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Comparative Studies on Asbestos Sheet Waste Powder as Partial Replacement of Cement in Concrete Production

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Abstract: In today's boom of urbanization, construction of civil infrastructure is very important for any developing country. Cement is one of the main materials used in construction. As the requirement of cement is increasing, Cement production is also increasing and consequently CO_2 content in environment. So efforts are being done to develop some alternative material for concrete production using Waste material. Asbestos cement sheet waste powder is one such alternative and other factor is the rising prizes of building construction materials are the factor of great worry. 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. This study was conducted to investigate the effect of using Asbestos cement sheet waste powder in concrete. Laboratory work was conducted to determine the performance of control sample and concrete with used Asbestos cement sheet waste powder. The performance of these types of concrete was determined by the workability test, density test and compressive strength test. The workability of concrete is determined using slump test. Meanwhile, compressive strength test is done to determine the strength of concrete. For each type of concrete sample, a total of six 150 mm x 150 mm x 150 mm cubes were cast. Therefore, we have planned to prepare some number of cubes using asbestos cement sheet waste powder at various proportions like 0%, 5%, 10%, 15% and 20 % by weight of cement. The cubes were tested at the ages of 7, 14 and 28 days to study the development of compressive strength. The results indicate that the concrete with using asbestos sheet waste powder were able to increase the workability of concrete and also the compressive strength. However, the density is reduced compare to standard mixture of concrete.

Keywords: Cement, CO_2 content, Asbestos cement sheet waste powder, Compressive strength .

I. INTRODUCTION

Concrete is one of the world's most used construction material due to its versatility, durability and economy. India uses about 7.3 million cubic meters of ready-mixed concrete each year. It finds application in highways, streets, bridges, high rise buildings, dams etc. Green house gas like CO_2 leads to global warming and it contributes to about 65% of global Warming. The global cement industry emits about 7% of green house gas to the atmosphere. To reduce this environmental impact alternative binders are introduced to make concrete. 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.

A. 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. Advantages of Using Asbestos Cement Sheet Waste Powder in Concrete

1) Increased compressive and flexural strengths.
2) Reduced permeability
3) Increased resistance to chemical attack.
4) Increased durability.
5) Reduced effects of alkali-silica reactivity.
6) Reduced shrinkage due to particle packing, making concrete denser.
7) Enhanced workability of concrete.

C. Objective

1) To identify the workability and durability of concrete containing asbestos sheet waste powder.
2) To enhancing the mechanical and durability features of asbestos sheet waste powder concrete.
3) To investigate the optimal use of asbestos sheet waste powder as cement in concrete composite.
4) To check the compressive strength by replacing cement with asbestos sheet waste powder at different percentage by weight i.e. 0%, 5%, 10%, 15% ,20%.
5) To check the suitability of reuse of asbestos sheet waste powder in a useful manner.
6) To minimize the overall environmental effects of concrete production using these materials as partial replacement.
7) Due to high amount of concrete from demolition waste, this material was studied as substitution of natural aggregates.

D. Scope

1) To provide a most economical concrete.
2) It should be easily adopted in field.
3) Using the wastes in useful manner.
4) To reduce the cost of the construction.
5) To find the optimum strength of the partial replacement of concrete.
6) Minimize the maximum demand for cement.
7) Minimize the maximum degradation in environment due to cement and safeguard the ozone layer from greenhouse gases.
8)

II. LITERATURE REVIEW

Asbestos is a naturally occurring fibrous material which is widely used in construction field, so we used asbestos in replacement of cement, partially in varying percentages of 0%, 5%, 10%, 15%, 20%, so we referred various materials and other journals by study of compressive strength of concrete with asbestos cement sheet waste .

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.

E.Gidarakos and K.Anastasiadou describe the technologies for the waste treatment of asbestos such as Asbestos land disposal, stabilization, Microwave treatment, Chemical treatment. Effect of asbestos cement sheet waste on flexural strength of concrete by Manu Chaudhary describes about the inclusion of superplasticizer with fine and coarse aggregates. Dr Zoltan Adamis detailed the view on Bentonite, kaolin and selected clay minerals in his presentation. It gives the overview about the kaolin's chemical properties and it uses on the compositions. It also described about the exposure level on human and the environmental levels.

