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Partially Replacement of Coarse Aggregate with Asbestos Sheet Waste in Concrete

Pappu Sharma[1], Parveen Berwal[2]
[1]M.Tech Scholar, [2]Assistant professor , Civil Department
Indus Institute of Engg. And Technology-Jind, 126102, India

Abstract : ***In this constructed environment, the rising prizes of building construction materials are the factor of great worry. The coarse aggregates are the main ingredients used in concrete. We all want that our structure must be strong, stable and should build with the construction material of reasonable prizes. Every construction industry totally trust on cement, aggregates whether it is coarse or fine for the production of concrete. In this research, we have replaced the coarse aggregate partially by using asbestos cement sheet waste. It is a waste material so by using asbestos sheet waste as a replacement we can solve the problems of price rising. Therefore, we have planned to prepare some number of cubes using asbestos sheet waste at various proportions like 0%, 5%, 10%, 15% and 20% by weight of coarse aggregate. The properties for fresh concrete are tested for compressive strength at the age of 7 and 14 days.***

Keywords : ***OPC 53 Grade, Coarse Aggregate, Fine Aggregate, Asbestos Sheet Waste, Water, Concrete***

I. INTRODUCTION

Concrete is an essential building material is widely used in the construction of infrastructure such as buildings, bridges, highways, dams, and many other facilities. Most concretes used are lime-based concretes such as Portland cement concrete or concretes made with other hydraulic cements. However, road surfaces are also a type of concrete, asphalt concrete, where the cement material is bitumen, and polymer concretes are sometimes used where the cementing material is a polymer. Almost in all the countries in the world various experiments are done at reducing the use of primary aggregates and escalating reuse and recycling have been introducing, which is economically technical or environmentally acceptable. As a result in developing countries like India the informal sector and secondary industries recycle 15-20 % of solid wastes in various building materials and components. Asbestos sheet waste also a solid waste used as a coarse aggregate in the concrete mixes. Asbestos products manufacturing industries are located in fifteen industrial states of India strategically important from raw materials and energy availability view point and also from consumption pattern view point. It is understood that Tamil Nadu, Andhra Pradesh, Haryana, Maharashtra, Madhya Pradesh and Gujarat consume more than 75 % of the asbestos in India.

II. MATERIAL USED IN STUDY

A. Asbestos

Asbestos is a set of six naturally occurring silicate minerals which all have in common their eponymous asbesti form habit: long, thin fibrous crystals, with each visible fiber composed of millions of microscopic "fibrils" that can be released by abrasion and other processes. They are commonly known by their colors, as blue asbestos, brown asbestos, white asbestos, and green asbestos.

Asbestos mining existed more than 4,000 years ago, but large-scale mining began at the end of the 19th century, when manufacturers and builders began using asbestos for its desirable physical properties: sound absorption, average tensile strength, resistance to fire, heat, electricity, and affordability. It was used in such applications as electrical insulation for hotplate wiring and in building insulation. When asbestos is used for its resistance to fire or heat, the fibers are often mixed with cement or woven into fabric or mats. These desirable properties made asbestos very widely used. Asbestos use continued to grow through most of the 20th century until public knowledge (acting through courts and legislatures) of the health hazards of asbestos dust outlawed asbestos in mainstream construction and fireproofing in most countries

B. Coarse Aggregate

Coarse aggregate, or simply "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 materials 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.

C. Portland Cement

Portland cement is by far the most common type of cement in general use around the world. This cement is made by heating limestone (calcium carbonate) with Portland cement is by far the most common type of cement in general use around the world. This cement is made by heating limestone (calcium carbonate) with other materials (such as clay) to 1450 °C in a kiln, in a process known as calcinations, whereby a molecule of carbon dioxide is liberated from the calcium carbonate to form calcium oxide, or quicklime, which is then blended with the other materials that have been included in the mix to form calcium silicates and other cementations compounds. The resulting hard substance, called 'clinker', is then ground with a small amount of gypsum into a powder to make Ordinary Portland Cement the most commonly used type of cement (often referred to as OPC). Portland cement is a basic ingredient of concrete, mortar and most non-specialty grout. The most common use for Portland cement is in the production of concrete. Concrete is a composite material consisting of aggregate (gravel and sand), cement, and water. As a construction material, concrete can be cast in almost any shape desired, and once hardened, can become a structural (load bearing) element.

D. Water

The water employed in the mixtures was taken from the Indus institute of engineering technology, concrete laboratory which is tap water. This water was also used in the curing tanks.

