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Director's Message

Engineers and scientists from several disciplines have been involved in shaping the revolutionary growth of technology in India. During the last few decades of engineering academics, India has witnessed geometric growth in engineering pass-out candidates. It is noticeable that the level of engineering knowledge has degraded gradually, while on the other hand competition has increased in each competitive examination including GATE and UPSC examinations. Under such scenario high level efforts are required to take an edge over other competitors.

B. Singh (Ex. IES)

The objective of MADE EASY books is to introduce a simplified approach to the overall concepts of related stream in a single book with specific presentation. The topic-wise presentation will help the readers to study & practice the concepts and questions simultaneously, which is very useful for Freshers.

The efforts have been made to provide close and illustrative solutions in lucid style to facilitate understanding and quick tricks are introduced to save time.

Following tips during the study may increase efficiency and may help in order to achieve success.

- Thorough coverage of syllabus of all subjects
- Adopting right source of knowledge, i.e. standard reading text materials
- Develop speed and accuracy in solving questions
- Balanced preparation of technical and non-technical subjects with focus on key subjects
- Practice online and offline modes of tests
- Appear on self assessment tests
- Good examination management
- Maintain self motivation
- Avoid jumbo and vague approach, which is time consuming in solving the questions
- Good planning and time management of daily routine
- Group study and discussions on a regular basis
- Extra emphasis on solving the questions
- Self introspection to find your weaknesses and strengths
- Study the exam pattern to understand the level of questions
- Apply shortcuts and learn standard results and formulae to save time

B. Singh (Ex. IES)
CMD, MADE EASY Group

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CIVIL ENGINEERING

Conventional Solved Paper-I

UPSC Engineering Services Examination

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Building Materials

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SYLLABUS

Timber : *Different types and species of structural timber, density-moisture relationship, strength in different directions, defects, influence of defects on permissible stress, preservation, dry and wet rots, codal provisions for design, Plywood.*

Bricks : *Types, Indian Standard classification, absorption, saturation factor, strength in masonry, influence of mortar strength on masonry strength.*

Cement : *Compounds of cement, different types, setting times, strength.*

Cement Mortar : *Ingredients, proportions, water demand, mortars for plastering and masonry.*

Concrete : *Importance of W/C Ratio, Strength, ingredients including admixtures, workability, testing for strength, elasticity, non-destructive testing, mix design methods.*

Q.1 What are the initial and final setting times of cement? How are they experimentally determined? Briefly explain the roles of gypsum and calcium chloride in cement.

[10 marks : 1995]

Solution:

Cement when mixed with water forms paste which gradually becomes less plastic and finally a hard mass is obtained. In this process of setting a stage, is reached when the cement paste is sufficiently rigid to withstand a definite amount of pressure. The time to reach this stage is termed as setting time. The setting time is divided into two parts, namely, the initial and the final setting times. The time at which the cement paste loses its plasticity is termed as initial setting time. The time taken to reach the stage when the paste becomes a hard mass is known as the final setting time.

Initial and final setting times are determined with the help of Vicat apparatus. A cement paste of standard consistency is filled into the Vicat mould in specified manner within 3-5 minutes. The needle of the apparatus is lowered gently and brought in contact with the surface of the test block. It is quickly released and allowed to penetrate into the test block. In the beginning, the needle completely pierce through the test block, but after some time when the paste starts losing its plasticity, the needle may penetrate only to a depth of 33-35 mm from the top. The period elapsing between the time when water is added to the cement and the time at which the needle penetrates the test block to a depth equal to 33-35 mm from the top is taken as the initial setting time.

For determining final setting time the needle of the Vicat apparatus is replaced by a circular attachment. The cement is considered as finally set when, upon lowering the attachment gently over the surface of the test block, the centre needle makes an impression while the circular cutting edge of the attachment fails to do so. In other words, the paste has attained such hardness that the centre needle does not pierce through the paste more than 0.5 mm.

The reaction of pure tricalcium aluminate (C_3A) with water is very fast and this may lead to flash set of cement. To prevent this flash set, gypsum is added at the time of grinding the cement clinker. The quantity of gypsum added has a bearing on the quantity of C_3A present. Calcium chloride is an accelerator which is added to cement in winter concreting which incidently works as antifreeze also. Calcium chloride increase the rate of hydration, thus can be used where the temperature is very low.

Q.2 What are the factors that influence the strength of concrete? Briefly discuss the effect of water cement ratio and workability on strength of concrete.

[10 marks : 1995]

Solution:

The factors that influence the strength of concrete are:

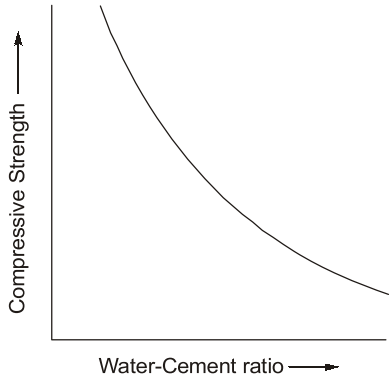
(i) Ratio of cement to mixing water i.e. water-cement ratio

(ii) Ratio of cement to aggregate

(iii) Grading, surface texture, shape, strength and stiffness of aggregate particles

