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EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF FINE AGGREGATE BY GRANITE POWDER IN HIGH STRENGTH CONCRETE

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Abstract:
Granite fines which are the by-product produced in granite factories while cutting huge granite rocks to the desired shapes, while cutting the granite rocks, the powder produced is carried by the water and this water is stored in tanks. After drained of water the granite dust remained is disposed on the lands. Disposing this granite fines is a major problem due its fineness. Hence an effect is made to utilize this fine granite powder in as a filler material in concrete. For that the basic properties of granite fines such as size, fineness, specific gravity, and moisture content were tested. The result shows that the property of granite fines is similar to that of ordinary sand. Therefore, granite fines can be effectively used as a replacement material for fine aggregate in concrete. For investigation purpose cubes are casted with 7 different proportions of granite fines and fine aggregate. The replacement percentage of granite fines to fine aggregate are 0, 10, 20, 30, 40, 50 and 100 for M20 mix proportions, specimens are tested after 28 days of curing, for compression strength, flexural and split tensile strength. The specimen casted with 40 % replacement of granite fines to fine aggregate gives higher strength when compared to control specimen.

Keywords: Granite Powder, Aggregate, CGF, OPC .

1. INTRODUCTION

Modifications have been made from time to time to overcome deficiencies of cement concrete yet retaining the other desirable characteristics. Extensive research in the field of concrete technology has led to development of special types of concrete which are capable of eliminating, to a great degree these basic deficiencies. Construction aggregate, is a broad category of coarse particulate material used in construction, including sand, gravel, crushed stone, slag, recycled concrete and geosynthetic aggregates. Aggregates are the most mined material in the world. Aggregates are a component of composite materials such as concrete and asphalt concrete; the aggregate serves as reinforcement to add strength to the overall composite material. Due to the relatively high hydraulic conductivity value as compared to most soils, aggregates are widely used in drainage applications such as foundation and French drains, septic drain fields, retaining wall drains, and road side edge drains. Aggregates are also used as base material under foundations, roads, and railroads. In other words, aggregates are used as a stable foundation or road/rail base with predictable, uniform properties (e.g. to help prevent differential settling under the road or building), or as a low-cost extender that binds with more expensive cement or asphalt to form concrete. Almost all natural aggregate materials originate from bed rocks. There are three kinds of rocks namely igneous, sedimentary and metamorphic. These classifications are based on the mode of rocks .It may be recalled that igneous rocks are formed by the cooling of molten magma or lava at the surface of the crest or deep beneath the crest. The sedimentary rocks are formed originally below the sea bed and subsequently lifted up. Metamorphic rocks are originally either igneous or sedimentary rocks which are subsequently metamorphosed due to extreme heat and pressure.

2. LITERATURE SURVEY

Divakar Y., et al., (2012) Highlighted the compressive strength has increased by 22% with the use of 35% replacement of fine aggregates with granite fines. With increase of granite fines up to 50% increasing compressive strength will limit to 4% only. The split tensile strength remains same for 0%, 25% and 35%. For 5% replacement there is an increase of 2.4% of strength and for 15% replacement there is a reduction of tensile Strength by 8%. However we can conclude that with the replacement of 35% granite fines the test results shows no decrease in strength compared with the conventional mix using fully sand as fine aggregates. The flexural strength of prism of 10cm x 10cm x 50cm without reinforcement, we can conclude that, there is 5.41% increase in flexural strength with 5 % replacement, and there is a small decrease up to 5% in flexural strength at 15%, 25% and 35% replacement with granite fines and further reduction in strength (i.e. 6%) at 50% replacement of granite fines in comparison with test results of nominal concrete mix of 1:1.5:3 (M-20) without granite fines. However there is no much change in flexural strength test conducted of all the variations.

Joseph O. et al., (2012) concluded that the flexural and tensile strength properties were found to compare closely with those for normal concrete. Hence, concrete with mixtures of lateritic sand and quarry dust can be used for structural construction provided the proportion of lateritic sand content is kept below 50%. Both flexural and tensile strengths were found to increase with increase in laterite content. Further work is required to get data for long-term deformation characteristics and other structural properties of the experimental concrete. These include: shear strength, durability, resistance to impact, creep, etc. Also, it may be necessary to investigate the optimum contents of lateritic sand and quarry dust in relation to the structural properties of the concrete. These will assist engineers, builders and designers when using the materials for construction works.

