"IMPACT OF ILLEGAL SAND MINING AND PARTIAL REPLACEMENT OF SAND WITH WASTE GLASS POWDER"

MAJOR PROJECT REPORT

Submitted in fulfilment of the requirement of

M.Tech, ENVIRONMENTAL ENGINEERING

Submitted by:

Sudhanshu Kumar(2K18/ENE/10)

Under the guidance of

Dr. GEETA SINGH

(Assistant Professor, Department of Environmental Engineering, DTU)

DEPARTMENT OF ENVIRONMENTAL ENGINEERING

DELHI TECHNOLOGICAL UNIVERSITY

(FORMLY DELHI COLLEGE OF ENGINEERING)

DELHI-110042

CANDIDATE DECLARATION

I hereby certify that the work which is being presented in the report entitle "IMPACT OF ILLEGAL SAND MINING AND PARTIAL REPLACEMENT OF SAND WITH WASTE GLASS POWDER" in partial fulfilment of the requirements for the award of the degree of Master of Technology in Environmental Engineering under DTU University, Delhi. It is an authentic record of my own work carried out during period from 2019 to 2020 under the supervision of Dr. Geeta Singh.

The matter embodied in this thesis has not been submitted by me for the award of any other degree of this or any other University Institute.

SUDHANSHU KUMAR

2K18/ENE/10

Place –Delhi

Date:

CERTIFICATE

This report entitled IMPACT OF ILLEGAL SAND MINING AND PARTIAL REPLACEMENT OF SAND WITH WASTE GLASS POWDER, Sudhanshu Kumar is recommended for the major project topic, as per the requirement for M.Tech. final Semester of Environmental Engineering under the supervision of Dr. Geeta Singh.

SUPERVISOR

Dr. Geeta Singh

DEPARTMENT OF ENVIRONMENTAL ENGINEERING

DELHI TECHNOLOGICAL UNIVERSITY

Place –Delhi

Date –

ACKNOWLEDGEMENT

I would like to thank respected Dr. Geeta Singh, (Assistant prof. of Environmental Engineering) for giving me such a wonderful opportunity to expand my knowledge for my own branch and giving me guidelines to present end semester report.

Secondly, I would like to thank my local guardian who helped me as I went through my work and helped to modify and eliminate some of the irrelevant or unnecessary stuffs.

Thirdly, I would like to thank my friends who helped me to make my work more organized and well-stacked till the end.

SUDHANSHU KUMAR

2K18/ENE/10

M.Tech (Environmental Engineering)

Department of Environmental Engineering

CONTENT

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Glass is amorphous material and inert in nature which can be recycled without altering its chemical properties. It mainly consist of silica and pozzolanic material so, it can be used as sand. Sand is major constituent of construction, which led to rapid growth in its demand. This rapid demand led to illegal mining of sand which is major threat to aquatic life and hydrological change. In world, concreting is done on mass level. In searching for the substitute ,glass contribute significant percentage in solid waste because of its pozzolanic behaviour and major composition of silica, it can be used in concrete. The main pretension of this study to observe the physical properties of concrete with partial replacement of waste sand in different percentage. Test conducted for study of compressive strength and workability of concrete at 0%,5%,10%,15%and 20% replacement of sand.

KEYWORDS:-partial replacement of sand, waste glass, glass powder, illegal sand mining.

CHAPTER 1
INTRODUCTION

1.1 GENRAL

Save environment! Save water! Save Tree! are some of the jargons that we read or listen on internet or from surrounding to protect the environment. There are many initiatives have been taken like PARIS climate agreement within UN, Zero Carbon Law by New Zealand, Calling Kaveri by Sadhguru etc. There are different way to save environment, among them one way is recycling and reuse the generated waste. By doing this we can reduce the waste to some extinct. According to World bank report (2017), global municipal solid waste generation was 2.01 billion metric ton and it will increase to 3.4 billion metric ton by 2050 and among this only 13.5% are recycled. In this, one thing is observed that rich or developed countries (such as US, Canada and member of EU) represent 16% of total world population but producing 34% of global waste generation. In India solid waste estimated by CPCB, waste generated by small city is 0.1 kg per capita per day, medium city produces 0.3-0.4 kg per capita per day, 0.5 kg per capita per day out of 3.8% waste is glass by weight. The main source of glass is broken glass panel, bottle, window glass, tube light etc. Considerable amount of contribution in solid waste, can be reduced by using partial substitution of sand by glass powder in production of concrete. As the glass contain pozzolanic material it can be used in extreme exposer condition like alternate drying and wetting, tidal zone, chemical exposer condition.

With increase in population and standard of living, demand for concrete house will increase. According World Economic Forum, India's 48% population will shift to middle income group by 2030, which require development of infrastructure therefore requirement of concrete structure will increase. For concreting large quantity of sand is required which is damaging the ecosystem of river like water retaining capacity, widening and deepening of river bed, increase in turbidity of river affect the aquatic animal, effect ground water table etc. Therefore, reducing the consumption of sand by using alternate material like copper slag, quarry dust, fly ash, offshore sand, granulated blast furnace slag (GGBS), washed bottom ash (WBA), foundry sand etc.

Thus, in this project, by studying few of already published paper on its usability as complete replacement or partial replacement of sand in concrete. To check its feasibility some of test are conducted.

1.2 OBJECTIVES

- To conduct characteristic strength tests of concrete M25.
- To find optimum percentage of Glass powder.

1.3 SCOPE OF THE STUDY

- Study the properties of concrete before and after mixing of glass powder.
- Effect of glass powder on compressive strength and workability.

CHAPTER 2
LITRATURE AND REVIEW

Bajad M.N. et al [2011] studied the strength of concrete when it was exposed to sulphur and when it was not exposed to sulphur. He partially replaced cement with glass powder upto 25% in both cases and found no effect of sulphur on compressive strength. The optimum value was obtained at 20%.

Chandana Sukesh et al[2013] concluded that with the increase in the percentage of quarry dust workability of concrete decreases. With the addition of fly ash in quarry dust ,complete replacement of sand can be done but if only quarry dust is used then optimum result lies between 55 to 75%.

Nwaubani Sunny O. And Poutos Konstantinos I [2013] studied the property of Cement mortars with substitution of cement with glass powder. He concluded that with increase in percentage of glass powder water absorption value also increases. But the value obtained at 5% and 20% of glass powder was similar.

Krati Gahoi and Rajeev Kansal [2015] studied the unit weight concrete and compressive strength of concrete of grade M20 and M30 for 3 day, 7 day and 28Day, by increasing the percentage of glass powder upto 25%.They found that with increase in percentage of glass powder unit weight of both the grade of concrete decreases and compressive strength was found optimum at 10%.

Abdullah Anwar [2016] studied in their research about compressive strength, tensile strength and flexural strength of concrete by replacing cement upto 25% in M40 grade of concrete. At 20% substitution he found satisfactory result i.e. compressive strength was 46.54 MPa, tensile strength was 6.23 MPa and flexural strengthwas8.35MPa.

Mannava Anusha and T.Ram Prasanna Reddy[2016] studied on partial replacement of glass powder with fine aggregate for 28 day and they found that compressive strength of cube and cylinder was 9% and 23% above the normal strength of mix. The optimum value of glass powder was 10% for compressive strength. The flexural strength was maximum at 10% replacement of sand and strength was 74% higher then the normal strength.

