WINTER–19 EXAMINATION
MODEL ANSWER

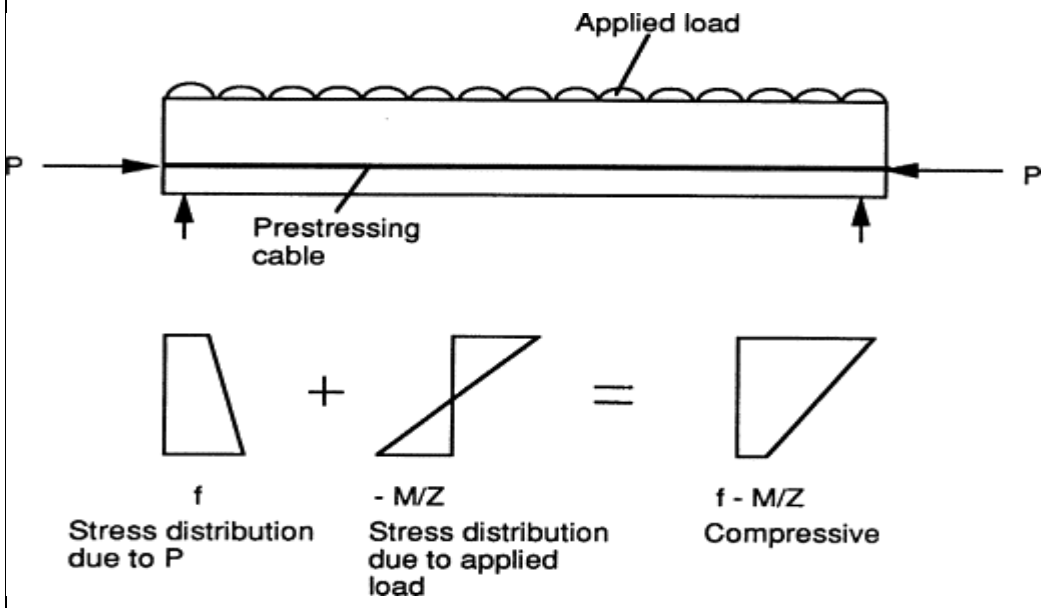
Subject Name: PRECAST & PRESTRESSED CONCRETE **Subject Code**: **22508**

Important Instructions to examiners:

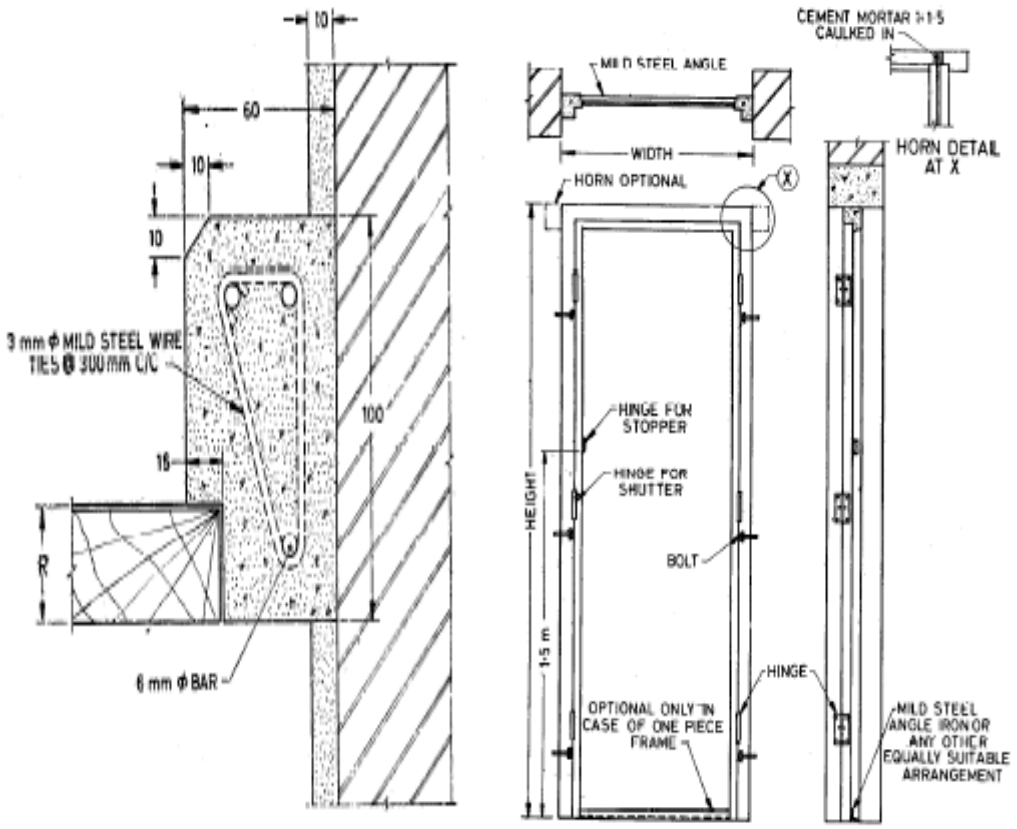
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors etc should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