III. LITERATURE REVIEW

Asbestos is a naturally occurring fibrous material which is widely used in construction field, so we used asbestos in replacement of coarse aggregate, partially in varying percentages of 5%, 10%, 15%, 20%, so we referred various materials and other journals by study of compressive strength of concrete with asbestos.

BY Manu Chaudhary, R.D. Patel who have a lot of journal under their name, they are the masters in the field of construction materials. This journal helped us to know the insight of the asbestos and its properties like compressive strength of the mix concrete. the above journal gives the various aspects of compressive strength of concrete mixed with asbestos.

We did refer the book of concrete technology by M.S. Shetty who is renowned author in this field of construction materials and technology from this we came to know the properties of concrete, cement, asbestos and its physical, chemical properties, compressive strength and its tensile strength and the other aspects of the construction materials. We got to know the procedure of the various methods of carrying out the process.

Mohammad Abdur Rashid (2012), studied the properties of concrete by replacing stone aggregate either partly or fully by crushed clay-brick. Concretes were made by replacing partially or fully the stone aggregate by equal volume of brick aggregate whereas everything else was kept same. The only variable in the study was the volumetric replacement of stone aggregate by brick aggregate at 0%, 25%, 50%, 75%, and 100%. It concluded that, reductions of unit weight and compressive strength of concrete by about 14.5% and 33% respectively.

R. Kamala, B. Krishna Rao (2012), in their study, used recycle aggregates and solid wastes from demolition waste and construction is showing a probable application in construction and as an alternative to primary and natural aggregate. Cubes, Cylinders and Prism were cast and tested for compressive, split tensile and flexural strength at 7, 28 and 56 days by partially replaced the crushed tile aggregate to conventional coarse aggregate. The compressive strength of the ceramic concrete varied from 32.88 MPa to 46.88 MPa and the split tensile strength is varied from 2.47 MPa to 3.72 MPa and flexural strength is varied from 5.33 MPa to 7.82 MPa at 28 days. So ceramic waste can be effectively used place of conventional aggregate. He also observed that the strength decreases from 50% replacement of coarse aggregate. Hence upto 40% we can use ceramic tiles as replacement of coarse aggregate.

G. Murali (2012) in his experimental study, effects of chemical admixture (supaflo) and the shabath stone on concrete were find. Natural aggregate are replaced by waste shabath stone at four different percentages namely 10%, 20%, 30% & 40 % by wt. of coarse aggregate. His test results show that the replacement of coarse aggregate by 30% gives a good strength. The Maximum Compressive strength of concrete can be found at 30% replacement of shabath stone was achieved to be 26% and 56% higher than the conventional concrete and flexural strength was gradually increased upto 11.76% and 15.29% and the tensile strength of concrete at 30% replacement was increased upto 21.70% and 28.30% with and without chemical admixture respectively.

IV. METHODOLOGY

This study was focused firstly to determine whether Asbestos Sheet Waste and its subordinate can be used as coarse aggregate for M35 grade of concrete. Scope of this project is to check the characteristic strength of M35 grade of concrete for four different proportion of Asbestos Sheet Waste, each proportion of Asbestos Sheet Waste Concrete M35 is suitable for footing, Residential and Highway application. The ingredient of the concrete consisted of cement; coarse aggregate (20mm) Asbestos Sheet Waste, fine aggregate and water.

A. Mix Design

Concrete is a versatile building material and its mix design may be define as the art of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing of concrete of certain minimum strength and durability as economically as possible

It can be designed for strength ranging from M10 (10MPa) to M100 (100MPa) and workability ranging from 0 mm slump to 150mm slump. In all these cases the ingredients of concrete are same, but it is their relative proportioning that makes the difference.

Following tests are conducted to determine the workability, strength and durability indicators of the concrete. A complete list of the tests is given below

B. Particle Size Distribution

"Particle size distribution" is an index (means of expression) indicating what sizes (particle size) of particles are present in what proportions (relative particle amount as a percentage where the total amount of particles is 100 %) in the sample particle group to be measured. Particle size distributions were carried out for all fine and coarse aggregates used in this project in accordance with IS 383-1970, Specification for Coarse and Fine Aggregate from Natural Sources for Concrete. The procedure for coarse aggregate sieving is much the same as for fine aggregate except that it is done on a larger scale. The sieves used for coarse aggregate sieving were 30 cm in diameter and the sieve aperture sizes used were 40mm, 20mm, 10mm, 4.75 mm and pan are shown in (Figure). A bigger mechanical shaker was operated for 10-15minutes, a little longer than for fine aggregate sieving; the rest of the methodology is much the same as that for fine aggregate sieving.

