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Experimental Study on Performance of Recycled Aggregate Concrete or Green Concrete to Improve the Strength and Durability Parameters of Concrete

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ABSTRACT

Conventional concrete is responsible for amount of carbon-dioxide emission to some Extent. So to reduce the emission, various types of concrete are developed using waste products from industries and agricultural use like blast furnace slag, silica fume, fly ash which requires low Amount of energy and also cause least harm to the environment. Green concrete is a new technology developed now days to reduce the effect on environment by production of cement. Cement contains high amount of carbon-di-oxide which harms the environment drastically, so by replacing the cement by various materials which causes harm to the environment we not only reduce the problem of disposal of these materials but we reduce the emission of carbon-di- oxide from cement and as a result of which we reduces the negative effect on environment.

Keywords - Green Concrete, Silica fume, Demolished Brick Aggregate, CO2 Emission, Eco-Friendly concrete.

INTODUCTION

Color has nothing to do with green concrete. It is a concept of thinking and environment into an every aspect of the raw materials manufacture over construction, mixture design to structural design, and durability. Green concrete is very often considered to be cheap to produce due to the use of recycled material whereby avoiding the charges for the disposal of waste, less energy consumption and greater durability.

While a normal construction practices are guided by short term economic considerations, sustainable construction is focused on best practices which emphasize on long term affordability, durability and effectiveness. At each stage of the life cycle of the construction, it increases ease and quality of life, while minimizing the negative environmental impacts and increasing economic sustainability of the construction. Any infrastructure designed and constructed in a sustainable way minimizes the use of resources through the whole life cycle of the construction process in which the green concrete play a vital role in achieving the sustainable construction. Having so much of advantageous has led to popularity in construction world and one of the emerging technology in sustainable construction. Green concrete is miracle of present and tool for future when the natural resources are on the verge of extinction.

Due to growing interest in sustainable development, engineers and architects are motivated more than ever before to choose materials that are more sustainable. Selection of material for concrete is more sustainable and minimizes environmental impact. Cement production accounts for more than 6% of all CO2 emission which is a major factor in the world's global warming (Greenhouse gas). India is the third largest cement producer in the World and one of the largest consumers of cement per capita in the world. Rough figures are that India consumes about 1.2 Ton/year/capita, while as World average is 0.6 Ton/year/capita. CO2 emissions from 1 ton of concrete produced vary between 0.05 to 0.13 tons. 95% of all CO2 emissions from a cubic meter of concrete are from cement manufacturing.

Cement is the one of the major component of the concrete. The production of one ton of cement releases one ton of a CO2 into the atmosphere. CO2 is known to be greenhouse gas that contributes to the global warming. The reduction in CO2 emission from a concrete can be achieved with a partial replacement of cement by the various supplementary cementitious materials. The use of these cementitious materials has resulted in an improvement of the properties of concrete.

So to reduce this environmental impact green concrete plays a vital role. By using recycled materials or waste materials which are harmful to the environment as a replacement of cement such as fly ash, silica flume, etc. we can reduce the CO2 emission from concrete as well as it reduces the environmental impact on earth. As a result of which green concrete is one of the major tool in the future when the natural resources are on verge of extinction.

HISTORY OF CONCRETE

The Indian cement industry is today, nearly 93 ages previous. The first plant was built in 1913 with an annual capacity of 0.01×10^6 t/a. The increase of cement manufacture in India has witnessed. The increase of cement manufacture in India has witnessed many a report and relaxed period, the most important creature the transfer from the control regime to "free regime" in the time 1989.The cement and concrete businessviewed both quantitative in addition to qualitative expansion in the free system, which carries on till date.

