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Application of Organic Waste in Concrete

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CHAPTER-1

INTRODUCTION

1.1 GENERAL

Construction sand is the necessary raw material that is being used mainly by the construction industry for especially for making concrete, mortar etc. Excessive mining on river beds has led to the demand for construction sand. Various alternatives are explored to meet the demand but there are many disadvantages.

In this massive developing world, generation of solid waste has increased tremendously. There are about 9 billion tons of waste produced daily. By doing this we are turning the world into a huge garbage dump.

Both the problems can be solved by using the non-recyclable waste from garbage for making sand like particles (equivalent to fine aggregates in concrete) which can be used civil construction.

The manufactured sand is partially replaced in concrete and their mechanical properties are tested for its feasibility. The coir which is a naturally reinforced fibre is added to the concrete to do a comparative study on strength characteristics of the concrete with and without natural fibres.

1.2 DEMAND FOR CONSTRUCTION SAND

The construction industry is growing with major believe on infrastructure. The demand for river sand is also increasing. The demand for sand has increased by 360 percent in the last 30 years and it continues to do so. The overuse of river sand for construction has many unwanted environmental and social effects. The illegal sand mining is becoming uncontrollable issue and natural sand deposits are diminishing. Sand mining has become a common practice and in turn resulted in a rapid growth of river sand mining activities which have given rise to various problems that require urgent action by the authorities.

Fig1

Sand is essential for development of the country, but at the same time the damages posed due to sand mining cannot be ignored. Uncontrolled illegal river sand mining creates a level of threats to rivers that are ecologically irreversible even in the long run; an urgent and sustainable solution is now needed for the affected rivers and communities.

As there is enormous demand for the sand in the construction industry, the river sand resources are exhausting. The illicit mining of natural resources is creating major problems.

Environmentalists are expressing objection in opposite to mining of the natural resources not only in India but all over the world. The regulating authorities such as The National Green Tribunal, Ministry of Environment and Forests, the State Environment Impact Assessment Authority (SEIAA) and the Pollution control Boards etc. are restraining sand mining without any license/permit or environmental clearance from river beds across the country.

1.2.1 AVAILABLE ALTERNATIVES

In all over the world Sand Researchers are in continuous search for the alternatives of River sand as it is becoming a scarce material. Natural sand deposits are becoming exhausted near a lot of areas where there is a huge metropolitan growth, the use of alternatives to sands to be replaced as the fine aggregate in concrete is receiving more attention and interest. As a solution for this, various alternatives are explored and used in many parts of the world. Some of them are

- Manufactured Sand (M Sand)
- Processed Quarry Dust
- Processed Crushed Rock Fines (CRF)
- Filtered Sand
- Fly Ash/ Bottom Ash/Pond Ash
- Slag Sand Offshore Sand
- Dune Sand
- Washed Soil
- Copper Slag Sand
- Construction Demolition Waste
- Powdered Glass
- Aluminium saw mill waste
- Granite Fines/Slurry

Fig 2

1.2.2 DISADVANTAGES OF AVAILABLE ALTERNATIVES

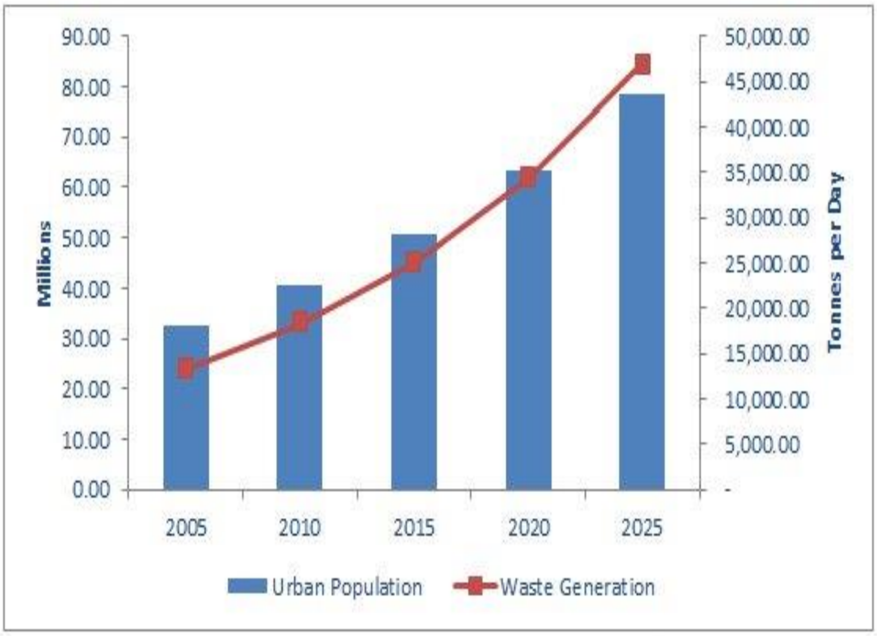
- Crushed sand contains a larger amount of micro-fine particles. This can have an effect on the strength of concrete.
- Crushed sand can be of coarser and angular texture. This can lead to more water and cement requirement to achieve the expected workability.
- The requirement of water is more.
- Switching noise and ripple exist.
- Complicated design.
- It involves a considerable labour cost, making the process expensive.
- Possible only in some instance.
- Not being appropriate for high energy environment
- More time is needed.
- The consequences of ASR reaction can lead to excessive deformations and loss in resistance as well as durability and stability.

1.3 GENERATION OF WASTE

There are 192 countries as recognized by United Nations Organisation (UNO). There is an exceptionally large developments such as car, mobile phone, laptops, construction technology etc. with the speed of this development generation of waste has also increased.

Fig 3

Each individual produces an average of 1.25 kg of solid waste (both recyclable and non-recyclable waste) per day and 9 billion tons daily. On producing the waste at this rate, we are turning the world into huge garbage dump.



Source: World Bank, Waste Concern, and Frost & Sullivan Analysis

Fig 4

Economic growth might be teetering across the world, but the amount of garbage generated by global cities is only going up. Together, urban centres generate 9 billion tons of solid waste daily and it is set to grow to 9.9 billion tons by 2025, according to projections by the World Bank.

1.3.1 ORGANIC WASTE

Corporates make use of recyclable waste such as metal, plastic, paper etc. Organic waste (non-recyclable waste) are sent to landfills. Air pollution which is one of the most common consequences of the landfills is one of the major problems that we are facing right now. The organic waste such as yard and food waste are the primary cause of the problem. Methane is emitted when the organic material is dumped along with little sand, which is the major contributor to global warming. Dumping the waste not only pollutes the air but also produces environmental problem on land and water.

There are 218 million operating landfills in the world. The most common means for disposing of municipal solid waste is burial in a sanitary landfill. Now a days, managing solid waste is not that easy both financially and logistically. According to a data compiled through Waste Business Journal's direct survey of landfill managers, the national average cost per ton of landfilled waste in 2017 was $50.30 per ton, which is forecast to rise to $51.19 by the end of 2018 and projected to climb even higher through 2021.

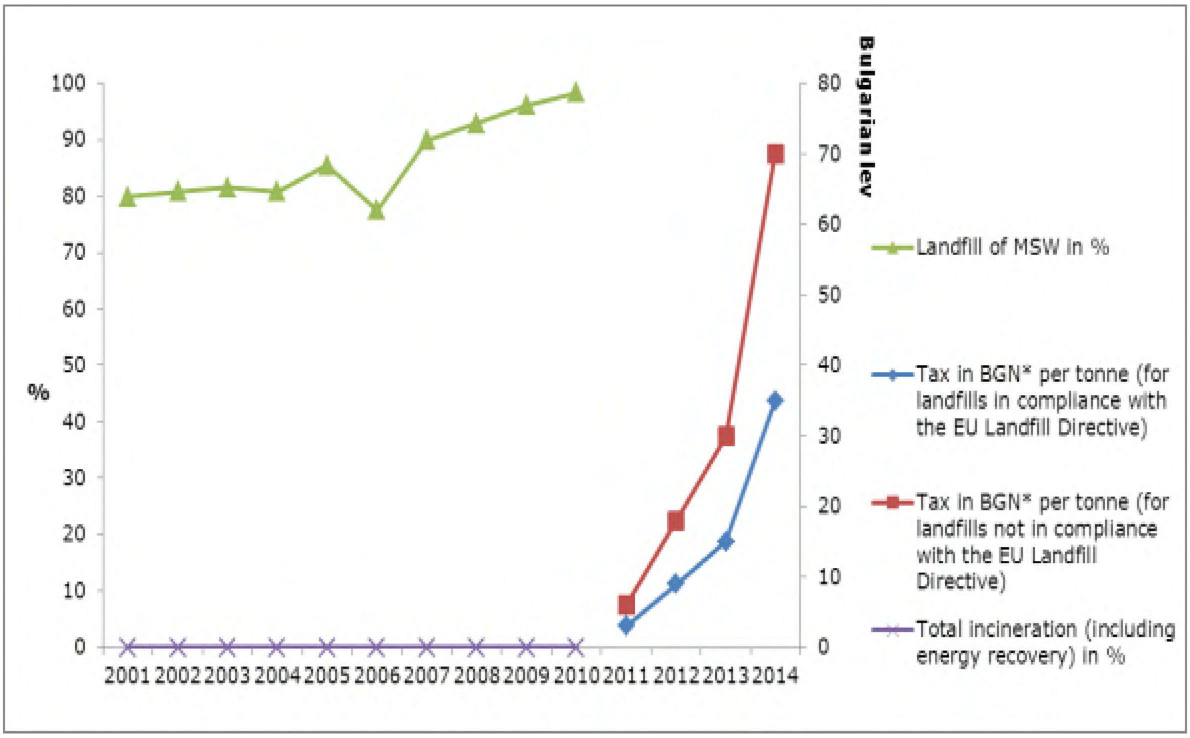


Fig 5

1.4 GARBAGE THE NEW RAW MATERIAL FOR HUMANITY

We aim on using the organic waste (non-recyclable waste) from the garbage to be turned into sand like particle (equivalent to fine aggregate in concrete) which can be used for civil construction. So that the demand for construction sand can be met and the above two important problems can be solved.

The waste is being collected from landfills, is separated into recyclable and non-recyclable waste. The non-recyclable waste goes through a process called hygienization which is a cleaning process. The volume the waste gets reduced here. The mixture is then crushed and sieved to required size. The mixture is autoclaved to encapsulate the bacteria's present in it and is converted into sand like particles (equivalent to fine aggregates in concrete). The prepared sand complies with the properties and microbiological standards of river sand.

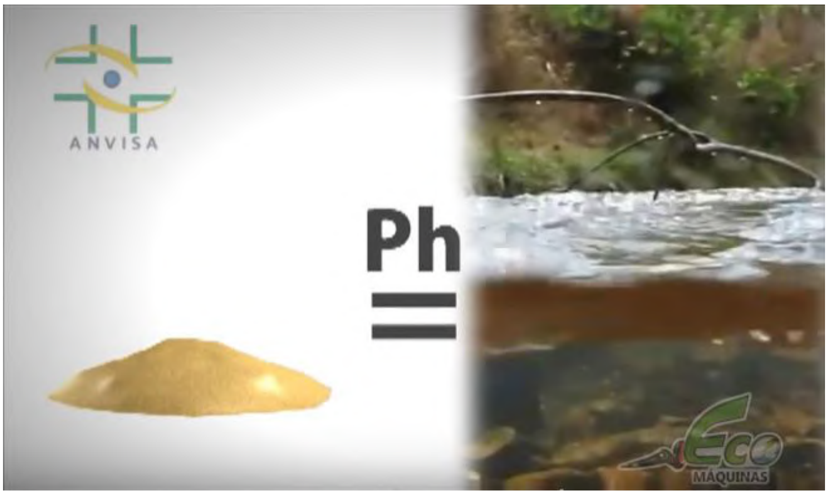


Fig 6

The following are the advantage

- New alternative for river sand.
- It is economical.
- The lifespan of existing landfill can be increased.
- Opening of new municipal waste storage can be avoided and the cost spent on it can be saved.
- By doing this waste has gone from being a problem to the source of renewable solution.
- Simple design
- Minimizes pollution.
- Protects the environment.
- Minimizes global warming.
- Conserves natural resources
- Contribution to creation of jobs

1.5 FIBRES IN CONCRETE

Fibres are generally used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibres produce greater resistance against impact, abrasion and shatter in concrete. They are small in size, discrete and uniformly distributed in concrete.

Fig 7

Fibres are classified based on their nature and varying properties on concrete. They are

1. Steel fibre
2. Glass fibre
3. Synthetic fibre
4. Natural fibre

1.5.1 NATURAL FIBRES IN CONCRETE

Fibers which are produced by plants, animals and geological processes are known as natural fibers. Plant fibers are used as an alternative source of steel and/or artificial fibers to be used in composites (such as cement paste mortar and/or concrete) for increasing its strength properties. There are different types of natural fibres. They are as follows

1. Sisal
2. Jute
3. Rice husk
4. Flax

5. Banana fibre
6. Palm oil fibre
7. Sugarcane bagasse
8. Coir
9. Hair

1.5.1.1 COIR IN CONCRETE

The fine aggregate in concrete is partially replaced with a non-polluting sand like particles and natural fibre is being added to the concrete. In this project coconut coir is used as the natural fibre because of its availability.

