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USE OF SILICA SAND PARTIAL REPLACEMENT OF FINE MATERIAL(SAND) IN CONCRETE

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Abstract:

An experimental study is conducted on "SILICA SAND", industrial waste mixed with cement concrete in partial replacement of cement as it contains high percentage of silicon. Silica sand is a by-product of glass manufacturing industries. Concrete made from silica sand as partial replacement of fine aggregate will be studied for workability, compressive strength, tensile strength, and modulus of elasticity. I will use silica sand as partial replacement of fine aggregate by different percentage for making concrete of grade M-20.. The percentage replacement will be 0%, 5%,10%,15%,20%, and 25% with natural fine aggregate by its weight. I will prepare cubes, cylinders, beams and finally slump test, compressive strength test, splitting tensile strength test and flexural strength test will be conducted to obtain the necessary results. a cement manufacturing company. In this study, the cement as well as fine aggregates are replaced by a byproduct from a cement manufacturing company at 5%, 10%, 15% and 20%. During hydration process there are cement particles which serves as filler instead of taking part in hydration. Hence, in this study the cement is also replaced by crystalline powder which acts as filler. The concrete taken for study is M20 grade. A large no. of trial mixes are required to select the desired optimum replacement of fine aggregate by silica sand The test program consists of carrying out compressive strength test on cubes, split tensile strength test on cylinders and flexural strength test on beams.

Keywords: Silica Sand, Compressive Strength, Flexural Strength, Split Tensile Strength

I. INTRODUCTION

Each year thousands of tons of waste materials are disposed on the valuable land which results in the occupation and degradation of valuable land. Decreasing of natural resources is a common phenomenon in developing countries like India due to rapid urbanization & industrialization involving construction of infrastructures. Currently waste handling is big problem. Therefore, many investigations are carried out in order to utilize industrial, constructional and domestic waste for concrete mix. There are many investigations are carried out on the using of rubber of tyres, plastic waste, bottom ash, fly ash, copper slag, quarry dust, tiles waste, recycled aggregate, waste glass etcCement is one of the most produced materials around the world. Due to the importance of cement as a construction material, and the geographic abundance of the main raw material, limestone, cement is produced in virtually all countries. The widespread production is also due to the relatively low price

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and high density of cement However, the production of Portland cement, an essential constituent of concrete, leads to the release of a significant amount of CO2 and other greenhouse gases (GHGs). SILICA is the most abundant mineral found in the crust of the earth. It forms an important constituent of practically all rock-forming minerals. It is found in a variety of forms, as quartz crystals, massive forming hills, quartz sand (silica sand), sandstone, quartzite, tripoli, diatomite, flint, opal, chalcedonic forms like agate, onyx etc… Silica sand contain a high proportion of silica (up to 99% SiO2) in the form of quartz and are used for applications other than as construction aggregates. They are produced from both loosely consolidated sand deposits and by crushing weakly cemented sandstones.

II. METHODOLOGY

Silica sand is finely powdered crystalline silica which can be used as a replacement of cement and fine aggregate. Its micro-filling effect reduces pores in concretes and provides better moisture resistivity and thus durability. The silica sand has various advantages such as energy efficiency, fire resistance, reduction of dead load, environmentally friendly, durable, light weight, low maintenance and low construction cost. Using silica sand in concrete can reduce the cost of concrete and may increase the strength to some extent. Silica sand is a preferred for construction material due to its higher surface hardness and density. Many research works are carried out to study the effects of such Concrete is generally considered to be the most widely used material on Earth. Concrete is a composite material which consists of cement, aggregate and water. Aggregate is a broad category of coarse particulate material used in construction, including sand, gravel, Crushed stone. Aggregate serves as reinforcement that provides strength to the composite material. Cement, when mixed with water acts as a binding material. Lower water to cement ratio will give better strength to concrete but will result in low workability whereas with higher water to cement ratio concrete with higher workability and less strength is achieved. In order to overcome this problem super plasticizers are used. Super plasticizers are high range water reducing agent which is capable of removing excess water that does not take part in hydration process without altering the strength of the concrete. In this paper, silica sand is used to replace cement in concrete. Silica sand is a by-product obtained from wet process of manufacturing Cement . In this paper the silica rich waste is used as partial replacement to fine aggregate. The global consumption of natural sand has become very high due to excessive use of concrete. Increased extraction of natural sand from river bed causes many problems like lowering of underground water table, disturbs the aquatic life, disturbs the tectonic plates in the distribution of seismic effects, changes the profile of river beds etc

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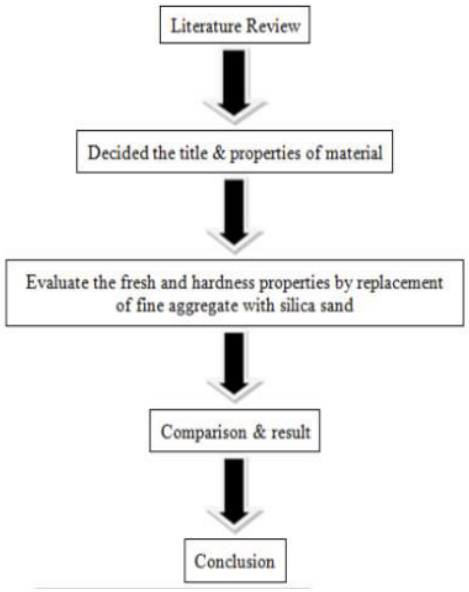

