नया साल, नयी शुरुआत

SSC JE (Tier-I)

UPPSC AE

2020

New Batch आज से शुरू
UTTAR PRADESH PUBLIC SERVICE COMMISSION

Combined State Engineering Services
(General Recruitment/Special Recruitment)

Advertisement No. A-5/E-1/2019

692 VACANCIES
### परिशिष्ट-4

परीक्षा योजना एवं पादयोग

सम्मिलित राज्य अभियंत्रण सेवा परीक्षा हेतु वस्तुनिष्ठ प्रश्नावली के निर्माण दो प्रश्न-पत्र होंगे---

<table>
<thead>
<tr>
<th>प्रथम प्रश्न पत्र</th>
<th>विषय</th>
<th>प्रश्नों की संख्या</th>
<th>अंक</th>
<th>कुल अंक</th>
<th>समय</th>
</tr>
</thead>
<tbody>
<tr>
<td>1—सामान्य हिंदी</td>
<td>25 (प्रत्येक प्रश्न 3 अंक)</td>
<td>75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2—मुख्य विषय (सिविल इंजी0–I, मैकेनिकल इंजीनियरिंग, विद्युत इंजीनियरिंग, कृषि इंजीनियरिंग)</td>
<td>100 (प्रत्येक प्रश्न 3 अंक)</td>
<td>300</td>
<td>375</td>
<td>2.30 (घंटा)</td>
<td></td>
</tr>
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</table>

<table>
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<tr>
<th>द्वितीय प्रश्न पत्र</th>
<th>विषय</th>
<th>प्रश्नों की संख्या</th>
<th>अंक</th>
<th>कुल अंक</th>
<th>समय</th>
</tr>
</thead>
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<tr>
<td>1—सामान्य अध्ययन</td>
<td>25 (प्रत्येक प्रश्न 3 अंक)</td>
<td>75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2—मुख्य विषय (सिविल इंजीनियरिंग–II, मैकेनिकल इंजीनियरिंग, विद्युत इंजीनियरिंग–II, कृषि इंजीनियरिंग–II)</td>
<td>100 (प्रत्येक प्रश्न 3 अंक)</td>
<td>300</td>
<td>375</td>
<td>2.30 (घंटा)</td>
<td></td>
</tr>
</tbody>
</table>

**व्यक्तित्व परीक्षा (साक्षात्कार)**

- 100 अंक

**कुल योग**

- 375 + 375 + 100 = 850 अंक
पाठ्यक्रम

सामान्य हिंदी— हिंदी का पाठ्यक्रम इस प्रकार बनाया जायेगा ताकि उम्मीदवार की हिंदी भाषा की समझ और शब्दों के कुशल प्रयोग की जाँच हो सके। इसका स्तर हाई स्कूल का होगा।

सामान्य अध्ययन: सामान्य अध्ययन के प्रश्न–पत्र समसामयिक घटनाओं और ऐसी बातों की उनके वैज्ञानिक पहलुओं पर ध्यान देते हुए जानकारी सम्मिलित होगी जो प्रतिदिन के अनुभव में आती है तथा जिनकी किसी शिक्षित व्यक्ति से अपेक्षा की जा सकती है। प्रश्न–पत्र में भारत का इतिहास, राजनीति और भूगोल के ऐसे
ENGINEERING MECHANICS, STRENGTH OF MATERIALS AND STRUCTURAL ANALYSIS.

Units and Dimensions, SI units, vectors, concept of force, Concept of particle and rigid body Concurrent, Non- Concurrent and parallel forces in a plane, moment of force and varignon’s theorem free body diagram, conditions of equilibrium Principle of virtual work, equivalent force system.

First and second Moment of area, Mass moment of inertia, Static Friction, inclined plane and bearings, kinematics and kinetics, kinematics in Cartesian and Polar Coordinates, motion under uniform and non-uniform acceleration, motion under gravity, Kinetics of particle: Momentum and Energy principles, D’Alembert’s principle, Collision of elastic bodies, rotation of rigid, bodies, simple harmonic motion.