The foundation of cement production in India was placed by Indian cement company Limited. In the time 1912-13 at Porbandar (Gujarat State) and commenced construction in 1914. For lots of person who exercise by means of study India build environment the metropolis of Chandigarh dates as of the mid 1950 is frequently believed to be the beginning point for the employ of toughened concrete in India. By that phase North America and Europe have been made by reinforced concrete for greater than 50 yrs and consequently this work investigates the utilization of this material in India throughout the ½ of the 20th century. The structures planned by Lutyens and Baker in New Delhi there have been smallest attention in India's construct surroundings from the 1/2 of the 20th century. There are no. of motives for this situation. The structures of this phase started to get on a additional international form, substitute the exoticism of the Indo-Saracenic method of the late 19th and early 20th century to facilitate the residues, so pleasing to lots of writers of Indian architectural history. The legal age of buildings, where a trendy is recognized, was through architect who be approximately unidentified inside and outside India and therefore has not drawn the concentration of western architectural historians.The investigation completed in 1947 through the finish of the British ~ lie in India, a stage of conversion for India and close to the "pause" in the building industry. though Anglo-Indian designers persistent to perform after the battle, they were conceal at first by Le Corbusier and Louis Khan- high-profile name bring in to assist encourage a new India - and after that by Indian designers for example Charles Correa, Balkrishna Doshi, and Raj Rewal.

PROPERTIES OF CONCRETE

Concrete has many characteristics which makes common construction material. In parliamentary procedure, the correct quantity of materials, placement, and curing are required for these attributes to be most favorable.

Superior concrete has numerous benefits that put in to its fame. Primary, it is reasonable when constituents are willingly utilizable. Concrete's lengthy life and relatively low preservation necessities augment its financial reimbursement. Concrete is not uniformly probably to decompose, decay, or fester as other construction materials. Concrete have the capability to be formed or transmit into about every desired type. Construction of the cast and casting be capable of occur on the worksite which reduces prices.

Concrete is a non-flammable material which increases its high fire resistance quality and its able to fire safe and withlocate high temperatures. It is opposed to airstream, water, rodents, and worms. Therefore, concrete is regularly used for storm protections.

Concrete material has some limit seven though it's numerous benefits. Concrete has a comparatively (i) low tensile strength (ii) low ductility (iii) low strength-to-weight proportion and is vulnerable to breaking. Concrete residue the material of selection for many purposes, despite of these restrictions.

INNOVATIONS IN CONCRETE

Progresses in concrete technology include the different parameters of concrete for example workability, strength, Durability and so on. But this current situation explains advance in concrete technology such as Admixtures, Plasticizers, Super plasticizers, retarders. And uses of these materials has become a lift for structural Engineers to bring down big constructions in usage in a smaller time.

The most important advances in Concrete technology deals, with the achievement of:

- Plasticizers,
- Super plasticizers,
- Retarders,
- Accelerators,
- Air-entraining admixtures,
- Pozzolanic Admixtures,
- Damp-proofing Admixtures,
- Gas forming Admixtures,
- Workability Admixtures,
- Bonding Admixtures,
- Coloring Admixtures and
- Corrosion Inhibiting Admixtures.

Not simply has this but these also incorporated construction Chemicals such as:

- Concrete Curing Compounds,
- Mold Releasing agents,
- Non-shrink high strength Grout,
- Surface Retarders,
- Guniting Aid
- Protective Coatings.

The above listed compounds are helpful not only in enhancing strength, toughness and operability of concrete, other than they are also helpful in protecting concrete, establishing bonds between concrete resources, providing concrete with good-looking colors, and also reducing water to a large amount, which is now a serious crisis.

STRENGTH OF CONCRETE

The strengthening of concrete is extremely depending upon the hydration process. Water, particularly the amount used, performs a vital role. When a smaller volume of water is use to be build concrete, the strengthening of concrete expands. A particular volume of water is graphed by the hydration effect itself. In essence, concrete is mixed with extra water is desirable for hydration process. To provide ample concrete workability, this additional water is combined. Smooth concrete is preferred to attain suitable filling and the making of the shapes. The water not utilized in the hydration effect will stay in the microstructure stoma space. These holes formulate the concrete fragile because of the deficiency of strength forming calcium silicate hydrate connections. A number of pairs will stay no substance how well the concrete has been compressed.