F S Umrigar et al (Jan2013)Studied the innovative use of hypo sludge and fly ash in concrete formulations as a supplementary cementitious material was tested as an alternative to conventional concrete. The cement has been replaced by hypo sludge and fly ash accordingly in the range of 0%, 10%, 20%, 30% and 40% by volume for M-25 and M-40 mix. Concrete mixtures were produced, tested and compared in terms of modulus of elasticity with the conventional concrete. The test was carried out to evaluate the modulus of elasticity after 56 days. This study includes different concrete mixtures which were produced to determine the influence of hypo sludge derived from J.K.Papers mill Pvt.Ltd, plant near Songadh, Tappi District and Maize Products (A division of Sayaji Industries Ltd) Power plant near kathwada, Ahmedabad District in Gujarat Statereferring to the Modulus of Elasticity. The modulus of elasticity of concrete is a very important mechanical parameter reflecting the ability of the concrete to deform elasticity. For concrete material, the secant modulus is defined as the slope of the straight line drawn from the origin of axis to the stress-strain curve at 1/3 of the ultimate strength.

Federio L.M and Chidiac S.E, 2001 has been concluded that 30% glass powder could be incorporated as cement replacement in concrete without any long-term detrimental effects. Up to 50% of both fine and coarse aggregate could also be replaced in concrete of 32 MPa strength grade with acceptable strength development properties. Better results are achieved when the waste glass powder replaced either 30 % or 70% of the sand with particles sizes ranging between 50 μm and 100 μm.

Idir. R,Cyr. M and Tagnit – Hamou.A,2009 carried out research on glass powder and it was found that glass of particle size 1.18 to 2.36 mm produced the highest expansion where as low expansion was observed at smaller particle sizes.

Pereira de Oliveira. L.A, J.P. Castro – Gomes, P. Santos, 2008 was observed that with a 30% replacement of cement by amber waste glass content of particle size 75μm along with fly ash, the compressive strength of concrete increase 25% at 7 days and 35% when tested for 28 days strength. This effect provide ample evidence that both fly ash and waste glass sand can be used together to produce concretes with relative high strength without any adverse reaction.

Mageswari L.M and B.Vidivelli, 2010 found that the glass of a particle size of 300 or smaller, the alkali reaction (ASR) induced expansion could be reduced. In fact, data reported in the literature show that if the waste glass is finely ground, under 75 μm. This effect does not occur and concrete durability is increased.

III. MATERIALS AND METHODOLOGY

This study was focused primarily to determine whether asbestos cement sheet waste powder and its derivatives can be used as an alternative to cement M35 grade concrete. As stated earlier, the scope of this project was to have four different mixes, each with a characteristic strength of 35 MPa which is suitable for footing and residential application Highway application.

The constituents of the concrete consisted of cement, coarse aggregate 20mm and fine aggregate and water.

It was trialed as the only coarse aggregate in one concrete batch and in order to provide a comparison, a concrete mix using asbestos sheet was used as a control mix. Asbestos sheet waste was chosen as it is already widely accepted and used within the construction industry as a cement in concrete.

A. Materiaz used

Concrete is a variable material. It is not practical to expect that the characteristics of a concrete mix can be identically replicated on a consistent basis. One of the main reasons for the variability in the concrete is because of the variability in the materials used to make the concrete. The four basic constituents of ordinary Portland cement concrete are:

1) Cement
2) Coarse aggregate
3) Fine aggregate
4) Water
5) Asbestos cement sheet waste powder

B. Cement

Cement can be defined as the bonding material having cohesive & adhesive properties which makes it capable to unite the different construction materials and form the compacted assembly. Ordinary Portland Cement also commonly known as OPC cement. This type of cement is also called normal setting cement since its setting is

normal when mixed with water .OPC cement is used in heavy structure where great strength is required such as heavy building, rigid pavement and bridge etc.

Name of Compound	Formula	Abbreviated	%Content
Tricalcium Silicate	$3CaO.SiO_2$	C_3S	25-50
Diacalcium Silicate	$2CaO.SiO_2$	C_2S	21-45
Tricalcium aluminate	$3CaOAl2O_3$	C_3A	5-11
Tetracalcium aluminoferrite	$4CaOAl_2O3Fe2O_3$	C_4AF	9-14

Table31: Typical composition of OPC

C. Coarse aggregate

The aggregates retained on 4.75 mm Sieve is called as coarse aggregates. Coarse aggregate should be screened crushed rock, angular in shape, free from dust particles, clay, vegetations and organic matters. Coarse aggregate has a maximum size of about 20 mm. The coarse aggregate having a specific gravity 2.65 and fineness modulus of 7.17. Water absorption of coarse aggregate is 0.89 %. Maximum size of aggregate is the standard sieve size (40mm, 25mm, 20mm, 12.5mm, 10mm) through which at least 90% of coarse aggregate will pass. Maximum size of aggregate affects the workability and strength of concrete. They should have following properties