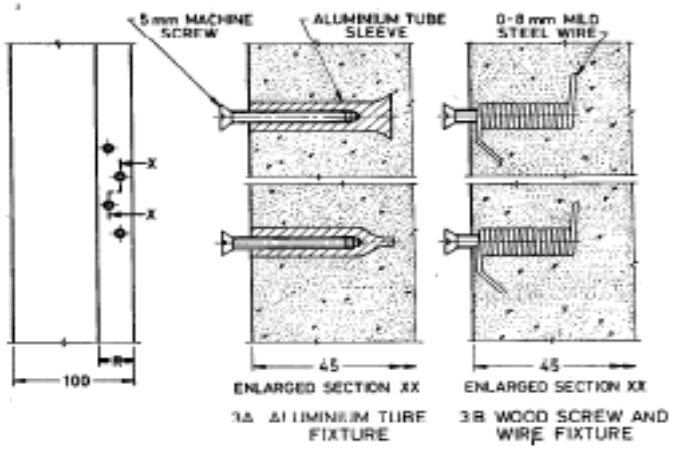
Q. No.	Sub Q. N.	Answers	Marking Scheme	Total Marks
Q.1		**Attempt any Five of the following:**		10
	a)	**State any two names of materials used in precast concrete**		
	Ans	1. Cement 2. Sand 3. Steel 4. Water 5. Polystyrene 6. Fly ash. 7. Ground granulated blast furnace slag	**1 M each for any 2**	

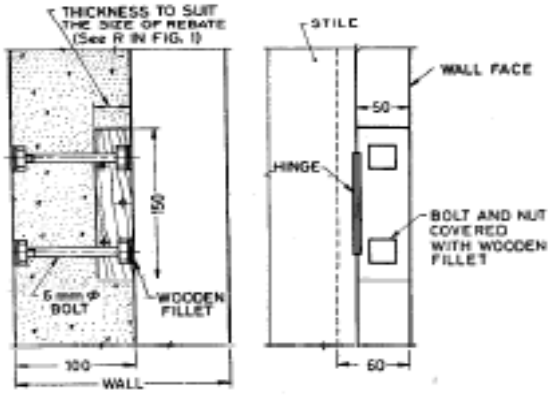
	b	**State any four precast non-structural components that can be used for speedy construction.** 1. Architectural Precast 2. Insulated Architectural Cladding 3. Insulated Wall Panels 4. Column Covers 5. Precast Concrete Light Wall 6. Precast Concrete Spandrels 7. Precast Concrete Solid Walls 8. Stormwater Deflector **9.** Façade **10.** Concrete panels for partition walls **11.** Concrete planks	**$^1/_2$ M each for any 4**	
	C) **Ans**	**Define Modules and modular co-ordination** **Modules:** Modules are a standard unit of size used to coordinate the dimensions of buildings and components. They are of two types: 1. Multi modules 2. Basic modules **Modular Co-ordination:** The modular coordination is defined as the basic module is in adopted the size of which is selected for general application to building and its components. The value of the basic module chosen is 100 mm for maximum flexibility and convenience. The symbol used for basic module is M 1M = 100mm 100 mm = 1M = It is international standard value.	**1 M** **1 M**	
	d) **Ans**	**Define Prestressed concrete and state types of prestressing steel.** **Prestressed concrete**: Prestressed concrete is basically a concrete in which internal stresses of a suitable magnitude and distribution are deliberately introduced so that the stresses resulting from external loads are counteracted to a desired degree. **Types of pre-stressing steel** 1) Plain hard-drawn steel wire conforming to IS: 785(Part 1)-1966 and IS: 1785(Part 2)-1967, 2) Cold-drawn indented wire 3) High tensile steel bar conforming to IS: 2090- 1962, and. 4) Uncoated stress relieved strand conforming to IS: 6006-1970.	**1M** **1 M (Any 2)**	
Q.1	**e)** **Ans**	**What is the basic principle of Prestressed concrete?** **Principle**: The compressive stresses induced by high strength steel tendons in a concrete member before the application of load, will balance the tensile stresses imposed in the member during its service.	**2 M**	

Q.1	**f) Ans**	**List the various types of losses of prestress in pretensioned pre-stressed member.** i. Elastic shortening ii. Shrinkage of concrete iii. Creep of concrete iv. Relaxation of steel	**$^1/_2$ M each**	
Q.1	**g) Ans**	**State cable profile in simply supported rectangular beam section.** **Cabe profile:** In a prestressed concrete member, external type of loads is balanced by transverse component of suitable cable profile, on effect of loading the net deformation increases the stress, strain and length of the tendon, extension of tendon, increase in strain, increase in stress.  	**1 M** **1M**	
Q.2	**a) Ans**	**Attempt any THREE of the following** **State any four advantages and four disadvantages of precast concrete.** **Advantages:** 1. Very rapid speed of erection 2. Good quality control 3. Entire building can be precast-walls, floors, **b**eams, etc. 4. Rapid construction on site 5. High quality because of the controlled conditions in the factory 6. Prestressing is easily done which can reduce the size and number of the structural members. **Disadvantages**: 1. Very heavy members. 2. Camber in beams and slabs. 3. Very small margin for error. 4. Connections may be difficult. 5. Somewhat limited building design flexibility. 6. Because panel size is limited, precast concrete cannot be used for two-way structural systems. 7. Economics of scale demand regularly shaped buildings.	**$^1/_2$ M each for any 4** **$^1/_2$ M each for any 4**	**12**

