$230 - 250$ MPa
Ultimate strength	$410 - 530$ MPa
Fracture strength	$250 - 300$ MPa
Elongation at fracture	$23 - 35\%$

Hence, the required elongation is **10 %**.

5. Explanation (a): A plate tears when its strength is lower than that of the rivets. Possible failures are tearing (splitting), shear, or bearing if edge distance is insufficient.

6. **Explanation: (c) Zig-Zag** refers to a **weld pattern**, not a weld **type**.
The other options — **Butt**, **Plug**, and **Lap** — are all types of welds.

7. **Explanation (c):** Base plates spread the column load over a larger bearing area.

8. **Explanation (d):** Riveted joints may fail by rivet shear, rivet bearing, or plate tearing. Joint strength is the smallest of these three capacities.

9. **Explanation (b):**
Engineering (average) stress $\sigma_e = \frac{P}{A_0}$
True stress $\sigma_t = \frac{P}{A_f}$
Engineering strain $\varepsilon_e = \frac{\ell_f - \ell_0}{\ell_0}$
True strain $\varepsilon_t = \ln\left(\frac{\ell_f}{\ell_0}\right)$
The plotted curve is the **engineering stress-strain** diagram.
A_0: initial area A_f: final area ℓ_0: initial length ℓ_f: final length

10. **Explanation (b):** IS 800 (1984) permits a 25 % increase in allowable stresses for rivets and bolts when wind or earthquake loads are considered.

11. **Explanation (c):**
Permissible stresses for shop rivets
$\tau_s = 100$ MPa, $\sigma_b = 300$ MPa
Gross hole diameter
$D = 16 + 1.5 = 17.5$ mm
Rivet value
Bearing strength $= D\, t\, \sigma_b = 17.5 \times 6 \times 300$
$= 31.5$ kN
Single-shear strength $= \frac{\pi D^2}{4}\tau_s = \frac{\pi}{4}(17.5)^2(100)$
$= 24.05$ kN
Rivet value = **24.05 kN** (governing).
Required rivets: $\frac{80}{24.05} = 3.33 \approx 4$.

12. **Explanation (b):** Rivet pitch must be at least 2.5 times the nominal diameter. Fewer than two fasteners would allow rotation; therefore, at least **two** bolts or rivets are mandatory for a lug-angle connection.

13. **Explanation (c):** The angle between F_1 and F_2 is smallest for **bolt 3**.

14. **Explanation: (d)** As per **IS 800-1984**, when a bolt is subjected to **combined shear and tension**, the **interaction equation** must be satisfied:
$$\frac{V}{V_0} + \frac{T}{T_0} \le 1.4$$
This defines a **linear interaction relationship** with a **sloped boundary** and a **maximum combined limit** of 1.4.

15. **Explanation: (c)** The axial forces on both sides cancel out, so bolts are subjected to moment only.
Moment on the rivets:
$M = P \times 100 + P \times 100 = 200P$
Distance of any rivet from centroid:
$r = \sqrt{30^2 + 40^2} = 50$ mm
Maximum force in a bolt:
$$\frac{M \cdot r}{\sum r^2} = \frac{M \cdot r}{4r^2} = \frac{M}{4r} = \frac{200P}{4 \times 50} = P$$

16. **Explanation: (*)** Bolted connections allow more slip between components compared to riveted ones.
To mitigate this, HSFG bolts (High Strength Friction Grip) designed as slip-critical connections are used.

17. **Explanation: (c)** The **permissible shear stress** for **power-driven shop rivets** is:
$\tau_{\text{rivet}} = 100$ MPa
The **permissible bearing stress** for **mild steel** is:
$\sigma_{\text{bearing}} = 300$ MPa
Now, the required ratio is:
$$\frac{\tau_{\text{rivet}}}{\sigma_{\text{bearing}}} = \frac{100}{300} = 0.33 \approx 0.6$$

18. **Explanation: (d)** According to IS:800, rivets and bolts under combined shear and tension must satisfy:
$$\frac{V}{V_0} + \frac{T}{T_0} \le 1.4$$
Given:
$V_0 = 30$ kN, $T_0 = 40$ kN
$$V = \frac{P\cos 45^\circ}{4}, T = \frac{P\sin 45^\circ}{4}$$
Substituting:
$$\frac{P}{\sqrt{2} \times 4 \times 30} + \frac{P}{\sqrt{2} \times 4 \times 40} \le 1.4$$
Solving:
$P \le 135.76$ kN

19. **Explanation: (a)** Toughness is the capacity of a material to resist fracture and is more relevant for ductile materials.
Ductile materials like mild steel have higher fracture strain, making them tougher than brittle materials like cast iron.