Fig 8

Coir, or coconut fibre, is a natural fibre extracted from the husk of coconut and used in products such as floor mats, doormats, brushes and mattresses. Coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut.

There are two types of coir's. They are

1. Brown coir
2. White coir

Brown coir is taken from ripened coconuts and have better strength characteristics than white coir. Due to the above reason, brown coir is used as the natural fibre in this project. A comparative study is made on the strength characteristics of concrete with and without fibre.

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

Papers on biodegradable wastes, Green building and sand manufacturing, different types of fibre reinforced concrete and other related subjects were studied for Indian and International journals, before starting the project as they are listed below.

2.2 LITERATURE REVIEW

2.2.1 ECOMAQUINAS KONLIX

2.2.2

Fig 9

We are already more than 7 billion people, each individual produces an average of 1.25 kg of waste per day, and this is, 9 billion tons daily. All of these wastes cause environmental problems such as pollution of air, land and water sources. Some organisation and companies reutilize some materials, but what remains is not reused. After 19 years of research, developments and tests, it was concluded PROCESS KONLIX, which turns waste into ecological bricks for construction as follows

After being collected from landfills, waste goes through a CLEANING process, then the recyclables are recycled (metal, plastic, etc.), what is left is CRUSHED and SIEVED until turn a sand is then mixed with the additive konlix, which encapsulates and inhibits the development of bacteria such as fecal coli forms, streptococcus and several others, resulting in a compound clean and within the microbiological standards

ANVISA and INMETRO. After these procedures, the sand is MIXED GROUND AND CEMENT, compacted and have the ecological brick, no smells, with twice the conventional ceramic brick and resistance within the norms of ABNT.

The volume of accumulated garbage, it would be possible to build millions of affordable housing through private companies, joint efforts, associations, local cooperatives, extending the useful life of landfills and preventing new municipal waste storage costs with the opening of new deposits. Now the garbage can stop being a problem and become a deposit renewable solution.

2.2.2 BUILDING WITH WASTE

- ***Compilers Dirk E. Hebel, Marta H. Wisniewska and Felix Heise etl*.,**

Looked into the worlds of architecture, construction, and the delightfully named field of "garbology" to find new and exciting materials made out of stuff you'd normally find at a landfill site. Their book says that, in future, we could end up by re-using pretty much everything, as we did back when all waste was organic.

- ***Newspaper Wood***

This design comes from Norway, where over 1m tonnes of paper and cardboard are recycled every year. The wood is created by rolling up paper and solvent-free glue to create something not dissimilar to a log, then chopping it into usable planks. The wood can then be sealed so it's waterproof and flame-retardant, and used to build anything you would normally build with wood.

- ***Nappy roofing***

Special recycling plants separate out the polymers from the, organic waste, and these polymers can then be used to create fibre-based construction materials like the tiles.

- ***Recy blocks***

These colourful bricks are made from old plastic bags, which are notoriously difficult to recycle in any other way. Recycled bags or plastic packaging are placed in a heat mould, and forced together to form the blocks. They're too lightweight to act as load-bearing walls, but can be used to divide up rooms or outdoor areas

- ***Bottle bricks***

This proposal is a little different, as it relies on producing a consumer well specifically so it can later be used as a building material. Lots of companies now make bottles in cuboid or other tessellated shapes, to make them easier to transport.

But the practice of doing so to create construction materials actually started with beer company Heineken in the 1960s – Alfred Henry Heineken, owner of the brewery, visited a.

Caribbean island and was dismayed at both lack of shelter, and the number of discarded Heineken bottles scattered everywhere. So, the company landed on a new, brick-shaped design for the bottle, shown in the images above. The bottleneck slots into the base of the next bottle, forming an interlocking line.

- ***Smog insulators***

One of our biggest waste receptacles is the air, which isn't great for our lungs, or for the human race's chances of survival on a planet that's rapidly getting hotter. "Dusty relief", a system created by the City of Bangkok and design firm New-Territories, involves placing an electrically charged metal mesh over a building, which attracts large smog particles and sticks them together. Eventually, this creates a kind of silvery fur over the building's surface. Not particularly attractive, perhaps, but much better than a similar shag forming on the insides of your lungs.

- ***Mushroom walls***

Here, designers figured out a way to grow wall insulator and packing materials using mycelium, a bacterium found in rotting organisms like tree trunks and agricultural by-products. If placed in a mould, these organic matters grow to the desired shape within a couple of days, and can then be stopped using a hot oven. This is particularly useful because traditional insulating and packing materials tend to be non-biodegradable, or, in the case of asbestos, poisonous.

- ***Plasphalt***

Plasphalt is made up of grains of plastic produced from unsorted plastic waste, which replaces the sand and gravel traditionally used in asphalt production. In testing, it was found that plasphalt roads were far less vulnerable to wear and tear than traditional asphalt, because the asphalt emulsion bonded better with the plastic than with gravel or sand.

- ***Wine cork panels***

These wall or floor tiles are made by combining recycled granulated cork with whole wine corks, which you can see as those oblong shapes in the tiles above. This is a pretty useful idea, considering the world apparently consumes around 31.7bn bottles of wine a year.

2.2.3 SOLID WASTE MANAGEMENT – MYSORE

- ***Mrs Poornima B. M, Scientist" C", CPCB, Bengaluru 2. Mrs Geetha B. P, Environmental Officer, KSPCB, Mysuru Regional Office. 3. Mr Prasanna Kumar, Environmental Engineer, MCC***

Solid Waste Management is a Nation-wide Phenomenon, and is a big challenge throughout the nation for human beings to keep our surrounding environment clean. Rapid industrialization and population growth in India have led to the migration of people from villages to cities, which generate thousands of tonne of Municipal Solid Waste (MSW) daily. The MSW amount is expected to increase significantly in the near future as the country strives to attain an industrialized nation status by the year 2020. The management of MSW is going through a critical phase, due to the unavailability of suitable facilities to treat and dispose of the larger amount of MSW generated daily in metropolitan cities. Poor collection and inadequate transportation are responsible for the accumulation of MSW at every corner. Unscientific disposal causes an adverse impact on all components of the environment and human health. The Ministry of Urban Development conducted the survey during 2014-15 as required under the National Sanitation Policy of 2008. Since the Swachh Bharat Mission is being implemented in urban areas with focus on construction of individual household, community and public toilets to eradicate open defecation and ensure door-to-door collection and disposal of municipal solid waste, all the 476. Class-1 cities have been ranked based on the data pertaining to these elements from the date generated in the survey.

Mysore city in Karnataka had topped the Swachh Bharat Rankings of 476 cities in the country. These rankings are based on the extent of open defecation and solid waste management practices in these cities. The city of Mysore leads the cities with minimal open defecation and extensive adoption of solid waste management practices. Mysuru City Corporation has been awarded as 2nd Best Performing Municipal Corporation under JnNURM. The Hon'ble president of India on 8th July 2011 presented the "Nagara Rathna" award at Mumbai. The problem of municipal solid waste management (MSWM) is also prevailing in the urban environment of India. The data concerning to Solid Waste

Management in Mysuru was obtained through MSW Format, inspection of the MSW facilities, interacting with Officials of KSPCB and MCC and authentic record of Municipal Corporation. Photographic evidences were also made for storage, treatment and disposal of MSW. The MSW facilities located in Mysore City was inspected by the following Officials from CPCB, KSPCB and Mysore City Corporation during November 24 – 25, 2015

Mysore has set one of the best examples of solid waste management in the country. The city of Mysore has a population of 1.2 million people. The generation of solid waste is 402 metric tons every day. Because of the waste management practices that the city has adopted very little waste is actually sent to landfill. A few years ago, the city began a major try to educate the citizens on the importance of segregation dry and wet waste. It also ensures 100% door to door waste collection in each of the 65 municipal wards and this has helped close to 80% of the waste that is collected door to door by waste workers is segregated. These workers have been trained not to take unsegregated waste. Part of wet waste is taken care of in 9 waste management centres that are located in different part of the city. Here the wet waste is turned into compost. The dry waste is further segregated into 24 different categories like bottles, steel containers, plastics bags etc., the municipality also has a 200-ton windrow composting facility operated by a private company. This facility can process the mixed waste and automatically segregate dry and wet waste. The wet waste is further converted into organic manure and sold to farmers of across the state. Because of the purposed collection, segregation, recycling and composting system Centre of Science and Environment awards Mysore the clean city award 2016.

2.2.4 SOLID WASTE MANAGEMENT

- ***M.R. Nalamwar Asst. Prof. Department of Civil Engg, Jagdambha College of Engg Yavatmal, Dr.D.K. Parbat Lecturer in civil Engg Govt. Polytechnic Nagpur, India.***

Waste is described as unused materials and products, leftover materials or by products which is produced at the time of construction or maintenance period of the buildings. In many cities in developing countries, the most serious environmental and health problems are related with inadequate solid waste management. A major environmental concern is gas release by decomposing garbage. Therefore, we need to focus on the solid waste generated from the household and community. As it is difficult to recycle food waste since it contains high levels of sodium salt and moisture and mixed with other waste during collection.

Today the proportion of food and garden waste in municipal waste stream is gradually increasing and hence a proper food and garden waste management strategy needs to be devised to ensure its eco-friendly and sustainable dispose. Rapid urbanization and population growth have magnified the necessity for adequate solid waste management throughout the world. In order to minimize the risk to the environment and human health, economically feasible solutions are sought for the treatment of solid waste, particularly in urban areas of low- and middle-income countries. This paper evaluates the suitability of a small-scale biogas system as a decentralized treatment option for the organic fraction of market and household solid waste. We have different techniques to convert this waste to useful materials like bio-fertilizers and bio-fuel. By using these techniques, we can efficiently manage all waste and energy from it. Nevertheless, there are successful projects mainly related to a few types of technologies. Based on the technologies being the most promising in the field of low-tech Anaerobic Digestion of biodegradable waste are ARTI (Appropriate Rural Technology Institute, Pune). About 2500 ARTI-plants are currently in use both in urban and rural households in Maharashtra. Urbanization and population growth are solely responsible for high increasing rate of solid waste and it proper.

Management is a major problem of Municipal Corporation. In this study, the sources and components of solid waste were identified; type and the quantity of solid waste disposed, methods of solid waste disposal and impact of improper waste management on health were highlighted.

2.2.5 MANUFACTURED SAND

- *Bisham k Vaidya, Ashish Waghmare, Sreedhar Patil Prof Savitribai Pune University. D.Y. Patil SOET, Charli, Pune, Maharashtra, India,*

Manufactured sand is a term which has small size than 4.75mm on base of fine aggregate and which is recessed from crushed rock or gravel. To study the manufactured sand the suitable replacement of natural sand firstly its compressive strength should be checked and secondly its cost comparison is studied. Initially, different natural and manufactured sand samples to be used in the concrete mixes were collected and their physical properties were studied. Then the quantity Of M30 grade used in residential building of 2 Case study were obtained. Then the trial mix were prepared of different proportion & Cost analysis is done between concrete cost of the construction done and the cost of my trial mix of different proportion of the natural sand and manufactured sand in concrete. Manufactured sand is a substitute of river for construction purposes sand produced from hard granite stone by crushing. The crushed sand is of cubical shape with grounded edges. Washed and graded to as a construction material. The scarcity of natural sand due to such heavy demands in growing construction activities have forced to find the suitable substitute. One of the cheapest and the easiest ways of getting substitute for natural sand is by crushing natural stone to get MS of desired size and grade.

2.2.6 PROPERTIES OF CONCRETE BY REPLACEMENT OF NATURAL SAND WITH ARTIFICIAL SAND

➢ *Vinayak Roseolar & Popa Kumbha*

"Properties of Concrete by Replacement of Natural Sand with Artificial Sand" in International Journal of Engineering Research & Technology Vol. 1 Issue 7, September – 2012 - In the present an attempt has been made to discuss the properties such as workability and compressive strength of concrete prepared by replacing natural sand with artificial sand at different replacement levels (0%, 20%, 40%, 60% and 100%). The development of cracks and their measurement is also studied. The results have shown that the natural sand can be replaced with artificial sand up to a maximum replacement level of 60% in order to produce concrete of satisfactory workability and compressive strength and also with cracks of lesser areas. Chirag D Magnani & Vassal N Patel "A Review on Need of Manufactured Sand in Concrete constructions as a Replacement to River Sand" in Indian Journal of Research.

2.2.7 UTILIZATION OF RECYCLED AND WASTE MATERIALS IN VARIOUS CONSTRUCTION APPLICATIONS

➢ *Jonny Bolden, Taher Abu-Lebdeh and Ellie Fini*

Review of several studies suggested that the use of recycled materials has positive impact through different aspects. This include the benefit in enhancing sustainability of the construction industry while reducing the cost, providing solutions to environmental pollution and reducing the need for natural resources. In this study, a questionnaire survey was conducted to find out the current practices in using the waste and recycled materials in the construction industry. Results indicated that some companies were not aware of the availability of the quality of materials performance, cost savings, or any other benefits including environmental benefits. It is thus recommended to create better documentation for green infrastructure, connecting researches and industry with an overview of what recycled materials are available for different construction applications. Companies need to be innovative in their use of recycled materials. Also, more data and better documentation are needed to encourage the use of waste and recycled materials in the construction industry.