		8. Need for repetition of forms will affect building design. 9. Joints between panels are often expensive and complicated. 10. Skilled workmanship is required in the application of the panel on site. 11. Cranes are required to lift panels.		
	b) **Ans**	**Describe any two design considerations for Precast Canal lining.** 1. Precast concrete slabs, laid properly on carefully prepared sub-grades and with the joints, effectively sealed, constitute a serviceable type of lining. The precast slabs are about 5 to 8 cm thick with suitable width and length to suit channel dimensions and to result in weights which can be conveniently handled. Such slabs may or may not be reinforced. 2. This type of lining is best suited for repair work as it can be placed rapidly without long interruptions in canal operation. Being prepared under controlled conditions, the quality of its concrete is good. It is easy to lay, involving less site operations; and it is cheaper compared to in-situ concrete lining. 3. Slabs being of small size, there are less shrinkage cracks; also repair of a damaged unit is easier; and, water pressure from ground water gets released through numerous joints that are there. 4. However, seepage losses are obviously more. Transportation of precast slabs may contribute to breakage. **Note: marks may be given for similar points.**	**2 M each for any 2**	
	c)	**Describe with sketch any two joints in doors and window frame.** 1. Connections must be adequate structurally. 2. Means of connections between adjacent must allow safe and speedy erection regardless of minor inherent inaccuracies in precast elements and in-situ concrete. 3. Physical details of joint and connections must permit economic manufacturing. 4. Spacing must be provided for welding insertion of gasket and similar operations in forming joints and connections. 5. Appearance of completed joints must be usually acceptable and match in scale of the completed structure 6. Precast reinforced concrete door and window frames shall be 60 x 100 mm or 70 x 75 mm in cross-section for single shutter door and 60 x 120 mm for double shutter door. 7. The overall sizes (width and height) of the frames shall confirm to the requirements of IS : 4021-1976	**$^1/_2$ M each for any 4**	







3C WOODEN BLOCK FIXTURE

All dimensions in millimetres.

2 M

	d) Ans	**Explain determination of Water absorption of paver block and state acceptable limits as per IS.** **Step 1. Saturation** The test specimen shall be completely immersed in water at room temperature for 24 * 2 h. The specimen then shall be removed from the water and allowed to drain for 1 min by placing them on a 10mm or coarser wire -mesh. 'Visible water on the specimens shall be removed with a damp cloth. The specimen shall be immediately weighed and the weight for each specimen noted in N to the nearest 0.01 N (Ww). **Step 2 : Drying** Subsequent to saturation, the specimens shall be dried in a ventilated oven at 107 + 7°C for not less than 24 h and until two successive weighing at intervals of 2 h show an increment of loss not greater than 0.2 percent of the previously determined mass of the specimen. The dry weight of each specimen (Wd) shall be recorded in N to the nearest O.OI N. **Step 3: Percent Water Absorption (W %)** The percent water absorption shall be calculated as follows: $$W(\%) = \frac{(W_{w} - W_{d})}{W_{d}} \times 100$$ **I.S. limit:** The water absorption, being the average of three units, when determined in the manner described as above, shall not be more than 6 % by mass and in individual samples, the water absorption should be restricted to 7 %	**1 M** **1 M** **1M** **1 M**	
Q. 3	a) Ans	**Attempt any THREE of the following** **Explain the procedure of the storage, transportation and erection of pre-fabricated building elements.** **Storage of pre-fabricated building elements:** 1) Procurement storage of Unloading raw materials 2) Testing of raw materials 3) Design of concrete mix 4) Fabrication of reinforcement cages 5) Oiling and laying of moulds in portion 6) Placing of reinforcement cages inserts and fixtures 7) Preparation of fresh concrete 8) Transport fresh concrete 9) De-pouring into mould etc. 10) Curing of concrete 11) Stacking of pre-cost element 12) Testing of finished Component	**4 M**	**12**

Transport of pre-fabricated building elements:

1) Transport of prefabrication elements must be carried out and with extreme care to avoid any flock and distress in elements and handled as far as possible to be placed in final portion.
2) Transport of prefab elements inside the factory depends on the method of production selected for the manufacture.
3) Transport of prefab elements from the factory to the site of action should be planned in conformity with the trafficable rules and regulations as stipulated by the authorities the size of the elements is often restricted by the availability of suitable transport equipment, such as tractor-am-tailor, to suits the load and dimension of the member in addition to the load carrying capacity of the bridges on the way.
4) While transporting the prefab elements in various systems, such as wages, trucks, bullock cards etc. care should be taken to avoid excessive cantilever actions and desired supports are maintained. Special care should be taken in negotiating sharp beds uneven of slushy roads to avoid undesirable stresses in elements and in transport vehicles.
5) Before loading the elements in the transporting media, care should be taken to ensure the base packing for supporting the elements are located at specified portion only.

Erection of pre-fabricated building elements.

1) It is the process of assembling the Prefabrication element in the find portion as per the drawing. In the erection of prefab elements, the following items of work are to be carried out.
2) Slinging of the prefab elements.
3) Tying up of erection slopes connecting to the erection hooks.
4) Cleaning the elements and the site of erection.
5) Cleaning the steel inserts before incorporation in the joints lifting and setting the elements to correct position.
6) Adjustments to get the stipulated level line and plumb.
7) Welding of cleats.
8) Changing of the erection tackles.
9) Putting up and removing the necessary scaffolding or supports.
10) Welding the insorts laying the reinforced in joints.
11) The erection work in various construction jobs by using prefab elements differs with risk condition, hence skilled foremen, and workers to be employed on the job.

Note: Marks may be given for any 3 points for each process.

	b)	**Explain any one method of Prefab system.** **Prefab system**: It refers to any part of a building that has been fabricated at a place other than its final location. For this reason, it can be referred to by other names such as off-site fabrication, off-site construction or off-site manufacture. **1. Panelized Wood Framing** Long segments of specially lamented timber are converted into solid frames, which are then suitably converted into panels with the help of plywood. With the highest possible length of 72 feet, you can be sure that these frames cover enough area to act as excellent roofing panels. Not only do these roofing panels help you minimize critical construction time but these panels also add safety to the roof construction process. **2. Timber Framing** This remains an increasingly popular prefabrication construction method for timber homes because of its convenience. A timber framing panel is first built in the factory, and then transported to the location of the onsite construction. The advantage of using the timber framing method is that it aids you with the quick erection of prefabricated buildings. **3. Concrete Systems** For the sake of increased durability and improved aesthetics, you must consider the infusion of precast concrete panels to your prefabricated building. Cast in the factory, these concrete components add solidity to your structure as concrete is heavier than most materials commonly used for construction. Furthermore, you can save money if you decide to opt for concrete systems. **4. Steel Framing** Perhaps the most widely utilized commercial and residential construction material, steel remains the go-to material for most modular building companies that intend to achieve durability and strength in the structures they construct. Steel framing is essential for the creation of steel panels, which can then be used for the construction of solid buildings. **5. Modular Systems** How does a modular building company achieve the perfect creation of a factory-constructed module? By implementing all of the prefabrication methods, of course! All the necessary components are first brought to the construction site, where they are slowly connected and securely laid out, and deeply rooted in the foundation that has been prepared to support the structure. And, the result is a brand, new modular building.	**1 M** **3 M each for any one**	