STRENGTH OF MATERIALS:

Simple Stress and Strain, Elastic constants, axially loaded compression members, Shear force and bending moment, theory of simple bending, bending stress, Shear Stress, Beams of uniform strength, Leaf Spring, close coiled helical springs, Strain Energy in direct stress, bending & shear. Deflection of beams; Macaulay’s method, Mohr’s Moment area method, Conjugate beam method, unit load method, Torsion of shafts, Transmission of power, Elastic stability of columns, Euler’s Rankin’s and Secant formulae. Principal stresses and strains in two dimensions, Mohr’s Circle, Theories of Elastic Failure, Thin and Thick cylinder, Stresses due to internal and external pressure- Lame’s equations.
**STRUCTURAL ANALYSIS:**

**PART – B**

**DESIGN OF STRUCTURES: STEEL, CONCRETE AND MASONRY STRUCTURES.**

**STRUCTURAL STEEL DESIGN:**
Structural steel: Factors of safety and load factors, rivetted, bolted and welded joints and its connections, Design by working, stress/limit state method of tension and compression member, beams of built up section, rivetted and welded plate girders, gantry girders, stancheons with battens and lacings, slab and gussetted column bases, Design of highway and railway bridges: Through and deck type plate girder, Warren girder, Pratt truss.
DESIGN OF CONCRETE AND MASONRY STRUCTURES:

Reinforced Concrete: Working Stress and Limit State Method of design-Recommendations of B.I.S. codes, design of one way and two way slabs, stairs-case slabs, simple and continuous beams of rectangular, T and L sections, compression members under direct load with or without eccentricity, isolated and combined footings, Cantilever and counter-fort type retaining walls, Water tanks: Design requirements as per B.I.S. code for rectangular and circular tanks resting on ground, Prestressed concrete: Methods and systems of prestressing, anchorages, analysis and design of sections for flexure based on working stress, losses of prestress, Earth quake resistant design of building as per BIS code. Design of brick masonry as per I. S. Codes, Design of masonry retaining walls.
PART – C

Building Materials, Construction Technology, Planning and Management

Building Materials: Physical properties of construction materials with respect to their use: stones, bricks, tiles, lime, glass, cement, mortars, Concrete, concept of mix design, pozzolans, plasticizers, super plasticizers, Special concrete: roller compacted concrete, mass concrete, self compacting concrete, ferro cement, fibre reinforced concrete, high strength concrete, high performance concrete, Timber: properties, defects and common preservation treatments, Use and selection of materials for various uses e.g. Low cost housing, mass housing, high rise buildings.

Constructions Technology, Planning and Management:

PART - D

GEO TECHNICAL ENGINEERING AND FOUNDATION ENGINEERING

Types of soils, phase relationships, consistency limits particles size distribution, classifications of soils, structure and clay mineralogy. Capillary water, effective stress and pore water pressure, Darcy's Law, factors affecting permeability, determination of permeability, permeability of stratified soil deposits. Seepage pressure, quick sand condition, compressibility and consolidation, Terzaghi's theory of one dimensional consolidation, consolidation test.

Compaction of soil, field control of compaction total stress and effective stress parameters, pore pressure parameters, shear strength of soils, Mohr Coulomb failure theory, shear tests.

Earth pressure at rest, active and passive pressures, Rankin's theory Coulomb's wedge theory, Graphical method of earth pressure on retaining wall, sheetpile walls, braced excavation, bearing capacity, Terzaghi and other important theories, net and gross bearing pressure.

Immediate and consolidation settlement, stability of slope, total stress and effective stress methods, conventional methods of slices, stability number.