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2.2.8 A REVIEW ON RECYCLED USE OF SOLID WASTE IN BUILDING MATERIALS

➢ *Oriyomi M. Okeyinka, David A. Oloke, Jamal M. Khatib*

Significant research studies have been conducted on the development of new building materials using different kinds of solid wastes (Table IV), if this kind of investigation continues at this rate; the possibility of achieving zero waste in the nearest future could be a reality.

The literatures studied establish the possibility of utilizing solid waste materials like, plastic, wood, metal, paper, glass and demolished concrete as constituent of building materials. The use of these wastes at adequate level of replacement or proportions as the case may be, will improve the intrinsic properties of the building materials concerned. The application of these construction materials in real construction is limited. More research is needed to study the actual behaviour or performance of solid waste-based building materials in their practical applications because, properties like durability which has to do with long-term performance can be best studied through this means. In addition, the need to establish an energy efficient method for processing the solid waste to make them suitable for use in concrete standard mix design formulation is also required.

To encourage practical application of the building materials containing recycled wastes, there is need for research which will be focused on promoting the acceptability of these kinds of construction materials to the public and international building standards. This can be made possible by incorporating laboratory experimentation, statistical analysis and modelling of such construction material to validate the outcome of experimentation in a real-life condition. The statistical analysis of the result will also enable the understanding of the confidence level of the results, thereby proofing it beyond reasonable doubt. Therefore, to address the research gaps identified in this review, an investigation of the applicability of recycled waste for the production of lightweight building material, with focus on sustainability has been proposed. This proposed research, intends to produce an environmentally friendly lightweight building block from recycled waste paper without the use of cement, with properties suitable for use as non-load bearing walling unit.

Laboratory experimentation will be carried out to develop adequate mixture proportioning process with which the standard mix design will be formulated, to aid the acceptability of this material to building regulating body and the general public, the technology available for producing and for ascertaining the quality of concrete/sandcrete block will be employed as much as possible. Energy efficient equipment to process the material both at preparation and experimentation stage will be designed and fabricated.

Numerical modelling will be used to validate the outcome of laboratory experimentation, in order to understand the actual behaviour of the material in practical application.

The significance of this proposed investigation can be justified based on the fact that, its success is expected to contribute to the use of recycled waste in concrete, which may result in reduction in environmental pollution, conservation of valuable land fill spaces, conservation of natural resources and energy, minimized use of Portland cement as well as reduction in construction cost.

2.2.9 STRENGTH PROPERTIES OF GLASS FIBRE CONCRETE

- *Chandramouli K., Srinivasa Rao P., Pannirselavam N*

The present-day world is witnessing the construction of very challenging and difficult civil engineering structures. Quite often, concrete being the most important and widely used material is called upon to possess very high strength and sufficient workability properties. Efforts are being made in the field of concrete technology to develop such concretes with special characteristics. Researchers all over the world are attempting to develop high performance concretes by using fibres and other admixtures in concrete up to certain proportions. In the view of the global sustainable developments, it is imperative that fibres like glass, carbon, polypropylene and aramid fibres provide improvements in tensile strength, fatigue characteristics, durability, shrinkage characteristics, impact, cavitation, erosion resistance and serviceability of concrete. Fibres impart energy absorption, toughness and impact resistance properties to fibre reinforced concrete material and these characteristics in turn improve the fracture and fatigue properties of fibre reinforced concrete research in glass fibre reinforced concrete resulted in the development of an alkali resistance fibres high dispersion that improved long term durability. This system was named alkali resistance glass fibre reinforced concrete. In the present experimental investigation, the alkali resistance glass fibres have been used to study the effect on compressive, split tensile and flexural strength on M20, M30, M40 and M50 grades of concrete.

1. A reduction in bleeding is observed by addition of glass fibres in the glass fibre concrete mixes;
2. A reduction in bleeding improves the surface integrity of concrete, improves its homogeneity and reduces the probability of cracks;
3. The percentage increase of compressive strength of various grades of glass fibre concrete mixes compared with 28 days compressive strength is observed from 20 to 25% and
4. The percentage increase of flexural and split tensile strength of various grades of glass fibre concrete mixes compared with 28 days is observed from 15 to 20%.

2.2.10 NATURAL FIBRE REINFORCED CONCRETE

- *Ankaiah, Chandrasekhar Reddy*

Fibre Reinforced concrete can offer a convenient, practical and economical method for overcoming microcracks and similar type of deficiencies. The fibre reinforced concrete means that in the concrete some type of materials (fibres) are used to increase the strength of concrete, because concrete weak in tension and more in compressive strength. So, increase the tensile strength for adding the fibres to concrete because the fibres are strong in tensile strength. Generally, the fibres are classified in to two types; they are artificial fibres and natural fibres. In the artificial fibres steel, asbestos, glass, carbon, synthetics etc are used and in the natural fibres horse hair, sisal, coir, bamboo, jute, aware, elephant grass, coconut fibres etc are used. And in this human hair was used as a fibre. Human hair is natural fibre and it is strong in tension, so it can be used as a fibre reinforcement material. Hair Fibre (HF) an alternate non-degradable matter. And also available in very cheap cost. The hair decomposing is difficult; it also creates environmental problems for its decompositions. Present studies have been undertaken to study the effect of human hair on plain cement concert on the basis of its compressive, crushing, flexural strength and cracking control to economize concrete and to reduce environmental problems and reduce the micro-cracks in concrete. Experiments were conducted on concrete cubes with various percentages of human hair fibre I.e. 0%, 1%, 1.5%, 2%, 2.5%, 3%, and 3.5% etc, by weight of cement for M20, M25 grade concretes. For each combination of proportions of concrete three cubes are tested for their mechanical properties.

According to the test performed it is observed that there is increment in strength in concrete by increased the percentage of hair by weight of cement 0% to 3%. And at 3.5% the concrete strength was started decreasing. So, the hair 3% is the mean value for adding of hair percentage by weight of cement, after adding of 3% of hair it was failure. The results are similar in compression test and splitting tensile test, i.e. .in compression test and splitting tensile test 3% of hair by weight of cement is mean point to failure of concrete.

2.2.11 REINFORCED CONCRETE USING DOMESTIC WASTE PLASTICS AS FIBRES

- *R. Kandasamy and R. Murugesan*

Fibre Reinforced Concrete (FRC) is a composite material consisting of cement-based matrix with an ordered or random distribution of fibre which can be steel, nylon, polythene etc. The addition of steel fibre increases the properties of concrete, viz., flexural strength, impact strength and shrinkage properties to name a few. A number of papers have already been published on the use of steel fibres in concrete and a

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considerable amount of research has been directed towards studying the various properties of concrete as well as reinforced concrete due to the addition of steel fibres. Hence, an attempt has been made in the present investigations to study the influence of addition of polythene fibres (domestic waste plastics) at a dosage of 0.5% by weight of cement. The properties studied include compressive strength and flexural strength. The studies were conducted on a M20 mix and tests have been carried out as per recommended procedures of relevant codes. The results are compared and conclusions are made.

The following conclusions are presented based on experimental results from the present investigation. Addition of 0.5% of polythene (domestic waste polythene bags) fibre to concrete

1. Increases the cube compressive strength of concrete in 7 days to an extent of 0.68%;
2. Increases the cube compressive strength of concrete in 28 days to an extent of 5.12%;
3. Increases the cylinder compressive strength of concrete in 28 days to an extent of 3.84%; Increases the split tensile strength to an extent of 1.63%; and
4. The increase in the various mechanical properties of the concrete mixes with polythene fibres is not in same league as that of the steel fibres.

2.2.12 STRENGTH BEHAVIOUR OF CONCRETE USING POLYMER MODIFIED AND STEEL FIBRE REINFORCED CONCRETE

➢ *Sachin Kumar, Mr. Pramod Saharan*

Concrete is being widely used in the construction work e.g. buildings, bridges, highways, tunnels etc. due to its high strength. A lot of research has been done or ongoing to improve the concrete strength with the advancement of technology. Relating to this a study has been carried out on the impact of concrete strength by using acrylic latex polymer modified concrete and steel fibre reinforced concrete (SFRC). It was observed in previous researches, in addition of SFRC increases the mechanical properties (compressive strength, tensile strength and flexural strength) of concrete. Now we will observe that the Involvement of acrylic latex polymer individual or combined with steel fibres effects on mechanical properties of concrete. For this, we have prepared a design mix of M25 grade as per IS 10262 2009.

We see that the compressive strength of M25, M25+AL, M25+SF and M25+AL+SF are 31 N/mm^2, 27 N/mm^2, 36 N/mm^2 and 34.5 N/mm^2 respectively. There is a decrease in compressive strength in case of using acrylic latex, but use of steel fibre shows a great increase in compressive strength which is due to the compactness and bonding between concrete and steel fibre. Steel fibres are also capable of taking load.

While in case of cylinder testing acrylic latex polymer enhances the tensile property of concrete. From the above observation, involvement of acrylic latex with or without steel fibre significantly increases the value of tensile strength.

Using of acrylic latex, flexural behaviour of prism shows an increase in the flexural strength of concrete. Combine use of steel fibre and acrylic latex also increases the flexural strength of concrete prism. This happens due the compactness of concrete due to the using acrylic latex polymer.

2.2.13 STEEL FIBRE REINFORCED HIGH PERFORMANCE CONCRETE BEAM-COLUMN JOINTS SUBJECTED TO CYCLIC LOADING

- *N. Ganesan, P.V. Indira and Ruby Abraham*

This paper describes the experimental results of ten steel fibre reinforced high performance concrete (SFRHPC) exterior beam-column joints under cyclic loading. The M60 grade concrete used was designed by using a modified ACI method suggested by Aitkin. Volume fraction of the fibres used in this study varied from 0 to 1% with an increment of 0.25%. Joints were tested under positive cyclic loading, and the results were evaluated with respect to strength, ductility and stiffness degradation. Test results indicate that the provision of SFRHPC in beam-column joints enhances the strength, ductility and stiffness, and is one of the possible alternative solutions for reducing the congestion of transverse reinforcement in beam column joints. Also, an attempt has been made to compare the shear strengths of beam-column joints obtained by using the models proposed by Tonos and co-workers, Baker and co-workers, and Jiro and co-workers. As these models are meant for the joints in ordinary concrete, comparison was not found to be satisfactory. The model proposed by Jiro and co-workers was modified to account for the presence of high-performance concrete. The proposed model was found to compare satisfactorily with the test results.

The SFRHPC joints undergo large displacements without developing wider cracks when compared to the HPC joints. This indicates that steel fibres impart high ductility to the SFRHPC joints, which is one of the essential properties for the beam-column joints.

1. Addition of fibres to the beam-column joints decreased the rate of stiffness degradation appreciably when compared to the joints without fibres. Hence, the technique of inclusion of steel fibres in beam column joints appears to be a useful solution in the case of joints subjected to repeated or cyclic loading.
2. During testing it has been noted that addition of fibres could improve the dimensional stability and integrity of the joints.

3. Also, it is possible to reduce the congestion of steel reinforcement in the beam-column joints by replacing part of ties in the columns by steel fibres.
4. Load carrying capacity of the joints also increased with the increasing fibre content.

2.2.14 USE OF COCONUT FIBRES AS AN ENHANCEMENT OF CONCRETE

➢ *Yally and Kwan*

This research describes experimental studies on the use of coconut fibre as enhancement of concrete. The addition of coconut-fibres significantly improved many of the engineering properties of the concrete, notably torsion, toughness and tensile strength. The ability to resist cracking and spalling were also enhanced. However, the addition of fibres adversely affected the compressive strength. When coconut fibre was added to plain concrete, the torsional strength increased (by up to about 25%) as well as the energy-absorbing capacity, but there is an optimum weight fraction (0.5% by weight of cement) beyond which the torsional strength started to decrease again. Similar results were also obtained for different fibre aspect ratios, where again results showed there was an optimum aspect ratio (125). An increase in fibre weight fraction provided a consistent increase in ductility up to the optimum content (0.5%) with corresponding fibre aspect ratio of 125. Overall the study has demonstrated that addition of coconut fibre to concrete leads to improvement of concrete the toughness torsion and the tensile stress, Further work is however, required to assess the long-term durability of concrete enhanced with coconut fibres.

The findings of experimental investigations on the strength characteristics of concrete enhanced with coconut fibres are reported. The following conclusions can be derived.

The addition of coconut-fibres significantly improved many of the engineering properties of the concrete, notably torsion, toughness and tensile strength. The ability to resist cracking and spalling were also enhanced. However, the addition of fibres adversely affected the compressive strength, as expected, due to difficulties in compaction which consequently led to increase of voids.

Despite its excellent properties, coconut fibre as an enhancement of concrete is unlikely to replace steel for the vast majority of structures. Experiments and demonstration projects around the world have shown that natural fibre enhancement is a viable and cost-effective alternative to conventional building materials. However, the construction industry is extremely conservative, and so the most likely development route is the use of the new materials in non-structural applications or in ones where the consequences of failure are not too severe.

Previous researchers like Gram (1983), Le Huu Do et al. (1995) Romildo et al. (2000) Savastano (2000) and Ramakrishna et al. (2004) have identified the following disadvantages in using natural fibres in cement-based composite

a) high water absorption of natural fibre causes unstable volume and low cohesion between fibre and matrix; and

b) natural fibre decomposes rapidly in the alkaline environment of cement and concrete.