D. Fine Aggregates

It is the aggregate most of which passes 4.75 mm IS sieve and contains only so much coarser as is permitted by specification. According to source fine aggregate may be described as:

1) Natural Sand– it is the aggregate resulting from the natural disintegration of rock and which has been deposited by streams or glacial agencies
2) Crushed Stone Sand– it is the fine aggregate produced by crushing hard stone.
3) Crushed Gravel Sand– it is the fine aggregate produced by crushing natural gravel.

According to size the fine aggregate may be described as coarse sand, medium sand and fine sand. IS specifications classify the fine aggregate into four types according to its grading as fine aggregate of grading Zone-1 to grading Zone-4. The four grading zones become progressively finer from grading Zone-1 to grading Zone-4. 90% to 100% of the fine aggregate passes 4.75 mm IS sieve and 0 to 15% passes 150 micron IS sieve depending upon its grading zone.

E. Asbestos Cement Sheet Waste

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

Asbestos cement sheet waste are taken from Narwana (Haryana). They were crushed into powder form by manually operating a hammer and passed into 90 micron IS sieve . The specific gravity of Asbestos Sheet waste material is 3.11 and fineness modulus of 3.07. Water absorption of Asbestos Sheet waste material is 4.46 %.

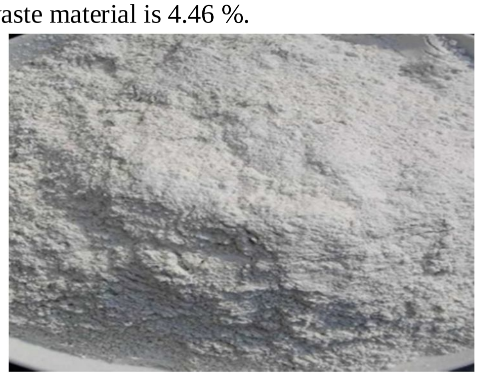

Fig 3.1 Asbestos Cement Sheet Waste Powder

F. Water

Although the water itself is often not considered when dealing with materials that go into the production of concrete, it is an important ingredient. Typically, 150 to 200 kg/m3 of water are used. The old rule of thumb for water quality is "If you can drink it, you can use it in concrete," although good-quality concrete can be made with water that is not really potable. Indeed, more bad concrete is made by using too much drinkable water than by using the right amount of undrinkable 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.

Tests on Cement

1) Fineness test
2) Consistency test
3) Setting time test
4) Soundness test
5) Specific gravity test

G. Fineness Test of Cement

This test will be performed according to IS:4031-15.

Apparatus

Balance capacity 500 gm, I.S. Test sieve 90 micron.

Procedure

1) Weigh accurately 300 gm of cement (W_1) and place it on a standard IS sieve 90 microns.
2) Break down any air set lumps in the sample with finger. But do not rub on the sieve.
3) Continuously sieve the sample by holding the sieve in both hands and giving a gentle wrist motion.
4) The sieving should be continuous for 15 minutes.
5) Weigh the residue left (W_2) after 15 minutes sieving and calculate percentage of residue retrained on 90 micron sieve.

Results The residue by weight not to exceed 10% for ordinary Portland cement.

Fig 3.2 Sieve shake

H. Initial and Final Setting Time

Vicat's apparatus will be used to estimate initial and final setting time of cement at normal consistency.

Apparatus Vicat's apparatus with mould and non-porous plate, Initial setting time 1 sq. mm Needle, Final setting time 1 sq. mm Needle with enlarged base**,** Balance, Measuring cylinder**,** Stopwatch, Thermometer rocedure

1) Weigh about 400 gm of neat cement Prepare neat cement paste by gauging the cement with 0.85 times the water required to give a paste of standard consistency.
2) Time will be recorded with stopwatch from the time the water is added.
3) Immediately after moulding, the test block will be placed in a moist closet or moist room and will be kept there till testing is done.