		Modular constructions have been gradually rising in popularity and much of this has to do with its increased efficiency while construction. Modular building companies are achieving higher levels of cost-efficiency, shorter periods of construction time, and with an increased emphasis on reducing resulting waste, there is very little left to be desired. Go on then, browse through our expansive product category. If you need further assessing, feel free to contact us; your needs are all that matter to us.		
	c) **Ans**	**Justify the necessity of use of high-grade materials in prestressed concrete.** 1) If mild steel is used, the working stress in it (i.e. 140 N/mm2) is more or less completely lost due to elastic deformation, creep and shrinkage of concrete. 2) The normal loss of stress in steel is generally about 100 to 240 N/mm2 and it is apparent that if this loss of stress is to be a small portion of the initial stress, the stress in steel in the initial stages must be very high, about 1200 to 2350 N/mm2. 3) These high stress ranges are possible only with the use of high strength steel. High strength concrete is necessary in prestressed concrete since the material offers high resistance in tension shear, bond and bearing. 4) In the zone of anchorages, the bearing stress being higher, high strength concrete is in variably preferred to minimize costs. 5) High strength concrete is less liable to shrinkage cracks, and has a higher modulus of elasticity and smaller ultimate creep strain resulting in smaller loss of prestress in steel. 6) The use of high strength concrete results in a reduction in the cross-sectional dimensions of prestressed concrete structural elements. With reduced dead weight of the material, larger spans become technically and economical practicable.	**1 M each for any 4**	

	d)	**State the advantages and disadvantages of prestressed concrete.**		
	Ans	**Advantages:** 1. The c/s is more efficiently used in fully prestressed members. 2. Dead loads are reduced considerably. 3. Improved shear resistance, due to the effect of compressive prestress, which reduces the principal tensile stress. 4. More resistance for impact and vibration. 5. Prestressed concrete is more predictable than R.C.C. 6. Prestressed concrete has more fatigue resistance 7. Prestressed concrete is more effective for water retaining structures 8. Deflections are less in prestressed structures and hence it is stiffer.	**$^1/_2$ M each for any 4**	
		Disadvantages (or) Limitations of Prestressed Concrete 1. The availability of experienced builders is scanty. 2. Initial equipment cost is very high. 3. Availability of experienced engineers is scanty. 4. Prestressed sections are brittle. 5. Prestressed concrete sections are less fire resistant. 6. In order to get the maximum advantage of prestressed concrete member,it is necessary to use not only High strength concrete but also high tensile steel wires. 7. Concrete used for prestressed work should have a cube strength of 35 N/mm2 for Post tensioned system and 45 N/ mm2 for pretensioned system.	**$^1/_2$ M each for any 4**	
Q. 4		**Attempt any THREE of the following**		**12**
	a)	**Calculate the number of precast slab panels using specification for components as per IS 15916-2010 for a room size 4 m X 5 m.**		
	Ans	**I.S. 15916-2010 Guidelines for Slab panels (Clause 11.1.6 & 11.9.1)** 1) For casting identical reinforced or prestressed panels one over the other with separating media interposed in between is calculated by Stack method. 2) Length of panel = Any desired size.		

		3) Breadth of panel = 1 to 4 m. 4) Mass = 5 t. 5) Stacking of precast element= Lifting of precast elements from the mould and transporting to the stacking yard for further transport by trailer or rail is part of this stage. **Given : Room size = 4 m X 5 m.** **Area of Room = 20 m^2** **Assume,** Length of panel = 4 m & Breadth of panel= 1 m Area of one panel = Length × Breadth = 4 × 1 = 4 m^2 No. of Panels for a Room= $\frac{\text{Area of Room}}{\textbf{Area of One Panel}}$ No. of Panels for a Room= $\frac{20}{4}$ **No. of panels = 5** **Note: Marks may be given for any assumed data.**	**2 M** **2 M**	
	b) **Ans**	**Explain the loss of prestress due to friction and slip of anchorage and state two remedial measures to avoid them.** **Loss due to Friction:** This loss occurs only in post-tensioned members. There always exists a certain amount of friction in the jacking and anchoring system and on the walls of the duct. So, the actual stress in the tendon is less than what is indicated by the pressure gauge. Considerable frictional loss takes place due to friction between the tendon and the material surrounding it, namely the concrete or the sheathing. Loss due to friction may be classified as below. (a) loss due to length effect (b) loss due to curvature effect. The length effect represents the effect of friction for a straight tendon due to slight imperfections of the duct. In practice, the duct meant for the straight tendon is not absolutely straight. Hence the cable will touch the duct or concrete This loss is also called the loss due to wobbling effect. In the case of curved ducts, the loss of prestress depends upon the radius of curvature R of the duct and the coefficient of friction between the duct surface and the tendon. For a straight or moderately curved profile, with curved or straight tendons, the value of prestressing force Po at a distance 'x' meters from tensioning end and acting in the direction of the tangent to the curve of the cable, shall be calculated	**1 M**	

$$\mathbf{Px = Po.}\ e^{-(\mu\alpha+kx)}$$

Where

Po= Prestressing force in the prestressed steel at the tensioning end acting in the direction of the tangent to the curve of the cable,

α = Cumulative angle in radians through which the tangent to the cable profile has turned between any two 'points under consideration,

p = Coefficient of friction between tendons and duct material;

(p may be taken as 0.55 for steel moving on smooth concrete,
0.30 for steel moving on steel fixed to duct, and
0.25 for steel moving on lead), and

k = Coefficient for wave effect varying from 15 x 10^{-4} to 50 x 10^{-4} per m.