Based on the above disadvantages future work on coconut fibre-enhanced concrete and mortar should concentrate on minimising the impact of these disadvantages.

Given the variety of fibre materials, the number of mix constituent and method of production, it is evident that product development should be the prime future research objective. Economic methods of natural fibre extraction, handling, and economical and automated methods of dispersing fibres at a batching plant is needed if large quantities of fibres are going to be used in construction.

Applications for coconut fibre enhanced concrete and mortar composite for housing need to be expanded. Since cement-based materials are well known insulators, another avenue for future research and product development would be the use of coconut fibre-cement composites for sound and heat insulation. Such products might be composed wholly of fibre-cement or use the fibre-cement as one component in an insulating member. It must be acknowledged that aerated concrete would be better, cheaper and easier than the proposed coconut fibre composite insulator however, it could be used as replacement where aerated concrete might not be available or comparatively expensive to produce.

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CHAPTER 3

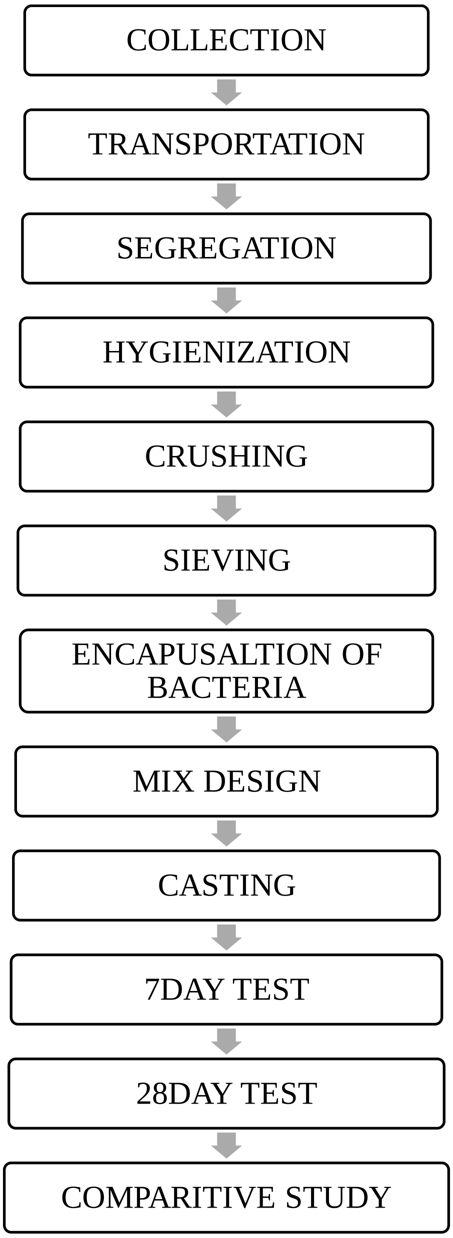
METHODOLOGY

3.1 GENERAL

The following process is followed for preparing and testing the sand like particles.

3.2 FLOW CHART

The process of converting organic waste into sand like particles (equivalent to fine aggregates in concrete) involves the following process.



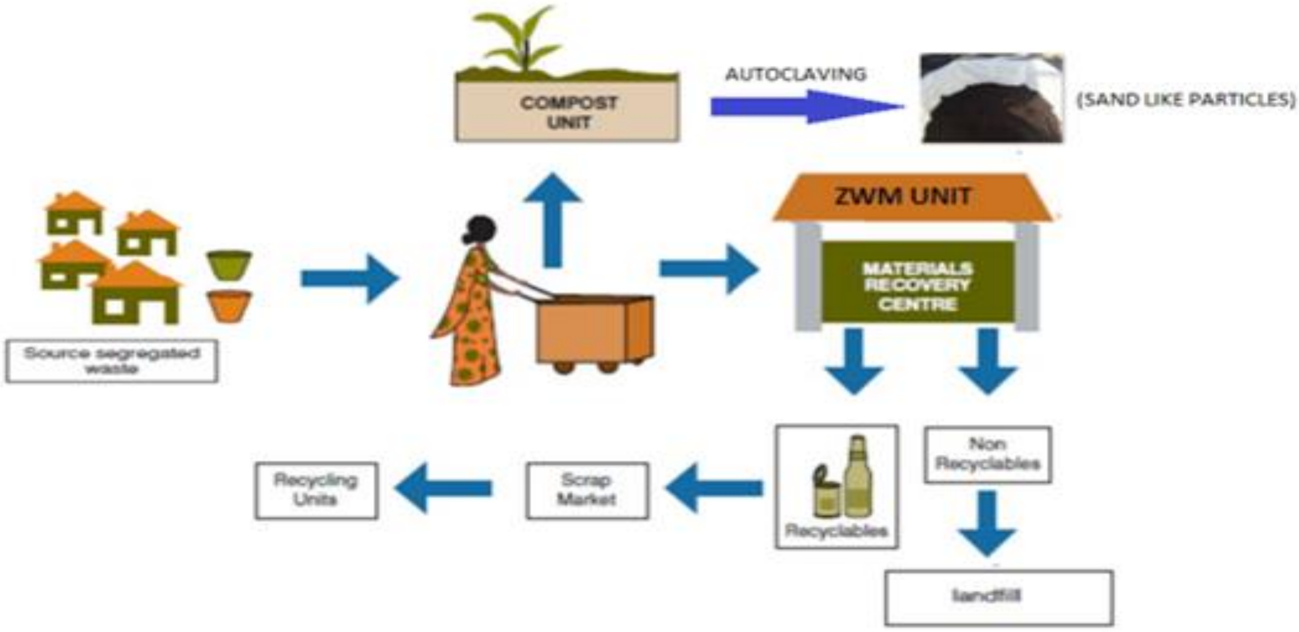


Fig 10

PHASE 1

3.3 COLLECTION OF WASTE

Different methods are used for collecting the solid waste from different sources. The waste from the households and commercials establishments are covered under door to door collection of waste through 112 no. Pushcarts or from 168 no. Auto Tipper. MCC has issued two colour coded bins to some of the households to encourage the segregation of waste at the source. Market and Chicken & mutton waste are being collected separately by 05 no. Auto tippers and 01 Canter. In order to facilitate collection of MSW from the bulk generators like Marriage & Function halls, Hotels, Restaurants & Lodgings, 20 Dumper bins have been placed at commercial areas and bulk waste generation points. The MSW stored in the Dumper bins is transferred to the compost facility using Dumper placers.

The waste brought through auto tippers and Lorries to the plant is being weighed at the weigh bridge and recorded. The waste is unloaded and it is segregated manually as the waste is moved on the conveyor belt, then it is stacked in the form of trapezoidal heaps called windrows.

Fig 11

3.4 TRANSPORTATION OF WASTE

The solid waste collected from the households and commercial establishments are stored temporarily in the dust bins and then transported to the disposal site. The waste that are collected are transported to the dumping site directly. Transportation of solid waste is carried by MCC and private sectors. Tipper Lorries-55 no. Compactors-2 no. and Dumper Placer vehicle-20 no. vehicles are used to transport collected solid waste to the compost facility. The tractors and dumpers carrying waste does not have a cover during the transportation of waste from collection point to dumping site and waste tends to spill on the roads. Tipper Lorries are used for the transportation of street sweeping waste and silt generated in the city. All vehicles that are used for Solid Waste Management in MCC are monitored through GPS system.

Fig 12

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3.5 SEGREGATION OF WASTE

The waste that is collected now undergoes a process of segregation. The recyclable waste is segregated from non- recyclable waste and is send for recycling. The required amount of non-recyclable waste is thus obtained for the process.

3.6 HYGIENIZATION

Hygienization is cleaning the waste and removing the odour and anaesthetic appearance.

Hygienization is the process by which the degradable solid waste undergoes the exposure to a certain amount of aeration process for the removal of odour and also helps in removal of bacteria.

In this process of hygienization followed in our city, bio degradable segregated waste is sent into a closed rotating cylinder which makes 1200 rotations per day. The waste is rotated in the cylinder for 2 days. The cylinder has oxygen supply in built and oxygen supplied triggers the aerobic process and the odour is removed and the waste is reduced by 50%.

The mixture also consists of mostly anaerobic bacteria which can be reduced by 50% by this hygienization.

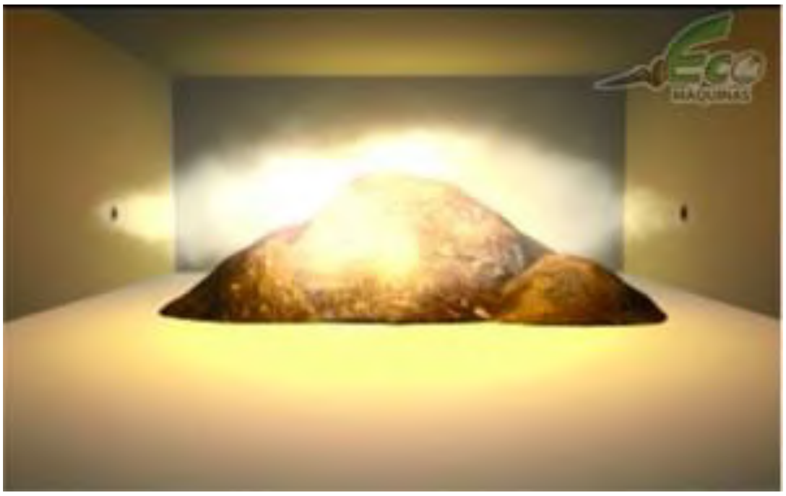

Fig 13

This process also emits a lot of water discharge which can be directly transported to biogas, vegetable green houses, orchids and other fields that need fertilization.

3.7 CRUSHING

In this process the waste from the hygienization is crushed and sieved as the direct output from the hygienization process is not uniform. The end product from hygienization has water content about 25-35% and size is big for granulation, it needs to be crushed to smaller materials.

3.8 SIEVING

Once the material is stabilized, it is fed to the sieving section using a Skid Steer Loader for screening. Three stage screening system is being adopted to achieve maximum screening efficiency. The first screen is of 65mm Trommel Screen, where the stabilized waste is fed and the output from this screen is carried through conveyor belt to the next screen and the reject are carried by a separate conveyor belt, collected. The processed output is transported through a conveyor belt to the next screen, while the rejects are moved on a separate conveyor belt, collected and stored.

3.9 ENCAPSULATION OF BACTERIA

Organic waste is being converted into a mixture there will presence of bacteria in it. Even though some of the bacteria’s may be removed in hygienization process, still some of the bacteria’s will be present in the mixture. Removing the present bacteria from the mixture is known as encapsulation of bacteria.

Fig 14

The sieved output mainly contains two types of bacteria. They are

- Streptococci
- Calculi.

3.9.1 STREPTOCOOCI

Streptococcus is a spherical bacteria, that belongs to the family Streptococcic, within the order Lactobacillus's in the phylum Firmicutes. Cell division in streptococci occurs along a single axis, so as they grow they tend to form pairs or chains that may appear bent or twisted. Most streptococci are oxidase-negative and catalase-negative, and many are facultative anaerobes.

3.9.2 FECCALCOLLI

A fecal coliform is a facultative anaerobic, rod-shaped, gram-negative, non-sporulating bacterium. Coliform bacteria generally originate in the intestines of warm-blooded animals. Fecal coliforms are capable of growth in the presence of bile salts or similar surface agents, are oxidase negative, and produce acid and gas from lactose within 48 hours at 44 ± 0.5°C. The term "thermo tolerant coliform" is more correct and is gaining acceptance over "fecal coliform".

Coliform bacteria include genera that originate in feces (e.g. Escherichia) as well as genera not of fecal origin (e.g. Enterobacter, Klebsiella, Citrobacter). Presence of fecal coliforms in water may not be directly harmful, and does not necessarily indicate the presence of feces.

3.9.3 AUTOCLAVING

The crushed and the sieved mixture contains a large number of bacteria present in it. A mixture containing bacteria is considered to be an organic material that can be used only as a compost. The bacteria present in mixture can also corrode the concrete resulting in a huge damage, hence it is very necessary to remove the bacteria from the mixture to convert it into the sand material. The bacteria are hence removed from the organic material by the process of autoclaving.

Autoclaving is a method of sterilization which uses high-pressure stem. The autoclaving process works by the concept that the boiling point of water (or steam) increases when it is under pressure. An autoclave is a pressure chamber that is used to carry out any industrial processes that requires elevated temperature and pressure different from ambient air pressure.

Autoclaves can be used to eliminate microorganisms, cure composites, vulcanize rubber, and for hydrothermal synthesis. Autoclaving is a very dependable method for the sterilization and decontamination of laboratory glassware, medical instruments and waste, reagents, and other media. Autoclaves can make the fungi, bacteria, spores, viruses and other microorganisms on surgical instruments such as scalpels, forceps, scissors and other metal items inactive.

The autoclaving process in this conversion of organic mixture into sand involves the mixture being subjected to gradual temperature increases under high pressure until 120 °C is reached and then steamed for around 15–20 minutes. The autoclave allows high pressure steam to flow around items in the chamber. Items should be separated as to allow the steam to penetrate throughout evenly. The steam can reach even in the small crevices and can kill all bacteria, viruses and bacterial spores. After autoclaving process the mixture is converted into sand as the properties of the mixture obtained is almost equal to the properties of the sand.