Subsurface exploration, methods of boring, sampling, penetration tests, pressure meter tests, essential features of foundation, types of foundation, design criteria, choice of type of foundation, stress distribution in soils, Boussinesq's theory, Westergaard method, Newmarks chart, pressure bulb, contact, pressure, applicability of different bearing capacity theories, evaluation of bearing capacity from filed tests, allowable bearing capacity, settlement analysis, allowable settlement, proportioning of footing, isolated and combined footings, rafts, pile foundation, types of piles, plies capacity, static and dynamic analysis, design of pile groups, pile load test, settlement of piles lateral loads, foundation for bridges, Ground improvement techniques: sand drains, stone columns, grouting, soil stabilization geotextiles and geomembrane, Machine foundation: Natural frequency, design of machine foundations based on the recommendation of B.I.S. codes.
CIVIL ENGINEERING PAPER-II
Part – A

FLUID MECHANICS, OPEN CHANNEL FLOW, HYDRAULIC MACHINES AND HYDROPOWER ENGINEERING.

Fluid Mechanics: Fluid properties and their roles in fluid motion, fluid statics including forces acting on plane and curved surfaces, Kinematics and Dynamics of Fluid flow: Velocity and acceleration, stream lines, equation of continuity, irrotational and rotational flow, velocity potential and stream functions, flownet, methods of drawing flownet, source and sink, flow separation, free and forced vortices.

Flow control volume equation, continuity, momentum and energy equations, Navier-Stokes equation, Euler’s equation of motion and application to fluid flow problems, pipe flow, plane, curved, stationary and moving vanes sluice gates, weirs, orifice meters and Venturi meters.

Dimensional Analysis and Similitude: Buckingham’s Pi-theorem, dimensionless parameters, similitude theory, model laws, undistorted and distorted models.

Laminar Flow: Laminar flow between parallel, stationary and moving plates, flow through pipes.

Boundary Layer: Laminar and turbulent boundary layer on a flat plate, laminar sub-layer, smooth and rough boundaries, submerged flow, drag and lift and its applications.

Turbulent flow through pipes: Characteristics of turbulent flow, velocity distribution, pipe friction factor, hydraulic grade line and total energy line, siphons, expansion and contractions in pipes pipe networks, water hammer in pipes and surge tanks.

Open Channel Flow: Flow types, uniform and nonuniform flows, momentum and energy correction factors, Specific energy and specific force, critical depth, resistance equations and roughness coefficient, rapidly varied flow, flow in transitions, Brink flow, Hydraulic jump and its applications, waves and surges, gradually varied flow, classification of surface profiles, control section, Integration of varied flow equation and their solution.
HYDRAULIC MACHINES AND HYDROPOWER:
Centrifugal pumps: Types, characteristics, Net Positive Suction-head (NPSH), specific speed, Pumps in series and parallel.
Reciprocating pumps, Air vessels, Hydraulic ram, efficiency parameters, Rotary and positive displacement pumps, diaphragm and jet pumps.
Hydraulic turbines: types, classification, Choice of turbines, performance parameters, controls, characteristics, specific speed.
Principles of hydropower development: Types, layouts and component works, surge tanks, *types and choice, Flow duration curves and dependable flow, Storage and pondage, Pumped storage plants, Special types of hydel plants.

Part – B
Hydrology and Water Resources Engineering
Hydrology: Hydrologic cycle, precipitation, evaporation, transpiration, infiltration, overland flow, hydrographs, flood frequency analysis, flood routing through a reservoir, channel flow routing- Muskingam method.
Ground Water flow: Specific yield, storage coefficient, coefficient of permeability, confined and unconfined aquifers, radial flow into a well under confined and unconfined conditions, Open wells and tube wells.
Ground and surface water resources single and multipurpose projects, storage capacity of reservoirs, reservoir losses, reservoir sedimentation.
Water requirements of crops consumptive use, duty and delta, irrigation methods, Irrigation efficiencies.
Canals: Distribution systems for canall irrigation, canal capacity, canal losses, alignment of main and distributary canals, Design of canals by kennedy's and Lacey's theoreie, Water logging and its prevention.
Diversion head works: Components, Principles and design of weirs on permeable and impermeable foundations, Khosla's theory, Bligh's creep theory Storage works.
Cross drainage works.
Types of dams, design principles of gravity and earth dams, stability analysis. Spillways: Spillway types energy dissipation.
River training: Objectives of river training, methods of river training and bank protection.
Part – C