Fig 1 Sieve shaker with sets of sieve

C. Specific Gravity Test

Specific gravity is the ratio of the density of a substance to the density of a reference substance; equivalently, it is the ratio of the mass of a substance to the mass of a reference substance for the same given volume. Apparent specific gravity is the ratio of the weight of a volume of the substance to the weight of an equal volume of the reference substance.

The specific gravity of coarse aggregate and asbestos sheet waste is frequently required for computation of several quantities such as void ratio, degree of saturation, unit weight of solids and unit weight of soil in various states. It is determined using a Pycnometer bottle as per IS: 2386 (Part 3) 1963.

Fig 2 Pycnometer bottle for specific gravity

D. Specific Gravity and Water Absorption of Coarse Aggregate

Water absorption value used to calculate the change in weight of fine aggregate due to water absorbed in pore spaces. They are also used to calculate the amount of water that is absorbed by fine aggregate during Portland mix concrete prepration.

The test is useful to determine the porosity of road aggregates and is an indirect measure of checking strength and quality of stones. Road stones which absorb more water are considered unsuitable to be used for road making. The water absorption is expressed as the percent water absorbed by aggregate in terms of oven dried weight of the aggregate.

This test helps to determine the water absorption of coarse aggregates as per IS: 2386 (Part III) – 1963.

Fig. 3 Wire bucket for Specific gravity

E. Abrasion Test

This test is used to determine the hardness of road aggregate (their resistance to wearing action at the top surface of the road pavement). Stone aggregate used for road making should be hard enough to resist the abrasion due to traffic movements. When fast moving traffic fitted with pneumatic tyres move on the road pavement, the soil particles presents between the wheels and road surface abrasion on the road aggregates.

The basic principle of los angeles abrasion test is to find out the percentage wear due to relative rubbing action between the road aggregates and the steel balls used to abrasive charge (for steel wheels) in a los angeles abrasion testing machine. This test is conducted as per IS: 2386 (part V) – 1963.

Fig. 4 Los angeles abrasion testing machine

F. Impact Test

This test is designed to evaluate the toughness of road aggregate (their ability to resist fracture blow of impact of traffic loads.) As a result of continuous traffic movements, the road aggregate tend to break into smaller pieces under sudden shock or impact. The impact test carried out in the laboratory determines the 'impact value' of broad arrogates which is a relative measure of their resistance to repeated impact blow. This test is conducted as per IS: 2386 (part V) – 1963.

Fig. 5 Impact test

G. Crushing Strength of Aggregate

Aggregate used in road construction, should be strong enough to resist crushing under traffic wheel load. If the aggregate are weak, the stability of the pavement structure is likely to be adversely affected. Thus, the aggregate must have a durable resistance to crushing.

The strength of aggregate is assessed by aggregate crushing test. The aggregate crushing value provides a relative measure of resistance to crushing under a gradually applied compressive load. To achieve a high quality of pavements, aggregate possessing high aggregate crushing value should be preferred. This test is conducted as per IS: 2386 (part V) – 1963.

Fig. 6 Crushing strength test

H. Soundness Test of Aggregates

The test is determined in the laboratory to know the durability of road aggregate i.e their ability to resist action of weathering agencies like heat, snow, rain storm etc. This test is conducted as per IS: 2386 (part V) – 1963.

Fig. 7 Soundness test

I. Workability Test

A very important characteristic of a concrete is its workability when it is wet (prior to setting into a hardened state). There are two reasons for this. The first is that placement becomes difficult if the concrete is too stiff and it may not be able to be pumped. The second reason is that the concrete may not be able to be compacted adequately thus leading to voids in the hardened concrete. Slump test for workability is done as per IS: 1199 – 1959

Fig. 8 Slump test

J. Compressive Strength Test

Out of many test applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. For cube test two types of specimens either cubes of 15 cm X 15 cm X 15 cm. The test is done as per IS 516-1959.

Fig. 9 Compressive strength test

V. RESULTS AND CONCLUSION

Results presented in this chapter consist of the control mixes plus mixes that incorporated Asbestos sheet waste. Results of mechanical properties of the concrete specimens, including compressive, the durability testing result (water absorption) are presented and discussed. Test results for various mixes are presented and discussed. C.A denotes coarse aggregate and A.S.W denote asbestos sheet waste.