Water provided to cement gives more strengthening but low workability. The high percentage of water in cement proportion leads to little strengthening, but provide super workability. The objective distinctness of aggregates is the texture and quantity of the form. These can ultimately affect strengthening since they influence the workability of concrete. But the aggregates build the concrete impracticable; the service provider is probably to add more water, which will grow weaker the concrete by raising the percentage mass of water in concrete.

Concrete's strength may caused by the adding up of admixtures. Admixtures are materials extra than the key constituents or strengthening which are added during the mixing process. Some mixing contents add variability to concrete while involving a smaller amount of water is to be used. Super plasticizer is to be used as an admixture for strengthening. This create concrete more practicable or fluid without addition of surplus water. A list of different admixture and their functioning given underneath. Note that not every admixtures boost concrete strength. Stability is a very significant term in using concrete for a known function. Concrete offers good presentation during entire life's of organization when concrete is mix-up correctly then proper care taken during curing time. High-quality concrete having unlimited life under the correct circumstances. Water, while significant for concrete having hydration or hardening properties, are also contribute a purpose in reducing toughness when the formation is constructed. This is occur only because water can convey dangerous chemicals to the internal of the concrete foremost to different shapes of deterioration. Such weakening eventually inserts costs because of maintenance and restore of the concrete organization. The service provider should be proficient to account for ecological issues and build a durable concrete organization if these aspects are considered when construction a concrete structures.

MATERIALS

The materials used in the concrete mixture projects are cement, cruser dust, F.A.,C.A. as described in detail below:

Cement:- Its one of the important component of concrete, since the binding medium for the distinct ingredients is created. Produced from naturally occurring raw materials and then mixing with toxic waste or underground. OPC 53 grades of Ordinary Portland cement (OPC) conforming to IS12269-1987 was used for the analysis.

Fine Aggregate:- Aggregates that cover almost 70 to 75 % concrete volume are often used in more than one way as inert ingredients. This is well known now a day, however, that the (i) physical (ii) chemical (iii) thermal properties of aggregates drastically affect the property of 23 mm and concrete results. To extract all pebbles, fine aggregates (sand) use as fresh dry sand sewn in a 4.75 mm sieve.

Coarse Aggregate:- For making concrete, coarse aggregate is used. They are generally in form of broken stone, or gravel that naturally occurs. Coarse aggregates are called material that is wide to be held at 4.75 mm sieve size. Up to 40 mm may be its maximum span.

Water:- For the preparation of concrete, water is so much important or as it engages in a chemical reaction with cement. In the presence of water gel is formed which helps increase the concrete's strength. For mixing, portable water is usually considered satisfactory. The pH value of water should not be lower than the maximum allowable values expressed in the following concentrations.

Limits of acidity: Not more than 5 ml of 0.02 NaOH should be needed to neutralize a 100 ml solution of water using phenolphthalein as an indicator. The test details are as stated in IS 3025.

Limits of alkalinity: Using a mixed indicator, neutralizing a 100 ml solution of water does notneed more than 25 ml of 0.02 natural H_2SO_4. The specifics of the tests are as stated in IS 3025.

Percentage of solids: When measured in compliance with IS 3025, the maximum allowable limits of solids are as set out in IS 3025.

The chemical and physical properties of groundwater shall be tested in conjunction with the soil investigation and if there is no water found to comply with the necessities of IS 456- 2000, it shall be clearly specified in the tender documents that contractor has to organize for the construction of good quality water indicating the source.

Water is to be found satisfactory for mixing and curing. For curing water shall not, however, create on the surface any undesirable stain or unsightly deposit.

For mixing or curing, sea water must not be used.

Water available for every source is to be tested before start any construction work and every three months thereafter until the end of work. In the case of groundwater, different test can also be performed for a separate drawdown point.

Micro Silica:- Silica fume used was confirming to ASTM – C (1240 – 2000) and was supply by "ELKEM INDUSTRIES" was name Elkem – Micro Silica 920 D. The silica fume is used as a partial replacement of cement.