Transportation Engineering


Railway Engineering: Permanent way, ballast, sleeper, chair and fastenings, points, crossings, different types of turn outs, cross-over, setting out of points, Maintenance of track, super elevation, creep of rails ruling gradients, track resistance tractive effort, curve resistance, Station yards and station buildings, platform sidings, turn outs, Signals and interlocking, level crossings.

Airport Engineering: Layouts, Planning and design.
Part – D
Environmental Engineering

Water supply: Estimation of water demand, impurities in water and their significance, physical, chemical and bacteriological parameters and their analysis, waterborne diseases, standards for potable water.

Water collection & treatment: Intake structures, principles and design of sedimentation tank, coagulation cum flocculation units slow sand filter, rapid sand filter and pressure filter, theory & practices of chlorination, water softening, removal of taste and salinity, Sewerage Systems, Domestic and industrial wastes, storm, sewage, separate and combined systems, flow through sewers, design of sewers.

Waste water characterization: Solids, Dissolved oxygen (DO), BOD COD, TOC, and Nitrogen, Standards for disposal of effluent in normal water course and on to land.

Waste water treatment: Principles and design of wastewater Treatment units--, Screening, grit chamber, sedimentation tank activated sludge process, trickling filters, oxidation ditches, oxidation ponds, septic tank; Treatment and disposal of sludge; recycling of waste water.

Solid waste management: Classification, Collection and disposal of solid waste in rural and urban areas, Principles of solid waste management.

Environmental pollution: Air and water pollution and their control acts. Radioactive waste and their disposal Environmental impact assessment of Thermal power Plants, mines and river valley projects, Sustainable development.
Part – E

Survey and Engineering Geology

(a) Surveying: Common methods and instruments for distance and angle measurements in Civil Engineering works, their use in plane table traverse survey, levelling, triangulation, contouring and topographical maps. Survey layouts for culverts canal, bridge, roads, railway alignment and buildings.
Basic principles of photogrammetry and remote sensing.
Introduction to Geographical information system.

Engineering Geology
Basic concepts of Engineering geology and its applications in projects such as dams, bridges and tunnels.
Design of Concrete Structures
By Sandeep Jyani Sir
Reinforced Cement Concrete

Reinforced Cement Concrete (RCC) is a composite mixture of Concrete and steel. Therefore, the structure formed is said to be Reinforced Cement Concrete Structure.
Some Important Codes

- IS 456: 2000  RCC
- IS 1343  Pre Stress Concrete
- IS 10262  Design Mix
- IS 383  Fine and Coarse Aggregate
- IS 875  Design Load for buildings and structures
Cement Concrete

It is a mixture of Cement, sand aggregate and water in a limited proportion.
Cement Concrete

It is a mixture of Cement, sand aggregate and water in a limited proportion.

The cement concrete is manufactured by two ways:
1. Nominal Mix Concrete
2. Design Mix Concrete
Cement Concrete

1. Nominal Mix Concrete
   - Quality control is sacrificed
   - Hard to determine the assurance of quality and strength of the concrete corresponding to the desired strength
   - In a nominal mix, material such as cement, sand and aggregate is not placed under ideal conditions before mixing
   - Skilled workmanship is also sacrificed due to which required strength is not achieved