1 M

Remedial measures:

1) Over-tensioning the tendons by an amount equal to the maximum frictional loss, and
2) Jacking the tendons from both ends of the beam, generally adopted when the tendons are long or when the angles of curvature are large.

1 M

Loss due to slip of Anchorage: In most of post-tensioning systems, when the cable is tensioned and the jack is released to transfer prestress to concrete, the friction wedges, employed to gripthe wires, slip a small distance before the wires can be firmly held between the wedges. The magnitude of slip depends upon the type of wedge and the stress in the wires. This loss of prestress occurs only in post-tensioned members as no anchorages are used in pre-tensioned members.

Loss of prestress due to anchorage slip = $\dfrac{E_S.\Delta}{L}$

where Es = Modulus of elasticity of steel,
Δ = Anchorage slip, and
L = Length of the cable.

1 M

Loss due to slip in anchorage is of special importance with short members and the necessary additional elongation may be provided at the time of tensioning to compensate for this loss

Remedial measures:

The loss during anchoring, which occurs with wedge-type grip, is normally allowed for on the site by over-extending the tendon in the prestressing operation by the amount of the draw - in before anchoring

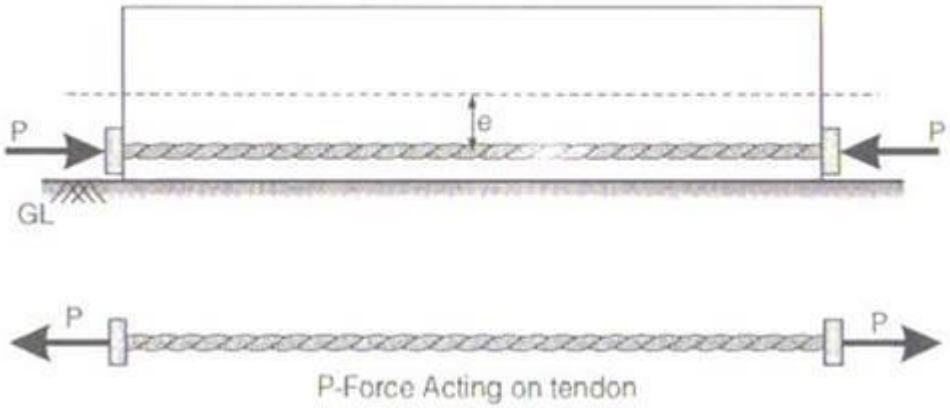
1 M

c) **Illustrate cable profiles for eccentric straight and parabolic cables with sketches.**

Ans

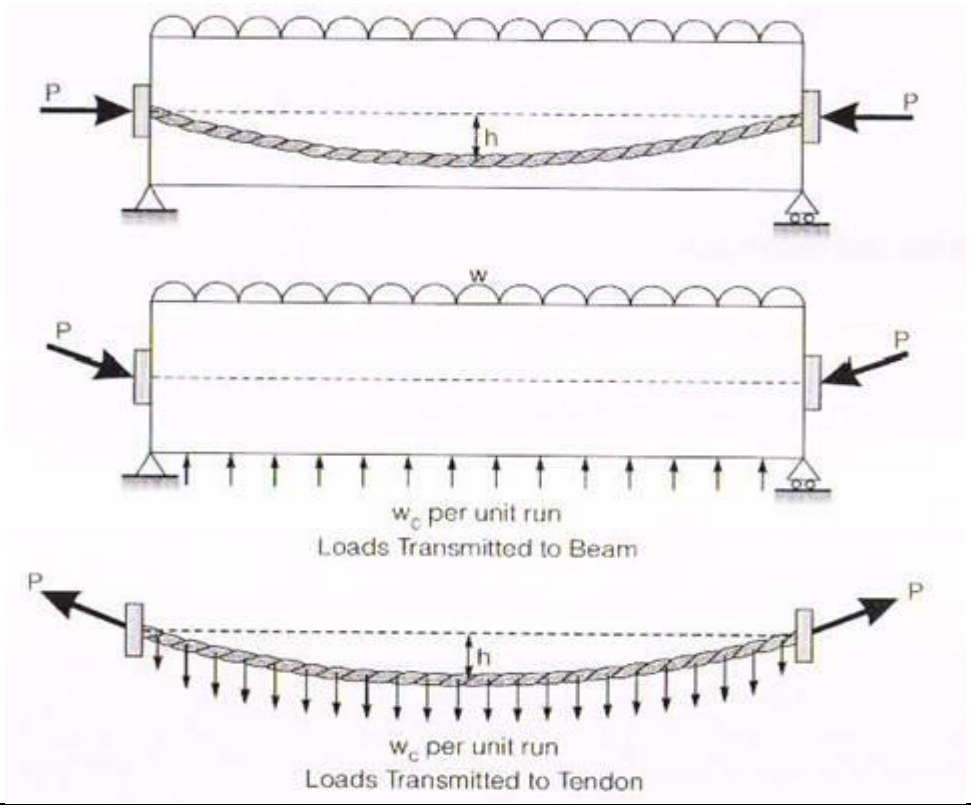
i) Eccentric straight cable profile:

The stress due to prestressing alone are generally combined stresses due to the action of direct load bending from an eccentrically applied load.
In this case, the load is applied concentrically and a compressive stress of magnitude (P/A) will act through out the section. Thus the stress will generate in the section as shown in the figure below.



