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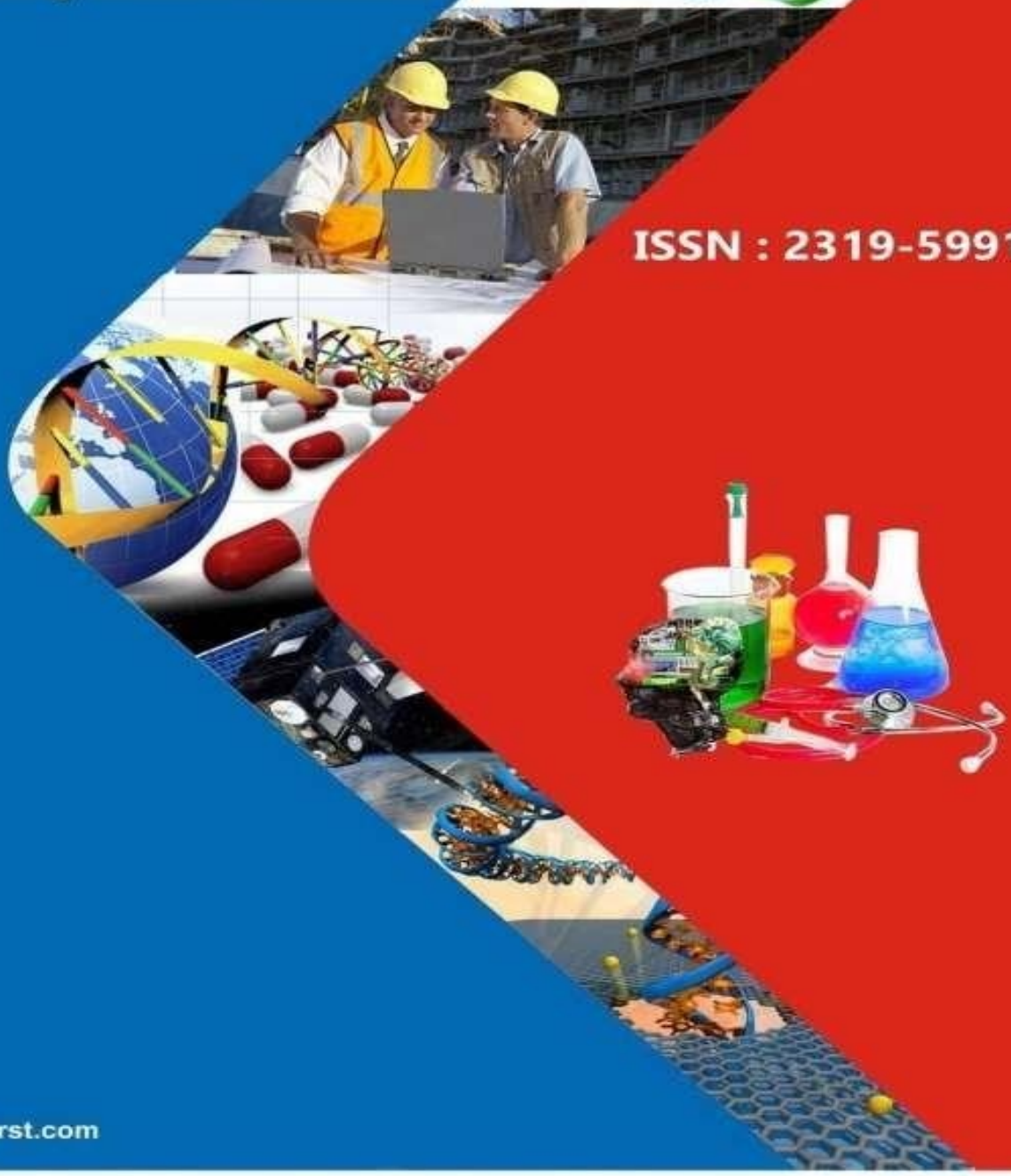

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INVESTIGATION ON STRENGTH PROPERTIES OF HIGH PERFORMANCE CONCRETE BY USING GGBS AND CRUSHED ROCK POWDER

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ABSTRACT

In the engineering industry, the improvement of existing materials allow for technological advancement and the construction of more reliable structures without over design. A High performance concrete is something which demands much higher performance from concrete as compared to performance expected from routing concrete. Use of chemical admixtures reduces the water content, thereby reducing the porosity within the hydrated cement paste. Mineral admixtures also called as cement replacement material (CRM) such as fly ash, rice husk ash, ground granulated blast furnace slag ,Met kaolin, silica fume are more commonly used in the development of High-performance mixes, act as pozzolanic materials as well as fine fillers, thereby the microstructure of hardened cement matrix becomes denser and strong. High performance concrete (HPC), a widely utilized material in heavy structural constructions. This paper gives the characteristics of HPC, the study of influence of water-binder ratio and the influence of strength.