A. Physical Properties

Table 1: Physical Characteristics of Fine Aggregates

Parameters	Specific gravity
C.A	2.52
A.S.W	1.70

B. Water Absorption of Aggregates

The amount of water absorption can be found allowing adjustment to the amount of free water and the amount of coarse aggregate in the concrete mix. The test result for water absorption is give as

Table 2: Water Absorption of Fine Aggregates (%)

Property	Coarse aggregate	Asbestos sheet waste	Method
Water absorption	0.89	4.46	IS

C. Sieve Analysis and Fineness Modulus

Sieve analyses were performed for fine aggregate, coarse aggregate and asbestos sheet waste in accordance with IS 383-1970. To ensure the samples taken were representative, a weighing machine was used to separate the samples into the minimum required weight.The increased amount of fines can be quantified by comparing the fineness modulus of the different sands. The higher the fineness modulus value, the coarser the aggregate is. Table 6 shows the fineness modulus of the various types of fine aggregate. Typical values range of FM from 2.3 and 3.0, a higher value indicating a coarser grading.

Table 3: Fineness Modulus for Various Fine Aggregates

Property	Fine aggregate	Coarse aggregate	Asbestos sheet waste	Method
Fineness Modulus	2.63	3.02	3.07	Calculation

D. Abrasion Test

This method is used to determine the abrasion value of coarse aggregate. It is often considered to know the suitability of aggregate when choice of aggregate is to be made for concrete to be used for wearing surface such as floors, road pavement and run-ways. This test is conducted under the specification of IS: 2386 (part V) -1963. The difference between the original weight and the final weight of the test sample is expressed as a percentage of the original weight of the test sample. This value is reported as the percentage of wear. The percentage of wear should not be more than 16 to 50 percent.

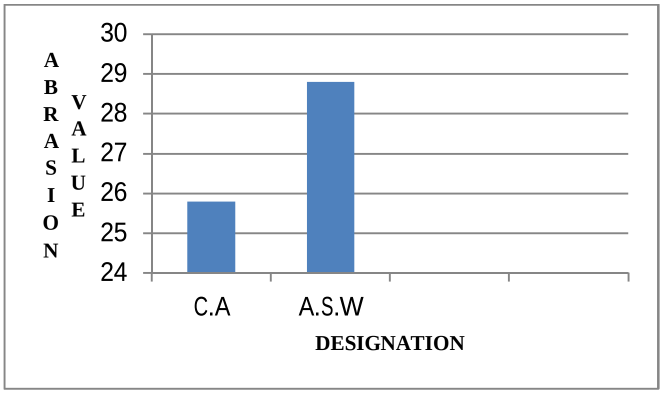

Fig. 1 Abrasion strength of coarse aggregate and asbestos sheet waste

E. Impact Test

Therefore the impact test should be performed by taking a weighed value of the aggregate so as to decide its suitability for use in the desire concrete mix. This test is designed to evaluate the toughness of road aggregate (their ability to resist fracture blow of impact of traffic loads.). It also act as useful factor to know the behavior of aggregate when subjected to wear. This test is conducted under the specification of IS: 2386 (part V) -1963. The aggregate impact value, thus determined should not exceed 45 percent by weight of aggregate for concrete other than wearing surfaces and 30 percent by weight for concrete to be used for wearing surfaces such as floors, road pavements, run way etc. In this test we observe that the impact value of coarse aggregate sample is 2.49 % less than the asbestos sheet**.**

