Model Answer: Summer- 2019

Subject: Concrete Technology | **Sub. Code: 22305**

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 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 the candidate and those in the 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 the 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.

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1		**Attempt any FIVE of the following:**		**(10)**
	a)	**List four major compounds of cement with their percentage in ordinary Portland cement.**		
	Ans.		**½ (each)**	**2**

Sr. No.	Name of compound	Formula	%
1	Tricalcium Silicate (C_3S)	3 CaO SiO_2	54.1
2	Dicalcium Silicate (C_2S)	2 CaO SiO_2	16.6
3	Tricalcium Aluminate (C_3A)	3 CaO Al_2O_3	10.8
4	Tetracalcium Aluminoferrite (C_4AF)	4 CaO Al_2O_3 Fe_2O_3	9.1

	b)	**State four requirement of good aggregate.**		
	Ans.	The requirements of good aggregate are as follows. 1. A good aggregate should be strong having sufficient impact, crushing and abrasion strength. 2. A good aggregate should be durable to resist atmospheric variation. 3. It should be non-reactive type to avoid alkali- aggregate reaction. 4. It should be clean i.e. free from organic and inorganic impurities. 5. It should be well graded with minimum voids. 6. It should have rough texture for better bonding.	**½ (each any four)**	**2**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1		7. It should not absorb water more than 5%from added water to avoid variation in w/c ratio. 8. It should have angular shape for strong interlocking of particular.		
	c)	**State Duff Abraham's water cements ratio law.**		
	Ans.	**Duff Abraham's Law –** For workable concrete, the compressive strength of concrete depends on water-cement ratio. Expression – $S = \frac{A}{B^x}$ where, S = Strength of concrete X = water-cement ratio A, B = Empirical constants	**2**	**2**
	d)	**Define concrete mix design.**		
	Ans.	**Concrete Mix Design:** It is the process of determining the quantity of materials required for given grade of concrete, is known as concrete mix design.	**2**	**2**
	e)	**List four materials used for filling joints in concrete.**		
	Ans.	Materials used for filling joints; 1. Asphalt, tar, bituminous materials 2. Fibre and fibre products 3. Sponge rubber 4. Cork 5. Polymer 6. Thermoplastic 7. Glass	**½ (each) any four)**	**2**
	f)	**State two disadvantages of air entraining admixtures.**		
	Ans.	**Disadvantages of air entraining admixtures:** 1. Porosity of the concrete mass increases the chances of honeycombing. 2. The density of concrete i.e. unit weight decreases. 3. Workability of concrete increases but strength of concrete decreases up to certain extent.	**1 (each any two)**	**2**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	**g)**	**Define hydration of cement**		
	Ans.	**Hydration of cement:** It is exothermic chemical reaction takes place when water is added to cement, which gives rise cement paste and large amount heat is evolved. About 120 cal/gm, heat is evolved. This is called as hydration of cement.	**2**	**2**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q. 2		**Attempt any THREE of the following:**		**(12)**
	a)	**Explain the procedure to determine fineness of cement by dry sieving method. State its IS requirement.**		
	Ans.	**Procedure to determine fineness of cement by dry sieving method:** 1. Take the 100 gm of cement sample given using balance as initial weight as W_1 gm. 2. Take 90 micron IS sieve and keep pan at bottom. 3. Place the measured 100 gm cement sample on 90 micron sieve and break the visible lumps present in cement using figures without pressing it on sieve. 4. Keep the lid on sieve. 5. Sieve the cement manually by giving wrist motion for 10-15 minutes, so that cement sample gets sieved completely. 6. Measure the weight of cement fraction retained on 90 micron sieve as W_2 gm. 7. Calculate the % fineness of given cement as (W_2 / W_1) x 100 8. Repeat all above steps to get average % fineness of given cement.	**3**	**4**
		IS requirement of Fineness of cement: According to IS:269, the % fineness of various cements should not exceed following limits. i) Ordinary Portland cement (OPC): 10 % max. ii) Rapid hardening Cement (RHC): 5 % max. iii) Low Heat Cement (LHC): 5 % max.	**1**	
	b)	**List four substances in water having deleterious effects. State their effects on concrete.**		
	Ans.	**Substances in water:** 1. Suspended particles 2. Inorganic salts 3. Acids and Alkalis 4. Algae 5. Sugar content 6. Mineral oil **Effects of deleterious materials on concrete:** **1. Suspended particles:** If the mixing of water contains suspended particles more than 0.02% by weight of total water un concrete, then it affects all properties other than strength of concrete. **2. Inorganic salts:** The inorganic salts like zinc chloride lead nitrate, sodium phosphate etc. reduces strength whereas sodium and potassium carbonates results very rapid setting of concrete. The presence of calcium chloride in water more than 1.5% of total weight of cement results reduces rate of setting of concrete. The salt content in sea water reduces the concrete strength about 10-20% and also affects curing in the form of efflorescence. **3. Acids and Alkalis:** The acids and alkalis present in industrial waste water results in undesirable alkali-aggregate reaction giving cracks on concrete surface. **4. Algae:** The algae present in water reduces bond between	**1 (each) any four)**	**4**

