EXPERIMENTAL STUDY OF STRENGTHENING THE CONCRETE BY USING CHEMICAL ADMIXTURE (C-S-H) AND GLASS FIBER

J. Jaya Chandran[1], Ku. Mani Kandhan[2]

[1]PG Student, Department of Civil Engineering, Nandha Engineering College, Perundurai, Tamilnadu, India.
[2]Assistant Professor, Department of Civil Engineering, Nandha Engineering College, Perundurai, Tamilnadu, India.

Abstract: *Concrete is the most important engineering material in construction industry because of its inherent strength properties. The failure of the structures are mainly due to low tensile strength of the concrete, so the addition of some other materials may change the properties of concrete. In this experimental investigation Calcium silicate hydrate(C-S-H) and Glass fiber are used to modify the mechanical behavior of the concrete. The calcium silicate hydrate (C-S-H) is a Nano-structured material, which is the main product of the hydration of Portland cement. It is used to increase the strength and creep of concrete. The ability of C-S-H gel to act as a binding phase arises from its nanometer- level structure therefore this product is engineered to give excellent performance when used in concrete and also glass fiber used for increased tensile strength and also reduced the minor cracks in the concrete. In this experiment the percentage varies from 1%, 2% and 3% of chemical with constant of 0.1 % and 0.2% of glass fiber. The experimental work consist of casting RC Beam, Cube, Prism and Cylinder each specimen are curing for 7 days, 14 days, 28 days and testing this test specimen to evaluate the behavior of concrete. The flexural strength of 1.2m beam also carried out by using ABAQUS software.*

Key words: M-Sand, Glass fiber, Calcium-Silicate-Hydrates, slump, compressive strength.

1. Introduction

As a construction material, concrete is largely produced than all other materials. Plain concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. Therefore the addition C-S-H and Glass fiber are added to improve the above properties. Nanotechnology is a new emergent technology which largely produced in construction industries. Many Nano materials are available in construction industries. In this project the calcium silicate hydrate and Glass fiber are used for analysis fresh and hardened behavior of concrete.

The performance of these Nano materials is strongly dependent on Nano-sized solid particles, such as particles of calcium-silicate-hydrates, (CSH) or Nano-sized porosity at the interfacial transition zone between cement and aggregate particles. Calcium silicate is a Nano sized material with some degree of crystallinity as observed by X-ray diffraction techniques. The silicate in chain units exist as dimers, pentamers and 3n-1 chain units and these chain units are connected by calcium ions making three dimensional Nano structures. In general, a Nanoparticle has a particle size in the range of 1 to 100 nm.

The internal micro cracks are inherently present in the concrete leads to its poor tensile strength. The propagation of such micro cracks, eventually leading to brittle fracture of the concrete. Addition of small closely spaced and uniformly dispersed fibers to concrete would act as crack arrester and would substantially improve its static and dynamic properties. This type of concrete is known as Fiber Reinforced Concrete. The Glass fibers are used for control the plastic and drying shrinkage and also reduce permeability of concrete.

As concrete is most usable material in construction industry it's been required to its quality. Improving concrete properties by addition of Nano particles have shown significant improvement then conventional concrete. In this concrete the Nano technology is used such as chemical admixture like calcium silicate and mineral admixture like glass fiber are added to concrete for increasing the strength, which is wider use in pre-stressed concrete and high rise buildings.

Nano technology in civil field has proved to make the construction faster, cheaper, safer and more varied. Nano technology construction can allow for the creation of structure from advanced home to skyscrapers much more quickly and efficiently. In this type of concrete is called Nano concrete.

Nano technology is one of the most active research areas which has wide application in almost all the field. A concrete made with Portland cement particle that are less than 500nm as a cementing agent.

Currently cement particles size range from a few Nano-meters to a maximum of about 100 micro meters. Nano particles of silica turn into Nano particles of cement in the chemical reaction that takes place in the concoction of concrete when concrete is reduced to Nano level its properties are strongly influenced so that it increase their strength and

durability. Addition of Nano silica to the concrete leads to improve the material passing which results in densifying of micro and Nano structures.

Research into new fiber reinforced concretes continues today. The steel, glass and synthetic fibers have been used to improve the properties of concrete. The concrete contain discontinuous, uniformly dispersed or discrete fibers is called fiber reinforced concrete. It is a composite obtained by adding a single type or blend of fibers to the conventional concrete mix.

Fibers can be in the form of steel fiber, glass fiber, synthetic fiber and natural fiber. Main role of fiber is to bridge the cracks that develop in concrete and increase the ductility of concrete elements. There is a considerable improvement in the post-cracking behavior of concrete containing fiber due to both plastic shrinkage and drying shrinkage. The fibers reduce the permeability of concrete and reduce bleeding of water. They also impart more resistance impact load.