K.I.M.Ibramhim[2017] replaced fine aggregate upto 40% with waste glass powder and further increase in percentage reduces the compressive strength and tensile strength reduces. At 15% substitution of sand

maximum value obtained and there was 25% and 37% increase in strength of compression and tensile. With increase in percentage of waste glass powder density of cube reduces and workability increases.

Jyoti R. Mali et al[2017] concluded that ,with in 100% replacement of sand with the GGBS, slightly decreased value was obtained than the standard mix but upto 75% can be done. The optimum percentage for split cylinder test (tensile test) and compressive strength was 40%.

Tanweer Ahmad etal.(2018) replaced stone dust and at 40% maximum value for stone dust was obtained. They further replaced stone dust with 20% of glass powder, the value obtained for compressive strength, flexure strength and split tensile at 7,14, 28 and 56 day was higher than the value obtained at 40% replacement of stone dust.

Jagriti Gupta et al[2018] found in its experiment that with the increase in percentage of glass powder in the concrete workability increases with increasing in the percentage of glass and absorption of water decreases. The density of concrete decreases with increase in percentage glass and compressive strength was maximum at 10% replacement.

Pawar L.alit Bhausing et al[2018] studied partial substitution of sand with copper slag and found that with the increase in percentage of copper slag workability increases .There was increase in compressive strength from 10 to 70% replacement of slag but optimum value obtained at 40% and at this percentage, modulus of elasticity was 3.92% higher than the standard mix .

Brijmohan Sharma[2019] replaced sand with granite powder and found that with the increase in percentage replacement of sand with granite powder, workability of mix decreases. Maximum value of compressive strength and flexural strength is obtained at 15%, further increase in percentage of granite powder result in decrease in its strength.

CHAPTER 3

MATERIAL

3.1 CEMENT

Most commonly used cement is Ordinary Portland Cement (OPC) and India is second largest producer after China. It is named as Ordinary Portland Cement because after hardening it resembles Portland stone. For Ordinary Portland Cement basic raw materials are categories into calcareous material (i.e. lime stone, chalk etc.) and argillaceous material (i.e. clay, marl etc.). After burning, these basic compounds together form complex compounds. These complex compounds are mainly responsible for properties of cement. These complex compounds are called bogue's compound as it found by R.H. Bogue. These complex compounds are Tricalcium Aluminate (C_3A), Tetracalcium Alumino Ferrite (C_4AF), Tricalcium Silicate (C_3S) and Dicalcium Silicate (C_2S). Tricalcium Aluminate (C_3A) has 5-15% proportion in cement which provides flash setting property to the cement. Its rate of hydration is very high i.e. it hydrates within 24 hours. Due to high rate of hydration it causes shrinkage and develop cracks in hard concrete. Tetracalcium Alumino Ferrite (C_4AF) has 8 -15% proportion of cement . It also provides flash setting property and hydrate within 24 hours. This compound is less significant than the Tricalcium Aluminate (C_3A). Both Tricalcium Aluminate (C_3A) and Tetracalcium Alumino Ferrite (C_4AF) have less tendancy of sulphate attack. Tricalcium Silicate (C_3S) has 40-60% proportion. This compound is mainly responsible for the early strength of cement and it is having best cementing action. It hydrates within a week and increase in proportion results in early strength. Higher proportion of C_3S, increases the frost resistance of the cement because of early strength. Dicalcium Silicate (C_2S) has 20-40% proportion in cement. It hydrates very slowly i.e. it take more than year to hydrate. This compound has least heat of hydration and responsible for ultimate strength of cement. By increasing the proportion C_2S in cement can make cement chemical resistant and its proportion is also increased for mass concreting. Silica in cement acts as pozzolanic material. These materials are called Pozzolanas. Pozzolanas are the biproduct material of industry which initially do not show any binding property but when they are mixed with cement they start behaving like a binding material. For example, Fly ash, Silica Fume, Ground Granulated Blast Furnace Slag, Rice husk ash etc.

Some of chemical reaction involve in cement are: -

$$C_3S + H_2O \xrightarrow{\text{hydration}} \underset{\text{gel}}{\text{C-S-H}} + Ca(OH)_2 + \text{Heat} \uparrow$$

$C_2S + H_2O \xrightarrow{\text{hydration}} \underset{\text{gel}}{\text{C-S-H}} + Ca(OH)_2 + \text{Heat}\uparrow$

$Ca(OH)_2 + \underset{\text{Siliceous}}{\text{Pozzolana}} \longrightarrow \underset{\text{gel}}{\text{C-S-H}}$

Cement acts binding material in concrete mix. It is made up of bogue compound. Property of cement can be changed by changing its chemical composition. The property of concrete can also change by addition of admixture. These admixtures are added to the cement to enhance the specific property of cement. There are about 15 types of admixture.

Cement used in this experiment is OPC of grade 53 (IS: 8112-1989).

Table 3.1:-Composition of cement

Compound	**Percentage**
Lime (CaO)	62
Silica (SiO_2)	22
Alumina (Al_2O_3)	5
Calcium Sulphate ($CaSo_4$)	4
Iron Oxide (Fe_2O_3)	3
Magnesia (MgO)	2
Sulphur (S)	1
Alcalies	1
Total	100

3.2 AGGREGATES

Aggregate occupy major volume of concrete and it constitute around 70% of the concrete mass. It provides strength and increases the volume of mix. This results in reducing the cost of production concrete. The property of concrete depends on property of aggregate like shape of strength, strength of aggregate, toughness, hardness etc. Aggregate are further divided into course and fine aggregate. According to IS: 383-1970, if the particle size is in between of 4.75 mm to 80 mm is considered as coarse aggregate and if particle size lies between 4.75 mm to 0.075 mm is considered as fine aggregate. Strength of concrete also depends on the shape and size of the aggregate which is determined by Flakiness index and Elongation index. Aggregate is said to Flaky if its average dimension is less than 0.6 times the mean dimension. Aggregate is said to elongated if its average dimension is greater than 1.8 times the mean dimension. If the Course aggregate is too Flaky or elongated will make concrete weaker. This test is not applicable for aggregate size lesser than 6.3 mm.

Construction have major contribution in economic growth, with increase in construction activity requirement of aggregate also increases. This rapid demand lead to illegal mining of sand affecting biological environment, hydrological environment.

Table 3.2:- Composition of sand

Compound	**Percentage**
Alumina(Al_2O_3)	13.86
Silica(SiO_2)	79.98
Potassium and Sodium (K and Na)	1.67
Calcium (Ca)	0.87
Titanium (Ti)	0.15
Iron (Fe)	1.89
Manganese (Mn)	1.44

Figure 3.1 Course aggregate

Figure3.2 Fine aggregate

3.2.1 HYDROLOGICAL EFFECT

The sediment caring capacity depends upon energy available in water. When the energy available in water is less than the particle, sediment settledown. These settled particles slowly construct river bed. These river bed provide satiable flow in river, water holding capacity etc.

Impact of illegal sand mining: -

a. Sand holds water for long time which acts as aquifer and slowly recharge ground water but due to illegal mining these bed are removed results in depletion of ground water table.
b. Illegal mining leads to exposer of bridge foundation.
c. Water quality deteriorated due to dust particle produced during mining.
d. Sand mining create large pit, when water fall into these pits energy of the water increases. This results in erosion of soil and progressive failure soil in upstream. Water moving out of pit contain lots of sediments and turbidity which further settle in down stream results in altering flow pattern of river.
e. With the increase in energy due to mining pit, gradient of the river increases. This result in widening of mouth of river at the end of sea which leads to increase in salinity at the junction.