Felixkala.T et al., (2010) concluded that the study on the performance concrete made with granite powder as fine aggregate and partial replacement of cement with 7.5% Silica fume, 10% fly ash, 10% slag and 1% super plasticiser subjected to water curing is conducted for finding the characteristic mechanical properties such as compressive strength, split tensile strength, modulus of elasticity, plastic and drying shrinkage strains of concrete mixtures at 26oC (±2oC) and 38oC (±2oC) for 1, 7, 14, 28, 56 and 90 days of curing for 0.40 water-cement ratio. The test results show clearly that granite powder as a partial sand replacement has beneficial effects of the mechanical properties of high performance concrete. Of all the 6 mixtures considered, concrete with 25% of granite powder (GP25) was found to be superior to other mixtures as well as GP0 and NA100 for all operating conditions. Therefore the conclusions are made based on a comparison of GP25 with the conventional concrete with 0% of granite powder, Manasseh Joel (2010) explained that the use of crushed granite fine to partially replace Makurdi river sand in concrete production will require a higher water to cement ratio, when compared with values obtained with the use of only Makurdi river sand. Peak compressive strength and indirect tensile strength values of 40.70N/mm2 and 2.30N/mm2 respectively were obtained when Makurdi river sand was replaced with 20% CGF in concrete production. Peak compressive strength and indirect tensile strength values of 33.07N/mm2 and 2.04N/mm2 respectively were obtained when crushed granite fine was replaced with 20% river sand as fine aggregate in the production of concrete.The use of only CGF to completely replace river sand is recommended where CGF is available and economic analysis is in favour of its usage. Based on findings from the study the partial replacement of Makurdi river sand with 20% CGF is recommended for use in concrete production for use in rigid pavement. Where crushed granite is in abundance and river sand is scarce, the complete replacement river sand with CGF is recommended for use in low to moderately trafficked roads. Kanmalai Williams C.et al.,(2008) concluded that the compressive strength, Split tensile strength modulus of elasticity, particularly in all the ages higher than that of the reference mix (GP0). There was an increase in strength as the days of curing increases. The water penetrability was about 5% less than the conventional concrete mixture. This result suggests that the proper use of the granite powder can produce high in concrete. In general, the behavior of granite aggregates with admixtures in concrete possesses the higher properties like concrete made by river sand. Thus granite aggregates performance concrete. The drying shrinkages of all the five concretes were very similar with a maximum value of 420 micro strain after 90 days. As regards shrinkage performance, these concretes are high performance.

3. EXPRIMENTAL ANALYSIS

Cement is the most important ingredient of concrete. One of the important criteria for the selection of cement is its ability to produce improved microstructure in concrete. The selection of proper grade and good quality of cement is important for obtaining HSC. Some of the important factors, which play a vital role in the selection of the type of cement are compressive strength at various ages, fineness, heat of hydration, alkali content, tricalcium aluminate (C3A) content, tricalcium aluminate (C3S) content, dicalcium silicate (C2S) content and compatibility with admixtures etc., Nowadays practically in site most of the constructions are being done by Ordinary Portland Cement (OPC). Different brands of cement have been found to possess different strength development characteristics and rheological behavior due to the variations in the compound composition and fineness. Hence, it was decided to use the cement from a single supplier. For the present investigation, Ordinary Portland Cement of brand name “JAYPEE” conforms to IS: 1489 (PT 1): 1991 were used. The coarse aggregate is the strongest and least porous component of concrete. As far as the shape of the aggregate is concerned, crushed granite coarse aggregate provides better interlocking and hence it helps to achieve higher strength than rounded gravel aggregate. The coarse aggregate meeting the requirements of IS: 383-1970 is suitable for making Concrete. Considering all the above aspects, angular coarse aggregates of maximum size 20mm were taken for the present investigation. As per IS: 383-1970 procedure the specific gravity of the coarse aggregate obtained as 2.78.