Fig 15

PHASE II

3.10 GENERAL

Due to constrain of time, the compost which had already gone through this process was purchased from a horticulture plant.

3.10.1 PURCHASE OF MANURE FROM THE HORTICULTURE

The compost was purchased from the horticulture farm in Cathedral road opposite to Stella Maris College called The Horticulture Society Gardens. They have various amounts of the organic manure packed and selling. There are 25kg bags, there are 10 kg, 5kg and 1kg bags also that are available.

We bought the 5kg bag for the initial conversion and testing process. The bag of 5kg cost about Rs.250.

Fig 16

The manure purchased from horticulture consists of plant wastes such as leaves and other wastes from plants.

The organic manure had already gone through a process of

3.10.1.1 COLLECTION

The collection of material for this process consist of only organic wastes from plants such as leaves and flowers.

3.10.1.2 SEGREGATION

There is no much process of segregation of waste as the manure does not involve non-biodegradable waste.

3.10.1.3 HYGIENIZATION PROCESS

Hygienization is the cleaning process in which the odour, anaesthetic view of waste is removed. The compost had gone through a hygienization process also.

3.10.1.4 CRUSHING PROCESS

The process also involves crushing the compost material of horticulture plant and the particles so that the compost does not vary largely by size. The compost brought was crushed. The compost after being brought from the horticulture, the following process was done

3.10.1.5 SIEVING PROCESS

Sieving is the process of separating the wanted elements and unwanted material or for characterizing the particle size distribution of a sample.

Fig 17

The compost brought is sieved manually to the size of 0.06mm to 0.03mm in soil lab. On sieving 5kg of compost 2.5kg was passing through 600 micron and retaining in 300 microns. The rest of 2.5 kg were either larger than the required size or very fine.

3.11 ENCAPSULATION OF BACTERIA

Encapsulation of bacteria means removing the bacteria's present in mixture. There are some methods to remove bacteria from the mixture but they had disadvantages too. The following are the methods by which the bacteria's can be removed

- By using chlorine
- By using hydrogen peroxide
- By autoclaving

3.11.1 BY USING CHLORINE

Using chlorine in concrete, reduces the life of the concrete. Chlorine causes corrosion of steel in concrete. If chlorine is used to remove the bacteria's present in the mixture then the water being used for concrete should be 100% free of chlorine. Then too it cannot be assured that there will be no corrosion. So, this method was not used.

3.11.2 BY HYDROGEN PEROXIDE

The effects of hydrogen peroxide are in surface morphology, strength, density, thermal conductivity of foam concrete and hydrogen peroxide utilization efficiency. The results show that these foam concretes are new and innovative building materials with interesting properties low mass density and high strength when the addition amount of hydrogen peroxide is in 5%~6% range. Responsible for these properties are the macro-and micro porosity. Macro pores are created by the process of adding hydrogen peroxide in different addition amount. It is also found that the utilization efficiency of hydrogen peroxide is higher when the addition amount of hydrogen peroxide is in the range of 5%~6%.

3.11.3 AUTOCLAVING

Autoclaving is the process of heating the mixture at a high temperature of 121°C for 15-20 minutes. Bacteria are single-celled microorganisms. They have a cytoplasmic membrane which is for protection and might also carry another barrier called a capsule. These single-celled organisms cannot survive at a temperature of 121°C.

Autoclaving was done in hot air oven in chemistry lab. It was done at 121 °C. Since the efficiency of hot air oven is less compared to the autoclaving machine, the process was done in instalments by taking small quantity of sample. The time of autoclaving was also increased and done for about 45 minutes.

Fig 18

Fig 19

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PHASE III

3.12 TREATMENT OF COIR

Treatment of fibres increases the strength of natural fibre composites. A strong sodium hydroxide treatment will remove lignin, hemi-cellulose and other alkali soluble compounds from the surface of the fibres which is to increase the numbers of reactive hydroxyl groups on the fibre surface available for chemical bonding. Moreover, the alkali treatment made the fibre surface clean by the removal of waxes, hemicellulose, pectin and part of lignin. The removal of these substances enhanced the surface roughness. Therefore, the mechanical interlocking at the interface could be improved.

Coir fibers were cut into range of 250 mm and treated with NaOH solution in different concentration namely 3 wt% at the room temperature. The treatment time were set at 6 hours with coir fiber to NaOH solution. This is done to clean the plant fibers. It also changes the fine structure of the native cellulose-I to cellulose-II by a process known as mercerisation. The reaction of sodium hydroxide with cellulose as follows.

Cell - OH + NaOH $\longrightarrow$ Cell – O- Na+ + H2 O + [Surface impurities]

After treatment, the fibers were wash with distilled water until neutralize and dried overnight.

Fig 20

CHAPTER 4

EXPERIMENTAL INVESTIGATION

4.1 GENERAL

The following are the test that are done for the prepared sand.

4.2 SPECIFIC GRAVITY TEST OF PREPARED SAND

The autoclaved product is tested for specific gravity.

➤ ***PROCEDURE***

1. Empty weight of pycnometer is taken as W_1.
2. Pycnometer was filled with one third of sand and weighed (W_2).
3. With one third of sample in pycnometer it is filled with water till the brim level and weighed (W_3).
4. The pycnometer is cleaned and filled with water until it is full. Weigh it and take the weight as W_4.

Fig 21

4.3 FRYING PAN TEST OF PREPARED SAND

Frying pan is test for crushed sand to find its surface moisture and absorption.

➤ ***PROCEDURE***

1. 500g of fine aggregate is taken for this test.
2. The wet sample is then weighed (W).

3. Heated very gently on the frying pan and stirred with metallic rod to maintain uniform distribution of heat, until the sheen disappears from the surface. The fine aggregates start showing free flowing characteristics when it becomes surface dry.
4. The aggregates are then cooled and weighed again. The surface dry aggregate weight (W_{sd}) is noted. The surface moisture is then calculated by using the formula.
   Surface moisture = $[(W – W_{sd}) / W_{sd}] \times 100\%$
5. Overheating must be avoided.
6. The weighed sample is heated again on the fry pan till the aggregate is bone. Dry aggregate weight is then taken (W_{bd}) after continuous heating. The absorption (absorbed water content) is then calculated by using the formula.
   Absorption = $[(W_{sd} – W_{bd}) / W_{bd}] \times 100\%$

Fig 22

4.4 SIEVE ANALYSIS AND FINENESS MODULAS OF PREPARED SAND

The sieve analysis test and fineness modulus test are done for the product. Fineness modulus of sand (fine aggregate) is an index number which represents the mean size of the particles in sand. The sieve analysis is done by standard sieves to arrive at the results. The cumulative percentage of sand retained on each sieve is added and subtracted by 100. This gives the value of fineness modulus.

Fine aggregate means the aggregate which passes through 4.75mm sieve. To find the fineness modulus of fine aggregate, different sieve sizes of 4.75mm, 2.36mm, 1.18mm, 0.6mm, 0.3mm and 0.15mm are required. Fineness modulus of fine aggregate is less than fineness modulus of coarse aggregate.

➢ *TEST PROCEDURE*

The sieves are arranged in descending order. The mechanical shaker is used for the test and the ordered sieves in position and the sample is poured in the top sieve and then close it with sieve plate. Then machine is switched on and the shaking of sieves should be done at least for 5 minutes.

Fig 23

4.5 SPECIFIC GRAVITY TEST OF COIR

The coir is treated with NaOH solution and tested for specific gravity.

➢ *PROCEDURE*

1. Empty weight of pycnometer is taken as W_1.
2. Pycnometer was filled with one third of coir and weighed (W_2).
3. With one third of sample in pycnometer it is filled with water till the brim level and weighed (W_3).
4. The pycnometer is cleaned and filled with water until it is full. Weigh it and take the weight as W_4.

4.6 MIX DESIGN

4.6.1 STIPULATIONS FOR PROPORTIONING

a) Grade designation	= M_{25}
b) Type of cement	= OPC 53 Grade conforming IS 12269
c) Maximum nominal size of aggregate	= 20mm
d) Maximum water-cement ratio	= 0.44 (Table 5 of IS 456 2000)
e) Workability	= 100-120mm slump

f) Exposure condition = Moderate

g) Degree of supervision = Good

h) Type of aggregate = Crushed Aggregates

4.6.2 TEST DATA FOR MATERIALS

a) Cement used = OPC 53 Grade conforming IS 12269

b) Specific gravity of cement = 3.15

c) Specific gravity of

1) Course aggregate 20mm = 2.67
2) Fine aggregate (river sand) = 2.65
3) Fine aggregate (sand from organic waste) = 2.59

d) Water absorption

1) Coarse aggregate = 0.5 %
2) Fine aggregate (river sand) = 2.5 %
3) Fine aggregate (sand from organic waste) = 1.28%

4.6.3. MIX PROPORTION

Material name	Quantity	Unit
Cement	422.73	Kg
Fine aggregate	565.72	Kg
Coarse aggregate	709.71	Kg
Water	183.63	mm
Slump	75-100	cm
Water cement Ratio	0.44	

Table 1

a) For each percentage of variation 15 cubes and 6 cylinders are to be casted.

b) Size of a cube mould is 100 x 100 x 10mm

c) Size of a cylinder mould is 150 x 300mm

d) Therefore (15 x $0.001m^3$ + 6 x $0.0052m^{3)}$ x the quantity value

4.6.3.1. VARIATIONS OF CASTING

a) 20% of prepared sand without fibre
b) 25% of prepared sand without fibre
c) 30% of prepared sand without fibre
d) 20% of prepared sand with fibre
e) 25% of prepared sand with fibre
f) 30% of prepared sand with fibre

4.6.3.2.FOR 20% VARIATION WITHOUT FIBRE

FOR CUBE

a) Cement	- 6.34 kg
b) Fine aggregate	- 8.48 kg
River sand	- 6.78 kg
Sand from organic waste	- 1.7 kg
c) Coarse aggregate 20mm	- 10.64 kg
d) Water	- 2.75 l

FOR CYLINDER

e) Cement	- 13.18 kg
f) Fine aggregate	- 17.65 kg
River sand	- 14.12 kg
Sand from organic waste	- 3.53 kg
g) Coarse aggregate 20mm	- 22.14 kg
h) Water	- 5.72 l

4.6.3.3 FOR 25% VARIATION WITHOUT FIBRE

FOR CUBE

a) Cement	- 6.34 kg
b) Fine aggregate	- 8.48 kg
River sand	- 6.38 kg
Sand from organic waste	- 2.12 kg
c) Coarse aggregate 20mm	- 10.64 kg
d) Water	- 2.75 l

FOR CYLINDER

e) Cement - 13.18 kg
f) Fine aggregate - 17.65 kg
River sand - 13.24 kg
Sand from organic waste - 4.41 kg
g) Coarse aggregate 20mm - 22.14 kg
h) Water - 5.72 l

4.6.3.4 FOR 30% VARIATION WITHOUT FIBRE

FOR CUBE

a) Cement - 6.34 kg
b) Fine aggregate - 8.48 kg
River sand - 5.94 kg
Sand from organic waste - 2.54 kg
c) Coarse aggregate 20mm - 10.64 kg
d) Water - 2.75 l

FOR CYLINDER

e) Cement - 13.18 kg
f) Fine aggregate - 17.65 kg
River sand - 12.35 kg
Sand from organic waste - 5.3 kg
g) Coarse aggregate 20mm - 22.14 kg
h) Water - 5.72 l

4.6.3.5 FOR 20% VARIATION WITH FIBRE

FOR CUBE

a) Cement - 6.34 kg
b) Fibre - 0.0317 kg
c) Fine aggregate - 8.48 kg
River sand - 6.78 kg
Sand from organic waste - 1.7 kg
d) Coarse aggregate 20mm - 10.64 kg
e) Water - 2.75 l

FOR CYLINDER

f) Cement	- 13.18 kg
g) Fine aggregate	- 17.65 kg
River sand	- 14.12 kg
Sand from organic waste	- 3.53 kg
h) Coarse aggregate 20mm	- 22.14 kg
i) Water	- 5.72 l

4.6.3.6 FOR 25% VARIATION WITH FIBRE

FOR CUBE

a) Cement	- 6.34 kg
b) Fibre	- 0.0317 kg
c) Fine aggregate	- 8.48 kg
River sand	- 6.38 kg
Sand from organic waste	- 2.12 kg
d) Coarse aggregate 20mm	- 10.64 kg
e) Water	- 2.75 l

FOR CYLINDER

f) Cement	- 13.18 kg
g) Fine aggregate	- 17.65 kg
River sand	- 13.24 kg
Sand from organic waste	- 4.41 kg
h) Coarse aggregate 20mm	- 22.14 kg
i) Water	- 5.72 l

4.6.3.7 FOR 30% VARIATION WITH FIBRE

FOR CUBE

a) Cement	- 6.34 kg
b) Fibre	- 0.0317 kg
c) Fine aggregate	- 8.48 kg
River sand	- 5.94 kg
Sand from organic waste	- 2.54 kg
d) Coarse aggregate 20mm	- 10.64 kg

e) Water - 2.75 l

FOR CYLINDER

f) Cement - 13.18 kg

g) Fine aggregate - 17.65 kg

River sand - 12.35 kg

Sand from organic waste - 5.3 kg

h) Coarse aggregate 20mm - 22.14 kg

i) Water - 5.72 l

4.7 MIXING OF CONCRETE

After the mix design is calculated, the sand, cement, water, fine and coarse aggregates are mixed for the concrete. It can be either mixed by hand or laboratory mixer.