Demolished Bricks:- Demolished bricks were collected from the demolished building of age 50 years. The collected sample were broken manually into pieces of size passing through 4.75mm IS sieve and retained on 150 micron IS sieve.

LITERATURE REVIEW

In 2016, Anita Bhatia, et al1 publishes a paper on green concrete in which they concluded that green concrete is very low energy and resource consumption, no environmental pollution and sustainable development. One can conclude that overcoming the above demerits would help to use the green cement concrete with a potentially new environmental friendly world. With the waste material as an alternative we can help to reduce the environmental problems and protect the naturally available materials for the future generation. (1)

In 2016, Praveer Singh, et all studied about the silica fume and comes to the conclusion that cement is becoming a scarce resource all over the world because of increase in demand day by day. The use of silica fume as a pozzolana material has increased in recent years because when mixed in certain proportions it enhances the properties of both fresh and hard concrete. Addition of silica fume in proper proportion improves durability attack by acidic waters and improving concrete conditions. (2)

In 2016, Tae Hyoung Kim, et all does study about the CO2 emission from concrete and concluded that concrete, a common construction material, is known to emit large amount of environmentally hazardous waste during the processes related to its production, construction, maintenance, and demolition. The CO2 emitted in a concrete production affect the acidification and global warming. (3)

In 2015, Kasi Rekha, et all studied about the brick wastes and concluded that the recycled brick aggrigate concrete is made used for the production of low grade recycled aggregate suitable for concrete production. The results showed that recycled brick aggregate concrete performed better than granite aggregate concrete at high temperature. The fire resistance of recycled brick aggregate concrete is better than the fire resistance of granite aggregate concrete. (4)

In 2015, Dhiraj Kumar Tiwari, et all studies about the green concrete and concluded that green concrete capable for sustainable development is characterized by application of industrial wastes to reduce consumption of natural resources and energy and pollution of environment. Application of green concrete is an effective way to reduce environment pollution and improve durability of a concrete under severe conditions. Green concrete has the good thermal & fire resistance. (5)

In 2015, Xian LI, et all conducted an experiments on concrete having fine aggregate replacement by demolished brick waste and they comes to the conclusion that recycled waste brick aggregate has obvious different properties from recycled concrete aggregate and is hardly accepted because of its lower strength the effect of recycled waste brick fine aggregate on compressive strength and flexural strength of mortar was studied. A good bond exists between recycled brick aggregate & the cement paste. The fire resistance of recycled brick aggregate concrete is better. (6)

In 2015, Kakamare M.S., et all studied about the Sustainable Construction Materials & Technology in which they concluded that green concrete is a type of concrete which resembles the conventional concrete but the production or uses of such concrete requires minimum amount of energy and causes least harm to environment. Green concrete is a very low energy and resource consumption, no environmental pollution, sustainable development. Green Concrete has good thermal and fire resistance, sound insulation than the traditional granite rock. (7)

In 2015, Mohammed Tarek Uddin1, et all studied about the demolished brick waste replacement as an aggregate and they concluded that investigations were carried out to explore the possibility of recycling of demolished brick aggregate concrete as coarse and fine aggregate. The compressive strength of mortar portion of concrete is higher than the compressive strength of recycled aggregate concrete; it indicates that failure of concrete specimen is initiated in recycled coarse aggregate. (8)

In 2014, Dewanshu Ahlawat, et all replaces the coarse aggregate by coconut shell & concluded that concluded that the rising cost of construction material is a matter of concern. The reason for increase in cost is high demand of concrete and scarcity of raw material. Hence the concrete technologists must search for some economical alternative to the course aggregate. Increase in percentage replacement by coconut shell reduces compressive strength of concrete. (9)

In 2014, Abhijeet Baikerikar et all reviews the green concrete concept and he concluded that construction industry is growing rapidly and new technologies have evolved very fast to cater different difficulties in the construction industry. Billions of tons of naturally occurring materials are mined for the production of concrete which will leave a substantial mark on the environment. This review paper gives a brief idea about the advantages and disadvantages about the green concrete. Replacement of traditional ingredients by waste material and by products gives economical & environment friendly concrete. (10)