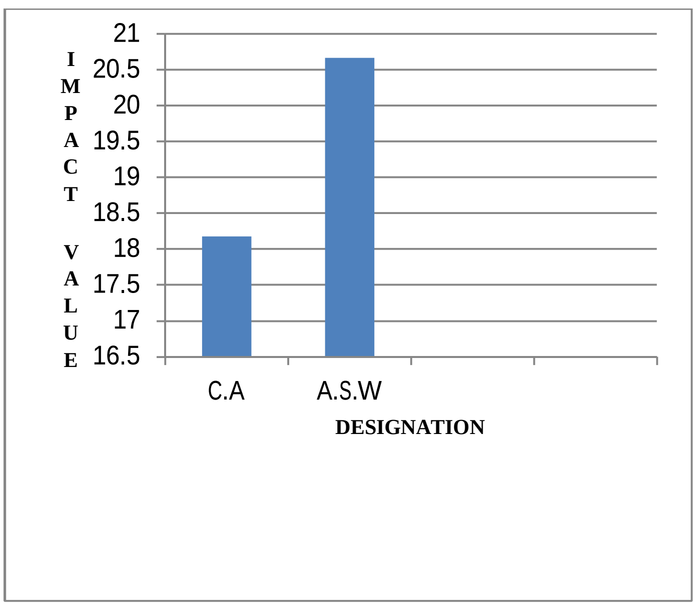

Fig. 2 Impact value of coarse aggregate and asbestos sheet waste

F. Soundness of Aggregate

Soundness refers to the ability of aggregate to resist excessive changes in volume as a result of changes in physical conditions. This test is conducted under the specification of IS : 2386 (part V) -1963. These physical conditions that affect the soundness of aggregate are the freezing the thawing, variation in temperature, alternate wetting and drying under normal conditions and wetting and drying in salt water. If concrete is liable to be exposed to the action of frost, the coarse and fine aggregate which are going to be

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used should be subjected to soundness test. Aggregates which undergo more than the specified amount of volume change is said to be unsound aggregates. As a general guide, it can be taken that the average loss of weight after10 cycles should not exceed 12 per cent and 18 per cent when tested with sodium sulphate and magnesium s sulphate respectively. Given sample of aggregate is sound/unsound

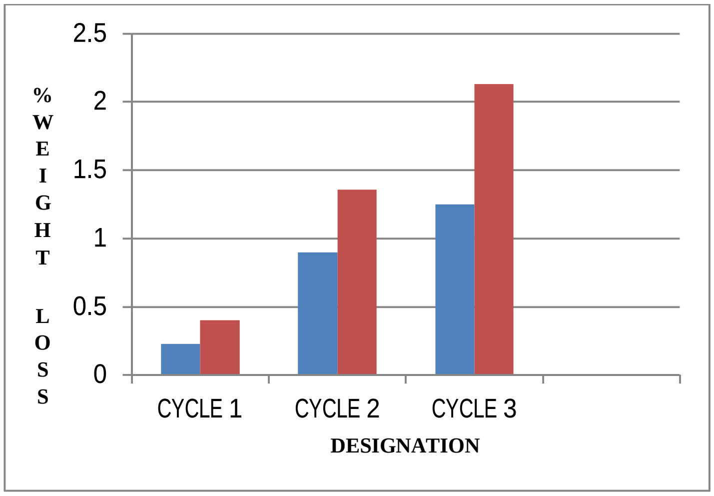

Fig. 3 Soundness test of coarse aggregate and asbestos sheet waste

G. Workability of Fresh Concrete

Workability of fresh concrete is find by Slump Test Overall, all mixes did have a moderate workability level but at least this was consistent throughout. The slump was measured twice, once for each batch. Although IS (Standards India 1997) states that for high slumps exceeding 110 mm a tolerance of ± 30 mm is permitted.

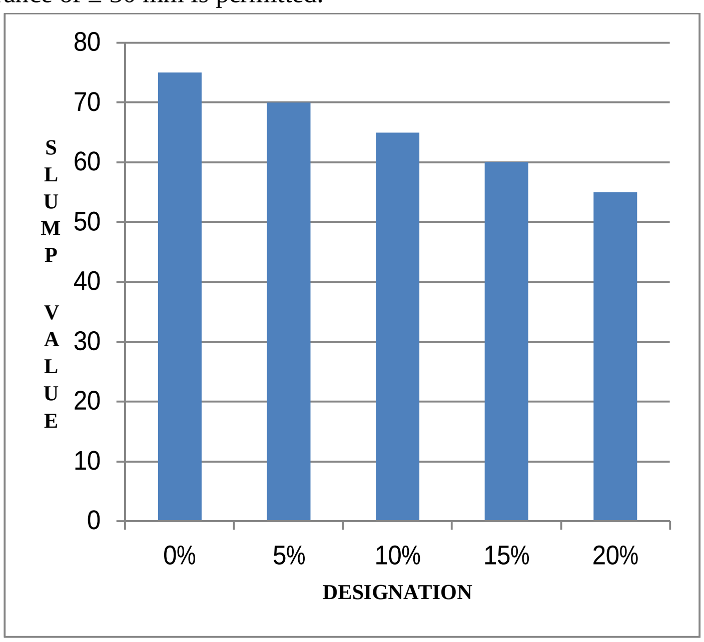

Fig 4 Workability of various mixes

H. Compressive Strength

For each mix, specimens were tested for compressive strength after 7 and 14 after casting. The average of three cubes was taken as the mean compressive strength. At this stage, the aim was to understand the manufacturing process of concrete incorporating red

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sand and to compare its workability and strength with correspondent natural sand mixture.