4.7.1 HAND MIXING

The cement is mixed with fine aggregate on a water tight none-absorbent platform until the mixture is thoroughly blended and is of uniform colour. The coarse aggregate is added and mixed with cement and fine aggregate until the coarse aggregate is uniformly distributed throughout the batch.

Water is added and it is mixed until the concrete appears to be homogeneous and of the desired consistency.

Fig 24

4.8 SLUMP CONE TEST

Concrete slump test or slump cone test is used to determine the workability or consistency of concrete mix prepared at the laboratory or the construction site during the progress of the work. Concrete slump test is carried out from batch to batch to check the uniform quality of concrete during construction**.**

Fig 25

4.8.1 Factors which influence the concrete slump test

- Material properties like fineness, particle size distribution, moisture content and temperature of cementitious materials.
- Size, texture, combined grading, cleanliness and moisture content of the aggregates.
- Air content of concrete.
- Concrete batching, mixing and transporting methods and equipment.
- Sampling of concrete, slump-testing technique and the condition of test equipment.
- The amount of free water in the concrete, and time since mixing of concrete at the time of testing.

4.8.2 Equipment's required for Concrete Slump Test

- Mould for slump test.
- Non-porous base plate
- Measuring scale
- Tamping rod.

The mould for slump test is in the form of the frustum. The mould is of 30 cm in height, bottom diameter 20 cm and top diameter 10 cm. The tamping rod is of steel 16 mm diameter and 60cm long.

4.8.3 Procedure for Concrete Slump Cone Test

- Clean the internal surface of the mould properly and apply oil.
- Place the mould on a horizontal non- porous base plate.
- Fill the mould with the prepared concrete mix in 3 approximately equal layers.
- Tamp each layer with 25 strokes with the tamping rod in a uniform manner over the cross section of the mould. For the subsequent layers, the tamping should penetrate into the underlying layer.
- Remove the excess concrete.
- Level the surface with a trowel.
- Raise the mould from the concrete immediately in vertical direction.
- Measure the height of the slump.

Fig 26

After the slump cone test is done, clean the moulds and apply oil in which the concrete is to be poured. Fill the concrete in the moulds in 3 layers then compact each layer with not less than 25 strokes per layer using a tamping and level the top surface and smoothen it with a trowel.

After 24 hours the test specimens are removed from their mould. The removed specimens are put in water for curing

These specimens are tested for strength characteristics after 7 days of curing and 28 days of curing.

4.9 COMPRESSION TEST

Compressive strength is the ability of the material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce in size. These specimens are tested by compression testing machine after 7 days curing and 28 days curing. Load is applied gradually at the rate of 140 kg/cm2 per minute till the specimens fails. Load when the specimen fails is divided by the area of specimen to give the compressive strength of concrete.

4.9.1 Procedure for Concrete Cube Test

- Remove the specimen from water after specified curing time.
- Dry the sample.
- Clean the bearing surface of the testing machine
- Place the specimen in the machine in such a way that the load shall be applied to the opposite sides of the casted cube.
- Align the specimen centrally on the base plate of the machine.
- Rotate the movable portion gently so that it touches the top surface of the specimen.
- Apply the load gradually and continuously at the rate of 140 kg/cm2/minute till the specimen fails
- Record the maximum load.

Fig 27

4.10 SPLIT TENSILE TEST

Split tensile strength is one of the important properties of concrete. The method is done using a concrete cylinder which splits across in the vertical diameter. The dimensions of the cylinder used for the split tensile strength is 150mm in diameter and 300mm in length.

4.10.1 CONCRETE POURING, COMPACTION AND CURING

- After preparation of the mixture, it is poured into the cylindrical mould after oiling it.
- Then, each layer is compacted with not less than 25 times by using a tamping rod.
- After compaction, the surface of the concrete should be levelled properly using a trowel.
- After 24 hours the specimen is demoulded and cured in fresh water for minimum of 7 days and maximum of 28 days.

4.10.2 PROCEDURE FOR THE TEST

- The wet specimen is taken from water after 7, 28 of curing.
- Then the specimen is allowed to dry.
- Place the specimen vertically in the centre of the base plate.
- Apply the load continuously at a rate within the range 0.7 to 1.4 MPa/min (1.2 to 2.4 MPa/min based on IS 5816 1999)
- Note down the breaking point (P)
- The split tensile strength of the specimen is calculated using the following formula

$$T= 2P/ \pi LD$$

Where

T = splitting tensile strength, MPa

P = maximum applied load indicated by the testing machine, N

D = diameter of the specimen, mm

L = length of the specimen, mm

4.11 DURABILITY TEST

Durability of concrete is the ability to resist the weathering and chemical action, while maintaining the desired engineered properties. There are two types of durability tests that we have done

- Saturated water absorption test
- Acid resistance test

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4.11.1 SATURATED WATER ABSORPTION TEST

Sorptivity, one of the parameters of durability test can be determined by saturated water absorption test. It depends on the permeability and porosity of the concrete.

4.11.1.1 PROCEDURE FOR THE TEST

a) 28 days cured samples are taken and dried.
b) The weight of the dry sample is noted.
c) The dried sample is oven dried till there is a considerable difference in the weight of the sample.
d) The weight of the oven dried sample is noted.
e) Then the sample is immersed in water.
f) After 7 days the sample is taken out from water and allowed to dry.
g) The weight of the sample is noted.
h) The weight gain is calculated using the formula.

$$\text{Saturated water absorption test} = \frac{W_s - W_d}{W_d} \times 100$$

Where,

W_s - Weight of saturated sample (g)

W_d - Weight of oven dried specimen (g)

Fig 28

4.11.2 ACID RESISTANCE TEST

Concrete can be harmed by acid attack because of its alkaline nature. Acids like sulphuric acid, hydrochloric acid, nitric acid are very aggressive on concrete. Decomposition of concrete takes place when acid comes in contact with it. Decomposition of concrete depends on the porosity of the concrete.

4.11.2.1 PROCEDURE FOR THE TEST

a) 28 days cured samples are taken and dried.
b) The weight of the sample is taken.
c) The sample is immersed in 5% sulphuric acid.
d) After 7 days the sample is taken and washed in running water.
e) The sample is kept in atmosphere for 2 days.
f) The weight of the sample is noted and weight is calculated using the formula.

$$\text{Acid resistance test} = \frac{W_s - W_d}{W_d} \times 100$$

Where,

W_s - Weight of saturated sample (g)

W_d - Weight of oven dried specimen (g)

g) The sample is tested for compression strength.
h) Loss in strength is calculated.

CHAPTER 5

RESULTS & DISCUSSION

5.1 GENERAL

The following are the results obtained by conducting

5.1 SPECIFIC GRAVITY TEST

FORMULA & CALCULATION

Specific Gravity, $G = (W_2 - W_{1)} / (W_4 - W_{1)} - (W_3 – W_{2)}$

$W_1 = 20.5g$

$W_2 = 40.5g$

$W_3 = 62g$

$W_4 = 50g$

$G = (40.5 – 20.5) / (50 – 20.5) – (62 – 40.5)$

$G = 2.59$

5.2 FRYING PAN TEST

FORMULA & CALCULATION

Surface moisture = $[(W – W_{sd}) / W_{sd}] \times 100\%$

$= [(671 – 556) / 556] \times 100\%$

Surface moisture = 2.06%

Absorption = $[(W_{sd} – W_{bd}) / W_{bd}] \times 100\%$

$= [(556 – 492.5) / 492.5] \times 100\%$

Absorption = 1.28%

5.3 SIEVE ANALYSIS AND FINENESS MODULESS

Sieve size	Percentage of individual fraction retained, by mass	Percentage passing, by mass	Cumulative percentage retained by mass
10mm	0	100	0
4.75mm	2	98	2
2.36mm	13	85	15
1.18mm	20	65	35
600µm	20	45	55
300µm	24	21	79
150µm	18	3	97
Pan	3	0	-
Total	100		283

Table 2

Therefore, Fineness modulus = 283÷ 100

Fineness modulus = 2.83

5.4 SLUMP CONE TEST

For all the variations of casting the slump obtained was true slump.

In a true slump the concrete simply subsides, keeping more or less to shape.

Fig 29

5.5 COMPRESSION TEST RESULTS

5.5.1 7 DAY COMPRESSION TEST RESULTS

VARIATION	RESULT (N/mm^2)
20% without fibre	16.8
25% without fibre	16.7
30% without fibre	16
20% with fibre	17.5
25% with fibre	17.5
30% with fibre	16.6

Table 3

5.5.1.2 GRAPH FOR 7 DAY COMPRESSION TEST RESULTS

WITHOUT FIBRE

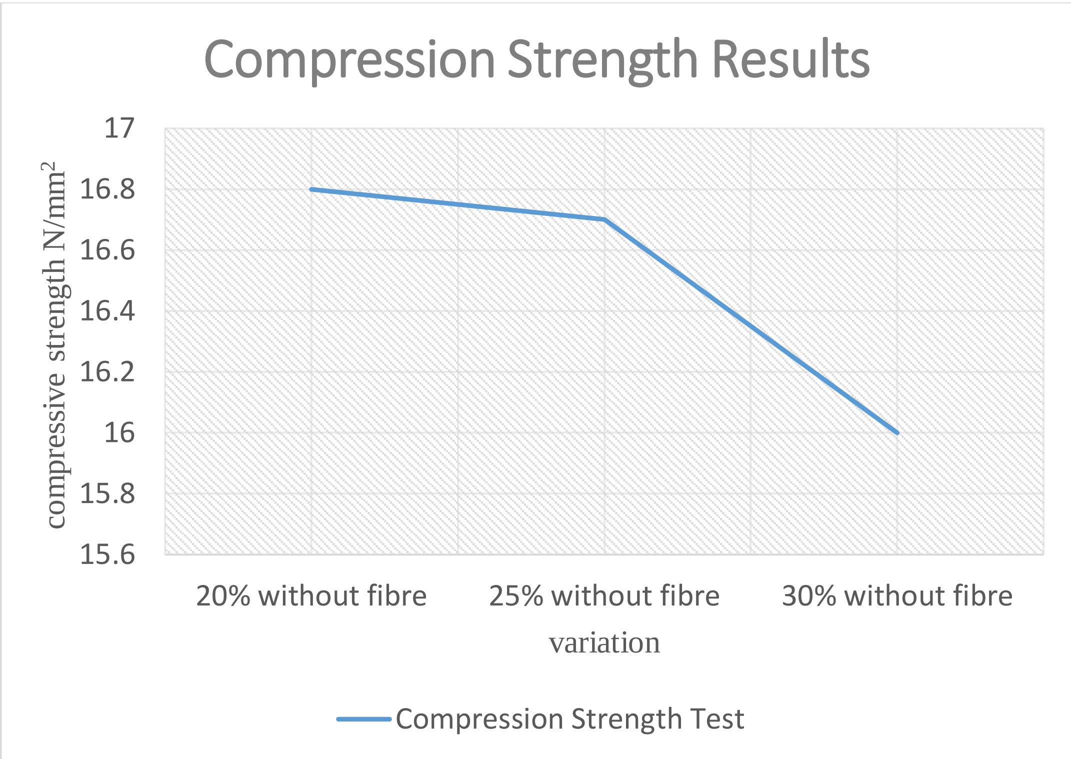

Fig 30

WITH FIBRE

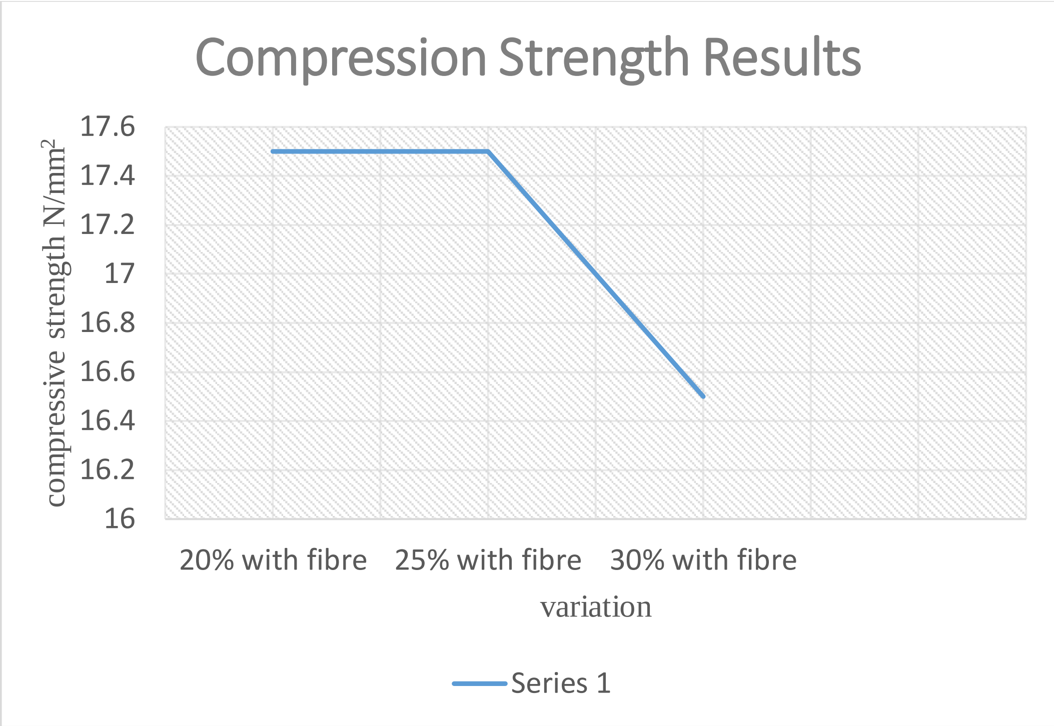

Fig 31

7 DAYS COMPRESSION STRENGTH TEST

Fig 32

5.5.2 COMPRESSION TEST RESULTS FOR 28 DAYS

VARIATION	RESULT (N/mm^2)
20% of prepared sand without fibre	25.3
25% of prepared sand without fibre	25.4
30% of prepared sand without fibre	24.8
20% of prepared sand with fibre	25.5
25% of prepared sand with fibre	25.4
30% of prepared sand with fibre	25

