IMPACT OF GGBS AS PARTIAL REPLACEMENT TO CEMENT AND QUARRY DUST AS FINE AGGREGATE ON DIFFERENT GRADES OF CONCRETE

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Abstract

The main goal of this study is to study the impact of ggbs as partial replacement to cement and quarry dust as fine aggregate on different grades of concrete. The present study is to find the behavior of concrete under compression, flexure and tensile test between the low strength concrete (M20) and high strength concrete (M60) made of quarry dust as fully replacement in fine aggregates and GGBS (20%, 35% and 50%) as a partial replacement in cement and with 0.25% to 0.5% super plasticizer with water binder.

In this study, quarry dust and GGBS at its maximum dosage and maximum usage of quarry dust is 100% and GGBS is 20%, 35% and 50%. From the obtained results it is observed that NDT tests gave fair results when compared with laboratory results.

M20 & M60 grades of concrete containing 20%, of GGBS and 100% quarry dust shown less compressive strength compared to M20 & M60 grades of concrete containing 35% and 50% of GGBS and 100% quarry dust.

M20 & M60 grades of concrete containing 20% of GGBS and 100% quarry dust shown less flexural strength compared to M20 & M60 grades of concrete containing 35% and 50% of GGBS and 100% quarry dust.

Key words: concrete, quarry dust, GGBS, M20grade, M60 Grade UPV test, Rebound Hammer

1 Introduction

Concrete is an artificial conglomerate stone made essentially of Portland cement, water, fine aggregates and coarse aggregates. The combine of all the materials results in a chemical reaction called as hydration and after that change in the mixture from plastic state to solid state occurs after a period of time. By reducing cost of constituent materials the cost of concrete can be reduced. Reduction of cost can also be achieved by using locally available alternative materials, instead of conventional materials. The consumption of fine aggregate in the production of concrete is very high, and some of the countries have encountered difficulties in meeting the supply of natural fine aggregate. To beat the demand and stress for river sand, specialists and professionals have recognized some option, for example, fly powder, GGBS, lime stone and so on. In India they have influenced endeavors to supplant river sand with quarry dust. River sand has been the most well known decision in the past for the fine aggregate of cement.

1.2 QUARRY DUST

The quarry dust is the result which is shaped in the handling of the rock stones which is separated into the coarse aggregate of various sizes. Quarry dust can be characterized as the deposit, following other non-voluble waste material after the extraction and handling of rocks to frame fine particles under 4.75mm. About 20 to 25 percent of the total production in each crusher unit is left out as the waste material that is quarry dust. This quarry dust can be viably utilized as a part of the development business as incomplete trade or completely swap for regular river sand.

1.3 ADMIXTURES:

[A] MINERAL ADMIXTURE: GGBS is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder.

Granulated Blast furnace Slag is the byproduct obtained in the manufacture of pig Iron in blast furnaces at around 1400° to 1500°C, in the molten form. The slag is obtained by rapidly chilling the molten ash from the furnace by means of chilled water and is ground at 400 m2/kg of fineness by using state of the art grinding mill to make GGBS. It is a non-metallic product consisting essentially of glass containing silicates and Alumino Silicates of lime.

2.MATERIAL PROPERTIES

2.1 CEMENT: Cement is a binder, a substance which is used for construction which sets, hardens and adheres to other materials, binding them together. Cement is seldom used on its own, but rather to bind sand and gravel together. It is used with fine aggregate to produce mortar for masonry, or with sand and gravel aggregates to produce concrete. The specific gravity of cement is 3.15.

2.2 QUARRY DUST: Quarry dust is fine rock particles. Quarry dust is formed when boulders are broken into small pieces. It is like fine aggregate and it is grey in color. The specific gravity of quart dust is 2.55.

2.3 COARSE AGGREGATE: If a material which is passing through 80mm sieve and retain on 4.75mm sieve then material is called coarse aggregate. Coarse aggregate is mined from shake quarries or it is dug from river beds, along these lines the size, shape, hardness, surface and numerous different properties can shift incredibly in light of location. By and large, coarse total can be portrayed as either smooth or adjusted, (for example, stream rock) or precise, (for example, pulverized stone). Due to this fluctuation, test techniques exist to describe the most pertinent attributes. The specific gravity of coarse aggregate is 2.63.