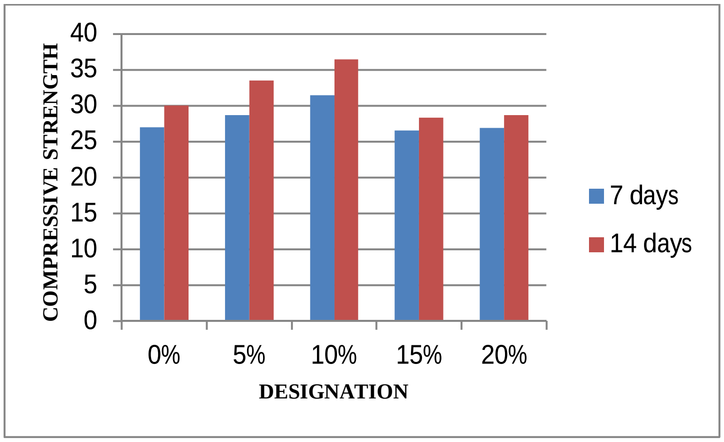

Figure 6 Comparison of Compressive Strength for various mix

VI. ANALYSIS OF RESULT

The main objective of this research was to investigate the possibility of using the fraction of Asbestos Sheet Waste as a Coarse Aggregate substitution in concrete mix design suitable for commercial environment. The opportunity to achieve low strength concrete using this potential resource for construction applications was also investigated.

It is observed from the experimental results and its analysis, that the compressive strength of concrete initially increases with replacement of Coarse Aggregate with Asbestos Sheet Waste and after that; there is decrease in compressive strength of concrete with further replacement of Coarse Aggregate with Asbestos Sheet Waste. From the experimental test result we can conclude that

In case of replacement of Coarse Aggregate, 10% Asbestos Sheet Waste content can be taken as the optimum dosage for compressive strength, which can be used for giving maximum possible compressive strength at any age for the mixed design of asbestos cement sheet waste and coarse aggregate concrete.

In case of replacement of Coarse Aggregate, the value increase of compressive strength of Asbestos Sheet Waste and Coarse Aggregate concrete compared with compressive strength of controlled mix is observed 1.67 N/mm^2 in 5% replacement and 4.42 N/mm^2 in 10% replacement at 7 days.

The value increase of compressive strength of Asbestos Sheet Waste and Coarse Aggregate concrete compared with compressive strength of controlled mix is observed 3.50 N/mm^2 in 5% replacement and 4.95 N/mm^2 in 10% replacement at 14 days. The impact on concrete mix design and properties of manufactured concrete were evaluated with a series of laboratory standard tests. The tests conducted in this research were just a few of those possible for assessing the strength and durability behavior of concrete mixes. From the results obtained, the following conclusions are made

A. In order for satisfactory performance in a concrete incorporating gave target compressive strength results in excess of the Indian standard requirement, that is 35 MPa, and they were capable of producing adequate compressive strengths for a M35 grade concrete.

B. In comparison to concrete using Coarse Aggregate, concrete using Asbestos Sheet Waste achieved similar strength characteristics greater than that of the control mix. Partially replaced Asbestos Sheet Waste by the weight of Coarse Aggregate also showed improved strength in the tests.

C. In the case of Asbestos Sheet Waste replaced concrete mixes (5%, 10%, 15%, 20 %,) the slump recorded slightly lower values than desirable, especially with the Coarse Aggregate (0%).

D. Concrete using Asbestos Sheet Waste also showed similar strength characteristics, there were some durability concerns for Asbestos Sheet Waste mixes with 20mm Coarse Aggregate. The Compressive strengths of Asbestos Sheet Waste were higher than that of Coarse Aggregate are replaced 10 % of its own weight. Compressive strength of concrete increased with the increase in Asbestos Sheet Waste replacement up to 10 % with different replacement levels of Asbestos Sheet Waste after that it goes decreasing. However, at 5% and 10% replacement level of coarse aggregate with Asbestos Sheet Waste, an increase in strength was observed with the increase in age, in case of 15% and 20% replacement level of Coarse Aggregate with Asbestos Sheet Waste, a decrease in strength was observed with increase in age.

E. In the case of M35 concrete mixes, 5% and 10% Asbestos Sheet Waste mixes performed similarly better than the control mixes, but in case of 15% and 20% control mix is better; however there were some concerns in regards to durability indicators.

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