2 M

ii) Parabolic cable profile

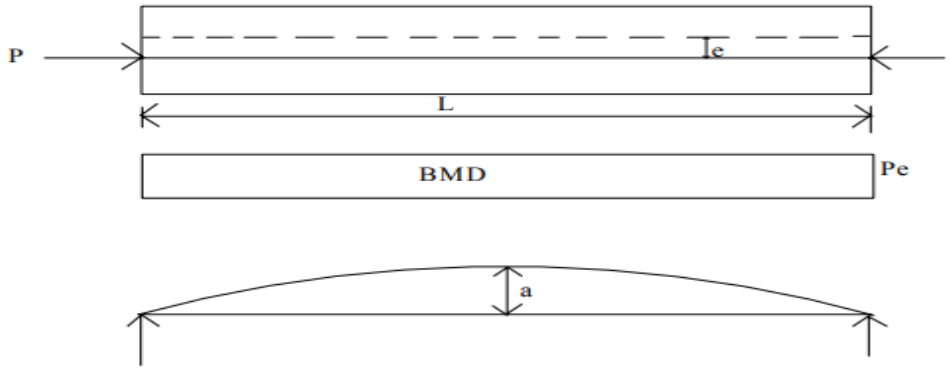


2 M

d) **Explain the effect eccentric straight and parabolic cables on stresses at mid span and at support with formulae.**

Ans

1. Straight tendon



If $P \rightarrow$ Effective prestressing force
$e \rightarrow$ Eccentricity
$L \rightarrow$ Length of the beam

2 M

Then,

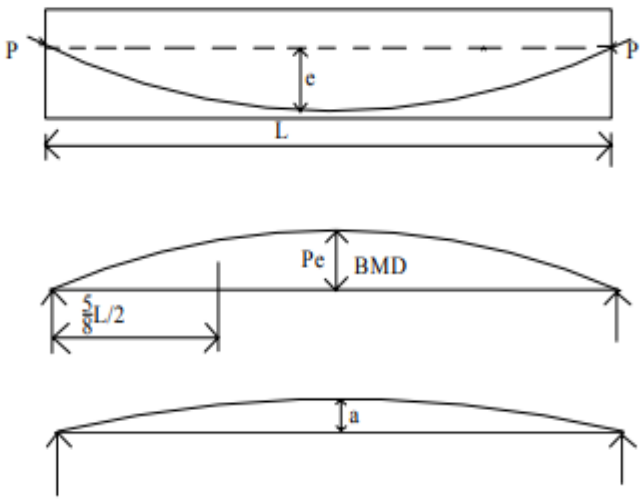
$$\text{Deflection, } a = -\frac{\left(Pe\frac{L}{2}\right)\left(\frac{L}{4}\right)}{EI} = -\frac{PeL^2}{8EI}$$

For Eccentric straight:

Stress at mid span: $\left(\frac{P}{A} + \frac{P.e}{Zb}\right)$

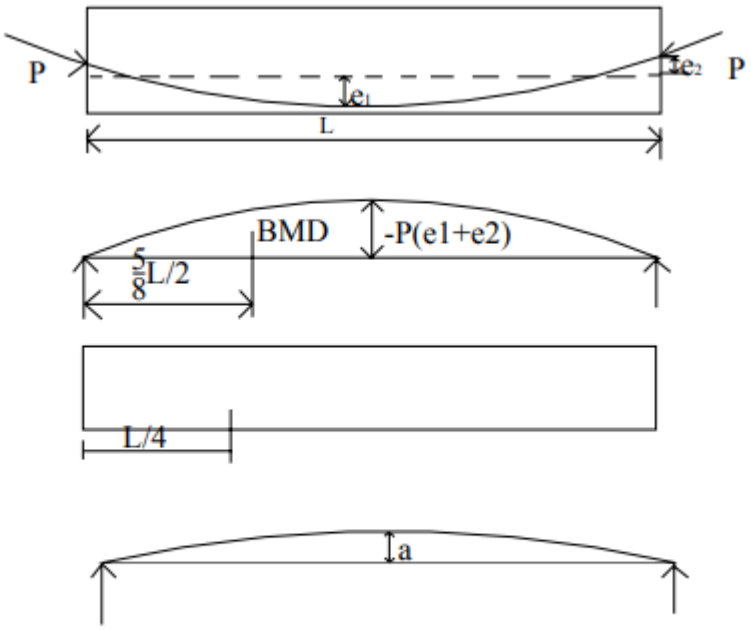
Stress at support: $\left(\frac{P}{A} - \frac{P.e}{Zt}\right)$

2. a) Parabolic Cable profile (Central anchor)



$$\text{Deflection, } a = \frac{Pe}{EI}\left[\frac{2}{3}\cdot\frac{L}{2}\cdot\frac{5}{8}\cdot\frac{L}{2}\right] = -\left(\frac{5PeL^2}{48EI}\right)$$

2 b) Parabolic cable profile (Eccentric anchor)