2. Experimental Investigation

Properties of Material

1. Cement
2. Glass fiber
3. Chemical admixture
4. Fine aggregate (M-sand)
5. Coarse aggregate
6. Water

2.1 Cement

Ordinary Portland Cement (OPC) is one of the most popular building materials used all across the globe. There is a fascinating story behind the naming of this widely used cement product. The name 'Portland' was given by the British cement manufacturer, Joseph Aspdin in 1824, due to its strong resemblance to Portland Stone, a type of white grey limestone found in the isle of Portland, Dorset in England. Joseph Aspdin is also credited to have patented the first true artificial cement, which he named as the Portland cement. While the chief chemical constituents of ordinary Portland Cement (OPC) are Calcium, Silica, Alumina and Iron, cement manufacturers continuously research and make efforts to further strength and improve the quality and other features of this particular type of cement. We offer the 53 Grade OPC Cement which gives even higher cement strength to match the rising demands of higher strength building material in the urban world. Property of cement details given below the table 2.1.1:

S.No	Test	Value
1	Specific Gravity	3.10
2	Bulk density	1330 kg/m^3
3	Normal Consistency	24%
4	Initial Setting Time	600 Min
5	Final Setting Time	482 Min

2.2 M-Sand (Manufactured Sand)

For aggregate produces concrete aggregate are end products while for concrete manufacturers, aggregates are raw materials to be used for concrete production. The quality of aggregates can be influenced while raw materials, gravel or rock may have characteristics which can't be modified by the production process. One extremely important factor is consistent supply of course, fine aggregate. In this regard a course aggregate produced by crushing basaltic stone and river sand is the major natural source of fine aggregate in our country.

However the intense construction activity is resulting in growing shortage and price increase of the natural sand in the country in addition the aggregate and concrete industry are presently facing a growing public awareness related to environmental threats. Therefore, looking for a viable alternative for natural sand is a must. One alternative used as replacement is the use of M sand. Property of cement details given below the table 2.2.1:

S.NO	TEST	VALUE
1	Specific Gravity	2.5
2	Fineness Modulus	8.436
3	Bulk density	1306 kg/m^3

Fig 2.2.1 Manufacture- Sand (M-Sand)

2.3 Coarse Aggregate (20mm)

It is the aggregate most of which is retained on 4.75 mm IS sieve and contains only so much finer material as is permitted by specification. According to source, coarse aggregate may be described as:

- **Uncrushed Gravel or Stone**– it results from natural disintegration of rock
- **Crushed Gravel or Stone**– it results from crushing of gravel or hard stone.
- **Partially Crushed Gravel or Stone**– it is a product of the blending of the above two aggregate.

According to size coarse aggregate is described as graded aggregate of its nominal size i.e. 40 mm, 20 mm, 16 mm and 12.5 mm etc. for example a graded aggregate of nominal size 20 mm means an aggregate most of which passes 20 mm IS sieve. A coarse aggregate which has the sizes of particles mainly belonging to a single sieve size is known as single size aggregate. For example 20 mm single size aggregate mean an aggregate most of which passes 20 mm IS sieve and its major portion is retained on 10 mm IS sieve.

20mm Size of Aggregate:

It is used for road construction as a lower layer beneath the asphalt surface. Currently this fraction is the most commonly used in Ukraine's construction industry. It is used both for small private construction and for construction of large industrial spaces. Aggregates of this fraction are used as sub-bases in construction of highways and railways and in production of concrete and massive structures from reinforced concrete. Property of cement details given below the table 2.3.1:

S.No	Test	Size of aggregate 20mm
1	Specific Gravity	2.63
2	Crushing value	18%
3	Impact value	23.55%
4	Water absorption	2%

Fig2.3.1(20mm Aggregate)

2.4 Calcium silicate

C-S-H is the Nano structured material. It create the Nano-structure chain unit between the cement particles. It is used in concrete primarily increasing strength of cement based materials. Calcium silicate hydrate (C-S-H) is one of the main product of hydration of Portland cement materials. The appearance of CSH is white in colour. The Bulk density is 0.40- 0.46 gm/cc and PH value is 7-8. The water absorption of calcium silicate hydrate (CSH) is 35-45 and Sio2 58-62. The Average particle size of calcium silicate hydrate (CSH) is 6 to 8. Table 2.4.1

S.No	Properties	Specification	Unit
1	Appearance	white powder	-
2	Bulk density	0.40 – 0.46	gm/cc
3	PH	7-8	-
4	water absorption	35-45	%
5	Sio_2	58-62	%
6	CaO	24-26	%
7	Alumina content	4.0-5.0	%
8	Moisture	0.5 max	%
9	Loss on ignition	7-9	%
10	Na_2O	0.05 max	%
11	Average particle size	6-8	µm
12	Residue on 700 mesh	1.0 max	%

2.6 Water:

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water are required to be looked into very carefully.