Table 4

GRAPH FOR 28 DAY COMPRESSION TEST RESULTS

WITHOUT FIBRE

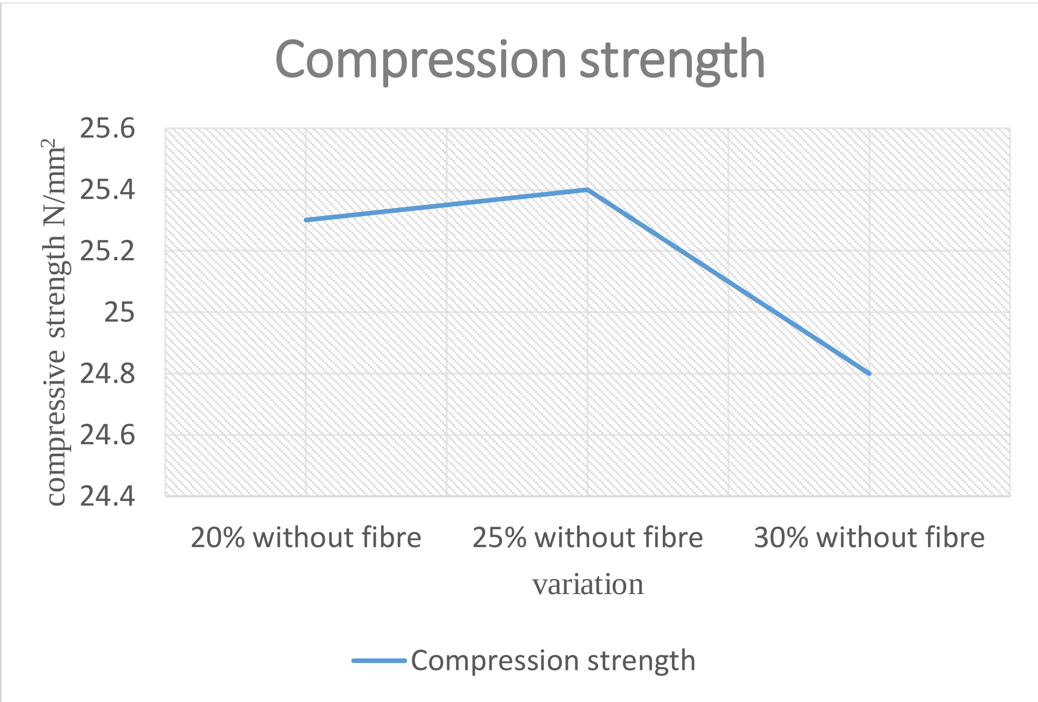

Fig 33

WITH FIBRE

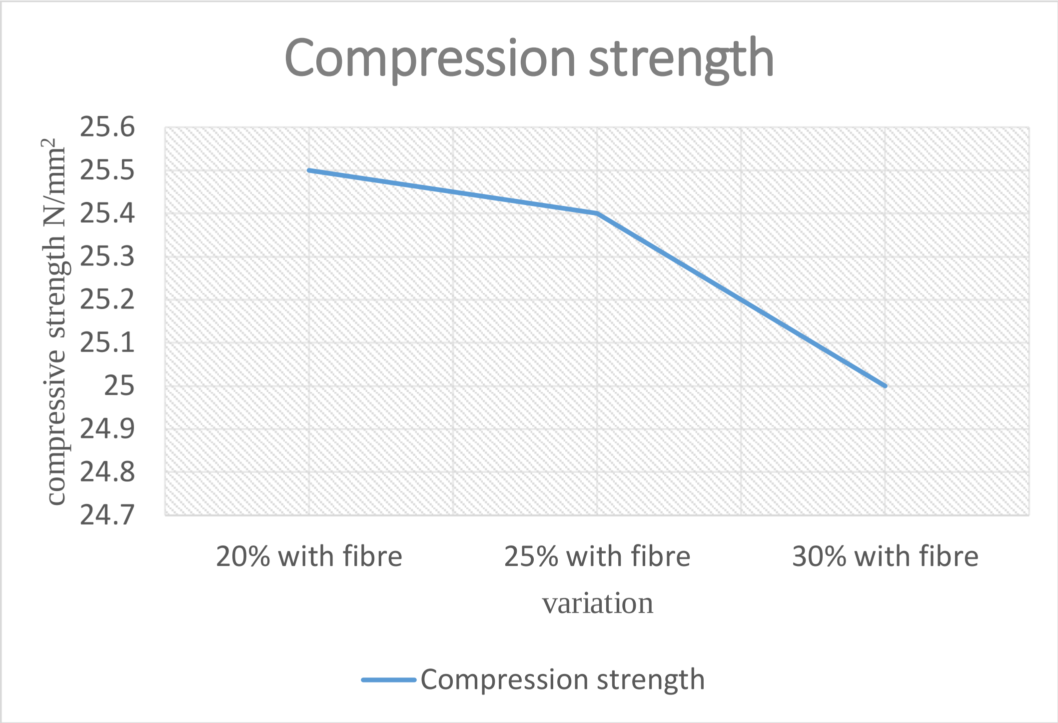

Fig 34

5.6 SPLIT TENSILE STRENGTH RESULTS

5.6.1 7 DAYS SPLIT TENSILE STRENGTH RESULT

VARIATION	RESULT (N/mm^2)
20% without fibre	1.68
25% without fibre	1.67
30% without fibre	1.61
20% with fibre	1.75
25% with fibre	1.75
30% with fibre	1.66

Table 5

5.6.1.2 GRAPH FOR 7DAYS SPLIT TENSILE STRENGTH

WITHOUT FIBRE

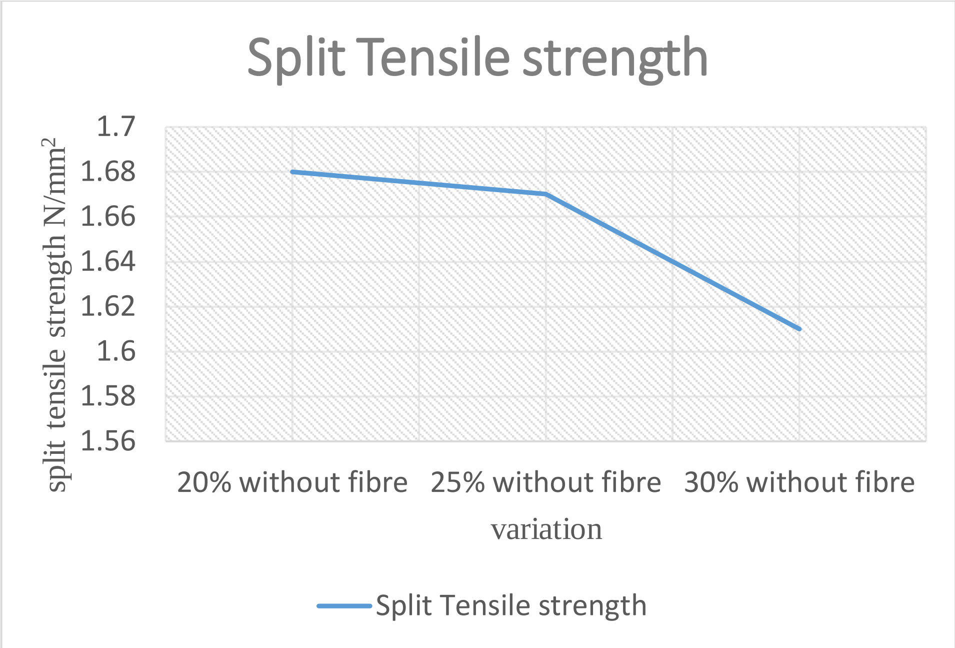

Fig 35

WITH FIBRE

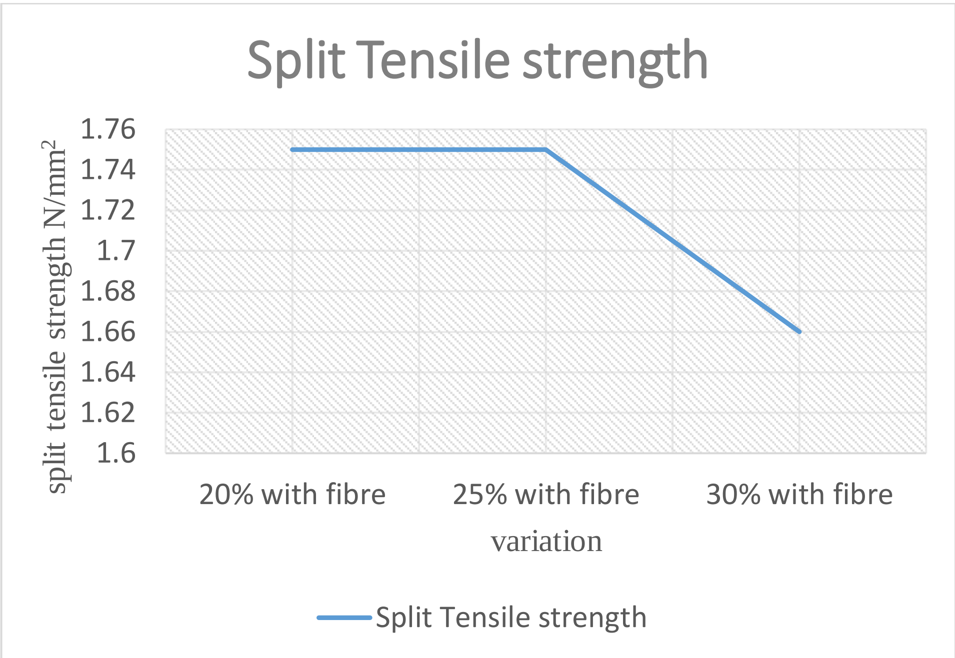

Fig 36

5.6.2 28 DAYS SPILT TENSILE STRENGTH RESULT

VARIATION	RESULT (N/mm^2)
20% without fibre	2.52
25% without fibre	2.53
30% without fibre	2.41
20% with fibre	2.56
25% with fibre	2.57
30% with fibre	2.53

