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PARTIAL REPLACEMENT OF FINE AGGREGATE IN CONCRETE

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Abstract
Asphalt concrete (AC) is a composite material composed of mineral aggregates adhered with a bitumen binder. Asphalt concrete is commonly called as asphalt, blacktop, bituminous concrete or DBM (Dense Bitumen Macadam). It is used to surface roads, parking lots, airports etc. The viscous nature of the bitumen binder allows asphalt concrete to sustain significant plastic deformations. Asphalt is usually mixed, spread and compacted while it's hot, and is therefore classified as a Hot Mix Asphalt. It has a continuous distribution of aggregate particle size and filler, and low design air void content, ranging from 3to5% .Rutting due to excessive permanent deformation, cracking due to fatigue, and hardening of the binder are common modes of failure for Asphalt Concrete. Therefore, attempts to improve the performance of asphalt concrete are constantly being investigated.
Keywords: Aggregate, cement, composite material, concrete

INTRODUCTION

oncrete is a composite construction material composed primarily of aggregate, cement and water. Generally Concrete is strong in compression and weak in tension. The aggregate is generally coarse gravel or crushed rocks such as limestone, or granite, along with a fine aggregate such as sand. The cement, commonly Portland cement, and other cementitious materials such as fly ash and slag cement, serve as a binder for the aggregate. Various chemical admixtures are also added to achieve varied properties. Water is then mixed with this dry composite which enables it to be shaped (typically poured) and then solidified and hardened into rockhard strength through a chemical process known as hydration. The water reacts with the cement which bonds the other components together, eventually creating a robust stone-like material. Concrete has relatively high compressive strength, but much lower tensile strength. For this reason is usually reinforced with materials that are strong in tension (often steel). Concrete can be damaged by many processes, such as the freezing of trapped water. Concrete is acknowledged to be a relatively brittle material when subjected to normal stresses and impact loads, where tensile strength is only approximately one tenth of its compressive strength. As a result for these characteristics, concrete member could not support such loads and stresses that usually take place, majority on concrete beams and slabs. Historically, concrete member reinforced with continuous reinforcing bars to withstand tensile stresses and compensate for the lack of ductility and strength. Steel reinforcement adopted to overcome high potentially tensile stresses and shear stresses at critical location in concrete member.

LITERATURE SURVEY

Divakar 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 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. Manasseh el al.(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. Kumara 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.

Materials Used

Cement: Ordinary Portland cement conforming to IS: 4031 was used for the preparation of test specimens.

Fine Aggregate: The fine aggregate used in this experimental investigation was natural river sand confirming to zone II of IS: 383 – 1970

Coarse Aggregate: Crushed granite aggregates particles passing through 20mm and retained on 4.75mm I.S sieve was used as natural aggregates which met the grading requirement of IS: 383 – 1970. Granite Powder: 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.

Mix Proportion For M20 Grade Concrete:

Water cement ratio of 0.45

Mix design used in concrete is 1:1.5:3.0

Properties of Materials:

Tests on Cement: 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.

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). For the present investigation, Ordinary Portland Cement of brand name "JAYPEE" conforms to IS: 1489 (PT 1): 1991 were used.

Tests on Fine Aggregate: ACI committee reports that sand with properties such as void ratio, gradation, specific gravity, fineness modulus, free moisture content, specific surface and bulk density have to be assessed to design dense mix with optimum cement content and reduced mixing water. For the present investigation, locally available sand was used and tested as per IS: 383-1970. From the test, specific gravity of the fine aggregate 2.6 was obtained.

Table 1: 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

Tests on Coarse Aggregate: 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.

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. Water conforming to the requirements of BIS:456-2000 is found to be suitable for making concrete.

Chemical Admixtures:

1. Increasing the workability without altering the mixture proportions.
2. Reducing both water and cement content in the mixture for purpose of reducing creep, shrinkage and thermal strains caused by cement hydration.
3. Reducing the mixing water volume and water-binder ratio in order to increase concrete strength and improved durability. Through there are many types of chemical admixtures available, the following are the commonly used admixtures. Plasticizers and the superplasticizer, Retarders and Air entertaining

Superplasticizers: Super plasticizers procedure extreme workability and thus flowing concrete. They achieve reduction in the water content without loss of workability. Their use generally leads to an overall reduction in the cost.

Granite Powder: 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.

Result

Maximum increase in bulk = 18.52% Optimum moisture content = 6%

Material Test Result:

Specific gravity of fine aggregate = 2.6
Specific gravity of coarse aggregate = 2.78
Specific gravity of cement = 3.15
Specific gravity of granite powder = 2.65
Optimum moisture content

Mix Design:

Conventional And Granite Powder Concrete M20: M20 grade of concrete has been designed as per IS code and the mix proportions is given in the table

Table 2: Mix proportions

Ceme nt	Fine Aggregate	Coarse Aggregate	W/C Ratio
1	1.5	3	0.5

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