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4) Standard needle will be placed on the test block and time will be observed when the needle fails to pierce the block beyond 5.0 +/- 0.5 mm (measured from the bottom of the mould)
5) The time difference between the starting time when water is added to cement to the time mentioned in (v) above will be noted as initial setting time.
6) The needle with annular attachment will be used for determining final setting time.
7) The cement shall be considered as finally set when upon applying the needle gently to the surface of the block, the needle makes an impression thereon, while the attachment fails to do so.
8) The difference of time from starting time when water is added to cement to the time mentioned in (viii) above will considered as final setting time.

Fig.3.3. Vicat's Apparatus

I. Specific gravity test

Le Chaterlier"s flask, weighing balance, kerosene (free from water). Le Chaterlier"s flask, is made of thin glass having a bulb at the bottom. The capacity of the bulb is nearly 250 ml. The bulb is 7.8 cm in mean diameter. The stem is graduated in millimeters. The zero graduation is at a distance of 8.8 cm from the top of the bulb. At 2 cm from the zero, there is another bulb is of length 3.5cm and capacity 17 ml. At 1 cm from bulb, the stem is marked with 18 ml and is grated up to 24 ml. The portion above 24ml mark is in the form of a funnel of diameter 5cm.

J. Procedure

1) Dry the flask carefully and fill with kerosene or naphtha to a point on the stem between zero and 1 ml.
2) Record the level of the liquid in the flask as initial reading.
3) Put a weighted quantity of cement (about 60 gm) into the flask so that level of kerosene rise to about 22 ml mark, care being taken to avoid splashing and to see that cement does not adhere to the sides of the above the liquid.
4) After putting all the cement to the flask, roll the flask gently in an inclined position to expel air until no further air bubble rise 3s to the surface of the liquid.

Note down the new liquid level as final reading.

Result

Weight of equal of water = (V_2-V_1) x specific weight of water.

Weight of equal of water = (V_2-V_1) x specific weight of water.

Weight of cement used =W gm

Initial reading of flask =V_1 ml

Final reading of flask =V_2 ml

Volume of cement particle= V_2-V_1 ml

Fig.3.4. Le Chaterlier's flask

K. Compressive Strength

Testing Machine -The testing machine may be of any reliable type, of sufficient capacity for the tests and capable of applying the load at the rate specified. The permissible error shall be not greater than ± 2 percent of the maximum load. The testing machine shall be equipped with two steel bearing platens with hardened faces. One of the platens (preferably the one that normally will bear on the upper surface of the specimen) shall be fitted with a ball seating in the form of a portion of a sphere, the centre of which coincides with the central point of the face of the platen. The other compression platen shall be plain rigid bearing block. The bearing faces of both platens shall be at least as large as, and preferably larger than the nominal size of the specimen to which the load is applied.

1) Age at Test

a) Tests shall be made at recognized ages of the test specimens, the most usual being 7, 14 and 28 days. Test at age of 56 days can also be performed. Ages of 13 weeks and one year are recommended if tests at greater ages are required. Where it may be necessary to obtain the early strengths, tests may be made at the ages of 24 hours ± ½ hour and 72 hours ± 2 hours. The ages shall be calculated from the time of the addition of water to the dry ingredients.

b) Number of Specimens:

c) At least three specimens, preferably from different batches, shall be made for testing at each selected age.

Fig.3.5 Compression test on CTM

L. Procedure

1) Specimens stored in water shall be tested immediately on removal from the water and while are still in the wet condition, surface water and grit shall be wiped off the specimen.

2) If the specimen received dry shall be kept in water for 24 hours before they are taken for testing.

3) Note the dimensions of the specimen to the nearest 0.2 mm and their weight shall be noted.

4) Before placing the specimen in the testing machine the bearing surface of the testing machine shall be wiped clean and any loose sand or other material should be removed from the surface of the specimen, which are to be in contact with the compression platens.

5) In case of cubes, the specimen shall be placed in the machine in such a manner that the load shall be applied to opposite sides of the cubes as cast, i.e. not to the top and bottom.

6) The axis of the specimen shall be carefully aligned with the centre of thrust of the spherically seated platens.

7) No packing shall be used between the faces of the specimen and the steel platen of the testing machine.

8) The load shall be applied without shock and increased continuously at a rate of approximately 14 N/mm^2, until the resistance of the specimen to the increasing load breaks down and any unusual features in the type of failure shall be note

IV. METHODOLOGY

This chapter describes the properties of material used for making concrete mix determined in laboratory as per relevant codes of practice. Different materials used in tests were OPC, coarse aggregates, fine aggregates, rice husk ash and waste paper sludge ash. The description of various tests which were used in this study is given below: Ordinary Portland Cement (OPC) of 53 Grade (Jaypee cement) was used throughout the course of the investigation.