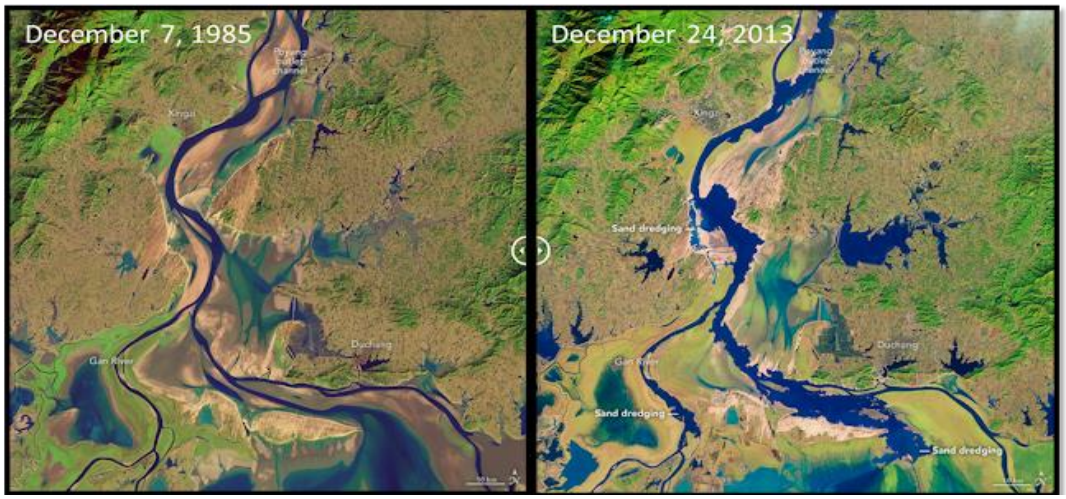


Figure 3.3 Sand mining in china poyang lake


Figure 3.4 Erosion at bridge foundation

Figure 3.5 Road created for sand mining

Figure 3.6 Impact of mining on the Ganga river

Case study:-

Chakki rivulet, Beas, Himachal Pradesh

By using water of Chakki rivulet, Village around it produced 5000 tone of food grain but due to illegal sand mining left these fertile lands of no use. According to villager underground water level dropped rapidly. Along with this, bridge at Kandwal is also facing threat due to illegal mining.

Choi rivulet, Kosi, Uttrakhand

In Choi rivulet, only chugaan can be picked by hand from riverbed but heavy excavators are used to extract sand. Once a fertile land used for cultivation now it is used for sand piling. The dust produced

due to mining adversely affected the productivity of litchi and mango. Near the vicinity of Choi rivulet water table was at 15 feet but now it is depleted to 150 feet.

Ganol river, Meghalaya

According to CEPARD (Centre for Environment Protection and Rural Development), due to excessive mining at Garo hill and river like Ganol, causing flood in low laying planer area by changing its main course. This results in flood in Salamara Manchchar district of Assam.

Coastal area, Kerala

Report submitted to Geological Survey of India by different committee, they gave mix report about sand mining at Kollam, Chavkkad and Ponnani costal area. But the main problem created by sand mining is enlargement of mouth of river. This results in mixing of sea water in river due to which Fish in that area get affected and salinity of water is increased. According to ministery of PWD of state, almost 100 of bridge are affected by sand mining.

3.2.2 ECOLOGICAL EFFECT

Effect illegal sand mining can be seen in bank of river, lake, coastal area, beach and dunes. Many places where sand mining is done results in extinction of local species like fish, gharial, dolphin etc. Sand mining adversely affected the coastal area like narrowing of river, expansion of river width etc.

Impact of illegal sand mining: -

a. Widening of river results in increase in surface area and braided stream. Due to increase in surface area of excess evaporation take place and due to braided stream movement of fish get restricted.
b. Sand in coastal area holds moisture, which provide support to various flora and fauna. All these local species get affected.
c. Due to increase turbidity of water, penetration of sun light gets reduced which affect the underwater life of river.
d. Breeding of underwater species are supported by sand. These sand particles provide stability to the egg.

Figure 3.7 Turbid river due to sand mining

Figure 3.8 Erosion of costal area

Figure 3.9 Breading of turtles

Figure 3.10 Increase in depth of river bed

Case study: -

Yamuna river, UP

Whole Yamuna is divided into 10 grid, among all Ekdala grid supply 50 to 100 trucks per day. According to Dr Sita Ram Taigor, due to illegal mining population of aquatic life get directly affected. Dolphins require deep clean water but due to sand mining turbidity of water increases and water level decreases which badly affect Gangetic dolphins of Yamuna river.

Chambal river, MP

According to census of MP government, only 68 number of Gangetic dolphins are left in 435 km length of Chambal river sanctuary which passes through MP, UP and Rajasthan. But according to the census

of 2016, the number of Gangetic dolphin was 78 which is decrease in 13% of its population. This decrease in population is mainly due Sand mining and vibration of machinery.

Son river

In 2017, Forest ranger of Son Gharial Sanctuary of Sodhi district was unable to locate a single hatch. Previously a male was located but now it is also missing. For breeding, Gharial lay there egg inside sand bed but illegal mining destroy there egg or not left sand near coast.

Kerala

Under the membership of Sastra Sahitya Parishad of environmental committee of Kerala ,almost 2 ha area of mangrove near the junction of Pallikkal river and sea are destroyed where more than 12 local mangrove species are available and among them some are endangered. The main cause of destruction of these area is sand mining.