High performance concrete (HPC) is a concrete meeting special combinations of performance and uniformity and normal mixing. This leads to examine the admixtures to improve to improve the performance of the concrete. On the other side, cost of concrete is attributed to the cost of its ingredients which is scarce and expensive, this leading to usage of economically alternative materials in the production. This requirements is drawn the attention of investigators to explore new replacements of ingredients of concrete.

This paper deals with the effective utilization of waste material in concrete production as a partial replacement for Cement and sand. The cement has been replaced by GGBS in the range of30%, 40% and 50% by weight of cement, crushed rock powder as sand in the range of 5%, 15% and 25% by weight of cement for M40grademix.

Keywords: High performance concrete, admixture, crushed rock powder.

I. INTRODUCTION

1 GENERAL

Concrete is considered as durable and strong material. Reinforced concrete is one of the most popular materials used for construction around the world. Reinforced concrete is exposed to deterioration in some regions especially in coastal regions. Therefore researchers around the world are directing their efforts towards developing a new material to overcome this problem. Invention of large construction plants and equipments around the world added to the increased of material. This scenario leads to the use of additive materials to improve the quality of concrete. As an outcome of the experiments and researches, cement based concrete which meets special performance with respect to workability, strength and durability known as “HIGH PERFORMANCE CONCRETE” was developed.

1.1 Historical Background

Although high strength concrete is often considered relatively new materials, its development has been gradual over many years. In

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USA, in the 1950's concrete with a compressive strength of 34mpa was considered high strength, in the 1960's, concrete with 41 to 52mpa compressive strength were used commercially.

In the early 1970's, 62mpa concrete was being produced. In the world scenario, however, in the last 15 years, concrete of very high strength entered the field of construction, in particular constraint of high-rise buildings and long span bridges. According to code IS 456-2000 compressive strength over 110mpa has been considered for the applications in cast-in-place buildings and pre-stressed concrete members. But recently reactive concrete is a one which having nearly compressive strength of 50mpa. It is completely based on pozzolanic materials.

1.2 Definition of HPC

The performance requirements of concrete cannot be the same for different applications. Hence the specific definition of HPC required for each industrial application is likely to vary. The Strategic Highway Research Programme (SHRP) has defined HPC for highway application on the following strength, durability, and w/c ratio criteria.

(a) It should satisfy one of the following strength criteria:

4 hour strength _17.5 Mpa

24 hour strength _35.0 Mpa

i. ays strength _ 70.0 Mpa

(b) It should have a durability factor greater than 80% after 300 cycles of freezing and thawing.

(c) It should have a water-cement ratio of 0.35 or less.

In general, a "High performance Concrete" can be defined as that concrete which has the highest durability for any given strength class, and comparison between the concretes of different strength classes is not appropriate. This means that, with the available knowledge, one can always strive to achieve a better (most durable) concrete required for a particular

1.3 High Performance Concrete

High Performance Concrete (HPC) is that which is designed to give optimized performance characteristics for the given set of materials, usage and exposure conditions, consistent with requirement of cost, service life and durability.

The American Concrete Institute (ACI) defines HPC "As concrete which needs special combinations and uniformity requirements that cannot always be achieved routinely by using conventional materials and normal mixing, placing and curing practices".

High performance in a broad manner can be related to any property of concrete. It can mean excellent workability in the fresh state like self leveling concrete or low heat of hydration in case of mass concrete, or very rigid setting and hardening of concrete in case of sprayed concrete or quick repair of roads and airfields, or low imperviousness of storage vessels, or very low leakage rates of encapsulation containments for contaminating material.

Also, the concrete must have a durability factor greater than 80 after 300 cycles of freezing and thawing to meet their definition.

1.4 Need of High Performance Concrete

- To put the concrete into service at much earlier age, for example opening the pavement at 3-days.
- To build high-rise buildings by reducing column sizes and increasing available space.
- To build the super structure of long-term bridges and to enhance the durability of bridge decks.
- To satisfy the specific needs of special applications such as durability, modulus of elasticity, and flexural strength. Some of these applications include dams, grandstand roofs, marine foundations, parking garages, and heavy industrial floors.