The three major forms of crystalline silica - quartz, tridymite and cristobalite- are stable at different temperatures and have subdivisions. For instance, geologists distinguish between alpha and beta quartz. When low temperature alpha quartz is heated at atmospheric pressure it changes to beta quartz at 573o C. At 870o C tridymite is formed and cristobalite is formed at 1470o C. The melting point of silica is 1610o C, which is higher than iron, copper and aluminium, and is one reason why it is used to produce moulds and cores for the production of metal castings. The crystalline structure of quartz is based on four oxygen atoms linked together to form a three-dimensional shape called a tetrahedron with one silicon atom at its centre. Myriads of these tetrahedrons are joined together by sharing one another'S corner oxygen atoms to form a quartz crystal. Quartz is usually colourless or white but is frequently coloured by impurities, such as iron, and may then be any colour. Quartz may be transparent to translucent, hence its use in glassmaking, and have a vitreous lustre. Quartz is a hard mineral owing to the strength of the bonds between the atoms and it will scratch glass. It is also relatively inert and does not react with dilute acid. These are prized qualities in various industrial uses Physical and chemical properties The three major forms of crystalline silica - quartz, tridymite and cristobalite- are stable at different temperatures and have subdivisions. For instance, geologists distinguish between alpha and beta quartz. When low temperature alpha quartz is heated at atmospheric pressure it changes to beta quartz at 573o C. At 870o C tridymite is formed and cristobalite is formed at 1470o C. The melting point of silica is 1610o C, which is higher than iron, copper and aluminium, and is one reason why it is used

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Experiments:

The concrete slump test measures the behavior or treatment of fresh concrete before it sets up. It is performed to check the workability of freshly made concrete, and thus therefore the ease with which concrete flows through it . It

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can also be used as an indicator or level of something of an improperly mixed batch. The test is thus popular due to the simplicity or proper way of apparatus used and simple procedure. The slump test is used to ensure the uniformity of different loads of the concrete under various field conditions.

Slump Test:

Clean the internal surface of the mould and apply oil Place the mould on a smooth horizontal non- porous base plate.

 Tamp each layer with 5 strokes of the rounded end of the tamping rod in a uniform manner over the cross section of the mould. For the subsequent layers, the tamping should penetrate into the underlying layer.

 Remove the excess concrete and level the surface with a trowel.

 Clean away the mortar or water leaked out between the mould and the base plate.

 Raise the mould from the concrete immediately and slowly in vertical direction.

 Measure the slump as the difference between the height of the mould and that of height point of the specimen being tested.

Slump test apparatus Slump is the most commonly used test for measuring workability of concrete at site as well as in the laboratory. The apparatus for slump test consists of a metallic mould in the form of a frustum of a cone with internal dimension as follows, Bottom dia. = 20cm, Top dia. = 10cm, Height = 30cm. Internal surface of mould is thoroughly cleaned and kept it on horizontal surface. Filled the concrete in four layer and tapper it with 16mm dia. Rod The mould is removed by lifting it slowly and carefully in a vertical direction. This allows the concrete is measured. This difference in height in mm is taken as slump of concrete**.**

III. RESULTS

Compressive Strength: Compressive strength is the most common test conducted on hardened concrete. It is very easy and simple to perform and partly because many of the desirable properties of concrete are qualitatively related to its compressive strength. Compression test specimens are used: cubes, cylinder and prisms. Take required quantities of material and mixed it by hand or by machine mixing. Concrete should be filled in mould in three equal layers. Each layer should be compacted for five times with a 16mm dia. rod. After hardened the specimens are taken out and cured in clean, fresh water. Curing is done until the required days of testing. The test should be carried out immediately upon the removal of specimen from water curing and after that finding out the compressive strength by compressive machine

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Fig. : Compressive testing machine

The normal tensile stress in concrete, when cracking occurs in a flexure test is known as modulus of ruptures, i.e. flexural strength. The standard test specimen is a beam of size 150mm × 150 mm × 700mm size. The specimen should be should be cast and cured in the same manner as for casting of cubes. The specimens should be immediately tested on removal from the water. The flexural strength can be finding out by universal testing machine. The flexural strength can be found out by central loading as well as the load is applied through two similar rollers mounted at the third point of the supporting span. The flexural strength can be found out by formula as follows

Fcr = □ Where,

P = Fracture load for beam

L = Span

b = Width of the beam

d = Depth of the beam

IV. CONCLUSION

Based on the limited experimental investigations conducted following are the conclusions derived

□ The compressive strength of 0% replacement compared with 5%,10%, 15%, and 20% replacement the strength increases up to 15% replacement corresponding to a peak value of 41.3N/mm 2 and decreases with further percent increase in replacement.

□ The flexural strength increases up to 15% to a value of 8.2N/mm 2 and decreases to 8.15N/mm 2 at 20% , 8.07N/mm 2 at 20% replacements.

□ The tensile strength though insignificant increases up to 15% replacement with corresponding value of 2.5N/mm 2 and decreases to 2.48N/mm 2 , 2.42N/mm 2 and 20% replacement.

□ Silica sand passing through 150µm sieve acts as a filler material between cement and fine aggregate there by making concrete more dense.

□ The 15% replacement of cement with silica sand is considered as optimum for durable concrete.

□ The concept of green concrete by using supplementary cementations materials like silica sand minimizes the environmental impact of concrete

□ The utilization of these waste by-products as partial replacement of cement, it would be more beneficial to the environment by reducing the environmental pollution.

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