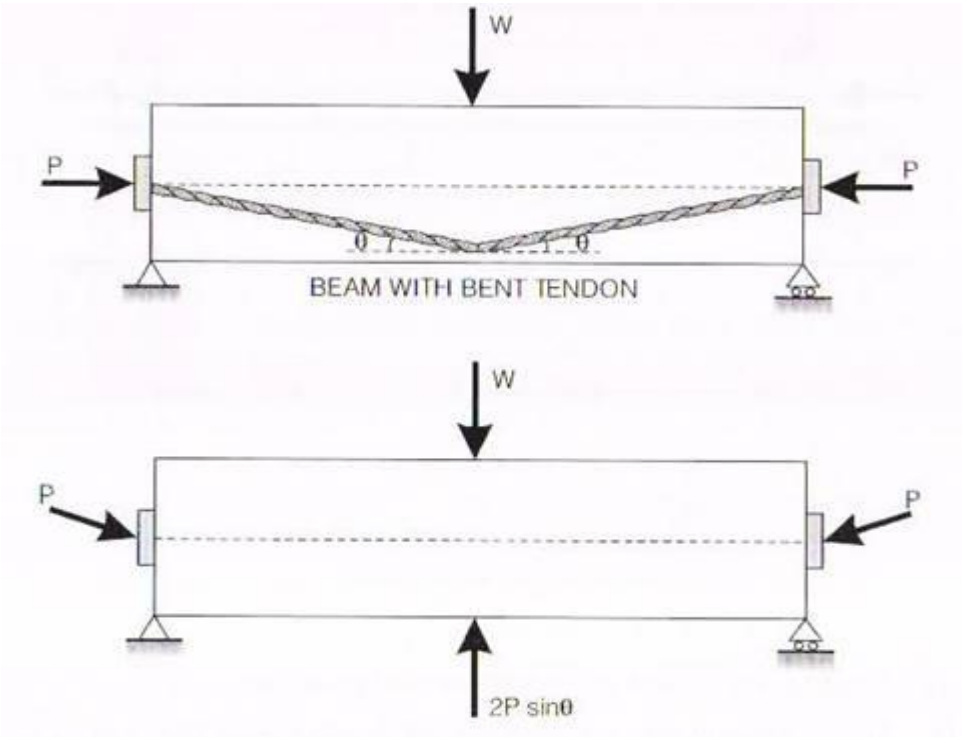


$$\text{Deflection, } a = \left[\frac{-5}{48}\frac{PL^2}{EI}(e_1 + e_2)\right] + \left[\frac{Pe_2L^2}{8EI}\right] = \frac{PL^2}{48EI}(-5e_1 + e_2)$$

2 M

e) A concrete beam supports concentrated load at center on the simply supported span. Suggest a suitable profile.

Ans



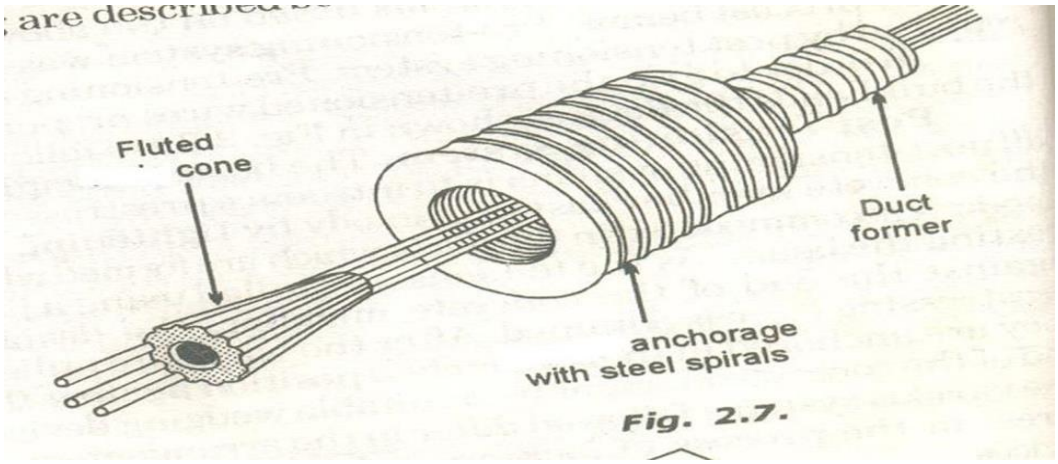
2 M for correct sketch

and

2 M for correct labelling

Q. 5		**Attempt any TWO of the following**		**12**
	a)	**Depict the effect of pre-fabricated building on the surrounding environment with respect to noise pollution, staking at elements and transportation.**		
	Ans	Noise pollution is the serious or more noise that may damage the activity or human life. The contribution of most outside noise is mainly due to building activities. Noise pollution affects both health and human nature Noise annoyance and corresponding problems, bring on noise pollutant through the process of building assemblage, and have come over exponentially significant. This hassle can affect the workers, as well as the residencies. Construction sites are a very common source of noise pollution. Construction and works related to demolition are mostly riotous and repeatedly take place in residential places (out of town). Construction noise is noise that arises from an activity at a construction site that includes; work due to demolition, work related to strategy, and building renewal work Construction noise contributors include pneumatic equipment, air compressors, machine mounted percussion drills, loaders, trucks and breaking equipment. Construction sites bring out lot of noise, mainly from heavy equipment and machinery used in construction field. Over noise is virtually annoyance and confound to the humanity, but can lead to loss of hearing, hypertension, and irregular heartbeat. The factors which influence the society and construction are identified. Such main sources of construction worksite noises are: 1. Diesel power generators 2. Cutting and welding processes 3. Heavy machinery like trucks 4. Transport of materials 5. Demolition 6. Maintenance and Repair 7. Erection. The noise levels created by construction equipment will vary greatly depending on factors such as, 1. The type of equipment 2. The specific model 3. The operation being performed and 4. The condition of the equipment. Noise effects on human beings in construction site are classified into two types such as **Noise hazards** i. Permanent hearing loss ii. Neural stress	**2 M** **2 M** **2 M**	