Toughness is essential under impact loading conditions.

20. Explanation: (b) The **permissible stresses in a weld** are generally taken as **equal to those of the parent metal** because the weld metal is designed to have mechanical properties **comparable to the base material** to ensure uniform strength and proper load transfer.

21. Explanation: (a) As per IS 800-1984, permissible stresses are reduced by **10 %** for **field rivets**.

22. Explanation: (c)
Net sectional area:
$A_n = (B - d') \cdot t = [300 - (16 + 1.5)] \cdot 10$
$= 282.5 \cdot 10 = 2825 \text{ mm}^2$

23. Explanation: (c)
Safe load transmitted by fillet weld:
$P = l \cdot (0.7s) \cdot 108$
$P = (60 + 50 + 60) \cdot (0.7 \cdot 6) \cdot 108 = 77112 \text{ N}$
$= 77.1 \text{ kN}$

24. Explanation: (c)
As per Clause 3.9.2.1 of IS:800-1984.

25. Explanation (a): For a hex-bolt designated **M16 × 70 NL**, the nominal diameter is 16 mm and the overall bolt length is 70 mm.

26. Explanation (c): IS 800 (1984) limits the maximum longitudinal pitch in tension members to
$p_{\max} = 16\,t$ (subject to $p_{\max} \le 200$ mm)

27. Explanation (c):
$$\text{Number of rivets} = \frac{P}{\text{Rivet value}} = \frac{700 \text{ kN}}{35 \text{ kN}} = 20$$

28. Explanation (b): The **effective length** of a fillet weld equals the overall weld length minus twice the weld size:
$L_{\text{eff}} = L_{\text{overall}} - 2s$
The deduction accounts for end craters; end returns of length $2s$ relieve high stress concentrations

29. Explanation (c): Tacking (stitch) rivets keep built-up sections acting together and prevent buckling. They are added whenever the spacing exceeds
$\begin{cases} 12t \text{ or } 200 \text{ mm} & \text{(compression)} \\ 16t \text{ or } 200 \text{ mm} & \text{(tension)} \end{cases}$
They are not designed for calculated stresses.

30. Explanation (d): Maximum longitudinal pitch:
1. Tension members: $16\,t$ or 200 mm (whichever is less)
2. Compression members: $12\,t$ or 200 mm (whichever is less)

31. Explanation (c):
Required overlap l:
Minimum overlap $\ge 5d = 5 \times 16 = 80$ mm
Total weld length $= 2l + 200$
Throat thickness $t = 0.7s = 0.7 \times 8 = 5.6$ mm
Equating weld strength to plate strength:
$110(2l + 200) \times 5.6 = 150 \times (200 \times 16) = 240000$
$l = 94.5 \text{ mm} \approx 100 \text{ mm}$

32. Explanation (a): For square-edged fillet welds, the maximum size is limited to **1.5 mm less than plate thickness**. For welds at the round toe of rolled sections, maximum size must not exceed $\frac{3}{4}\,t$.

33. Explanation (c): Permissible-stress increases for wind/earthquake:
1. Rivets, bolts, tension rods: **+25 %**
2. Structural steel, steel castings: **+33 ⅓ %**

34. Explanation (d):
Rivet value (governed by shear, crushing, tearing) = 50 kN
$$\text{Number of rivets} = \frac{840 \text{ kN}}{50 \text{ kN}} = 16.8 \approx 17$$

35. Explanation (a): Constant K versus angle between fusion faces:

Angle (°)	60–90	91–100	101–106	107–113	114–120
K	0.70	0.65	0.60	0.55	0.50

36. Explanation: (a) When the **load line passes through the centroid** of the rivet group, the rivets are subjected to **direct shear only**.
There is **no eccentricity**, so **no moment** is induced, and therefore **no additional tension or bending** arises in the rivets.

37. Explanation (b): No engineer can guarantee absolute safety; working-stress design (WSM) can be uneconomical. Factors of safety accommodate uncertainties in strength and serviceability.