1.7 Cost of High Performance Concrete

Cost-Extended service life, lower maintenance cost, and fewer repairs mean that HPC applications results in lower life-cycle costs

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than conventional construction. Initial cost of HPC, however, can be as much as double that for typical concrete, depending on the materials, size of the project, and negotiations between supplier and contractor.

1.8 Preparation of High Performance Concrete

High performance concrete are made with carefully selected high quality ingredients and optimized mixture designs; these are batched, mixed, placed, compacted, and cured to the highest industry standards. Typically, such concretes will have a low water-cement ratio of 0.2 to 0.35. Super plasticizers are usually used to make these concretes fluid and workable. Table 1.2 lists materials often used in high performance concrete and why they are selected.

II. LITERATURE REVIEW

2.1 General:

This chapter presents a review of literature on subject of this thesis. The review covers the following aspects: i) Studies on High-Performance-Concrete over view on pozzolanas in concrete iii) Studies on Super plasticizers

2.2 Studies on High- Strength- Concrete (HSC):

P.L.Domone, and M.N.Soutsos, (1995) "The results show broadly similar effects to those in lower strength concrete, although of differing magnitude in some cases. Some potential advantages of ternary blends for optimization of properties have been demonstrated. Long- term strength of PFA and GGBS mixes may not reach those of 100% Portland cement mixes when the water-binder ratio is reduced to 0-26 and below, but micro silica can increase the strength of all mixes".

R.Duval and E.H.Kadri (1998) "The results show that partial cement replacement up to10% silica fume does not reduce the concrete workability and propose a model to evaluate the compressive strength of silica fume concrete at any time. The increase of the compressive strength of SF concretes depends much more on the decrease of the water/cementitious materials ratio than on the replacement of silica fume with cement'.

ShreetiS.Mavinkurve, et al., (2003) "Present paper discusses the approach adopted to develop HPC mix by means of laboratory trials using HRM. The various properties of concrete, both in the fresh and hardened states are also highlighted .It can be concluded the high strength concrete up to compressive strength of 82.75 M pa, having quite low permeability and with reasonably high slump can be developed using Indian HRM and cement".

2.3. Studies on Superplasticizers:

Super plasticizers are widely used in concrete processing to increase the rheological properties of hardened pastes. Super plasticizers are chemical admixtures which can maintain an adequate workability of fresh concrete at low water/cement ratio for a reasonable period of time, without affecting the setting and hardening behavior of the cementitious system. Super plasticizers are introduced in concrete. Like many other admixtures to perform a particular function, consequently they are frequently described according to their functional properties. Super plasticizers have been classified as high range water reducers (HRWR) to distinguish them from other categories of less effective water reducers.

Franklin (1976) stated that, super plasticizers are organic polyelectrolyte, which belong to the category of polymeric dispersants. The performance of super plasticizers in cementations system is known to depend on cement fineness, cement composition mode of introduction to the mixture etc., as well as on the chemical composition on super plasticizer. For many years, it was not possible to reduce water/cement ratio of concrete below 0.40 till the advent of super plasticizers. The super plasticizers were first used in concrete in 1960s and their introduction occurred simultaneously in Germany and Japan (Meyer and Hottori, 1981). At first, the super plasticizers were used as fluidizers than water

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reducing agents. By using large enough super plasticizer, it was possible to lower the water/binder ratio of concrete down to 0.30 and still get an initial slump of 200mm. Reducing the water/binder ratio below 0.30 was a taboo until.
Bache reported that using a very high dosage of super plasticizers and silica fume, water binder ratio can be reduced to 0.16 to reach a compressive strength of 280MPa (Bache, 1981).

III. MATERIALS USED IN PRESENT PROJECT AND THEIR METHODS

3.1 MATERIALS

In This Present Investigation The Following Materials Were Used.

3.1.1 Ordinary Portland Cement (53 Grade),

3.1.2 Fine Aggregate (<425µ),

3.1.3 Coarse Aggregates

3.1.4 Ground Granulated Blast Furnace Slag

3.1.5 Crushed Rock Powder

3.1.6 Super Plasticizer (Varaplast Pc-432)

3.1.1 Ordinary Portland cement:

Portland cement is the most common type of cement in general use around the world, used as a basic ingredient of concrete, mortar, stucco, and most non-specialty grout. It usually originates from. It is a fine powder produced by grinding Portland cement clinker (more than 90%), a limited amount of calcium sulphate (which controls the set time) and up to 5% minor constituents as allowed by various standards. Portland cement clinker is a hydraulic material which shall consist of at least two-thirds by mass of calcium silicates (3CaOSiO2and2 CaO•SiO2), the remainder consisting of aluminum and iron-containing clinker phases and other compounds. The ratio of CaO to SiO2 shall not be less than 2.0. The magnesium oxide content (MgO) shall not exceed 5.0% by mass.