The physical properties of the cement as determined from various tests conforming to Indian Standard IS: 12269:1987 are listed in

Characteristics	Value
Specific gravity	2.60
Bulk density	5%
Fineness modulus	2.804

Table 3.2 Physical Properties of fine aggregates

Characteristics	Value
Type	Crushed
Colour	Grey
Shape	Angular
Nominal Size	20 mm
Specific Gravity	2.62
Total Water Absorption	0.89
Fineness Modulus	7.17

Table 3.3 Properties of Coarse Aggregates

A. Asbestos Cement Sheet Waste Powder

Asbestos cement sheet waste are taken from Narwana (Haryana). They were crushed into powder form by manually operating a hammer and passed into 90 micron IS sieve . The specific gravity of Asbestos Sheet waste material is 3.11

Appearance	Fine powder
Particle Size	Sieved through 90 micron sieve
Specific gravity	3.11
Color	Off white

Table 3.4 Physical properties of Asbestos cement sheet waste powder

B. Mix Design

Concrete is an extremely versatile building material because, 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 basic ingredients of concrete are the same, but it is their relative proportioning that makes the difference.

Basic Ingredients f Concrete: -

Cement – It is the basic binding material in concrete.

Water – It hydrates cement and also makes concrete workable.

Coarse Aggregate – It is the basic building component of concrete.

Fine Aggregate – Along with cement paste it forms mortar grout and fills the voids in the coarse aggregates.

Properties desired from concrete in plastic stage: -

1) Workability
2) Cohesiveness

3) Initial set retardation Properties desired from concrete in hardened stage: -
4) Strength
5) Imperviousness
6) Durability

Concrete mix design is the method of correct proportioning of ingredients of concrete, in order to optimize the above properties of concrete as per site requirements. In other words, we determine the relative proportions of ingredients of concrete to achieve desired strength & workability in a most economical way.

Decision Variables in Mix Design

A mix design for M35 grade of concrete, having moderate workability (Slump range 25mm to 75mm)

Cement:-

53 grade (Although, actual 28 days compressive strength = 53 N/mm^2)

Specific gravity for cement = 3.15

Specific gravity for asbestos sheet waste powder = 3.11

Fine aggregate

Fineness modulus of fine aggregate = 2.804

Specific gravity for fine aggregate = 2.60

Coarse aggregate

20mm - Specific gravity of coarse aggregate = 2.65

Fineness modulus of coarse aggregate = 7.17

Target mean strength for mix proportioning

In order that not more than specified proportion of test results is likely to fall below the characteristics strength, the concrete mix has to be proportioned for higher target mean compressive strength f'_{ck}. The margin over characteristic strength is given by the following relation

$f'_{ck} = f_{ck} + K$

where

f'_{ck} = target mean compressive strength at 28 days in N/mm^2

f_{ck} = characteristic compressive strength at 28 days in N/mm^2

K = Himsworth Coefficient is taken as 1.65 for 5 % probability of failure.

K= Standard deviation N/mm^2

The values of K are given in Table 1 of IS 10262-2009 for fair, good and very good degree of control .

Say for M35 grade of concrete,

K = 1.65 (where 5% result are allowed to fall below specific design strength)

Standard Deviation= 5 N / mm^2.

Target Mean Strength = $35 + 1.65 \times 5 = 43.25$ N/mm^2

Selection of water cement ratio

From table 5 of IS 456-2000, maximum water cement ratio is 0.45.

Selection of water content

From Table 2 of IS 10262-2009, maximum water content is 186 liter for (25 to75mm slump range) for 20mm aggregate

Estimated water content for 75mm slump = $186+\frac{3}{100}\times186 = 191.58$

Calculation of cement content

Water – cement ratio = 0.45

Cement content $=\frac{191.58}{0.45} = 425.73$ kg/m^3

From Table 5 of IS 456, minimum cement content for serve expose condition = 340 kg/m^3 and maximum cement content is 450 kg/m^3 and calculated cement content = 425.73 kg/m^3 hence ok.