5. **Cement and aggregate:** hence reduces strength of concrete.
6. **Sugar content:** The sugar content in water between 0.05-0.15% by weight of water results in retarding setting time and early strength of concrete. The sugar more than 0.20% will give fast setting but reduces ultimate strength of concrete.
7. **Oil content:** Mineral oil more than 8% reduces strength of concrete and vegetable oil shows detrimental effects on concrete strength at its later stages.

Q.2 c) Calculate the fineness modulus of a sample using following data. Total weight of sample is 1kg.

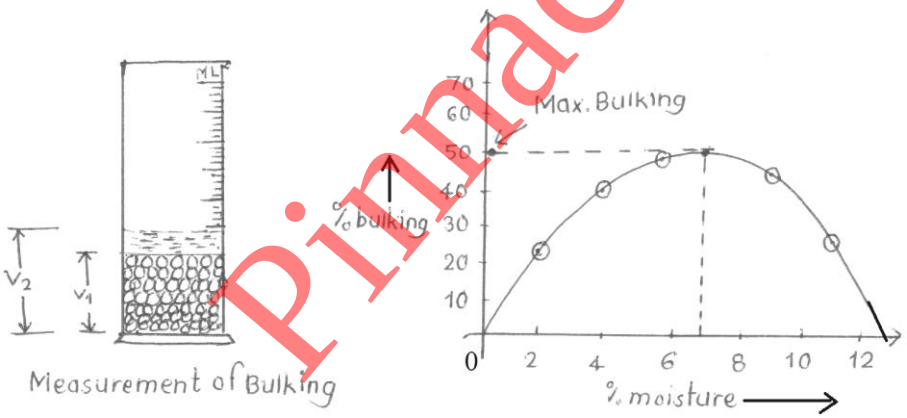
Sieve	**4.75**	**2.36**	**1.18**	**600**	**300**	**150**	**Pan**
Size	**mm**	**mm**	**mm**	**µ**	**µ**	**µ**	**--**
Weight retained (gm)	**100**	**150**	**300**	**200**	**120**	**90**	**40**

Ans.

Sieve	**Size**	**Weight retained (gm)**	**Cumulative weight retained (gm)**	**Cumulative weight retained (%)**
4.75	mm	100	100	10
2.36	mm	150	250	25
1.18	mm	300	550	55
600	µ	200	750	75
300	µ	120	870	87
150	µ	90	960	96
Pan	--	40	1000	
∑ % cumulative wt. retained upto 150µ IS sieve				**348**