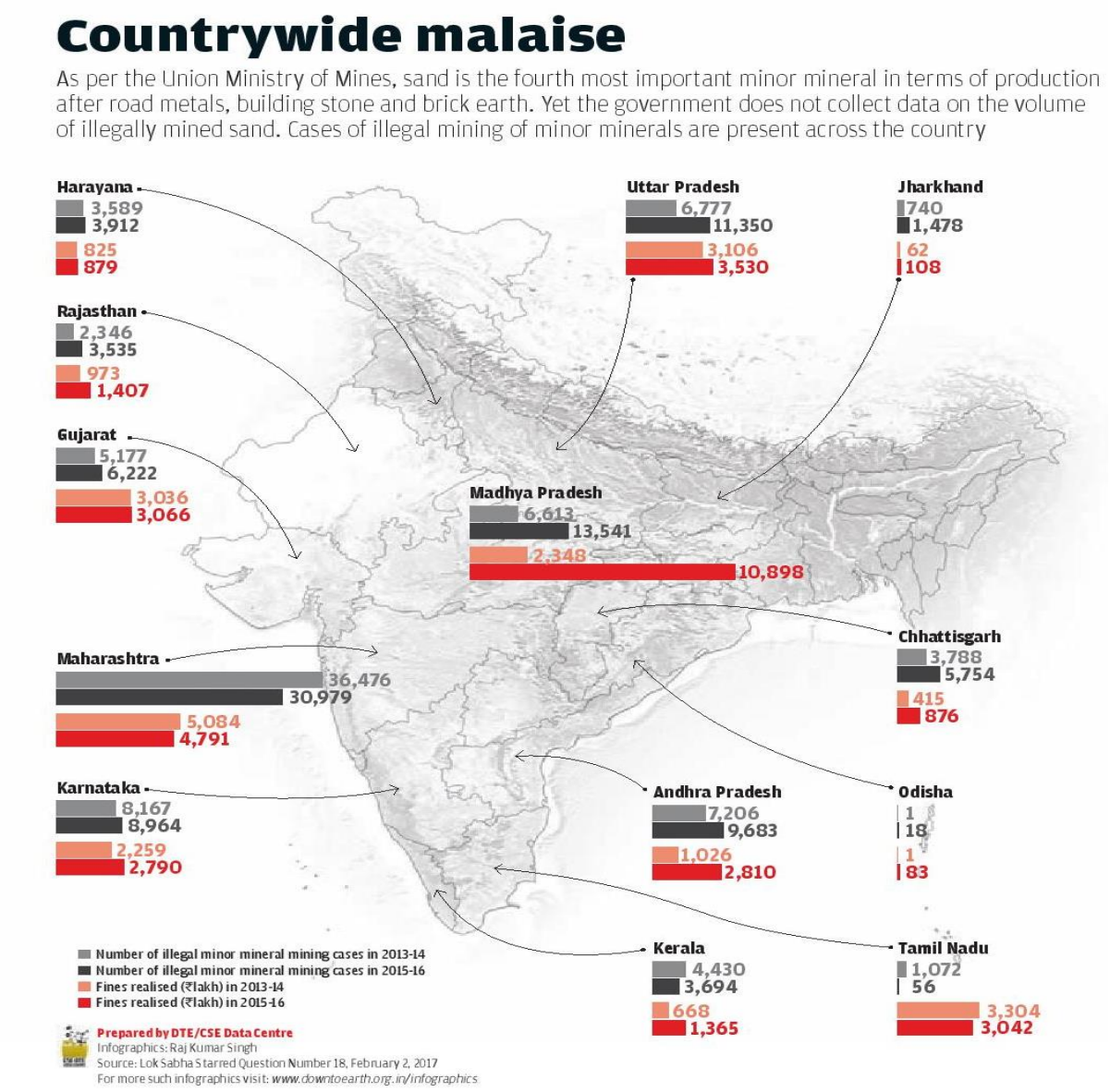


Figure 3.11 Cases of illegal mining in India

3.2.3 LEGAL PROVISIONS FOR PREVENTION OF ILLEGAL MINING

The **Mines and Minerals (Development and Regulation) Act, 1957,** enacted by the Indian Parliament declares it as an Act to provide for the development and regulation of mines and minerals under the control of the Union. It relates to regulation of minor mineral or development of minor minerals and is intended only as a measure of regulating the upkeep and maintenance of natural resources of the country.

The Kerala Protection of River Banks and Regulation of Mining of Sand Act, 2001, under section 13(2) of the Constitution, empowers the District Collector to notify the ban on sand removal from any river or river bank during any period, if dredging of sand disturbs the biophysical environment system of the river. The Sand Act is intended to address the indiscriminate and uncontrolled removal of sand from the rivers with the primary object of preventing large scale loss of sand from river banks and river beds leading to loss of water.

Though several powers were given to authorities under the Act, certain errors in the provisions of Sand Act affected Kerala's Sand Mining Laws. On 23rd February 2010, the Kerala High Court ordered quashing of all cases under the Sand Act, 2001 resulting in the need for broader and proper amendment of Sand Act (2001).

In **Subhash Kumar v. State of Bihar (AIR 1991 SC 420)**, the Supreme Court held that public interest litigation is maintainable for ensuring enjoyment of pollution free water and air which is Included in the right to life under Article 21 of the Constitution. It further held that "if any thing endangers or impairs the quality of life in violation of laws, a Citizen has right to have recourse to Article 32 of the Constitution for removing the pollution of water or air which may be detrimental to the quality of life".

In **Manimalayar Samrakshana Samithi v. State of Kerala and others (WP (C) No. 31125 of 2006)**, the Kerala High Court held that "illegal sand mining is being carried out by the sand mining lobby in the rivers of Kerala, especially Manimala, Pamba etc. The River Management Committees are not functioning properly in spite of the legislation passed and the expert committee is not continuously monitoring the effects of the mining of sand from the rivers. Before conducting auction in each year, expert committee is not meeting or visiting the place. This is a sorry state of affairs. The Government should see that collection of sand within one km of any of the bridges or any of the irrigation projects in the rivers of Kerala is prohibited. Before auctioning the sand mining, report from the expert committee should be obtained and without obtaining a favourable report, no steps for auctioning sand should be done". The court further directed the district administration including the police to prevent illegal sand mining by making public awareness and also to check illegal sand mining by keeping a constant vigil.

In **Gokul Das v. Geologist and others (2009 (3) KHC 821)**, the Kerala High Court held that "the lowering of water table in many parts of the Kerala State is of great concern for every body. It has been proved by scientific studies that the water table in the state is going down, which would ultimately result in scarcity of water in the State in the long run. The lowering of water table is one of the deleterious effects of excessive sand mining. Excessive sand mining would result in many other ecological imbalances. It further held that while granting permits for mining sand in properties near rivers, even if the property is beyond the distance limit prescribed in the Kerala Protection of River Banks and Regulation of Removal of Sand Ad, 2001, there is a real likelihood danger of unscrupulous persons misusing the permit to cause irreversible damage to the river beds. The District Collector has a say in the matter of issue of mining permits. The District Collector is competent and empowered to consider the question as to whether mining of sand from a particular property would cause damage to ecology. He can certainly issue orders regarding banning of mining of sand in particular areas in a district or in the district as a whole. The source of such power can be traced to Article 21 of the Constitution of India, even if such powers are not specifically conferred by the Rules, for ensuring Sustainable Development". The court also gave directions for the formation of Expert committees to regulate mining of ordinary sand in specified areas.

3.3 GLASS POWDER

Glass is amorphous solid which is non crystalline in nature. This may be transparent or non-transparent in nature based on its chemical composition therefore it is widely used as optics, glass panel, electronic industries etc. It is formed by rapid cooling from molten state to solid state, due to rapid cooling glass behave as brittle material. If glass is cooled slowly this will form quartz which is a crystalline material. The chemical compostion of glass and quartz are same but different in rate of cooling leads to show different properties. The primary constituent of glass is sand and its major chemical compound is silica or silicon dioxide. Almost 90% manufactured glass are soda-lime glass in which 70% contributed by silica. Glass is non-reactive with water and other generally used liquid, these are inert in nature and chemically non-reactive which allow it to use in chemical industries, electrical implementation etc. The specific gravity of glass varies according to composition i.e. 2.2 to 7.2. Theoretically glass is a stronger material but presence of bubble, scratches etc. can reduce its strength.

As per study of Indian metro cities(2007), solid waste composed of organic waste, inert, paper, plastic, textiles, glass, metal and leather and its percentage composition are 41%, 40%, 6%, 4%, 4%, 2%, 2%, and 1% respectively.

According to CPCB (2012), waste generated by small city is 0.1 kg per capita per day, medium city produces 0.3-0.4 kg per capita per day, 0.5 kg per capita per day out of 3.8%waste is glass by weight. As per Ministry of Environment, Forest and Climate change of India, total annual solid waste generated in year 2018 was 52,971,720 MTPA and its 2% will be 1059434.4 MTPA.