Proportion of volume of coarse aggregate and fine aggregate

From Table 3 of IS 10262-2009 volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate(zone 4) 20 mm size $0.66\times0.9 = 0.59$

Volume of fine aggregate = 1- 0.59 = 0.41

In this case water cement ratio is 0.45. Therefore, volume of coarse aggregate is required to be increased to decrease the fine aggregate content. As the water cement ratio is lower by 0.05, the proportion of coarse aggregate is increased by 0.01(at the rate of ±0.01for every ±0.05 change in water cement ratio). Therefore, corrected proportion of volume of coarse aggregate for the water cement ratio of 0.45=0.63

Mix calculation

The mix calculations per unit volume of concrete shall be as follows:

Volume of concrete(a) $= 1\ m^3$

Volume of cement(b) $= \frac{\text{Mass of cement}}{\text{specific gravity of cement}} \times \frac{1}{1000}$

$= \frac{425.73}{3.15} \times \frac{1}{1000}$

$= 0.135 m^3$

Volume of water(c) $= \frac{\text{Mass of water}}{\text{specific gravity of water}} \times \frac{1}{1000}$

$= \frac{191.58}{1} \times \frac{1}{1000}$

= 0.19158

Volume of all in aggregate(d) $= [a - (b + c)]$

= 1- 0.325

$= 0.674\ m^3$

Mass of coarse aggregate = d × volume of coarse aggregate × specific gravity of coarse aggregate × 1000

= 0.674 × 0.59 × 2.65 × 1000

= 1053.79 kg

Mass of fine aggregate = d × volume of fine aggregate × specific gravity of fine aggregate × 1000

= 0.674 × 0.41 × 2.60 × 1000

= 718.48kg

Mixture no.	Replacement %	Coarse aggregate kg/m^3	Cement kg/m^3		Fine aggregate kg/m^3	Water lit/m^3	Water-cement ratio
			Cement kg/m^3	A.S.W.P kg/m^3			
1	0	1053.79	425.73	0.00	718.48	191.58	0.45
2	5	1053.79	404.45	21.28	718.48	191.58	0.45
3	10	1053.79	383.16	42.57	718.48	191.58	0.45
4	15	1053.79	361.88	63.85	718.48	191.58	0.45
5	20	1053.79	340.58	85.15	718.48	191.58	0.45

Table 3.5 Mix Quantities Used per cubic meter of Concrete

V. RESULTS AND DISCUSSION

A. Slump Test

Mix	Percentage	Slump Value
Control	0%	90mm
A.C.S.W.P	5%	75mm
	10%	65mm
	15%	45mm
	20%	35mm

Table 5.1 Slump Tests Results

The slump value v/s percentage of replacement was shown in Fig 5.1. The slump decreased when a higher amount of asbestos cement sheet waste powder is added in concrete.

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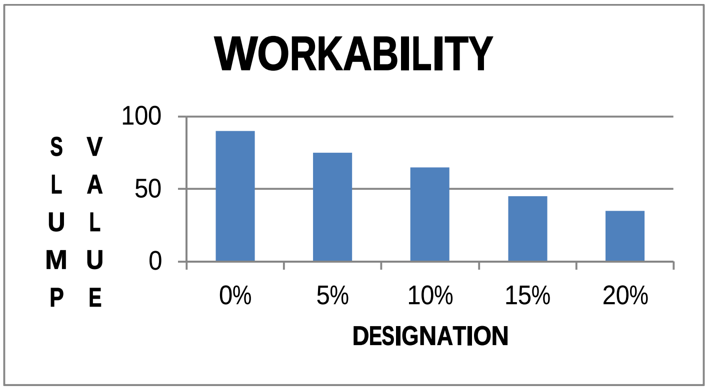

Fig. 5.1 Workability of various mix

C. *Effect of Age on Compressive Strength*

The 28 days strength obtained for M35 Grade Control concrete is N/mm^2.The strength results reported in table no 5.2.1 are presented in the form of graphical variations, where the compressive strength is plotted against the % of cement replacement. With the increase in the percentage replacement of cement with asbestos cement sheet waste powder there is increase in Compressive Strength up to 10 % replacement after that there is decrease in Compressive Strength with further replacement of cement with asbestos cement sheet waste powder. The maximum Compressive Strength of 44.52 N/mm^2 was attained at 10% replacement, while the minimum strength of 26.89 N/mm^2 was attained at 20% replacement. Till 10% replacement, concrete Compressive Strength increases gradually but after 10% it reduces. The strength increased as the percentage of replacement increased to a certain limit and beyond that strength decreases. So it is beneficial to use asbestos cement sheet waste powder in place of cement up to 10%. Beyond that it is not beneficial as strength decreases.