2.4 WATER: Utilization of water should be of potable tap water. Water is basic really taking shape of cement. Adding water to the blend sets off a synthetic response when it comes into contact with the cement. The water utilized as a part of the blending of cement is as a rule of a consumable standard. Utilizing non drinking water or water of obscure immaculateness hazards the quality and functionality of cement.

2.5 AURAMIX 450:

This greatly improves cement dispersion. At the start of the mixing process an electrostatic dispersion occurs but the cement particle’s capacity to separate and disperse. This mechanism considerably reduces the water demand in flowable concrete. Auramix 450 combines the properties of water reduction and workability retention. It allows the production of high performance concrete and/or concrete with high workability

2.1.5 GGBS

Ground granulated blast furnace slag is a sustainable material which helps in greener environment by reducing the energy consumption and carbon dioxide gas emission.The specific gravity is 2.85.

3. EXPERIMENTAL PROGRAM

3.1 Mixing Procedure Preliminary the mix was named with desired value desired value because to obtain proper proportion. The mix design method was used to gain a mix compressive strength. Considering the papers reviewed the mix proportions of the concrete mix M20 and M60 was considered in the initial stage and the percentage of Quarry dust as fully fine aggregate replacement added by weight was 100%. For all percentages of replacement 20%, 35% and 50% GGBS and with different dosages of super-plasticizer was used to generate the following mixes Quarry dust 100%, GGBS 20%, GGBS 35%, GGBS 50% respectively. The coarse aggregates was put first and followed by quarry dust, cement, GGBS and water. The super plasticizer can be added while mixing or before mixing within water. The specimens casted to check compressive strength (cubes), flexural strength (beams), split tensile strength (cubes), rebound hammer test (cubes) and ultra-sonic pulse velocity (cubes) as Cement, Admixtures and Quarry dust are replaced. An appropriate curing enormously adds to diminish the porosity and drying shrinkage of cement and in this manner to accomplish higher quality and more prominent protection from physical and substance assaults in forceful condition. A tilting rotary drum was used to mix all the ingredients well so that no individual material was found separated from the mix and the specimens were casted using removable iron moulds which was previously oiled on all the side of the moulds and the concrete poured in it was well compacted using the vibrating table which would probably remove all air voids if present. After casting the next day the specimens were demoulded and allowed for curing in pure water. The specimens were cured for 7, 14 and 28 Days.

3.2 Compressive strength

Testing of hardened concrete plays an important role in controlling and confirming the quality of cement concrete work. The main factor of the use of concrete in structures is its compressive strength. One of important properties of hardened concrete is its strength which represents the ability of concrete to resist forces. If the nature of the force is to produce compression, the strength is termed compressive strength.

3.3 Flexural strength

For a brittle material flexural strength is a mechanical property to be investigated, solid which is characterized as a concrete material's ability to bend or twist under load. Flexural quality is the measure of the rigidity in bending of a section. It is estimated as far as stress. Flexural quality is a measure of an unreinforced solid shaft or chunk to oppose disappointment in twisting.

3.4 Split tensile strength

The tensile strength is one of the basic and important properties of the concrete. The concrete is not usually expected to resist the direct tension because of its low tensile strength and brittle nature, however the determination of tensile strength of concrete is necessary.

3.5 Rebound hammer test

Rebound hammer test is done to discover the compressive strength of cement by utilizing rebound hammer. The rebound back of a versatile mass relies upon the hardness of the surface against which its mass strikes when the plunger of the rebound hammer is squeezed against the surface of the solid, the spring controlled mass bounce back and the degree of such a bounce back relies at first glance hardness of cement.

3.6 Ultra-sonic pulse velocity test

This test is done to survey the nature of cement by ultra-sonic pulse speed. The strategy comprises of estimating the time travel of a ultra-sonic pulse going through the solid being tried. Similarly higher speed is acquired when solid quality is great as far as speed, thickness, consistency, homogeneity etc.