Glass powder was obtained from waste glass. Glass was cleaned properly and glass was broken. Glass powder sieved and particle size between 2.36mm and 0.075 mm was kept. The composition of glass powder is: -

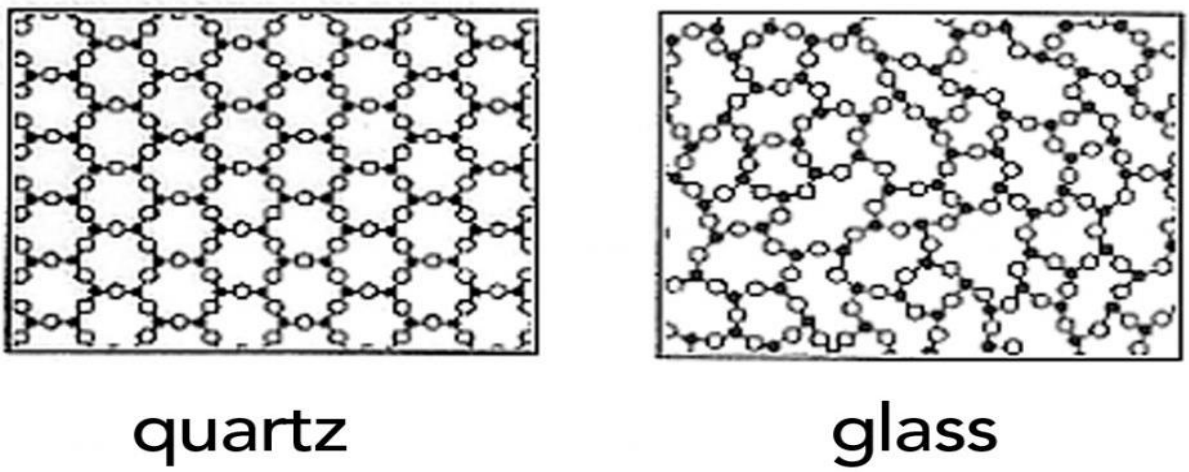


Figure 3.12 Variation silicon dioxide with rate of cooling

Figure 3.13 Waste glass

Figure 3.14 Cursed glass

Table 3.3:-Composition of glass powder

Compound	**Percentage**
Silica (SiO_2)	71.1
Lime (CaO)	9.2
Iron Oxide (Fe_2O_3)	0.16
Alumina (Al_2O_3)	0.95
Magnesia (MgO)	4.4
Sodium Oxide (Na_2O)	12.6
Sulfur Trioxide (SO_3)	0.06
Potassium Oxide (K_2O)	0.31

3.4 WATER: -

Water is used to make concrete paste which should be free from harmful content like acid, salt, organic matter, oil & grease, sugar and other vegetative matter. The water in concrete should not be in excess amount because it leads formation of voids inside the body of concrete after evaporation due to which strength reduces. Deficiency of water, which also not desirable because workability will be reduced,

improper compaction due to which again voids will be formed and strength will be reduced. Water used for concrete should be free from algae, organic component, alkalinity should be within limit etc.

Water used in this experiment is potable water.

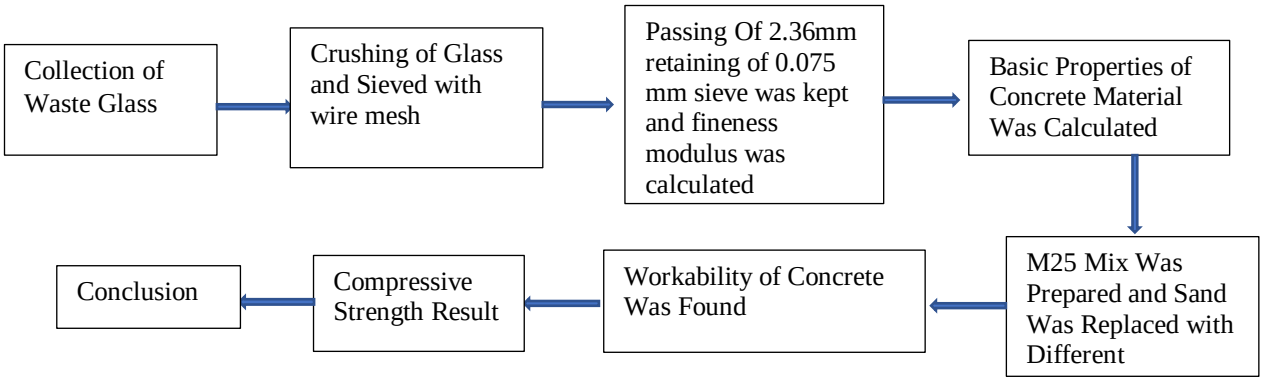
Table 3.4:- Permissible limits as per IS456:2000	
pH	less than 6
Organic matter	200ppm
Inorganic matter	3000ppm
Sulphate	400ppm
Chloride	500ppm for RCC & 2000ppm for PCC
Suspended matter	2000ppm

CHAPTER 4

METHODOLOGIES

4. METHODOLOGY

Waste glass was collected from market. The broken glass was collected and cleaned. The powdered content was collected with help of wire mesh which help in removal of excess size large glass particle. The obtained glass powder was sieved with 2.36 mm sieve. Glass powder passing 2.36 mm and retaining 75 micron was kept. The collected material was kept for replacement of cement. This process was continued until required quantity obtained. The Glass powder was kept inside oven at 100 degree Celsius. Glass powder was sieved to calculate fineness modulus which will give average particle size of cursed glass. This Glass powder was used to partially replace the sand with 0%,5%,10%,15%and 20%. For each replacement sand, three cube were casted and each time workability was calculated. For calculation of compressive strength average of three cubes were taken and these value should not varies +/- 15. Workability test was conducted to test ease of placement of concrete. Concrete was filled in frustum in three layer and each layer 25 number of blow was given and workability is checked.



4.1 COMPESSIVE STRENGTH

Compressive strength of concrete is destructive test which can be determined using cubical, cylindrical , prismoidal mould. The strength obtained from cylindrical mould is 0.8 times the strength of cubical mould, due to restraining effect in central portion. Strength of concrete depends upon quality of ingredients used, exposure condition, admixture used, degree of compaction and skill of the working man. In casting, if the size of aggregate is less than 20 mm than 15 cm X 15 cm X 15 cm size cube

mould will be used and if the size of course aggregate is less than 10 mm than 10 cm X10 cm X10 cm size cube mould will be used. After filling of mould, it is kept at 27+/-2 degree Celsius then demoulded after 24 hours. After 28 days of curing, it is kept in open air for drying. Then gradual loading of 14 N/mm^2/ minute is applied and average of three cube is taken. The compressive strength of these three cube should not varies more than 15% of average value of cube. The strength of should not be less than characteristic strength of cube although it is designed for target mean strength.

This test gives compressive strength cube .This test check the quality control of mix . This test also check, whether desired strength of mix is achieved.

APPARATUS REQUIRED:-

- 150mm X 150mm X 150mm moulds (30 no.)
- Temping Rod (600mm&16mm)
- Universal testing machine
- Wrench
- Trowel
- Lubricant(Grease)
- Cloth

PROCEDURE:-

- A nominal mix of 1 :1.48 : 2.55 was prepared.
- Inner dimension of mould was measured and after that grease was applied on inner surface of cube.
- Prepared concrete was filled in cube in three layer i.e. 50 mm each layer.
- Each layer was tamped with the help of temping rod 35 times so, that rod should not penetrate on another.
- After filling the mould, cubes were taken to vibrator so that air taped inside cube can be removed which will further create honeycomb.
- Above procedure was repeated for different percentage of glass powder.
- After 24 hours, the mould was kept in curing chamber for 7 day and 28 day.
- After 7 day and 28 day, compressive test was conducted.