F. M.=∑ % cumulative wt. retained upto 150µ IS sieve / 100
F.M. = 348/100
F.M. = 3.48

Marks: 3 + 1 = 4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	d) Ans.	**Explain determination of bulking of fine aggregate with neat sketch.** **Determination of bulking of fine aggregate (sand):** 1. Take 100 gm. of given sand sample and fill it in measuring cylinder about one-third of its weight. Take this volume of sand V_1 ml. 2. Now add 2% water by weight in sand initially. Shake the cylinder vigoursly using palm at top and bottom to cylinder. Note down the increased volume of sand V_2 ml. 3. Calculate % bulking of sand as $b_1 = ((V_2 - V_1)/ V_1] \times 100$ 4. Repeat above steps by adding water at suitable intervals (say 2%) i.e. 4%, 6%, 8% etc. and observe increased volumes V_3, V_4, V_5 etc. Also calculate corresponding % bulking as b_2, b_3, b_4% using above formula. 5. Finally draw the bulking curve as % water versus % bulking as shown in fig below. Note down the maximum % of bulking and corresponding optimum % of water from it.  	3 1	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3		**Attempt any THREE of the following:**		**(12)**
	a)	**Suggest the degree of workability in terms of slump for the following:** **i) Pavements using pavers** **ii) Canal lining** **iii) Heavily reinforced sections** **iv) In-situ piling**		
	Ans.	**Degree of workability in terms of slump for the following:** i) Pavements using pavers: 25-75 mm ii) Canal lining: 70-80 mm iii) Heavily reinforced sections: 50-100 mm iv) In-situ piling: 100-150 mm	**1 (each)**	**4**
	b)	**Explain two causes of each** **i) Segregation** **ii) Bleeding of concrete**		
	Ans.	**Causes of Segregation:** 1. Inaccurate water cement ratio. 2. Improper mixing of concrete ingredients. 3. Longer distance transportation. 4. More height of concrete placing. 5. Excessive or over vibration. **Causes of Bleeding of concrete:** 1. Inaccurate concrete mix proportion with higher w/c ratio 2. Use of more flaky aggregates. 3. Insufficient mixing of concrete. 4. Lean mix i.e. less cements content. 5. Delay in finishing of freshly placed concrete mix.	**1 (each any two)** **1 (each any two)**	**4**
	c)	**Write the significance of water-cement ratio and its effect on hydration of cement.**		
	Ans.	**Significance of water-cement ratio:** The W/C ratio plays very vital role in concrete mixture. The improper or random selection of W/C ratio leads in various defects in fresh and hardened concrete. If W/C ratio is less (say w/c= 1/4 = 0.25), then concrete will become harsh and results in honeycombing or porous nature due to poor workability. If w/c ratio is more ((say w/c= 5/4= 1.25), then concrete undergoes segregation and bleeding. Thus finally concrete shows defects in it. Therefore w/c ratio should be optimum, which depends on grade of concrete and exposure conditions hence w/c ratio should be selected from IS: 456:2000. If w/c ratio is opted out properly as mentioned above, then concrete possess good workability, compressive strength and durability ultimately	**2**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	**c)**	**Effect of water-cement ratio on hydration of cement:** When w/c ratio is less i.e. less water in concrete mix, then it leads to less availability of water than that of required for complete hydration. It decreases the rate of hydration of cement. When w/c ratio is more i.e. excessive water in concrete, then it results in abundant availability of water for sufficient hydration. But such large water may not give proper binding of aggregates.	**2**	
	d)	**Explain two factors affecting properties of hardened concrete.**		
	Ans.	**Factors affecting properties of hardened concrete:** 1. **Type and quality of materials used:** If type and quality of materials used for concrete i.e. cement, sand, aggregate and water is not as per IS recommendations, then the properties of hardened concrete like strength, durability will affect drastically. Reactive aggregates reduce fire resistance and acidic/alkaline water gives cracks in concrete. Lesser grade of cement reduces strength and durability of hardened concrete. 2. **Mix proportion of materials:** The badly mix proportion of good quality materials will result in reduced segregation and bleeding, which finally shows reduced workability and strength of concrete. Improper mix i.e. random water cement ratio shows harshness in concrete, which finally results in unfinished surface of hardened concrete. 3. **Methods of concreting operations:** If the concreting operations like batching, mixing, transportation are not completed in standard manner, then one cannot ensure sufficient strength and durability of concrete in hardened stage. Also lesser compaction results in honeycombing, which shows lack of impermeabilty in concrete. 4. **Workmanship:** This is another important factor on which all the properties of hardened concrete depend. If the supervisors, labours, masons etc are not working properly, then the bad workmanship result in various defects in hardened concrete in terms of reduced strength, more chances of creep etc. 5. **Weather conditions:** The atmospheric variation also affects the properties of hardened concrete. The high temperature results in expansion cracks and reduced temperature gives rise to shrinkage cracks. Alternate drying and wetting of concrete in monsoon season may shows creep in concrete. The sudden change in weather conditions reduces strength and durability of hardened concrete.	**2 (each any two)**	**4**