<table>
<thead>
<tr>
<th>Grade of Concrete</th>
<th>Proportion (Cement: Fine aggregate: Coarse aggregate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M5</td>
<td>1 : 5 : 10</td>
</tr>
<tr>
<td>M10</td>
<td>1 : 3 : 6</td>
</tr>
<tr>
<td>M15</td>
<td>1 : 2 : 4</td>
</tr>
<tr>
<td>M20</td>
<td>1 : 1.5 : 3</td>
</tr>
</tbody>
</table>
1. M10 grade of concrete approximates ______ mix
   a) 1 : 3 : 6
   b) 1 : 1 : 2
   c) 1 : 2 : 4
   d) 1 : 1.5 : 3
Cement Concrete

$M5 \rightarrow 1:5:10$

$M7.5 \rightarrow 1:4:8$

$M10 \rightarrow 1:3:6$

$M15 \rightarrow 1:2:4$

$M20 \rightarrow 1:1.5:3$

$M25 \rightarrow 1:1:2$
1. M10 grade of concrete approximates _____ mix

a) **1 : 3 : 6**

b) 1 : 1 : 2

\[ M5 \rightarrow 1:5:10 \quad M15 \rightarrow 1:2:4 \]

c) 1 : 2 : 4

\[ M7.5 \rightarrow 1:4:8 \quad M20 \rightarrow 1:1.5:3 \]

d) 1 : 1.5 : 3

\[ M10 \rightarrow 1:3:6 \quad M25 \rightarrow 1:1:2 \]
5.1 Cement
The cement used shall be any of the following and the type selected should be appropriate for the intended use:

a) 33 Grade ordinary Portland cement conforming to IS 269
b) 43 Grade ordinary Portland cement conforming to IS 8112
c) 53 Grade ordinary Portland cement conforming to IS 12269
d) Rapid hardening Portland cement conforming to IS 8041
e) Portland slag cement conforming to IS 455
f) Portland pozzolana cement (fly ash based) conforming to IS 1489 (Part 1)
g) Portland pozzolana cement (calcined clay based) conforming to IS 1489 (Part 2)
h) Hydrophobic cement conforming to IS 8043
i) Low heat Portland cement conforming to IS 12600
j) Sulphate resisting Portland cement conforming to IS 12330

5.2.1.4 Metakaoline
Metakaoline having fineness between 700 to 900 m²/kg may be used as pozzolanic material in concrete.

NOTE—Metakaoline is obtained by calcination of pure or refined kaolinitic clay at a temperature between 650°C and 850°C, followed by grinding to achieve a fineness of 700 to 900 m²/kg. The resulting material has high pozzolanicity.

5.4.2 The pH value of water shall be not less than 6.
2. As per I.S. 456 - 1978, the pH value of water shall be
   (a) less than 6
   (b) equal to 6
   (c) not less than 6
   (d) equal to 7
2. As per I.S. 456 - 1978, the pH value of water shall be
   (a) less than 6
   (b) equal to 6
   (c) **not less than 6**
   (d) equal to 7
3. Which code gives the details regarding water to be used in concrete?

a) IS 456  
b) IS 383  
c) IS 565  
d) IS 3012
3. Which code gives the details regarding water to be used in concrete?

a) **IS 456 Clause-5.4 Water**

b) IS 383

c) IS 565

d) IS 3012

---

**5.4 Water**

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel.

**5.4.2 The pH value of water shall be not less than 6.**

**5.4.3 Sea Water**

Mixing or curing of concrete with sea water is not recommended because of presence of harmful salts in sea water. Under unavoidable circumstances sea water may be used for mixing or curing in plain concrete with no embedded steel after having given due consideration to possible disadvantages and precautions including use of appropriate cement system.
4. As per IS 456:2000, the organic content of water used for making concrete should not be more than –

a) 200 mg/L
b) 250 mg/L
c) 100 mg/L
d) 150 mg/L
4. As per IS 456:2000, the organic content of water used for making concrete should not be more than –

a) 200 mg/L
b) 250 mg/L
c) 100 mg/L
d) 150 mg/L

---

Table 1 Permissible Limit for Solids
(Clause 5.4)