In 2014, Chirag Garg, et all publishes the review paper on green concrete & they come up with the conclusion that the concrete is made with concrete wastes which are eco-friendly so called as green concrete. The paper covers the aspect on how to choose a material for green concrete. It has been observed that 0.9 tons of CO2 is produced per ton of cement production. Also the composition of cement is a 10% by weight in eco-friendly construction technique. Thus, by the use of green concrete it is possible to reduce CO2 emission in the atmosphere towards eco-friendly construction technique. A trend is increasing of incentives for the greater use of manufactured and recycled aggregates in construction. (11)

In 2014, Umesh Sharma, et all studied about the silica fume & concluded that concrete is the most important engineering material in a construction industry because of its inherent strength properties. Micro silica primarily of very fine smooth spherical silicon oxide particles with an extremely high surface area. Micro silica particle are 100 times smaller than as that of cement particle. Silica fume is usually categorized as a supplementary cementitious material. These material exhibit pozzolanic properties, cementitious properties and a combination of both properties due to this properties it can affect the concrete behaviour in many ways. Silica fume is a material which may be a reason of Air Pollution. This is a by-product of some Industries. Use of micro-silica with concrete decreases the air pollution. Silica fume also decrease the voids in concrete. (12)

In 2012, N. K. Amudhavalli et all concluded that Portland cement is the most important ingradient of concrete and is a varsetile and relatively high cost material. Lasrge scale production of cement is causing enviornmental problems on one hand and depletion of natural resourses on other hand. This threat to ecology has led to researchers to use industrial by products as supplementary cementatious material in making concrete. This paper represents the detail experimental study on compressive strength, flextural strength and split tensile strength. Consistency of cement depends upon its fineness. Silica fume is having greater fineness than cement and greater surface area so the consistency increases greatly, when silica fume percentage increases. (13)

In 2012, Verma Ajay, et all concluded in there paper that concrete is the most important engineering material and the addition of some other materials may change the properties of concrete. With increase in a trend towards the wider use of concrete for high rise buildings there is a growing demand of concrete with higher compressive strength. There are two types of materials crystalline and noncrystalline. Micro silica or silica fume is very fine non crystalline material. Silica fume is produced in electric arc furnace as a by-product of the production of elemental silicones or alloys containing the silicon. Silica fume was initially viewed as cement replacement material and in some area it is usually used as replace by much smaller quantity of silica fume may be used as pozzolanic admixtures. Silica fume increases the strength of concrete more 25%. Silica fume is much cheaper than cement therefore it very important from economical point of view.(14)

METHODOLOGY

In this study i have done a various test like sieve analysis of F.A., coarse aggregate, Micro Silica, Demolished Bricks and its specific gravity along with its compressive strength, Flexural Strength Test and tensile strength.

Grading of F.A.:

Grading of Fine Aggregate show the average particle size of sand. The following table show the fineness of sand. In sieve analysis I took 1000 gm of sand material. As per IS-383:1970 for Gradation of fine aggregates following sieves are used: 10mm, 4.75mm, 2.36mm, 1.18mm, 600micron, 300 micron and 150micron, nature of Aggregate: river sand

Table: Sieve Analysis Of F.A.

Sieve Size	Average Wt. Retained(gm)	Cumulative Wt.(gm)	Percentage of cumulative Wt.(gm)	Percentage passing	Limit as per IS 383
10 mm	0	0	0	0	100
4.75 mm	3.5	3.5	0.35	99.65	95-100
2.36 mm	56	25.5	2.55	97.45	85-100
1.18 mm	219	81.5	8.15	91.85	75-100
600 micron	583	300.5	30.05	69.95	60-79
300 micron	105	883.5	88.35	11.65	12-40
150 micron	12.0	988.5	98.85	1.15	0-10
PAN	0.00	1000	100	0	
Total		1000	1000	311	

We know that,

Fineness Modulus = cumulative percentage retained on specified sieves /100 So, Fineness Modulus = 311/100 = 3.11 ≈ 3.11