Table 3.1 Approximate Oxide Composition Limits of OPC

COMPOSIT0ION	PERCENTAGE (%)
CaO	60-67 %
SiO_2	17-25%
Al_2O_3	3.0-8.0 %
Fe_2O_3	0.5-6.0 %
MgO	0.1-4.0 %
Alkalies (Na_2O,K_2O)	0.4-1.3 %
SO_3	1.3-3.0 %

3.1.2 Fine Aggregate

The sand used for the experimental programmed was locally procured and conformed to Indian Standard Specifications IS: 383-1970. The sand was first sieved through 425µ sieve to remove any particles greater than 425µ and then was washed to remove the dust.

For the aggregate producer, the concrete aggregates are end products, while, for the concrete manufacturer, the aggregates are raw materials to be used for mix designs and successful concrete production. The aim of this study was to identify which fine aggregate characteristics are important, and additionally to relate the extent of the effect that the aggregate has on the concrete as compared against the effect of the changes in mix design. Fine aggregate is natural sand which has been washed and sieved to remove particles larger than 425µ. The fine and coarse aggregate are delivered separately. Because they have to be sieved, a prepared mixture of fine and coarse aggregate is more expensive than natural all-in aggregate. The reason for using a mixture of fine and coarse aggregate is that by combining them in the correct proportions, a concrete with very few voids or spaces in it can be made and this reduces the quantity of comparatively expensive cement required to produce a strong concrete.

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Table 3.4 : Physical Properties of FA

Aggregate Properties	FA
Specific gravity	2.62
Water absorption (%)	1.0
Bulk density (kg/m^3)	1460
Fineness modulus (%)	3.537
Moisture Content (%)	1.50

Set of Sieves for Fine Aggregate

3.1.3. Crushed rock powder (Crushed Rock Powder 425µ)

The Andhra Pradesh Government is seeking to encourage use of Crushed rock powder, a natural sand substitute for use in the construction sector. This move comes in the backdrop of shortage of sand supply impacting the construction sector in the State. The Government is in the process of streamlining sand quarrying and prevents its indiscriminate use. Crushed rock powder is sand manufactured in the stone quarries. It is a substitute for the river sand used in construction. Manufacturers claim it is better than the river sand. River sand, which is one of the constituents used in the production of concrete, has become expensive and scarce. So there is large demand for the alternative materials. The crusher dust produced from granite crushers is one of the alternative materials for river sand. The utilization if crusher dust which can be called as Crushed rock powder has been accepted as a building material in the western countries. Lot of research has been done regarding the crusher dust as alternative materials for river sand. They have used the crusher dust of size which has been passed through 75 micron. Crushed rock powder or crusher dust obtained from local granite crushers was used in concrete to cast the cubes and cylinders. The bulk density of Crushed rock powder IS 1768 kg/m3. The specific gravity of Crushed rock powder is 2.65.

Table 3.6 : Physical properties CRUSHED ROCK POWDER

Property	Crushed rock powder	Test method
Specific gravity	2.54-2.60	IS 2386 (Part III) 1963
Bulk Relative density(kg/m^3)	1720-1810	IS 2386 (Part III) 1963
Absorption (%)	1.20-1.50	IS 2386 (Part III) 1963
Moisture content (%)	Nil	IS 2386 (Part III) 1963
Fine particles less than 0.075mm (%)	12-15	IS 2386 (Part I) 1963
Sieve analysis	Zone II	IS 383 – 1970

3.1.4. Coarse Aggregate

According to IS: 383-1970, coarse aggregate most of which is retained on 4.75mm IS sieve. Coarse aggregate may be described as:

i. Uncrushed gravel or stone which results from natural disintegration of rock,

ii. Crushed gravel or stone when it results from crushing of gravel or hard stone, and

iii. Partially crushed gravel or stone when it is a product of the blending of (i) and (ii).

In this project, coarse aggregates are naturally occurring crushed stones. They are hard, strong, dense, durable, clear and free from veins and adherent coating, and free from injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. Also they are not flaky, scoriaceous and elongated pieces.