Table 6

5.6.2.1 GRAPH FOR 28 DAYS SPLIT TENSILE STRENGTH

WITHOUT FIBRE

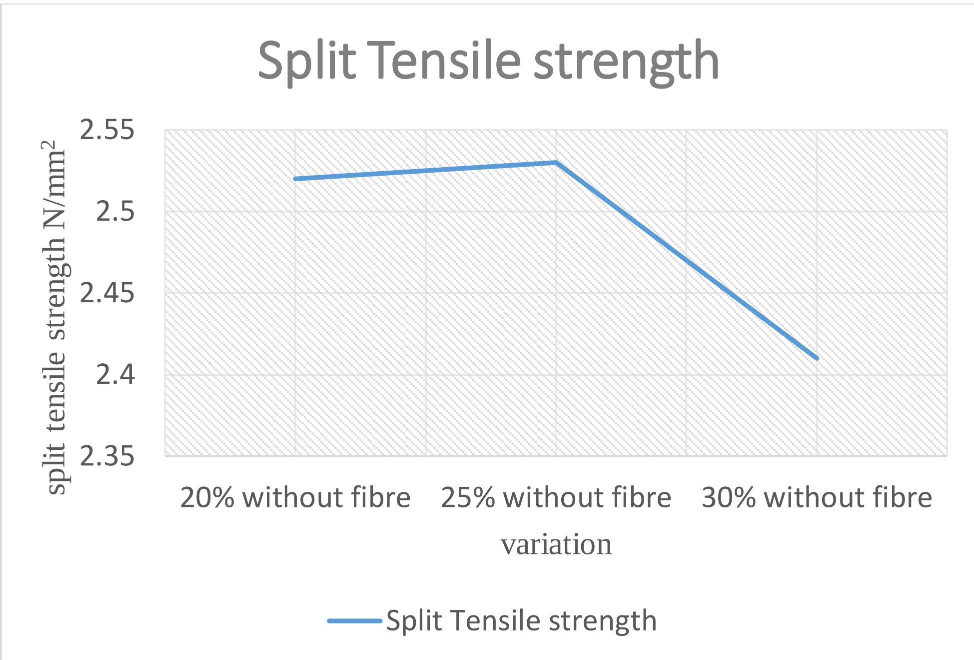

Fig 37

WITH FIBRE

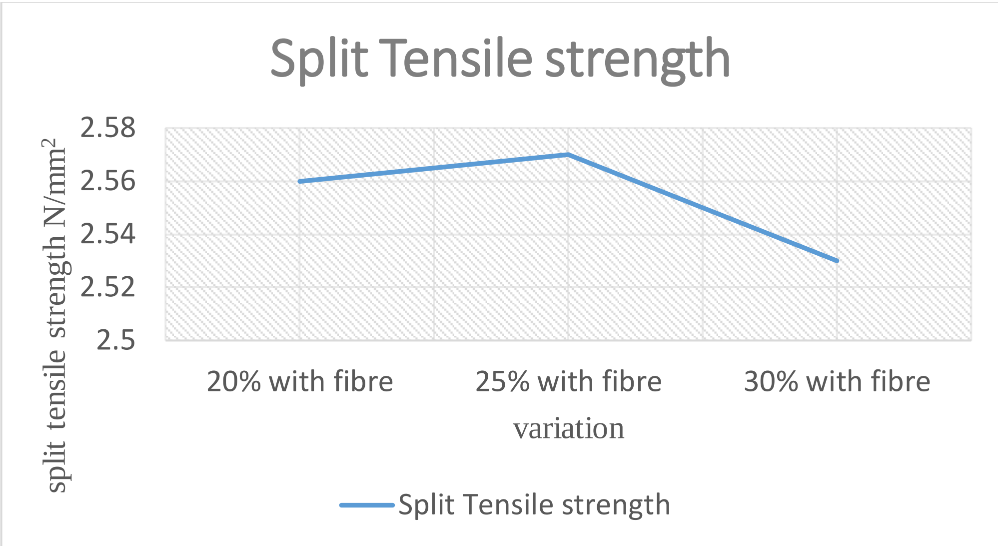

Fig 38

5.7 DURABILITY TEST

5.7.1 SATURATED WATER ABSORPTION TEST RESULT

VARIATIONS	WEIGHT OF SPECIMEN BEFORE THE TEST W_d (g)	WEIGHT OF SPECIMEN AFTER THE TEST W_s (g)	WEIGHT GAIN %
20% of prepared sand without fibre	2306	2392	3.2
25% of prepared sand without fibre	2354	2434	3.3
30% of prepared sand without fibre	2244	2341	4.3
20%of prepared sand with fibre	2471	2546	3.0
25% of prepared sand with fibre	2582	2656	2.8
30% of prepared sand with fibre	2503	2603	3.99

Table 7

5.7.1.1 GRAPH FOR SATURATED WATER ABSORPTION TEST

WITHOUT FIBRE

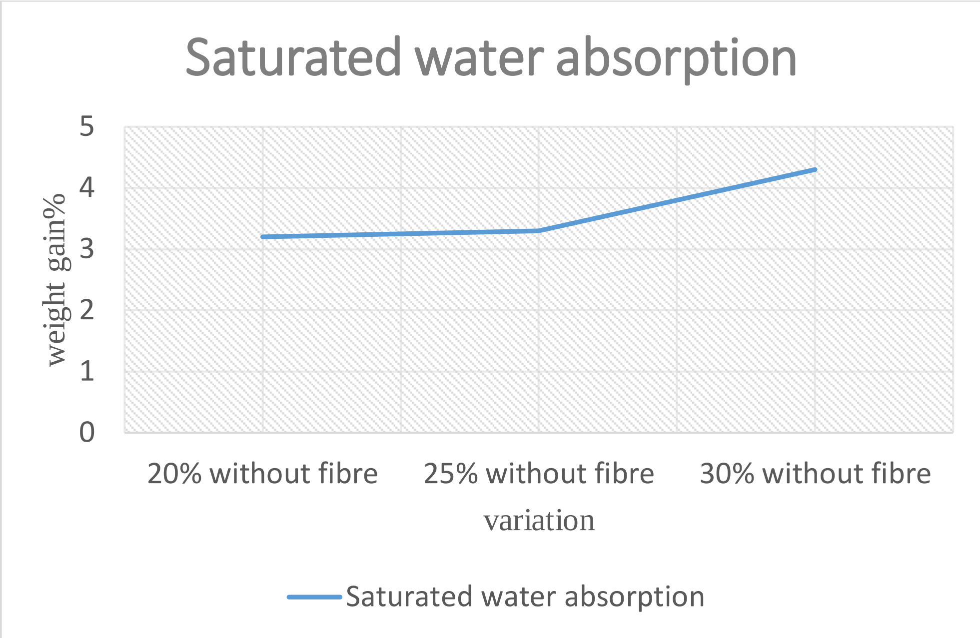

Fig 39

WITH FIBRE

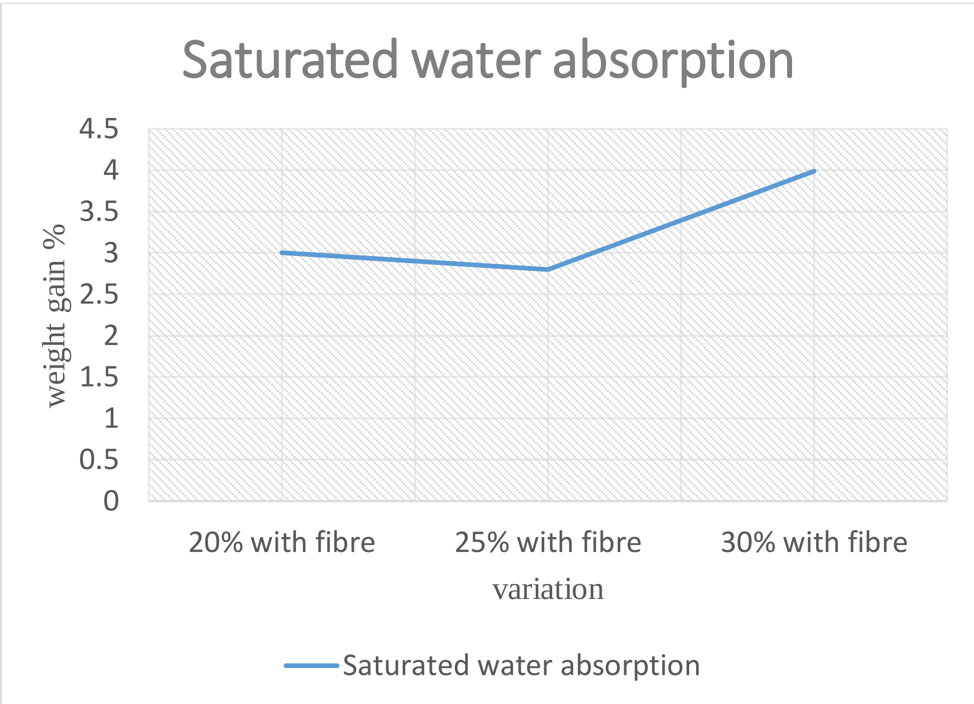

Fig 40

5.7.2 ACID RESISTANCE TEST

Variations	Weight of specimen before test w_d (g)	Weight of specimen after test w_s (g)	Weight loss %	Compression strength of specimen before test	Compression strength of specimen after test	Strength loss %
20% without fibre	2388	2381	0.33	25.30	25.10	0.79
25% without fibre	2560	2551	0.33	25.40	25.15	0.99
30% without fibre	2363	2353	0.42	24.83	24.53	1.10
20% with fibre	2491.5	2484	0.31	25.50	25.34	0.63
25% with fibre	2604.5	2596	0.32	25.41	25.23	0.67
30% with fibre	2253.5	2245	0.37	25	24.7	1.21

Table 8

5.7.2.1 GRAPH SHOWING ACID RESISTANCE TEST WITHOUT FIBRE

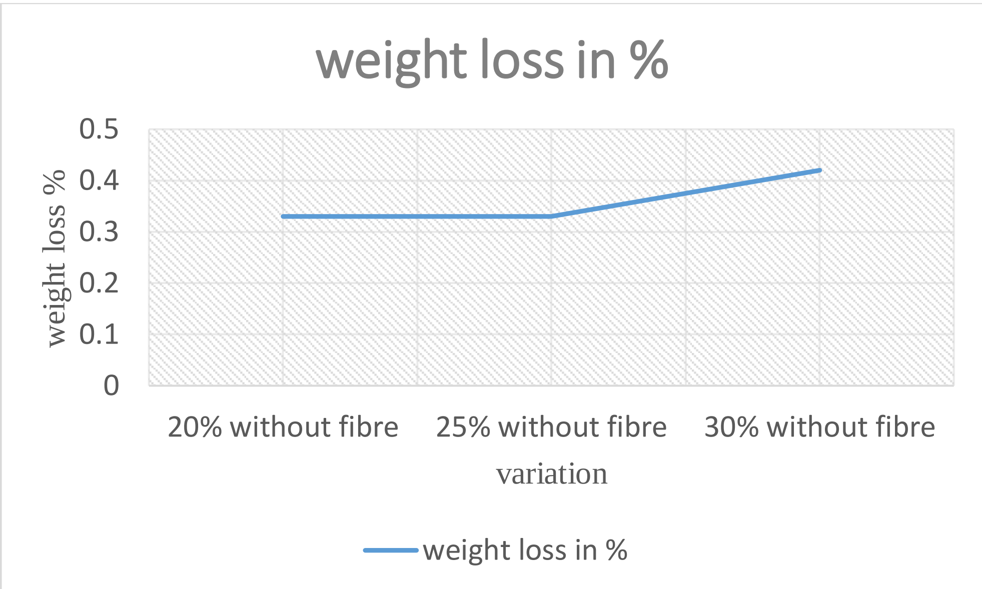

Fig 41

WITH FIBRE

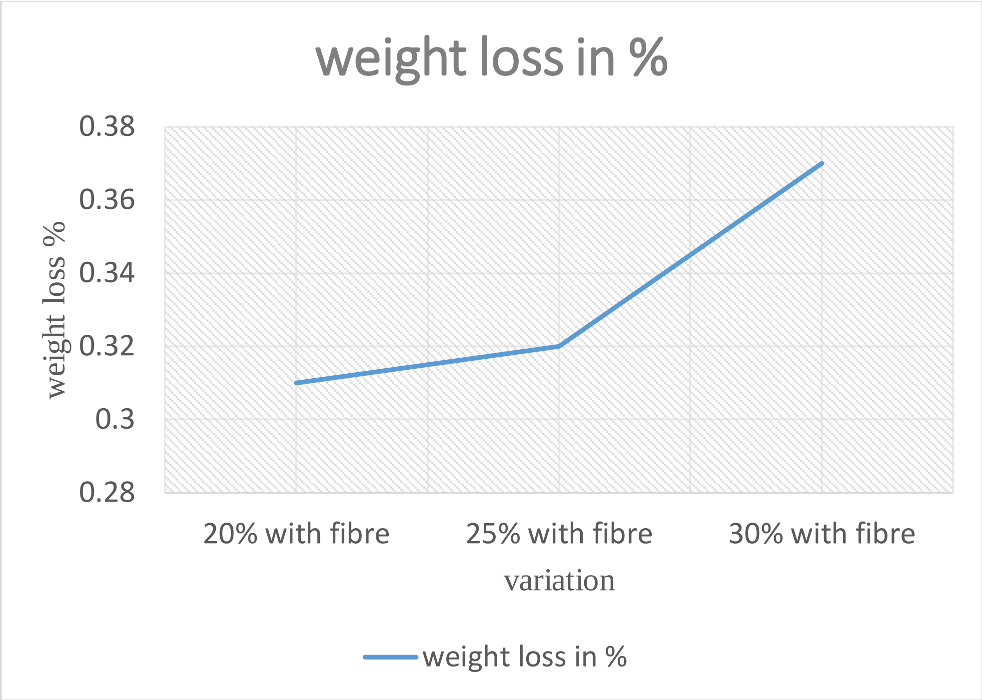

Fig 42

CHAPTER 6
CONCLUSION

After a series of test, it was observed that the properties of the prepared sand is equal to the properties of the river sand. The prepared sand can be partially replaced in concrete up to 25% without compromising the strength characteristics.

The following table shows the strength characteristics of conventional concrete and the concrete made up of prepared sand.

Strength characteristics	**Conventional concrete**	**Concrete made up of prepared sand**
Compression strength at 28 days (N/mm^2)	25	25.4
Split tensile strength at 28 days (N/mm^2)	2.5	2.53
Saturated water absorption test for 1 week (%)	<5	3.3
Acid resistance test for 1 week (%)	<0.5	0.33

Table 9

On comparing the concrete with and without natural fibre (coir), the strength characteristics of the concrete with the fibre tends to increase than the concrete without fibres.

At present situation the difference in the cost of the river sand and the prepared sand is less since the process is being done only in one city in the country. If the process is started in all the urban and rural areas of the country more money can be saved both in construction and landfill. The basic strength characteristics have been studied in this project. Further study can be extended to check the economical viability of the product.