4. RESULTS

4.1 Compressive strength Test

Tests on hardened concrete results are tabulated below. Table 4.1 shows the results of compressive strength results and Fig.4.1 shows the graphical representation of compressive strength results for various percentage of quarry dust and GGBS.

Table 4.1: Compressive strength test results

Mix designation	Compressive strength in N/mm^2 w.r.t curing period in days		
	7 days	14 days	28 days
M20 -100% quarry dust and 20% GGBS	17.5	21.5	26.2
M20- 100% quarry dust and 35% GGBS	19.8	23.2	27.6
M20- 100% quarry dust and 50% GGBS	21.1	24.3	29.5
M60- 100% quarry dust and 20% GGBS	45.33	52.6	69.2
M60-100% quarry dust and 35% GGBS	46.1	53.4	71.3
M60-100% quarry dust and 50% GGBS	44.35	50.8	68.5

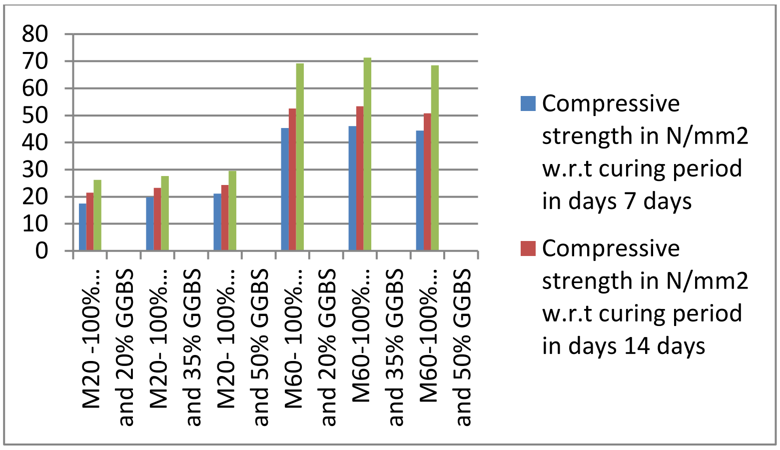

Fig.4.1 Compressive strength results

4.2 Flexural Strength Test

Table 4.2 shows the flexural strength results and Fig.4.2demonstrates the graphical portrayal of flexural quality outcomes for different level of quarry dust and GGBS.

Table 4.2: Flexural strength test results

Mix designation	Flexural strength in N/mm^2 w.r.t curing period in days	
	14 Days	28 days
M20 -100% quarry dust and 20% GGBS	2.28	2.98
M20- 100% quarry dust and 35% GGBS	2.31	3.15
M20- 100% quarry dust and 50% GGBS	2.39	3.61
M60- 100% quarry dust and 20% GGBS	4.9	6.8
M60-100% quarry dust and 35% GGBS	5.2	7.82
M60-100% quarry dust and 50% GGBS	5.1	7.8

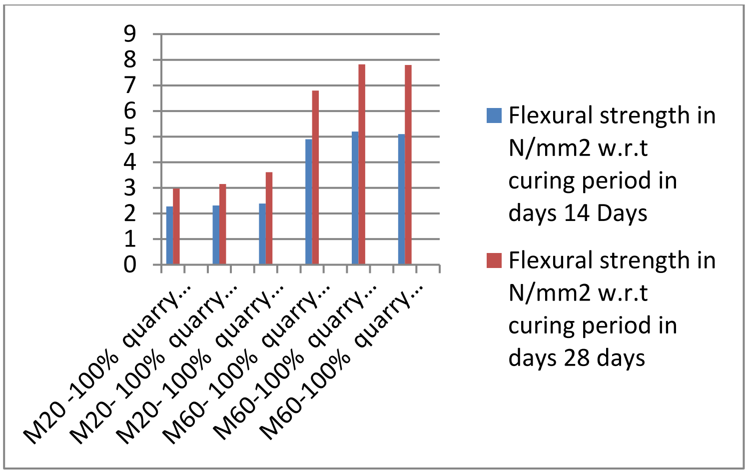

Fig.4.2 Flexural strength results

4.3 Split Tensile strength test.

Table 4.3 shows the results of split tensile strength and Fig.4.3 shows the graphical representation of split tensile strength results for various percentage of quarry dust and GGBS.