The particle shape of the aggregate contributes to the effectiveness of producing a high performance concrete. Crushed rock creates a much better bond between the paste and the aggregate than a gravel does. However, the aggregate-mortar bond may be more important in flexure tests than in compression tests.

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Set of sieves for coarse aggregate

3.2 Admixture

INTRODUCTION

Admixture is defined as a material, other than cement, water and aggregates that is used as ingredients of concrete and is added to the batch immediately before or during mixing. Additive is a material which is added at the time of grinding cement clinker at the cement factory. Admixtures are chemicals which are added to concrete at the mixing stage to modify some of the properties of the mix. Admixture should never be regarded as substitute for good mix design, good workmanship, are use of good materials.

The history of admixture is old as the history of concrete. It embraces a very vast field, but little type of admixture caller water reducers or high range water reducers, generally referred as plasticizers, are of recent interest. Plasticizers were not manufactured in India and them to be imported, and hence costly. Lack of education and awareness of the benefits occurred by the use of plasticizers, and we were used to making generally low strength concrete of the M15 to M30 which do not really need the use of plasticizers.

In the simplest cases, Portland cement concrete is a four –component mixture of water, Portland cement, fine aggregate and coarse aggregate. Additional components such as chemical admixture (air entraining agents, super plasticizers) and mineral admixtures (coal fly ash, silica fume, blast furnace slag) may be added to the basic mixture to enhance certain properties to the fresh or hardened concrete. High performance concrete mixtures, which may be required to meet several performance criteria (e.g., compressive strength,. Elastic modulus, rapid chloride permeability) simultaneously, typically contain at least six components. Thus, optimizing mixture proportions for high-performance concrete can be a difficult and time- consuming task.

WHAT ARE ADMIXTURES?

Admixtures are natural or manufactured chemicals which are added to the concrete before or during mixing. The most often used admixtures are fly ash, silica fume, air entraining agents, water reducers, water reducing retarders and accelerators.

WHY WE USE ADMIXTURES?

Admixtures are used to give special properties to fresh or hardened concrete. Admixtures may enhance the durability, workability or strength characteristics of a given concrete mixture. Admixtures are used to overcome difficult construction situations, such as hot or cold weather placements, pumping requirements, early strength requirements, or very low water cement ratio specifications.

TYPES OF ADMIXTURES

1. CHEMICAL ADMIXTURE
2. MINERAL ADMIXTURE

3.2.1. Chemical Admixture

CHEMICAL ADMIXTURES are added to concrete in very small amounts mainly for the entertainment of air, reduction of water or cement content, plasticization of fresh concrete mixtures, are control of setting time.

Seven types of chemical admixtures are specified in ASTM 494, and AASHTOM 194, depending on their purpose in PPC.

General and physical requirements for each type admixtures which were used are included in the specifications.

1. Air-entertainment
2. Water-reducing
3. Set-retarding
4. Accelerating

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5. Super plasticizers

A. CHEMICAL ADMIXTURE USED

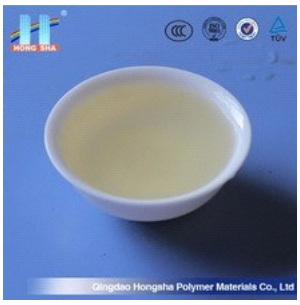
The chemical admixture which we used in this present project is varaplast pc 432

VARAPLAST PC 432: has been primarily developed for applications in the ready mixed and precast concrete industries where the highest durability and performance is required.

Super plasticizing action of VARAPLAST PC 432 is different Super plasticizer based on sulfonated melamine and naphthalene formaldehyde condensate, which create electrostatic repulsion of particles. VARAPLAST PC 432 initially creates the same electrostatic repulsion and further stabilizes the mixes due to static repulsion of long lateral chains linked to the polymer backbone.

Table 3.8 : Physical and Chemical Properties of Superplasticizer

Characteristics	Superplasticizer
Calcium chloride Content	Nil
Specific gravity	1.08 at 20 °C
Air entrainment	Less than 1% additional air is Entrained.
Setting time	1 - 4 hours retardation depending on dosage and climatic conditions.
Chloride content	Nil to BS 5075



ADVANTAGES

During mixing and placement

- High workability without segregation or bleeding
- Less vibration required and reduced labour requirement
- Can be placed compacted in congested reinforcement
- Chloride free

IV. TEST RESULTS AND DISCUSSIONS

TEST RESULTS AND DISCUSSIONS

The test data and results obtained from the tests conducted in the present investigations 40 concrete cubes have been presented in this chapter in which the tests are carried out, importance has been given to workability, ultimate compressive strength, cracking and durability. The results of high performance concrete are compared with individual percentage replacements and different combinations of admixtures for two types of concrete M40. Qualities such as workability, compressive strength, cracking have been observed and recorded.