Figure 4.1 Filling of concrete in cube

Figure 4.2 Filled cube

Figure 4.3 Curing of concrete

Figure 4.4 Appling load on cube

Figure 4.5 Failed under compression

Figure 4.2 Failed cube

4.2 WORKABILITY TEST

Workability is property by which concrete can be placed, compacted, mixed and transported easily or it can be defined as amount of internal work done by concrete. If concrete having higher workability than amount of external energy required will be reduced. Workability of concrete depends upon shape of concrete, surface texture of concrete, grading of aggregate, water content, admixture and mix proportion etc. Workability can be tested by slump cone test, Compaction factor test, Flow table test, Vee-Bee Consistometer test. There range of utility are:-

Table 4.1:- Range of workability for different test

Degree of workability	Slump	Compaction factor	Vee-Bee time	Use
Very low	-	0.75-0.8	10- 20 sec	Road work
low	25-75 mm	0.8-0.85	5-10 sec	Shallow section, Mass concreting of light reinforcement
Medium	50-100 mm	0.85-0.92	2-5sec	Heavily reinforced section, pumpable concrete
High	100-150 mm	0.92 above	-	Piling
very high	-	0.92 above	-	Trmie pile

Slump value calculated by slump cone test. The shape of slump can be of three type True slump, Sheared slump and Collapse slump.

APPARATUS REQIRED

- Conical frustum
- Tamping rod
- Wrench
- Trowel

PROCEDURE:-

- Clean the Frustum such that it is free from moisture.
- Place the mould (cone) on the steel plate.
- Fill the frustum in 3 or 4 layer.
- Tamp each layer 25 times such that it should not penetrate other layer.
- Lift the frustum slowly.

Figure 4.7 Filling of cone

Figure 4.8 Measurement of slump

Figure 4.9 Slump value

CHAPTER 5

MIX DESIGN CALCULATION

Concrete is term which is used to indicate the paste prepared by addition of water in specified proportion in the mixture of material i.e. course aggregate, fine aggregate ,cement, and admixture if required. The process of measuring the ingredient required for the preparation of concrete is termed as batching. It is of two type, weight batching and volume batching. In volume batching proportion of aggregates are done by volumetry basis, this type of mix are generally used for minor engineering work because its accuracy is low.

Table 5.1:- Nominal Mix proportion (IS456:2000)

Nominal mix	Ratio
M5	1:05:10
M7.5	1:04:08
M10	1:03:06
M15	1:02:04
M20	01:1.5:3

In weight batching proportion of aggregate is done on the weight basis which more accurate than the volumetry batching. It is used in precision work and therefore it increase the cost production. If any structure require concrete strength more than 20 N/mm^2 then Mix design concrete is used.

In this project weight batching is used for accurate result.

A. IS CODE PARAMETER

a. Grade of concrete design= M25
b. Type of cement=OPC53 (Ultratech)
c. Maximum nominal size of aggregate=20mm
d. Minimum cement content=300 Kg/m^3 (IS456:2000)
e. Maximum water to cement ratio = 0.5
f. Exposure condition=Moderate
g. Method of concrete placing=non pumpable
h. Degree of supervision= Good
i. Type of aggregate = Crushed angular aggregate
j. Workability= 75 (IS456:2000)
k. Maximum cement content=450 Kg/m^3(IS456:2000)

l. Chemical admixture= No

B. TEST DATA CALCULATION

a. Cement used =OPC 53
b. Specific gravity of cement=3.15
c. Specific gravity of river sand= 2.68
d. Specific gravity of aggregate
    1) Course aggregate of 20 mm size=2.9
    2) Course aggregate of 10 mm size=2.635
e. Specific gravity of glass powder=2.45
f. Water absorption
    1) Course aggregate of 20 mm size= .65
    2) Course aggregate of 10 mm size= .51
    3) Fine river sand= 1.27
g. Free surface moisture
    1) Course aggregate= Nil
    2) Fine aggregate= Nil
h. Sieve analysis
    1) Course aggregate of 20 mm size=55%
    2) Course aggregate of 10 mm size=45%
i. Proportional Mix of aggregate
    1) Course aggregate (20+10) mm= 58%
    2) Fine aggregate (river sand) =42%

C. Target mean strength = 25+1.65*4=31N/mm^2

D. Adopting water cement ratio =0.4

E. Selection of water content= 186 L

Estimated water content for 50 mm slump=186 L

F. Calculation of cement content=186/0.4 =465 Kg/m^3

But maximum cement content as per IS456:2000 clause 8.2.4.2 is 450 Kg/m^3,So provide 450 Kg/m^3

G. Proportion of volume of course aggregate and fine aggregate

From table 3 IS 10262:2000 volume of course aggregate corresponding to 20 mm size course aggregate and fine aggregate of zone two, for water cement ratio of 0.5=0.6 and for 0.4= 0.62

a. Volume of course aggregate =0.62
b. Volume of fine aggregate =0.38

H. Mix calculation per unit volume pf concrete shall be

a. Volume of concrete= 1 m^3

b. Volume of cement= 450/(3.15*1000)=0.1428 m^3
c. Volume of water=0.186 m^3
d. Volume of all aggregate=1-(0.186+0.1428)=0.6712 m^3
    1) Mass of course aggregate =0.6712*0.62*2.774*1000=1154.38 Kg/m^3
        I. Mass of 20 mm aggregate(55%)=1154.38*0.55=634.91 Kg/m^3
        II. Mass of 10 mm aggregate(45%)=1154.38*0.45=519.47 Kg/m^3
    2) Mass of fine aggregate= 0.6712*0.38*2.65*1000=675.9 Kg/m^3

I. Amount of material required for 1 m^3 mix without water correction

a. Cement=450 Kg/m^3
b. Water=186 Kg/m^3
c. Fine aggregate=675.9 Kg/m^3
d. Course aggregate=1154.38 Kg/m^3
e. Water cement ratio=0.4

J. Amount of material required for 1 m^3 mix after water correction

a. Cement=450 Kg/m^3
b. Water=170.713 Kg/m^3
c. Fine aggregate=667.39 Kg/m^3
d. Course aggregate=1147.6 Kg/m^3
e. Water cement ratio=0.4

K. Mix proportion for M25 concrete:-

a. Grade of design= M25
b. Cement type= OPC53 (Ultratech)
c. Maximum nominal size of aggregate= 20mm
d. Minimum cement content =300Kg/m^3 (IS456:2000)
e. Maximum water to cement ratio=.5(IS456:2000)
f. Exposure condition= Moderate
g. Method of concrete placing=non pumpable
h. Degree of supervision= Good
i. Type of aggregate = Crushed angular aggregate
j. Workability= 75 (IS456:2000)
k. Maximum cement content=450 Kg/m^3(IS456:2000)
l. Chemical admixture= No
m. Specific gravity of cement=3.15
n. Specific gravity of river sand= 2.63
o. Specific gravity of course aggregate=2.774

p. Specific gravity of glass powder=2.45
q. Cement=450 Kg/m^3
r. Water=170.713 Kg/m^3
s. Fine aggregate=667.39 Kg/m^3
t. Course aggregate=1147.6 Kg/m^3
u. Water cement ratio=0.4
v. Proportion of cement: fine aggregate: course aggregate =1:1.48:2.55

CHAPTER 6
RESULT AND DISCUSSION

6.1. SIEVE ANALYSIS OF GLASS POWDER AND SAND

Fineness modulus is an index number which indicate the average size of aggregate. With the increase in fineness modulus, the average size of aggregate also increases. If the sand have fineness modulus greater than 3.2 than it should not be used in concreting. Fineness modulus for fine sand, medium sand and course sand are 2.2 to 2.6, 2.6 to 2.9 and 2.9 to 3.2 respectively.