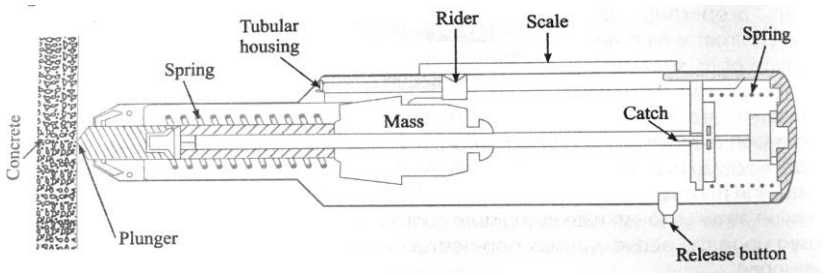
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4		**Attempt any THREE of the following:**		**(12)**
	a) Ans.	**List eight factors affecting workability of concrete.** **Factors affecting workability :** 1. Water content (W/C ratio) 2. Mix proportions of concrete 3. Size of aggregate 4. Shape of aggregate 5. Surface texture of aggregate 6. Grading of aggregate 7. Use of admixtures 8. Method of mixing of concrete.	**½ (each any eight)**	**4**
	b) Ans.	**Write the procedure (steps) of mix design of concrete with reference to the provisions laid in IS:10262-2009** **IS method of mix design with steps-** The concrete mix design is done by IS 10262-2009 using following steps- 1. Calculation of target mean strength –The concrete mix design is done for specific target strength which is calculated first. It is calculated by using formula, $f'_{ck} = f_{ck} + t.S$; where, f'_{ck} = target mean strength after 28 days f_{ck} = characteristics compressive strength at 28 days S = standard deviation from IS 456 T = tolerance factor from IS 456 2. Selection of water-cement ratio- The w/c ratio is selected from the graph of generalized relationship between w/c ratio and compressive strength. The selected w/c ratio is checked against the limiting w/c ratio and lower of two is adopted. 3. Selection of water content- The maximum water content per cubic meter of concrete with nominal maximum size of aggregate s finalized in this step. The water content adopted is used for computing cement content in next step. 4. Calculation of cementitous material content – From adopted w/c ratio and selected maximum water content the quantity of cementious materials is calculated. It is checked against the minimum cementitous content for durability requirement ad larger of the two values is adopted as cement content. 5. Calculation of coarse aggregate proportion –The volume of coarse aggregate per unit volume of total aggregate is chosen in this step based on nominal maximum size of aggregate 6. Selection of combination of coarse aggregate fractions- The different sizes viz. 10 mm , 20 mm , 25 mm are taken in proportion from grading , confirming in table 2 of IS 383 7. Calculation of fine aggregate proportion- From above steps, absolute volume of all ingredients of concrete the mix proportion is calculated for said mix design of concrete.	**4**	**4**