Workability

Portland cement is in a form of agglomeration of particles held together by forces. During mixing process the agglomeration break down into fragments and hydration takes places at the surface of fragments. With the application of admixture the hydrating cement on the surface of fragments deflocculates each reduces the inter-particle fraction.

The effect reduced the relation of water between particles. More workable concrete can be obtained or less water required for a specified workability. As the inter-particle forces are reduced a more even dispersion of cement particles hence a more even hydration of cement can be achieved with an improvement to the density and strength of concrete may be designed to have proportion of fine aggregates with low flakiness index such as river sand.

With the presence of admixtures, the concrete can be flowable and pumpable. However, bleeding of concrete may occur and require attention. Also the presence of wet concrete on formwork is increased. Thus form work design should acknowledge the rate of concrete pour. The workable concrete will allow complete compaction without segregation.

Table 4.1: Slump Cone Test RESULTS

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MIX PROPROTION	SLUMP
CM	100
30%GGBS	85
40%GGBS	110
50%GGBS	120
30%GGBS+5%RS	97
30%GGBS+15%RS	63
30%GGBS+25%RS	52
40%GGBS+5%RS	96
40%GGBS+15%RS	64
40%GGBS+25%RS	54
50%GGBS+5%RS	97
50%GGBS+15%RS	62
50%GGBS+25%RS	51

Compressive Strength

Compression test is the most common test conduct on hardened concrete, partly because easy test to perform, and partly because most of the desirable characteristic properties of concrete are qualitively relat6;ed to its compressive strength.

The cube specimen of 15cmx15cmx15cm was cast to test various concrete mixtures for compressive strength. The cubes after the moulding were stored in curing tanks and on removal of cubes from water at 7 days and 28 days the compressive strength was conducted. The water and grit on the cubes was removed before testing the cubes. The test was carried as per IS: 516-1959.

Crack Pattern

From the experiments it is observed that as soon as crack propagates the sudden failure occurs in high performance concrete cubes is shown in figure

Table 4.2 : Compressive Strength Test Results

S.No.	Grade of Concrete	Compressive Strength of 7 Days (MPa)	Compressive Strength of 28 Days (MPa)	Compressive Strength of 90 Days (MPa)
1.	CM	42	49.5	52.6
2	30%GGBS	43.5	51	54.2
3	40%GGBS	44.2	53.5	55.8
4	50%GGBS	38.4	49.2	51.3
5	30%GGBS+5%RS	37	48	50.68
6	30%GGBS+15%RS	36.5	45.2	49.6
7	30%GGBS+25%RS	36	44.4	47.5
8	40%GGBS+5%RS	42.5	51.3	53.7
9	40%GGBS+15%RS	43.4	52.5	53.5
10	40%GGBS+25%RS	39.2	49.3	48.5
11	50%GGBS+5%RS	34.1	44	46.5
12	50%GGBS+15%RS	33.1	43.2	45.4
13	50%GGBS+25%RS	32.3	42.5	44.8

Split Tensile Test

Since there is no direct method for finding the tensile strength of concrete indirect method is adopted in this method the same compression testing machine as used for finding the compressive strength is used. The cube specimens of size 150*150*150 mm were cast in steel mould. Casting was conducted in three layers with each layer compacted by using ramping rods up to sufficient levels. The specimens remained in the steel mould for 24 hours and then it is de-molded and then placed in curing tank. After 28 days specimen were taken out and exposed to atmospheric condition so as to obtain dry surface. The specimen is placed diagonally in the standard compression testing machine. The concrete cubes were placed in the machine in such a manner that the load was applied on the diagonally edge surface of the cube as cast. The load was applied gradually till the specimens to the increasing loads breaks down and no greater load was sustained. The maximum load applied is the specimen was recorded and the appearance of any unusual cracks was noted. The ultimate load value was recorded. Results are compared with the reference specimen and their details are show.