Tests On Coarse Aggregate:

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Fineness modulus calculation

SIEVE SIZE	*SAND % PASSING*
4.75 mm	*100*
2.36 mm	*89*
1.18 mm	*88*
600 μm	*93*
300 μm	*86*
150 μm	*45*

Table.3.1

Water

Water is an important ingredient of concrete as it chemically participates in the reactions with cement to form the hydration product C-S-H gel. The strength of cement concrete depends mainly from the binding action of the hydrated cement paste gel. A higher water-binder ratio will degrease the strength, durability, water-tightness and other related properties of concrete. As per Neville, the quantity of water added should be the minimum required for chemical reaction of hydrated cement, as any excess of water would lead end up only in the formation of undesirable voids (capillary pores) in the hardened cement concrete paste. Hence, it is essential to use a little paste as possible consistent with the requirements of workability and chemical combination with cement. From concrete mix considerations, it is important to have the compatibility between the given cement and the chemical and mineral admixtures along with the water used cement and mineral admixtures along with the water used for mixing. With its high content of cementitious materials is susceptible to a rabid loss of workability on account of high amount of heat of hydration generated. Therefore attention is required to see that the initial hydration rate of cement should not be significantly affected. Quality and quantity of water is required to be looked very carefully.

Chemical Admixtures:

HSC is a low water binder ratio and has ultra fine particles in the form of mineral admixture such as SILICA FUME. Effective dispersion of cement and silica fume is necessary to achieve proper microstructure of the hardened concrete as well as the workability of the concrete without increasing the unit water and cement content of a mix. Hence, the chemical admixtures are essential ingredients in the HSC mix, as the increase in the efficiency of cement paste by improving the workability of the mix and there by resulting in considerable decrease of water requirement. Thus, with W/B ratio as low as 0.3 or less, the concrete can be produce with the use of chemical admixtures. The water content could be reduced, thereby effective control on W/B ratio could be maintained to achieve the desired strength and improved durability. Granite powder is obtained from the crusher units in the form of finer fraction. The highest compressive strength was achieved in samples containing 40% granite powder. This is a physical mechanism owing to its spherical shape and very small in size, granite powder disperses easily in presence of superplasticizer and fills the voids between the quarry sand, resulting in a well packed concrete mix. Granite powder can be used as filler as it helps to reduce the total voids content in concrete. Granite powder

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and quarry rock dust improve pozzolanic reaction. The quarry rock dust and granite powder can be used as 100% substitutes for natural sand in concrete. The compressive, split tensile and durability studies of concrete made of quarry rock dust nearly 15% more than the conventional concrete. The concrete resistance to sulphate attack was enhanced greatly.

Bulking of sand

s.no	% of water added	Amount of water in ml	Height of g.p without water(H1)	Height of g.p with water(H2)	H1-H2	% of increase in bulk H1-H2/H2
1	2	47	11	12.5	1.5	12
2	4	94	11	13.0	2.0	15.38
3	6	141	11	13.5	2.5	18.52
4	8	188	11	13.3	2.3	17.29
5	10	235	11	13.0	2.0	15.38
6	12	282	11	11.2	0.2	1.79
7	14	329	11	10.8	0.2	1.8

Table.2

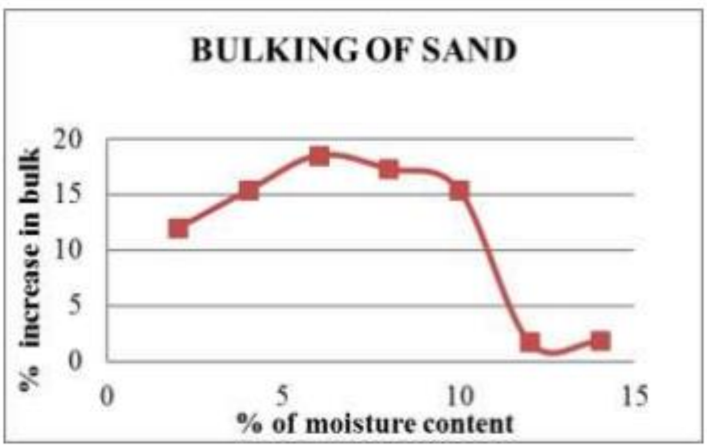

Fig.1. Bulking of sand

CONCLUSION

The test specimens where cast in cast-iron moulds. The inside of the mould were applied with oil to facilitate the easy removal of specimens. For obtaining the binder content, the cement and silica fume were thoroughly mixed with one another in dry condition. The fine aggregate and the Granite powder were thoroughly mixed with one another in dry condition. The coarse aggregate, fine aggregate and the binder

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content were placed in a concrete mixer machine and then mixed thoroughly in dry condition. For addition of water initially 75% of the mix water is added to the dry mix and mixed thoroughly. The super plasticizer was added to the remaining 25% of the mix water and added to the mix and then the mixing was carried out about 2 to 3 minutes.

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