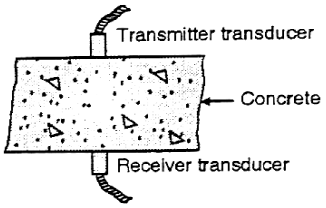
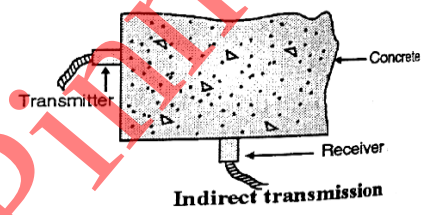
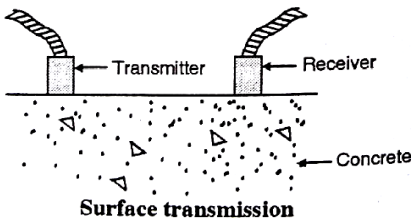
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	**c)** **Ans.**	**Write two effects and two precautions of cold weather and hot weather concreting.** **Effects of cold weather concreting:** 1. Due to cold weather, concrete shows reduced rate of hardening, which results delay in removal of formwork. 2. Water added in concrete mix gets frozen quickly, which results in difficulty in mixing showing less workability of concrete. 3. Snow fall during concerting increases the w/c ratio, which may lead to segregation and bleeding in concrete. 4. Ordinary method of curing becomes unsuitable in such humid conditions. 5. Due to freezing and thawing effect, concrete may results in contraction cracks. 6. Due to excessive moisture, lumps get formed in cement bag. 7. During transportation, concrete becomes hard due to ice formation of water added. **Precautions of cold weather concreting:** 1. Concrete work should be done during day time or on sunny days. 2. Warm water should be added for mixing of ingredients of concrete. 3. Before placing of concrete, the formed ice, snow or frost should be removed from formwork. 4. The accelerating admixtures should be used to increase hardening of concrete. 5. A protective cover should be used over casted concrete to avoid cold winds and snow fall. 6. Aggregates (fine and coarse) should be heated before its use. **Effects of hot weather concreting:** 1. Due to hot weather, concrete shows rapid rate of hardening, which results difficulty in transportation of concrete. 2. Water from concrete mix gets evaporated fastly, which results on w/c ratio and less workability of concrete. 3. Water may get absorbed by formwork, aggregate or ground due to excessive heat. 4. More shrinkage cracks get developed on concrete surface due to incomplete hydration with less water in concrete. Hence, early finishing becomes more essential. 5. Continuous curing is required to keep humidity and to avoid further development of cracks. 6. Air entrained in concrete may get expelled due to temperature, hence workability may reduce additionally. **Precautions of hot weather concreting:** 1. During hot weather, transportation of concrete should be done quickly, without delay to avoid hardening of concrete. 2. Concrete should be covered with polythene before and after concreting work to minimize defects. 3. Before placing, water should be sprinkled on ground and formwork to avoid water absorption from concrete mix. 4. Concreting work should be done during night time only. 5. Retarding admixtures should be used to reduce rate of setting.	½ **(each any two)** ½ **(each any two)** ½ **(each any two)** ½ **(each any two)**	**4**

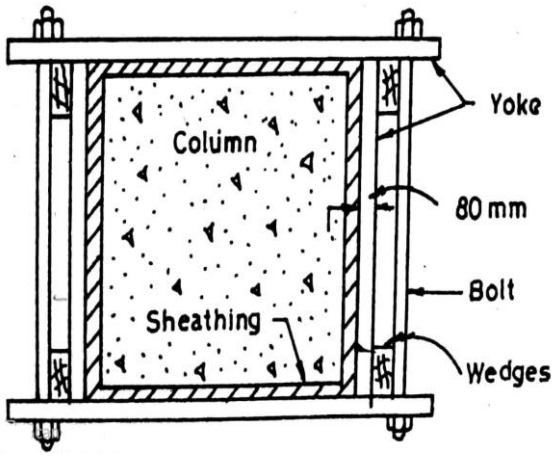
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4		6. Low heat cement should be preferred to minimize heat evolution. 7. High w/c ratio and ice crystals should be used to maintain workability.		
	d)	**Differentiate between retarding and accelerating admixtures with following points.** **i) Hydration process** **ii) Setting time** **iii) Weather condition** **iv) Use**		
	Ans.	The accelerating and retarding admixtures can be compared as follows.	**1 (each)**	**4**