Table 4.3: Split tensile strength test results

Mix designation	Split tensile strength N/mm^2 w.r.t curing period in days	
	14 Days	28 days
M20 -100% quarry dust and 20% GGBS	2.08	3.11
M20- 100% quarry dust and 35% GGBS	2.78	3.65
M20- 100% quarry dust and 50% GGBS	2.91	3.86
M60- 100% quarry dust and 20% GGBS	3.87	5.48
M60-100% quarry dust and 35% GGBS	4.32	5.98
M60-100% quarry dust and 50% GGBS	4.5	6.5

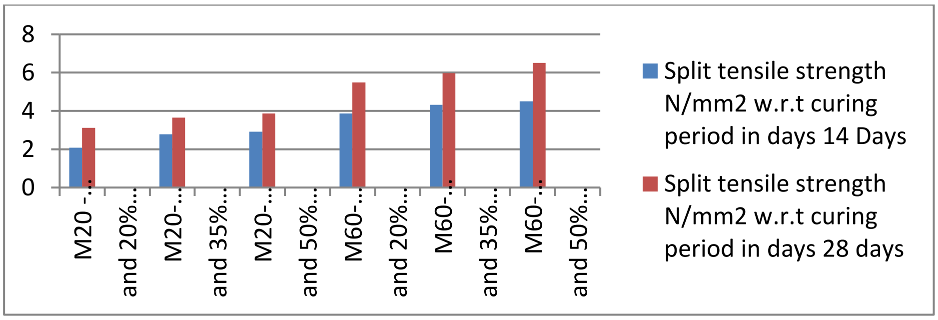

Fig.4.3 Split tensile strength results

4.4 Rebound Hammer Test

Below tables shows the results of ndt tests values. Table 5.5 shows the rebound hammer tests results for 25% GGBS and 100% quarry dust for M20 grade concrete, table 5.6 shows rebound hammer tests results for 50% GGBS and 100% quarry dust for M20 grade concrete, table 5.7 shows rebound hammer tests results for 25% GGBS and 100% quarry dust for M60 grade concrete and table 5.8 shows rebound hammer tests results for 50% GGBS and 100% quarry dust for M60 grade concrete.

Table 4.4: M20 20%GGBS 100% Quarry Dust

Sl No.	Direction	Compressive strength value from Rebound Number	Compressive strength (N/mm^2) (average)
`1	Top	22	24
		24	
		26	
2	Bottom	25	25
		23	
		27	
3	Side	26	25
		30	
		28	

5.Conclusion

1. In light of the trial think about, it is discovered that quarry dust can be utilized as an elective material to the normal stream sand and can be presented as a constructional material. It is found that, quarry dust enhances its mechanical property of cement if utilized alongside GGBS and super plasticizer.
2. Use of quarry dust alongside GGBS will lessen the cost of cement since it is a waste material from quarries and GGBS.
3. The concrete workability reductions with expanding level of quarry dust in the blend by including super plasticizer (Auramix 400), the desired workability have been achieved during the mixing of concrete.
4. The specific gravity and sieve analysis results demonstrates that the quarry dust can be utilized as other option to river sand.
5. As we have seen GGBS is a good replacement to cement with 20%, 35% and 50% in some cases and serves effectively but it can’t replace cement completely. But even though it replaces partially it gives very good results and a greener approach in construction and sustainable development.
6. From the obtained results it is observed that NDT tests gave fair results when compared with laboratory results.
7. M20 & M60 grades of concrete containing 20%, of GGBS and 100% quarry dust shown less compressive strength compared to M20 & M60 grades of concrete containing 35% and 50% of GGBS and 100% quarry dust.
8. M20 & M60 grades of concrete containing 20% of GGBS and 100% quarry dust shown less flexural strength compared to M20 & M60 grades of concrete containing 35% and 50% of GGBS and 100% quarry dust.

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