The fine aggregate used in this experiment have fineness modulus of 2.981 which is less than 3.2 and course type of sand was used and it is partially substituted with waste glass of fineness modulus of 2.413 which also less than 3.2. Sand is substituted by glass powder having fineness modulus 2.413 which medium size. With increase in fineness of glass its binding property also increases because of its pozzolanic behaviour which will provide more strength to the concrete.

Table 6.1:- Fineness modulus

% PASSING OF SAND	% PASSING OF GLASS	IS CODE 383 LIMIT
100	100	100
91.60	100	90 - 100
84.64	100	75 - 100
63.30	72.26	55 - 90
43.82	49.18	35 - 59
14.23	27.52	8. - 10
4.12	9.76	0 - 10
0.00	0	
2.981	2.413	FINENESS MODULUS

6.2. SLUMP CONE TEST

Slump cone test used for concrete having workability between low to high i.e. settlement of slump from 25 mm to 150 mm. The shape of slump can be of three type True slump, Sheared slump and Collapse slump. This test can be performed in field as well as in lab. With increase in water content, workability also increases and if water is increased gradually then slump shape can be attained from true to collapse slump but if the water content is very high than it will reduce the strength of concrete and initial setting time also increases.

In this experiment, concrete is designed for workability of 75 mm which have low workability. The workability obtained is increasing with increase in proportion of glass powder. Slump obtained in all the sample is Sheared slump.

Table 6.2:- Slump value

% REPLACEMENT OF SAND	SLUMP VALUE OF M25
0	30
5	34
10	40
15	45
20	51

Figure 6.1 Settled Slump

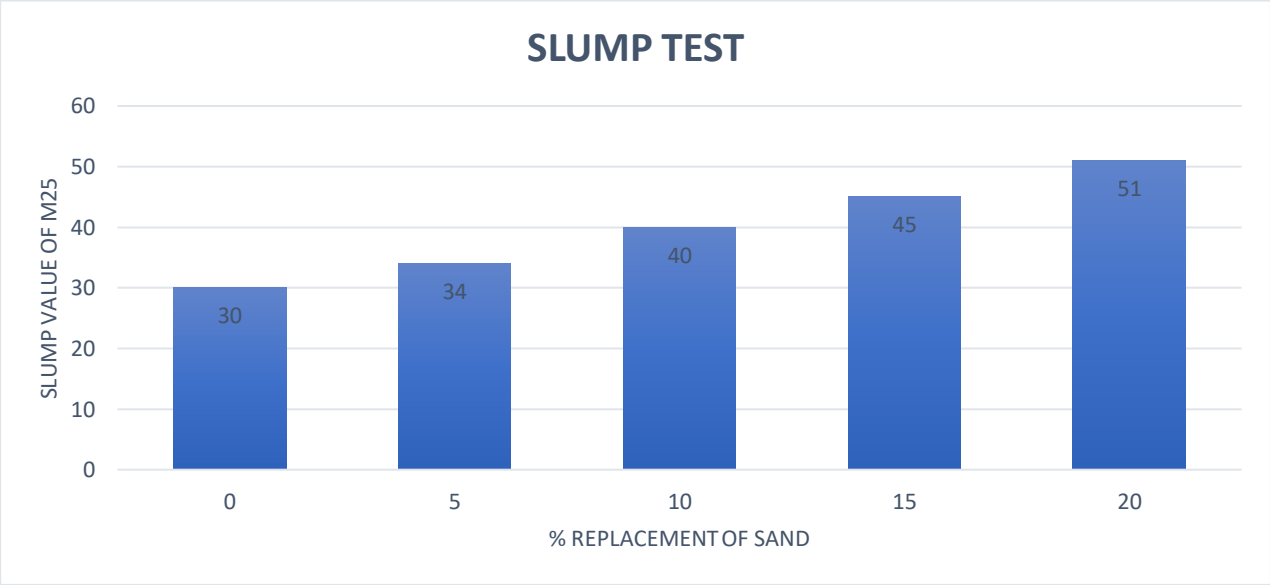


Figure 6.2 Graph of slump value

6.3 COMPRESSIVE STRENGTH

Compressive test is destructive test used to determine the compressive strength of concrete. In this test gradual application of compressive force of 14 N/mm^2 on cube of size 15 cm X 15 cm X 15 cm. Concrete is brittle material therefore failure obtained in cube sample is at 45° from the principle axis.

In this experiment, mix proportion of 1:1.48:2.55 is obtained. The compressive strength of cube was determined bat 7 days and 28 days. The optimum value obtained at 10% substitution of glass powder for both the period but it can be replaced upto 25% because compressive strength value obtained in both cases are higher than 0% substitution of sand in concrete.

Table 6.3:-Mix for compressive strength

% REPLACEMENT OF SAND	AMOUNT OF GLASS(g)	AMOUNT OF CEMENT(g)	FINE AGGRIGATE (g)	COURSE AGGRIGATE(g)	WATER CEMENT RATIO=.4
0	0	2000	2960	5100	800
5	98	2000	2862	5100	800
10	196	2000	2764	5100	800
15	294	2000	2666	5100	800
20	392	2000	2568	5100	800

Table 6.4:- Compressive strength of mix after 7 days and 28 days

% REPLACEMENT OF SAND	SAMPLE AREA(Cm)	COMPRESSIVE STRENGTH (MPa)		AVERAGE COMPRESTIVE STRENTH(MPa)	
		7 DAY	28 DAY	7 DAY	28 DAY
0	225	22.67	33.33	22.89	32.81
		23.11	32.44		
		22.89	32.67		
5	225	24.00	34.67	23.89	34.44
		23.78	34.22		
		24.00	34.44		
10	225	26.00	35.56	25.97	35.56
		25.68	35.78		
		26.22	35.33		
15	225	23.11	33.78	23.48	33.41
		23.78	32.89		
		23.56	33.56		
20	225	22.67	33.11	23.26	32.81
		24.00	32.44		
		23.11	32.89		