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Tested as per</th>
<th>Permissible Limit, Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>IS 3025 (Part 18)</td>
<td>200 mg/l</td>
</tr>
<tr>
<td>ii)</td>
<td>IS 3025 (Part 18)</td>
<td>3000 mg/l</td>
</tr>
<tr>
<td>iii)</td>
<td>IS 3025 (Part 24)</td>
<td>400 mg/l</td>
</tr>
<tr>
<td>iv)</td>
<td>IS 3025 (Part 32)</td>
<td>2000 mg/l for concrete not containing embedded steel and 500 mg/l for reinforced concrete work</td>
</tr>
<tr>
<td>v)</td>
<td>IS 3025 (Part 17)</td>
<td>2000 mg/l</td>
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### Table 1 Permissible Limit for Solids

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<td>3,000 mg/l</td>
</tr>
<tr>
<td>iii)</td>
<td>IS 3025 (Part 24)</td>
<td>400 mg/l</td>
</tr>
<tr>
<td>iv)</td>
<td>IS 3025 (Part 32)</td>
<td>2,000 mg/l for concrete not containing embedded steel and 500 mg/l for reinforced concrete work</td>
</tr>
<tr>
<td>v)</td>
<td>IS 3025 (Part 17)</td>
<td>2,000 mg/l</td>
</tr>
</tbody>
</table>

Civil Engineering by Sandeep Jyani
5. For RCC construction, the maximum size of coarse aggregate is limited to –
   a) 10mm
   b) 15mm
   c) 20mm
   d) 25mm
5. For RCC construction, the maximum size of coarse aggregate is limited to –

a) 10mm

b) 15mm

c) 20mm

d) 25mm

5.3.3 Size of Aggregate

The nominal maximum size of coarse aggregate should be as large as possible within the limits specified but in no case greater than one-fourth of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of the form. For most work, 20 mm aggregate is suitable. Where there is no restriction to the flow of concrete into sections, 40 mm or larger size may be permitted. In concrete elements with thin sections, closely spaced reinforcement or small cover, consideration should be given to the use of 10 mm nominal maximum size.
6. Mild steel used in RCC structure conforms to:
   a) IS : 432
   b) IS : 1566
   c) IS : 1786
   d) IS : 2062
6. Mild steel used in RCC structure conforms to:

a) **IS : 432**

b) **IS : 1566** (hard drawn steel wire fabric)

c) **IS : 1786** (high strength deformed bars)

d) **IS : 2062** (structural steel)
Materials

5.6 Reinforcement

The reinforcement shall be any of the following:

a) Mild steel and medium tensile steel bars conforming to IS 432 (Part 1).

b) High strength deformed steel bars conforming to IS 1786.

c) Hard-drawn steel wire fabric conforming to IS 1566.

d) Structural steel conforming to Grade A of IS 2062.
Cement Concrete

2. Design Mix Concrete
   • It is the ideal mix of the concrete for ideal strength
   • Materials used like cement, sand, aggregate are always placed under ideal temperature and ideal humidity
   • Skilled workmanship is used to achieve the ideal proportion of the mix
   • In Design mix, Concrete is manufactured at the nodal place called Batching Plant and there after it is transported to the site through transit mixture
   • During the process of transportation, the ideal temperature for the ideal proportion mix is maintained through admixtures like plasticizers and super plasticizers, which do not alter the strength of the mix proportion of concrete but delay the setting time of the concrete
Characteristic Compressive Strength

As per IS 456:2000, the value of strength below which not more than 5% of the test results are expected to fall

Mean Strength

It is the strength in which the 50 percent of test results are expected to fall and 50 percent are expected to pass. The strength is called Mean Strength