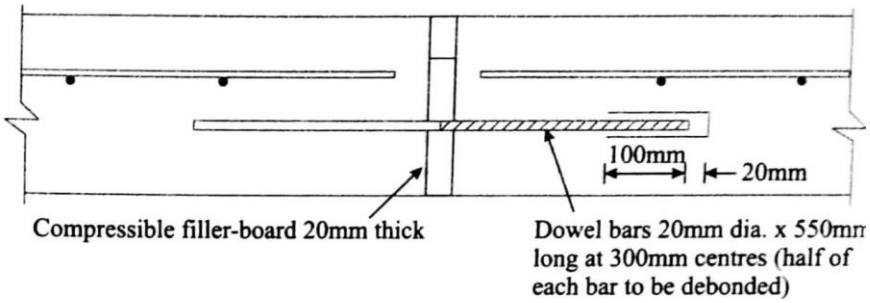
	Accelerating Admixture	**Retarding Admixture**
Hydration process	Due to accelerating admixture, hydration process completes very quickly. Hence hardening of concrete takes place earlier.	Due to retarding admixture, hydration process completes slowly, hence concrete hardens very slowly.
Setting time	Setting time of concrete reduces due to addition of accelerating admixture.	Setting time of concrete increases due to addition of retarding admixture
Weather condition	It is useful for concreting in cold weather condition.	It is useful for concreting in hot weather condition.
Use	• It is applicable where delay in construction is not allowed i.e. road construction. • It is useful where quick setting is required i.e. in underwater construction. • It is beneficial where rapid hardening of concrete is necessary i.e. in case of high rise structures.	• It is applicable where high heat and vibrations are required to reduce i.e. in machine foundations and nuclear power plant. • It is useful where slow setting of concrete is required i.e. in extreme hot weather concreting. • It is beneficial where slow hardening of concrete is necessary i.e. in mass concrete structures.

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	**e)**	**Define the following special types of concretes with its one use.** **i) Vacuum concrete** **ii) Fiber reinforced concrete** **iii) High performance concrete** **iv) Self-compacting concrete**		
	Ans.	The uses of special types of concretes are as follows. **i) Vacuum concrete:** It is the concrete in which entrained air and excess water form concrete mix is taken out from vacuum pump, called vacuum concrete. **Use:** i. Industrial floor sheds. ii. Hydro power plants iii. Bridges, ports and harbours iv. Cooling towers **ii) Fiber reinforced concrete:** The concrete made up of using one or more type of fibers in the concrete mix, is known as fiber reinforced concrete. **Use:** i.Construction of air field, road pavements, industrial floorings, bridge decks, etc. ii.Useful in canal lining, refractory lining. iii.Useful in fabrication of precast products like pipes, boats, beams, staircase steps, wall panels etc. iv.Applicable in construction of explosive resistive structures. **iii) High performance concrete:** The high performance concrete is a concrete in which certain characteristics are developed for a particular application and environment, so that it will give excellent performance in the structure to be built, is called as High performance concrete. **Use:** i. Construction of special structures like atomic power stations, satellite launching station, heavy duty runway, etc. ii. Mass concrete structures like dams, long span bridges, etc. **iv) Self-compacting concrete:** It is the concrete which settle down under its own weight so that it does not require any type of external vibration for its compaction. **Use:** i. Thin walled structures like pardi, retaining wall etc. ii. Highly reinforced sections i.e. large bridge and machine foundations iii. Pumped concrete for floors and slabs. iv. Pre-stressed concrete	**1 (each)**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5		**Attempt any TWO of the following:**		**(12)**
	a)	**Draw a neat and labelled sketch of rebound hammer and write two limitations of it.**		
	Ans.	**Labelled sketch of rebound hammer:** 	**4**	
		Limitations of Rebound hammer test: **1.** Rebound of hammer may get affected due to roughness of concrete surface. **2.** The age of concrete also varies with rebound number i.e. cured concrete gives more rebound no. than fresh one. **3.** Surface moisture of concrete may give inaccurate rebound number. **4.** Type of concrete ingredients i.e. cement, coarse aggregate may affect rebound number. **5.** Size and shape of specimen also affect hammer impact.	**1 (each any two)**	**6**
	b)	**Write one suitability of each different six non-destructive tests.**		
	Ans.	The suitability of various non-destructive tests are as follows. 1. **Surface hardness test-** To estimate the concrete strength using Williams testing pistol and impact hammer. 2. **Rebound hammer test-** To estimate the strength of concrete and comparative investigations. 3. **Ultrasonic pulse velocity test-** To determine homogeneity of concrete mass and strength of concrete. 4. **Penetration and pullout technique-** To determine penetration and pullout resistance of concrete mass and hence to determine concrete strength. 5. **Dynamic or vibration test-** To evaluate durability and uniformity of concrete and to estimate its strength and elastic properties. 6. **Radioactive method-**To measure density and thickness of concrete using X and gamma ray 7. **Nuclear method-** To determine moisture and cement content. 8. **Magnetic method-** To determine cover of reinforcement in concrete mass. 9. **Electrical method-** To measure moisture content and thickness of concrete. 10. **Acoustic emission techniques-** To study the initiation and growth of cracks in concrete.	**1 (each any six)**	**6**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	c) Ans.	**Explain the technique and ways of measuring ultrasonic pulse velocity through concrete. Draw sketches.** **Methods of measuring ultrasonic pulse velocity** 1. Direct transmission 2. Indirect transmission 3. Surface transmission **Direct transmission-** The transmitting and receiving transducers are placed on opposite surfaces of the concrete slab as shown in figure below.  **Direct transmission** **Indirect transmission:** The transmitting and receiving transducers are placed on opposite surfaces of the concrete slab. This will give maximum sensitivity and provide a well-defined path length as shown in figure below.  **Indirect transmission** **Surface transmission:** The transmitting and receiving transducers are placed on same or either side of surfaces of the concrete slab as shown in figure below.  **Surface transmission**	1 1 1 1 1 1	6