Sl. No.	% Replacement of Coarse Aggregate	Compressive Strength (N/mm2)		
		7 days	14 days	28 days
1.	0%	27.00	30.00	37.00
2.	5%	28.67	33.50	41.23
3.	10%	31.42	38.45	44.52
4.	15%	26.56	28.36	31.76
5.	20%	26.89	28.71	34.30

Table 5.2 Detail of compressive strength of mixes

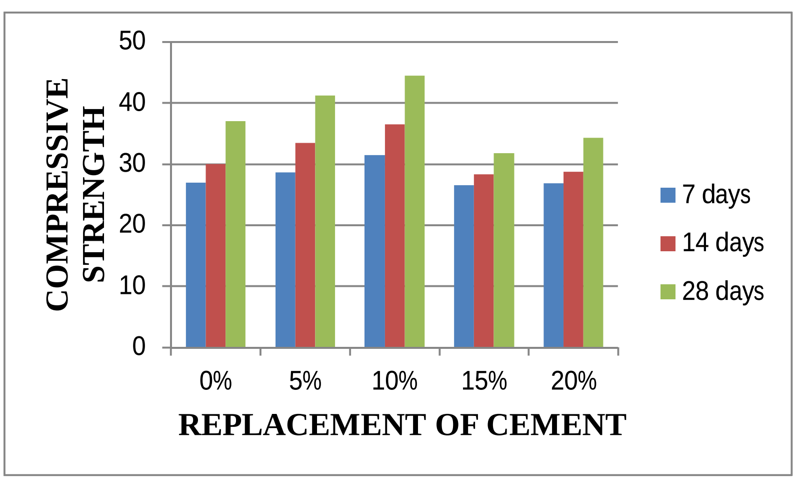

Fig. 5.2 Comparison of Compressive Strength for various mix

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VI. CONCLUSION AND FUTURE WORK

The main objective of this research was to investigate the possibility of using the fraction of asbestos cement sheet waste powder as a Cement 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 cement with asbestos cement sheet waste powder and after that; there is decrease in compressive strength of concrete with further replacement of cement with asbestos cement sheet waste powder. From the experimental test result we can conclude that

1. In case of replacement of Cement, 10% Asbestos cement Sheet Waste powder 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 cement concrete.
2. In case of replacement of Cement, the value increase of compressive strength of Asbestos cement Sheet Waste powder and Cement 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 cement Sheet Waste powder and Cement 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:

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

Concrete using Asbestos cement Sheet Waste powder also showed similar strength characteristics, there were some durability concerns for Asbestos cement Sheet Waste powder mixes with cement. The compressive strengths of Asbestos cement Sheet Waste powder were higher than that of Cement are replaced 10 % of its own weight.

Compressive strength of concrete increased with the increase in Asbestos cement Sheet Waste powder replacement up to 10 % with different replacement levels of Asbestos cement Sheet Waste powder after that it goes decreasing. However, at 5% and 10% replacement level of cement with Asbestos cement Sheet Waste powder, an increase in strength was observed with the increase in age, in case of 15% and 20% replacement level of Cement with Asbestos cement Sheet Waste powder, a decrease in strength was observed with increase in age.

In the case of M35 concrete mixes, 5% and 10% Asbestos cement Sheet Waste powder 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.

From the results obtained, it can be deduced that Asbestos cement Sheet Waste powder used in M35 grade concrete can achieve increased strengths to an equivalent mix using Cement.

More importantly, for application in severe environments, it offers improvements in performance for the durability characteristics (water absorption) assessed.

Based on the results of all of the marine grade concrete mixes, the indication is that Asbestos cement Sheet Waste powder performs better as a replacement of Cement.

As such, Asbestos cement sheet waste powder showed ability to replace with a cement. Using Asbestos cement Sheet Waste powder in low strength concrete showed that they do have potential to be used in industry.

A. Further Studies

Further research is required to explore other aspects of Asbestos cement sheet waste powder concrete. Because of the improved durability performance of Asbestos Sheet Waste observed in this investigation, it is recommended that future research is focused on Asbestos Sheet Waste for this application. The results presented in this thesis gave an indication of the compressive strength and durability characteristics (water absorption), however in order to enable Asbestos cement sheet waste powder concrete to become accepted as a common construction material, the following experimental studies can be conducted in future with respect to Asbestos cement sheet waste powder Concrete-

1) Effect of different type of admixtures on Asbestos cement sheet waste powder concrete can be studied.
2) Durability Test such as initial setting time and final setting time, soundness test, heat of hydration on Asbestos cement sheet

waste powder Concrete can be studied.