According to IS: 383-1970 the fineness modulus lies in zone III

Grading Of Course Aggregate (20mm):

As per IS-383:1970, sieves used were 40mm,20mm, 10mm, and 4.75mm.Location: Gwalior

Sieve Analysis of course Aggregate (20mm)

Sieve Size	Average Wt. Retained(gm)	Cumulative Wt.(gm)	Percentage of cumulative Wt.(gm)	Percentage passing	Limit as per IS 383
40 mm	0	0	0	100	100
20 mm	1176.5	57.825	57.825	40.175	85-100
10 mm	735	37.75	94.575	4.425	0-20
4.75 mm	79	3.95	98.525	0.475	0-5
2.36	9.5	0.475	100	0	
1.18	0	0	100	0	
600micron	0	0	100	0	
300micron	0	0	100	0	
150micron	0	0	100	0	
PAN	0	0	100	0	
Total	2000	2000	758.3	0	

We know that,

Fineness Modulus =cumulative percentage retained on specified sieves /100 So, Fineness Modulus = 758.925/100 = 7.58825 ≈ 7.58

Grading Of Course Aggregate (10mm):

As per recommendation of IS-383:1970, Sieves were used for Gradation of C.A. are 12.5mm, 10mm,4.75mm and 2. Grading Of course Aggregate show the average particle size of sand. The following table show the sieve analysis of course aggregate .In sieve analysis I was taken 2000 gm of aggregate of 10 mm As per IS-383:1970

Sieve Analysis Of course Aggregate (10mm)

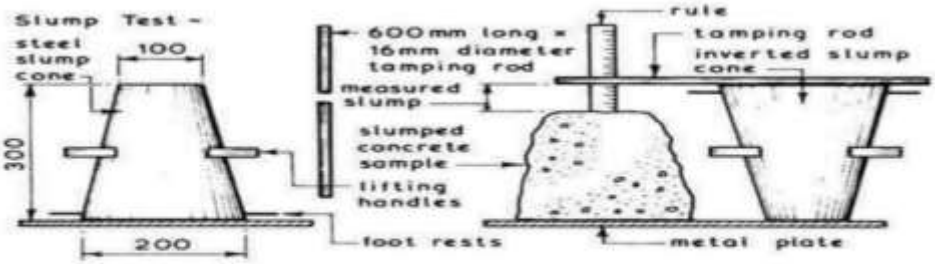
Sieve Size	Average Wt. Retained(gm)	Cumulative Wt.gm)	Percentage of cumulative Wt.(gm)	Percentage passing	Limit as per IS 383
12.5 mm	0	0	0	100	100
10 mm	42	42	2.1	97.9	85-100
4.75 mm	1348	1390	93.9	30.5	0-20
2.36 mm	488	1878	100	6.1	0-5
1.18mm	122	2000	100	0	
600micron	0		100	0	
300micron	0		100	0	
150micron	0		100	0	
PAN	0		100	0	
Total	2000		566.5		

We know that,

Fineness Modulus =cumulative percentage retained on specified sieves /100 So, Fineness Modulus = 566.5/100 = 5.66

SLUMP TEST

Slump Cone Consist Of Cone Like Structure Which Is Used To Find Workability of freshen concrete .This test is done by the guidelines of IS: 1199-1959 and procedure followed to evaluate workability is given below.



Note - Dimensions are in mm

SUMMARY:

Silica fume is a material which may cause air pollution; this is the byproduct of some industries. Addition of micro silica in cement reduces the air pollution and makes concrete more sustainable; as well as the optimum replacement of cement with silica 5% to 15% leads to increase in strength whereas the 20% replacement leads to decrease in strength of concrete. Silica fume is finer than cement and more reactive to concrete ingredients so it increases the normal consistency of cement and achieves more strength in less time as compare to conventional concrete. By replacing the fine aggregate with demolished brick waste, there is no significant effect on any strength of concrete, but the overall cost of concrete reduces up to 20% so economically the concrete is more economical than conventional concrete.

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