3. Mix Proportion

General:

Mix design is the process of selecting suitable ingredients of the concrete and determining their relative proportion with object of producing concrete possessing certain minimum desirable properties like workability in fresh state minimum desirable and durability in hardened state.

Design mix based on IS: 10262-2009 method:

Target Mean Strength:

fck = fck +1.65*s

From table 1 IS:10262-2009(Page 2)Value of

Standard deviation(s)for M25grade = 4 N/mm^2

Target mean strength = 25+(1.65*4)= 31.6 N/mm^2

Table 3.1 Mix Proportion For Trial Number:

Material	Weight(kg)	Volume(m^3)
Cement	435.40kg/m^3	0.140m^3
Water	191.58kg/m^3	0.192 m^3
fine aggregate	614.56kg/m^3	0.56m^3
coarse aggregate	1110.3kg/m^3	0.43 m^3

4. Result And Discussion

Test on Fresh Concrete

1. Slump cone test
2. Compaction factor test

1.Slump cone test

M-Sand = 85mm

2.Compaction factor test

M-Sand = 0.78

Test on Hardened Concrete

1. Compressive strength test
2. Split tensile strength test
3. Flexural strength test

1. Compressive strength test

One of the important properties of concrete is strength in compression. The strength in compression has definite relationship with all other properties of concrete. These properties are improved with the improvement in compression strength. The aim of the experiment test is to determine the maximum load carrying capacity of test specimens. The compression test specimens were tested on a compression tested on a compression testing machine (CTM) of capacity 2000KN.The specimen was placed on machine in such a way that its position is at right angle to it shown position which it had at the time of casting. load is applied gradually as the rate 14N/mm2/min or 320KN/min. Test results given below the table:

Table 1.1 Compressive Strength at 7, 14 and 28 Days

Typeof Concrete	Compressive Strength(N/mm²)		
	7 Days	14 Days	28 Days
Conventional concrete	24.44	29.06	36.93

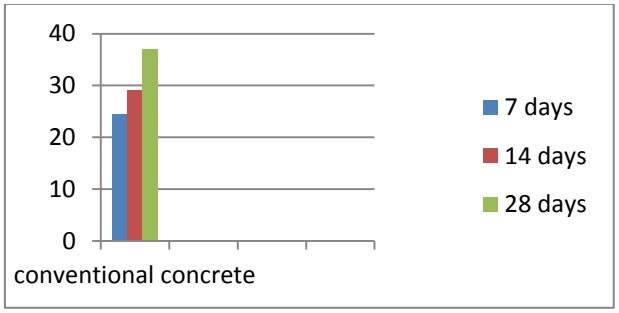

Chart 1.1Compressive strength at 7,14 and 28 days

5. Conclusions:

The experiment is conducted on concrete with addition of calcium silicate and glass fiber for find the comparison between conventional concrete and Nano concrete with calcium silicate and glass fiber.

- The 1.2m Reinforced concrete beam is analyzed to obtain the behavior of the beam in analytically by using ABAQUS software.

- According to the IS code procedure in 7days curing process maximum value of compressive strength obtained is 29.733N/mm^2. In 14days curing process the maximum value of compressive strength obtained 38.02N/mm^2. In 28days curing process the maximum compressive strength obtained is 43.48N/mm^2.

- The split tensile strength test are conduct for calcium silicate and glass fiber are used an admixture in various mix proportion. According to IS code procedure in 7 days curing process maximum split tensile strength obtained is 3.01N/mm^2. In 14 days curing process value of split tensile strength obtained is 3.54N/mm^2. In 28 days curing process the maximum value of split tensile strength obtained is 3.92N/mm^2.

- The flexural strength test are conduct for calcium silicate and glass fiber are used an admixture in various mix proportion. According to IS code procedure in 7 days curing process maximum flexural strength obtained is 6.5N/mm^2. In 14 days curing process maximum flexural strength obtained is 8.25N/mm^2. In 28 days curing process maximum flexural strength is obtained 7.75N/mm^2.

- The maximum flexural strength of 1.2m beam obtained by using ABAQUS software. The non-destructive test like rebound hammer and Ultra sonic pulls velocity are done for the specimen which gives the better result similarly to the destructive tests.

- The result of the test are taken in various day that result are placed in graph to show the variation of on the result.

- The addition of calcium silicate and the glass fiber give the good mechanical properties such as compressive strength, flexural strength and split tensile strength are compared then convention concrete.

- It is established that makes M3 and M6 mixes give the maximum strength limit. It show the admixture of calcium silicate and glass fiber increase the strength of concrete and reduce the cost effectively.

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