3) The effect of addition of Asbestos cement sheet waste powder on the durability characteristics of commercial concrete.
4) The effect of high temperature on the properties of M35 concrete with Asbestos cement sheet waste powder.
5) The effect of addition of Asbestos cement sheet waste powder on the shrinkage and the creep properties of concrete.
6) Use of admixtures would be of value if deemed feasible.
7) Economic viability of using Asbestos cement sheet waste powder as cement in marine grade Concrete.

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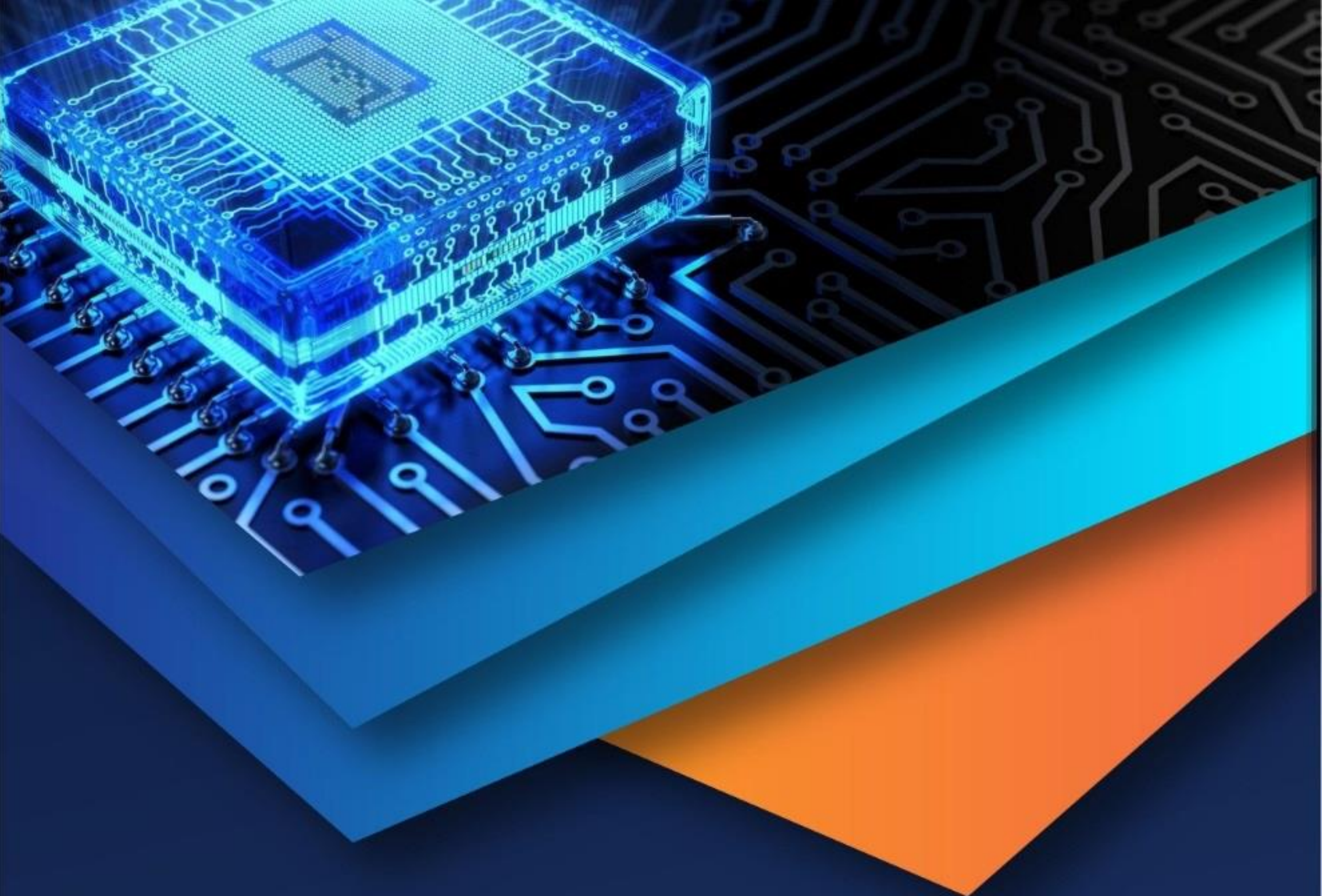

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