Figure 6.3 Cube under compression

Figure 6.4 Failed cube

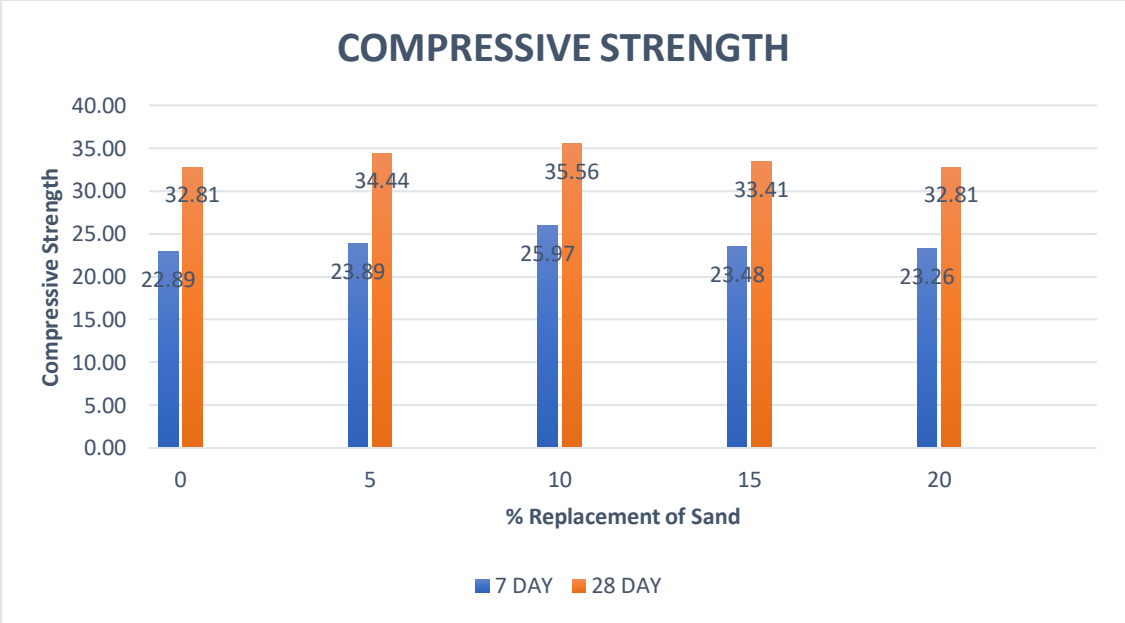


Figure 6.5 Graph of compressive strength at 7 day and 28 day

CHAPTER 7
CONCLUSION

In general prospective sand is considered as an abounded quantity because it is available as sea sand, river sand, desert mountain sand etc. but only river sand is used as construction material. According to Times of India, requirement of river sand is increased almost tripled from 2000 to 2017. There is no actual figure of illegal mining of but according to World Wildlife Fund calls 'largest extractive industry on the planet' with almost 50 billions of sand and gravel being mined each year. However, report submitted by union minister of India to the Rajya Sabha this year almost 4.16 lakh cases of illegal mining reported in between 2013 to 2017. Some step has been taken by NGT and supreme court but visible effect is not seen. So, other way is to reduce demand of sand by substituting with some other material.

In this experiment, sand is partially replaced by glass powder in which workability increases with increase in percentage of glass powder and optimum value of compressive strength is attained at 10% of replacement sand.

CHAPTER 8

REFRANCE

1. Abdulla Anwar, “The influence of waste glass powder as a pozzolanic material in concrete,”IJCIET, Volume 6, Issue 6, Nov.-Dec 2016.
2. Brijmohan Sharma,”A study and comparative analysis of mechanical properties of concrete after partial replacement of sand with granite powder for M30 grade,” IJERT, ISSN: 2278-0181 ,VOLUME 8 Issue 6, June-2016.
3. Code for Mix Design of Concrete IS:10262:2009.
4. Chandana Sukesh et.al,” Partial replacement of sand with quarry dust in concrete,”IJITEE, ISSN:2278, Volume 2, Issue 6, May2013.
5. Jyoti R. Mali. et. al,”Partial replacement of fine aggregate with GGBS. International journal for research and development,” Volume 5, Issue 1, 2017.
6. K.I.M. Ibrahim,” The effect of using waste glass as partial replacement of sand on concrete,” IOSR Journal of mechanical and civil engineering,e-ISSN:2278-1684,p-ISSN:2320-334X, Volume 14, issue 2,march-april 2017.
7. Krati Gahoi, Rajeev Kansal,”Waste glass powder as a patial replacement of ppc,”IJSR ISSN:2319-7064(online).
8. Lois Koehnken et.al.,”Impacts of riverine sand mining on fresh water ecosystems,”WILEY, River Res Applic 2010,36:362-370.
9. K..Aparna Srivastav,”Partial replacement of fine aggregate by using waste glass,”International Journal of new innovations in engineering and technology,”ISSN:2319-6319,Volume 4,Issue 3,march 2016.
10. Mannava Anusha, T. Ram Prasana Reddy,”Replacement of fine aggregate with glass powder in high performance concrete,”IJATIR, ISSN 2348-2370, Volume 8,Issue 15, October 2016, Page 2967-2973.
11. Nandeshwar Lata,”Strength of concrete partially replacement fine aggregate of glass powder,”IJERT, ISSN:2278-0181,2018.

12. Podlia Sankara Pitchaiah,"Impact of sand mining on environment,"SSRG International Journal of Geo informatics and Geological Science-Volume 4, Issue 1, Jan to April 2017.
13. Prajakta N. Haramkar etal,"Partial Replacement Of Fine Aggregate By Using Glass Powder ,"International Conference On Emanations in Modern Engineering Science and Management.
14. Pawar L.alit et.al.,"Effect of copper slag as a sand replacement,"ICRTET 2018.
15. Plain And Reinforced Concrete code IS:456:2000.
16. Recycled glass and cement (2012, February 21) retrieved 20November 2016.
17. Shayan Ahmad, Xu Aimin,"Performance of GP as a pozzolanic material in concrete: A field trial on concrete slabs.Cement and Concrete Research,"36(2006) 456-468.[2006].
18. Shayan Ahmad and Xu Aimin,"Value-added utilisation of waste glass in concrete.Cement & Concrete Research,"34 (2004) 81-89 [2004].
19. Shetty M.S., "Concrete Technology", S.Chand and Company, reprint 2016.
20. Tanweer Ahmad etal.,"Experimental study on concrete by partial replacement of fine aggregate with stone dust and cement by glass powder for M30 grades of concrete,"IJERD,ISSN:2321-9939,volume 6,issue 1,2018.
21. Vandhiyan R.etal,"Utilization of glass powder in concrete-A Literature review,"International journal for innovation research in science engineering and technology. ISSN:2319-8753,Volume 3 Issue 7 ,July 2014.
22. http://www.cpcbenvis.nic.in/cpcb_newsletter/SOLID%20WASTE.pdf.
23. https://weather.com/en-IN/india/news/news/2018-10-26-illegal-sand-mining-indias-biggest-environmental-challenge
24. https://www.tribuneindia.com/news/archive/himachal/illegal-mining-poses-threat-to-12-panchayats-463789
25. https://www.pressreader.com/india/businessstandard/20170417/281565175632226
26. https://www.northeasttoday.in/sand-mining-goes-unregulated-in-garo-hills/
27. https://timesofindia.indiatimes.com/city/bhopal/illegal-sand-mining-pushes-gharials-to-brink-in-son-river/articleshow/58968658.cms

28. http://www.business-standard.com/article/news-ians/indiscriminate-sand-mining-100-kerala-bridges-in-danger-117011901555_1.html
29. http://www.thehindu.com/todays-paper/tp-national/tp-kerala/Mineral-sand-mining-posing-threat-to-mangrove-forests/article17281729.ece
30. http://www.deccanchronicle.com/nation/in-other-news/070317/kerala-debate-hots-up-again-on-move-to-mine-sea-sand.html
31. https://www.sixdegreesnews.org/archives/21496/illegal-sand-mining-2017-indian-rivers-continue-to-loose-mindless-mining-battle
32. https://www.news24.com/news24/southafrica/news/sand-mining-free-for-all-20170201
33. https://www.nationalgeographic.com/news/2018/03/vietnam-mekong-illegal-sand-mining/