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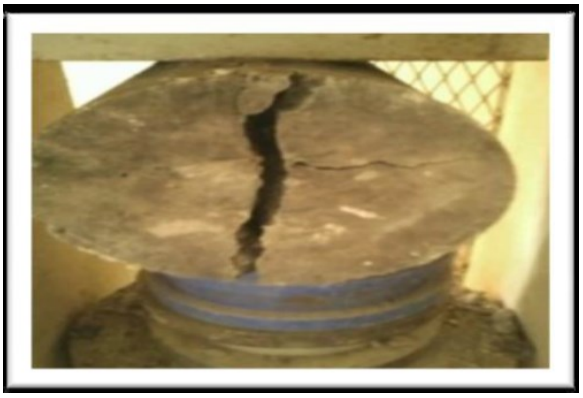
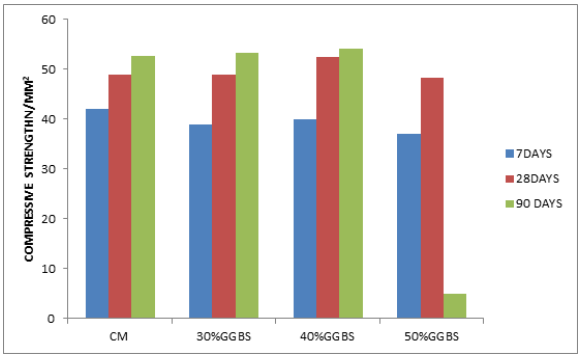


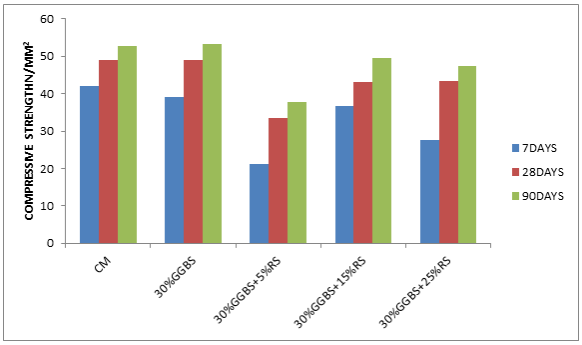
Table 4.3 : Split Tensile Strength Test Results

S.No	Grade of Concrete	7 Days Strength	28 Days Strength
1	CM	3.18	3.56
2	30%GGBS	3.37	3.85
3	40%GGBS	3.86	4.15
4	50%GGBS	3.7	3.65
5	30%GGBS+5%RS	3.17	3.45
6	30%GGBS+15%RS	3.27	3.56
7	30%GGBS+25%RS	3.22	3.63
8	40%GGBS+5%RS	3.34	3.78
9	40%GGBS+15%RS	3.85	4.13
10	40%GGBS+25%RS	3.28	3.82
11	50%GGBS+5%RS	3.16	3.56
12	50%GGBS+15%RS	3.06	3.79
13	50%GGBS+25%RS	3.12	3.62

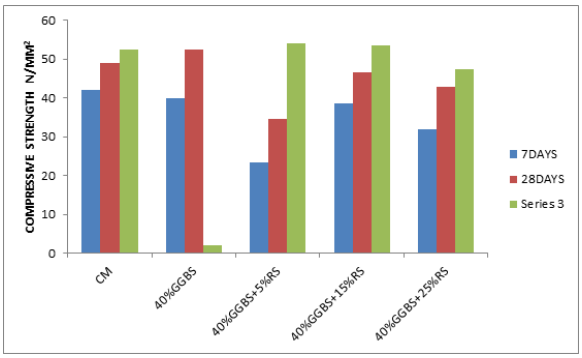
Graphical Representation of Compressive Strength

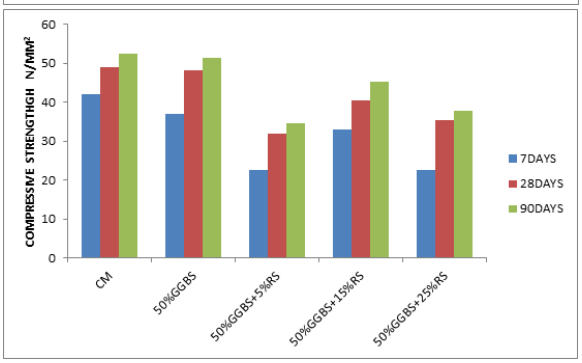


COMPRESSIVE STRENGTH OF GGBS MIXES:

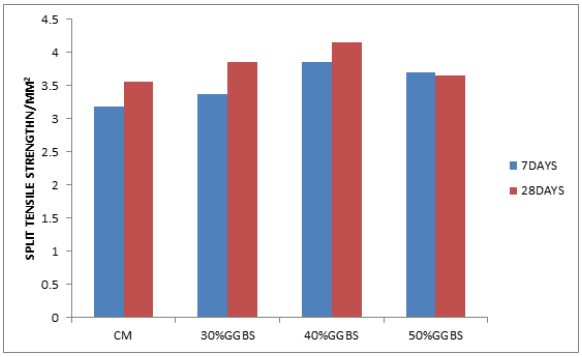


COMPRESSIVE STRENGTH OF GGBS WITH VARITIONS OF CRUSHED ROCK POWDER





SPLIT TENSILE STRENGTH OF GGBS MIXES:



SPLIT TENSILE STRENGTH OF GGBS WITH VARITIONS OF CRUSHED ROCK POWDER

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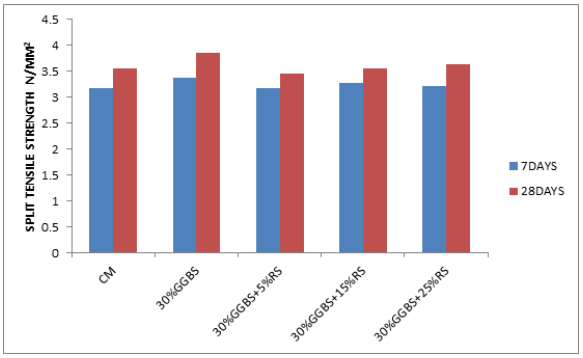

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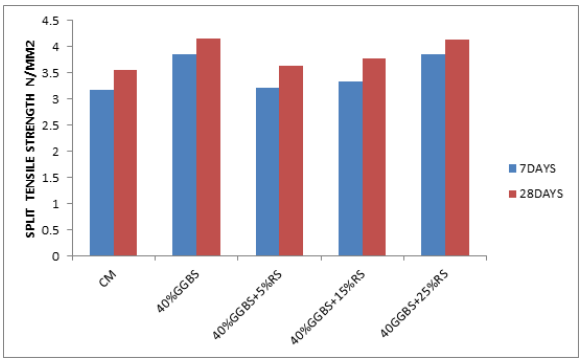

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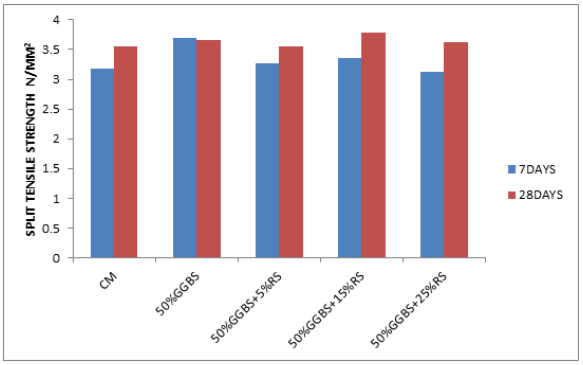

V. CONCLUSIONS AND SUGGESTIONS

CONCLUSIONS:

- In high performance concrete mix design as water cement ratio adopted is low, super plasticizers are necessary to maintain required workability. As the percentage of mineral admixture is increased for through mixing and for obtaining the desired strength.
- The workability of concrete was found to be increases with the increase in GGBS in concrete. It further decreases as the percentage of Quarry Sand increases
- In M40 grade of concrete as the water-cement ratio of 0.36 is in sufficient to provide the good workability, hence super plasticizer are necessary for those grades of concrete.
- Maximum compressive and flexural strength has been obtained for replacement of cement by 40% GGBS.
- Compressive strength of concrete can be improved by using admixtures.
- From the graph it is proved that Crushed rock powder can be used as an alternative material for the fine aggregate.
- The compressive strength is increased as the percentage of Crushed rock powder is increased and further decreases.
- We observed that better results obtained when GGBS is replaced up to 40% and Crushed rock powder up to 15%.
- Maximum compressive strength obtained for replacement of cement by 40% GGBS and sand by 15% of Crushed rock powder
- Maximum split tensile strength obtained for replacement of cement by 40% GGBS and sand by 15% of Crushed rock powder,
- The scope of using high performance concrete in our constructional activities lies large, viz., precast, prestressed bridges, multi-storied buildings, bridges and structures on coastal areas and like.
- To affect this change, we will have to review the designing to structures by encouraging use of high performance concrete.

SUGGESTION FOR FUTURE WORK

- The same investigation can be carried out for different water –cement ratios for each mineral and chemical admixture and also for different grades of concrete.
- GGBS AND Crushed rock powder combinations proves to be the most effective combinations all the mineral admixtures as it contributes to achieve very high compressive strength.

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