(iv) Maximum size of aggregate

Effect of water-cement ratio on strength of concrete: Strength of concrete primarily depends upon the strength of cement paste. The strength of cement paste depends upon the dilution of paste or in other words, the strength of paste increases with cement content and decreases with air and water content. As per Abram's water-cement ratio law the strength of concrete is only dependent upon water-cement ratio provided the mix is workable. The relation between the water cement ratio and strength of concrete is shown in the figure:



It can be seen that lower water cement ratio could be used when the concrete is vibrated to achieve higher strength whereas comparatively higher water-cement ratio is required when concrete is compacted. In both cases when the water-cement ratio is below the practical limit the strength of the concrete falls rapidly due to introduction of air voids. The graph showing the relationship between the strength and water-cement ratio is approximately hyperbolic in shape. Sometimes it is difficult to interpolate the intermediate value. Therefore, if the graph is drawn between strength of concrete and cement-water ratio an approximately linear relationship is obtained. This linear relationship is more convenient to use than water-cement ratio curve for interpolation.

Effect of workability on strength of concrete: The water-cement ratio is not the only parameter which affect the strength of concrete. Hundred per cent compaction of concrete is an important parameter for contributing to the maximum strength. Lack of compaction will result in air voids whose damaging effect on strength and durability is equally or more predominant than the presence of capillary cavities.

To enable the concrete to be fully compacted with given efforts, normally a higher water-cement ratio than that calculated by theoretical considerations may be required that is to say the function of water is also to lubricate the concrete so that the concrete can be compacted with specified effort forthcoming at the site of work. The lubrication required for handling concrete without segregation, for placing without loss of homogeneity, for compacting with the amount of efforts forthcoming and to finish it sufficiently easily, the presence of a certain quantity of water is of vital importance. The quality of concrete satisfying the above requirements is termed as workable concrete.

Q.3 What is decay in timber ? How is it detected? How can be the timber guarded against decay? Name any two diseases of timber.

[10 marks : 1995]

Solution:

The timber is said to be decayed when it is so deteriorated that it loses its value as an engineering material. The various defects due to which timber is prone to decay are attack of fungi and insects. When these defects are in excess, the timber decays and such timber is not used for engineering purposes.

The various situations which favours early decay of timber are:

(i) Alternate dry and wet conditions.

(ii) Bad storage or stacking of timber.
(iii) Fungi which are responsible for developing diseases in timber.
(iv) Improper seasoning.
(v) Keeping timber in contact with damp wall, damp earth etc.
(vi) Shocks or impacts received during young age from natural forces such as fast blowing wind etc.
(vii) Use of timber without taking out sapwood from its structure.
(viii) Using seasoned timber without applying suitable preservative on its surface.
(ix) Using unseasoned timber without application of protective coat of paint or tar.

The detection of decay may be done as follows:
(i) Abnormal colour is an indication of incipient decay.
(ii) Area showing a range of brown colours different from the normal colour of wood indicates presence of fungus which is a sign of decay.
(iii) An abnormal mottled appearance often indicates decay.
(iv) Softness and brashness of wood are signs of incipient decay.
(v) Roughness of surface is another indication of fungal attack.
(vi) Many decays produce a few to numerous small pits in the beginning of the attack. The presence of soft spots of intense discolouration are signs of incipient decay.

The timber can be protected from decay by seasoning and preservation techniques.

Seasoning of timber: It is the process by which the moisture content of timber is reduced to a suitable level depending upon the use. Timber should be seasoned as early as possible after felling because felled timber is nothing but dead vegetation that will rot and decay due to many environmental agencies. Once the moisture content is brought down to safe limits further safety lies in proper care in use and preservation. Seasoning cannot entirely stop shrinkage and swelling if the timber is exposed to saturated air conditions. But seasoning does reduce this tendency and also ensures freedom from many other agencies causing decay.

Preservation of timber : No timber is immune to deterioration and ultimate disintegration if exposed for a sufficiently long period to ordinary atmospheric conditions. The principal causes of deterioration of wood are fungal infection, termite and other insects attack, mechanical failure and fire. The resistance of wood to these agents of destruction may be increased by the application of a suitable chemical(s) to the wood.

Charring of wood is a form of preservative treatment used as a measure against decay. Application of antiseptic liquids is a modern process and there are many chemicals and many methods of application which are possible depending upon the species of timber and use. Preservatives can be classified as:

(i) Oil type: Coal tar creosote with or without admixtures of petroleum, coal tar, fuel oil etc.
(ii) Organic solvent type: Consists of toxic substances dissolved in volatile spirits like copper, DDT etc.
(iii) Water soluble (leachable) type: Salts like zinc chloride, borax etc.
(iv) Water soluble (fixed) type: Water soluble salts with a fixative salt like copper-chrome-arsenic composition, chromated $ZnCl_2$, etc.

Blue stain, brown rot, dry rot, heart rot, sap stain, wet rot white rot, etc. are some of the diseases of timber.

Q.4 Explain the purpose of conducting soundness test of cement. Describe the apparatus and method of test with the help of neat sketches. What are the permissible limits of observations in the test?
[10 marks : 1996]

Or

Describe the procedure to list the soundness of cement. Name the constituents causing soundness.
[10 marks : 2010]