Confidence Limit

Confidence Limit is the maximum probability of a particular test result shall be within a range of $f_m - 1.64\sigma$ to $f_m + 1.64\sigma$
Probabilistic Curve

\[ \sigma = \text{standard deviation} \]
\[ \text{(depends on grade of concrete)} \]

\[ f_m = f_{ck} + 1.64\sigma \]
\[ \Rightarrow f_{ck} = f_m - 1.64\sigma \]

\[ f_m = f_{ck} - 1.64\sigma \]
\[ \Rightarrow f_{ck} = f_m + 1.64\sigma \]
\[ \Rightarrow f_{ck} = f_m \pm 1.64\sigma \]
Young’s modulus of Elasticity of Concrete

As per IS 456: 2000, young’s modulus of elasticity of concrete is ...

\[ E_c = 5000 \sqrt{f_{ck}} \]

\[ f_{ck} = \text{Characteristic compressive strength} \]
Young’s modulus of Elasticity of Concrete

As per IS 456: 2000, young’s modulus of elasticity of concrete is ...

\[ E_c = 5000 \sqrt{f_{ck}} \]

For example, for M25,

\[ E_c = 5000 \sqrt{25} \]

So, \[ E_c = 5000 \times 5 = 25000 \text{ N/mm}^2 \]
7. The characteristic strength of concrete is defined as that compressive strength below which NOT more than

(a) 2% of results fall
(b) 10% of results fall
(c) 5% of results fall
(d) None of these
7. The characteristic strength of concrete is defined as that compressive strength below which NOT more than

(a) 2% of results fall
(b) 10% of results fall
(c) 5% of results fall
(d) None of these
8. The target mean strength of M20 grade concrete is 27 N/mm², what is the value of standard deviation?

a) 2.01  
b) 3.5  
c) 4.24  
d) 5
8. The target mean strength of M20 grade concrete is 27 N/mm², what is the value of standard deviation?

a) 2.01
b) 3.5
c) **4.24**
d) 5

\[
\text{Target mean strength } f_m = 27 \ \frac{N}{\text{mm}^2}
\]

\[
\text{Characteristic strength } f_{ck} = 20 \ \frac{N}{\text{mm}^2}
\]

\[
\Rightarrow f_m = f_{ck} + 1.65\sigma
\]

\[
\Rightarrow 27 = 20 + 1.65\sigma
\]

\[
\Rightarrow \sigma = 4.24 \ \frac{N}{\text{mm}^2}
\]**
9. The modulus of elasticity of concrete (in N/mm²) can be assumed as follows where $f_{ck}$ is the characteristic cube compressive strength of concrete (in N/mm²)

(a) $4000 \sqrt{f_{ck}}$
(b) $5000 \sqrt{f_{ck}}$
(c) $2000 \sqrt{f_{ck}}$
(d) $3000 \sqrt{f_{ck}}$
9. The modulus of elasticity of concrete (in N/mm\(^2\)) can be assumed as follows where \( f_{ck} \) is the characteristic cube compressive strength of concrete (in N/mm\(^2\))

(a) \(4000 \sqrt{f_{ck}}\)
(b) \(5000 \sqrt{f_{ck}}\)
(c) \(2000 \sqrt{f_{ck}}\)
(d) \(3000 \sqrt{f_{ck}}\)
10. As per IS 456, the number of grades of standard concrete mixes is
   a) 3
   b) 4
   c) 5
   d) 7
10. As per IS 456, the number of grades of standard concrete mixes is

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<th>Grade Designation</th>
<th>Characteristic Compressive Strength of 150 mm Cube at 28 Days in N/mm²</th>
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**Grades of Concrete**

**Ordinary Concrete**
- M10
- M15
- M20

**Standard Concrete**
- M25
- M30
- M35
- M40
- M45
- M50
- M55
- M60
- M65
- M70
- M75
- M80
- M85
- M90
- M95
- M100

**High Strength Concrete**

*after amendment # 4, May 2013*

Civil Engineering by Sandeep Jyani
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