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6		**Attempt any TWO of the following:**		**(12)**
	a)	**Explain the significance of batching, compaction and curing of concrete.**		
	Ans.	**Significance of Batching:** 1. If the batching of materials required for concrete is not done appropriately, then random quantity of materials produce non-homogeneous concrete, which further leads to various difficulties in handling the concrete operations in terms of bad workability and poor strength. 2. There are more chances of wastage of concrete to produce good quality of concrete. 3. Un-batched materials results in various defects in concrete in later stages.	**2**	
		Significance of Compaction: 1. If compaction is not done then the concrete mass shows voids in it, resulting porous concrete. 2. Insufficient compaction results in honeycombing of concrete, hence it is important to get dense concrete 3. Compaction is significant to achieve desired strength and to ensure enhanced durability of concrete structure.	**2**	**6**
		Significance of Curing: 1. Curing plays vital role in completing the hydration of cement hence to achieve characteristic strength of concrete. 2. Curing is essential to gain early and ultimate strength of concrete. 3. Curing is necessary to make the concrete impermeable in nature its hardened state.	**2**	
	b)	**Draw a neat and labelled sketches of following:** **i) Plan of column formwork.** **ii) Expansion joint with load transfer device.**		
	Ans.	**i) Plan of column formwork.**  	**3**	**6**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6		**ii) Expansion joint with load transfer device.**  **Expansion Joint with Load-Transfer Device**	**3**	**6**
	c)	**(i) Suggest the relevant method of water-proofing used for following construction.** 1) Basement of buildings. 2) Swimming pool. 3) Water tank. **(ii) Suggest the relevant method of transportation of concrete used for construction in following situation.** 1) Concreting in hilly areas. 2) Concreting of high-rise building. 3) Concreting under water.		
	Ans.	**Method of water-proofing for:** 1) **Basement of buildings:** Waterproofing by using waterproof sealants. 2) **Swimming pool:** Waterproofing by spraying or grouting in cracks. 3) **Water tank:** Waterproofing by water proof coat.	**1 (each)**	
		Method of transportation of concrete for: 1) **Concreting in hilly areas:** Ropeway and helicopter. 2) **Concreting of high-rise building:** Skip and hoist arrangement, concrete pump, slip form technique. 3) **Concreting under water:** Tremie pipe, grout pipe.	**1 (each)**	