38. Explanation (b):
Bearing strength:
$$P = f_b\, d\, t = 250 \times 16 \times 5 = 20 \text{ kN}$$

39. Explanation (b): Effective fillet-weld length is

$L_{\text{eff}} = L_{\text{actual}} - 2s$

The deduction compensates for end craters at the weld termini.

40. Explanation (c): Fillet welds must resist the resultant of shear and bending stresses:

$\sigma_{\text{res}} = \sqrt{40^2 + 120^2} = 126.49$ MPa

41. Explanation (d): Throat thickness:

$t = 0.7 \times 8 = 5.6$ mm

Safe load:

$P = (80 + 60 + 80)t \times 110 = 220 \times 5.6 \times 110$

$= 135\,520$ N $= 135.52$ kN

42. Explanation (a):

$t = 0.7 \times 6 = 4.2$ mm

$I_p = 2\pi R^3 t$

$\tau = \dfrac{TR}{I_p} = \dfrac{8 \times 10^6 \times 60}{2\pi \times 60^3 \times 4.2} = 84.21$ MPa

43. Explanation (a): Assuming $\frac{5}{8}\ t$ effective penetration in a single-V butt weld:

$P_{\text{max}} = 150 \times \dfrac{5}{8} \times 12 \times 150 = 168.75$ kN

44. Explanation (c):

Hole diameter $= 20 + 2 = 22$ mm

$p_{\text{min}} = 2.5 \times 20 = 50$ mm

$e_{\text{min}} = 1.5 \times 22 = 33$ mm

$2e_{\text{min}} + (n-1)p_{\text{min}} = 140$

$2 \times 33 + (n-1) \times 50 = 140$

$n = 2.48 \Rightarrow n_{\text{max}} = 2$

45. Explanation (c):

Allowable shear:

$P = \dfrac{0.7 \times 6 \times 100 \times 110}{1000} = 46.2$ kN

46. Explanation (c):

For an eccentrically-loaded group of bolts:

$$F_i = \frac{Mr_i}{\sum r_i^2}, M = Pe$$

Bolt deformation—and hence load—is proportional to its distance r_i from the centre of rotation.

47. Explanation (d): Fillet weld capacity is evaluated from the **shear strength of the fusion metal**.

48. Explanation (c): High bearing-strength plates and high-strength bolts reduce bolt count and connection length, thereby **increasing the likelihood of block-shear failure**.

49. Explanation: (d) According to IS 800:2007, Clause 6.1, the design strength of a tension member is governed by the least of the following three failure modes:

1. Rupture at a critical section – typically occurs at net section across a hole or notch.
2. Yielding of gross section – elastic failure across the full uncut cross-sectional area.
3. Block shear – combined tension and shear failure at the end connection region (often where bolts are present).

Since all three modes can govern under different circumstances, all must be considered.

Thus, the correct answer is: 1, 2 and 3 → (d).

50. Explanation: (b) Both statements are true but Statement (II) is not the correct explanation of Statement (I).

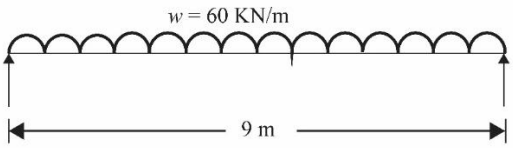
51. Explanation: (c) The ultimate tensile strain in steel typically lies in the range of 0.12 – 0.20. This value corresponds to the maximum strain a steel material can endure before fracture occurs, which is why option (c) is correct.

52. Explanation: (c)

1. Statement 1 is correct: Structural steel has high strength per unit weight compared to RCC (Reinforced Cement Concrete). Steel is stronger and lighter, which makes it more efficient in terms of strength-to-weight ratio.
2. Statement 2 is correct: The steel members are slender or small in size compared to RCC because steel has a higher strength, requiring less material for the same structural strength.
3. Statement 3 is correct: Steel structures are particularly useful in constructing tall buildings, long-span bridges, and airplane hangars because of their high strength and flexibility in design.

Thus, the correct answer is (c): 1, 2, and 3.

53. Explanation: (b)



The maximum bending moment for a simply supported beam under a uniformly distributed load is

$M = \dfrac{wL^2}{8} = \dfrac{60 \times 9^2}{8} = 607.5$ kNm

$= 607.5 \times 10^3$ Nmm