		Noise nuisance i) Efficiency ii) Mental stress iii) Irritability iv) Sleep interference v) Habit of talking loudly vi) Hearing loss vii) Concentration **Note: Marks may be given for similar points.**		
	b) **Ans**	**Explain freyssinet system of prestressing with respect to process and application with sketches.** **Process: -** 1. The freyssinet system was the first to be introduced among the post – tensioned system high tensile steel wires 5mm to 8mm diameter about 12 in number are arranged to form a group into a cable with spiral spring inside. 2. The spiral spring provides the means for a proper clearance between the wires and thus provides a channel which can be cement grouted. 3. It further assists to transfer the reaction to concrete. The whole thing is enclosed in a thin metal steel. 4. The anchorage consisst of a cylinder of ordinary good quality concrete and is provided with corrugation on the outside. 5. It has a center conical hole and is provided with heavy hoop reinforcement. 6. These cylinders are kept in the proper position and the central conical plugs are pushed into the conical holes after cable are tightened. 7. The central hole passing axially through the plug permits cement grout to be injected through it. 8. In this way the space between the wires will be filled with the grout. This provides additional restraint against the slipping of the tendons. **Application** 1. Bridge decks and piers 2. Nuclear containment vessels 3. Liquefied natural gas (LNG) storage tank 4. Off share platforms. 5. Wind turbine towers etc.	**2 M** **2 M**	**12**

		 Fig. 2.7.	**2 M**	
	c) **Ans**	**For what type of structures do you recommend post-tensioning?** **1) High rise buildings.** In long span slab where beam is not provided & the slab of assembly hall, cinema theaters etc. like structure where the distance between columns are more, then post tensioning is used. It also used in construction of concrete slabs on the ground is areas where soil is more likely to move. **2) Stadiums:** Post-tensioning allows long clear spans and a highly creative architectural approach. **3) Strengthening of existing structures** that are susceptible to seismic shifts. **4) Long span bridges**: - The use of post-tensioning for bridges where it allows very demanding geometry requirements, including complex curves, variable super elevation and significant grade changes.Precast concrete segment construction in bridges to allow for longer span by using post tensioned system. **5) Water tank**: - Tanks and silos, post-tensioning can provide virtually crack-free concrete. **6) Wall panels** **7) Parking decks , Tennis court** **8) Slabs on ground:** Post Tensioning is used extensively for slabs on grade where soils are likely to move (expansive soils)	**1 M each for any 6**	

6		**Attempt any TWO of the following**		12
	a)	**Concrete beam is post tensioned by a cable carrying an initial stress of 1200N/m^2 The slip at jacking end was observed to 5 mm the modulus of elasticity of steel is 210 kN/mm^2 . Estimate percentage loss of stress due to anchorage slip if the length of beam is (i) 25m (ii) 5m**		
	Ans	Given Initial stress = 1200 N/mm^2 Anchor slip = Δ = 5 mm Es = 210 kN/mm^2		
		CASE I – When Length of beam= 25m		
		Loss of prestress due to anchorage slip = $\frac{E_s.\Delta}{L}$		
		$= \frac{210 \times 10^3 \times 5}{(25 \times 10^3)}$		
		= 42 N/mm^2	**1M**	
		Percentage loss = $\frac{\text{loss of stress}}{\text{initial stress}}$ **x100.**		
		$= \frac{42}{1200}$ x 100		
		Percentage loss = 3.5 %	**1M**	
		CASE II : When Length of beam = 5 m		
		Loss of prestress due to anchorage slip = $\frac{E_s.\Delta}{L}$	**1 M**	
		$= \frac{210 \times 10^3 \times 5}{(5 \times 10^3)}$ = 210 N/mm^2		
		Percentage loss = $\frac{\text{loss of stress}}{\text{initial stress}}$ **x100.**	**2 M**	
		$= \frac{210}{1200}$ x100		
		Percentage loss = 17.5 %	**1M**	

b) **A pre- tensioned concrete beam of rectangular cross section, 180 mm wide and 300 mm deep, is prestressed by nine high tensile wires of 7 mm diameter located at 100 mm from the soffit. If the wires are tensioned to a stress of 1200 N/mm2. Calculate the percentage of loss of stress due to elastic deformation assuming modulus of elasticity of concrete and steel are 31.5 KN/mm2 and 210 KN/mm2 respectively.**

Ans

Given
b = 180mm
d= 300 mm
Initial stress =1200 N /mm2
Es = 210 KN /mm2
Ec = 31.5 KN/mm2

Calculate area of the beam

Area = b X d

= 180 X 300

= 54000 mm2 **1 M**

Calculate Moment of Inertia

Moment of inertia (I) = $\frac{b\,.d^3}{12}$

$= \frac{180 \times 200^3}{12}$

$= 405 \times 10^6 \ mm^4$ **1 M**

Calculate Eccentricity

Eccentricity (e) = 150-100

= 50 mm

Modular ratio = m = Es/Ec

= 210/31.5
= 6.67

Area of Steel Wire

= As = $9 \times \frac{\pi}{4}(7^2)$ = 346.36 mm2

Initial prestressing force

= Po = Initial stress × Area force of steel wire
= 1200 x 346.36
= 415.6 x 10^3 N **1 M**

Stress in concrete at the level of steel

$= \frac{Po}{A} + \frac{Po\,.e^2}{I}$

$= \frac{415.6 \text{ x } 10^3}{54000} + \frac{415.6 \text{ x } 10^3 \times 50^2}{405 \times 10^6}$

= 10.26 N/mm2 **1 M**

Loss of stress due to elastic shortening of concrete

		= Modular Ratio × Stress in Concrete = 6.67 × 10.26 = 68.434 N/mm2	1 M	
		Percentage loss $= \frac{\textbf{Loss of elastic shortening}}{\textbf{Initial stress}}$ $= \frac{68.434}{1200} \times 100$ **Percentage loss = 5.7 %**	1 M	