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A Project Report
on

"PARTIAL REPLACEMENT OF CEMENT WITH GLASS POWDER IN CONCRETE"

Submitted in the partial fulfillment of the requirement for the VIII Semester Project Work – 17CVP85 for the award of degree of

Bachelor of Engineering
in
Civil Engineering
Submitted by

MOHAMED INAYATHULLA	1GV17CV016
TITUS WILSON	1GV17CV024
BASAVARAJ GOOLAPPA	1GV17CV004
PALLAVI B S	1GV17CV018

Carried out at
Dr. T. THIMMAIAH INSTITUTE OF TECHNOLOGY
Under the Guidance of
Mr. Praveen K, Assistant Professor,
Dept. of Civil, Dr. TTIT

Dr. T. THIMMAIAH INSTITUTE OF TECHNOLOGY
(Formerly Golden Valley Institute of Technology)
Department of civil engineering
Kolar gold fields – 563120

Dr. T. THIMMAIAH INSTITUTE OF TECHNOLOGY
Oorguam Post, K.G.F-563120
(Approved by AICTE, New Delhi, Affiliated to VTU-Belagavi,
Approved by Govt. Of Karnataka and ISO 21001-2018 Certified)

DEPARTMENT OF CIVIL ENGINEERING.

CERTIFICATE

Certified that the Project Work entitled *"PARTIAL REPLACEMENT OF CEMENT WITH GLASS POWDER IN CONCRETE"* is a bonafied work carried out by **MOHAMED INAYATHULLA--1GV17CV016, TITUS WILSON--1GV17CV024, BASAVARAJ GOOLAPPA--1GV17CV004, PALLAVI B S--1GV17CV018,** in the partial fulfillment for the award of degree of Bachelor of Engineering in **Civil Engineering of the Visvesvaraya Technological University**, Belagavi during the year 2020-2021. It is certified that all corrections/suggestions indicated for the assessment have been incorporated in the Project report deposited in the departmental library. The Project report has been approved as it satisfies the academic requirement in respect of Project Work – 17CVP85 prescribed for the Bachelor of Engineering Degree.

12/08/21	12/8/21	12/8/2021
Signature of Guide	**Signature of HOD**	**Signature of Principal**
Mr. Praveen K	**Dr. K Ramesh**	**Dr. Syed Ariff**

Head of the Department
Dept. of Civil Engineering
Dr. T. Thimmaiah Institute of Technology
Oorgaum, K.G.F. - 563 120

PRINCIPAL
Dr. T. Thimmaiah Institute of Technology
Oorgaum, K.G.F. - 563 120.

Name of Examiners	Signature with Date
1. Dr. K Ramesh	1. 12/8/2021
2. M MANEELA	2. M Maneela 12/8/2021

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ABSTRACT

Concrete is one of the world's most used construction material due to its versatility, durability, and economy. Sustainable construction practice means creation and responsible management of a healthy built environment considering resource efficiency and ecology. Manufacturing of cement is a major source of greenhouse gas emissions. Million tons of waste glass is being generated annually all over the world. Once it becomes as waste it is disposed as landfills, which is unsustainable as it does not decompose in environment. Glass material when ground to a very fine powder shows pozzolanic properties which can be used as partial replacement for cement in concrete. Glass is replaced in certain intervals of 5% and strength is noted down.

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CHAPTER-1

INTRODUCTION

1.1 General

INTRODUCTION TO CONCRETE:

a) A composite material that consists essentially of a binding medium, such as a mixture of Portland cement and water, within are embedded particles or fragments of aggregate, usually a combination of fine and coarse aggregate.

b) Concrete is by far the most versatile and most widely used construction materials worldwide. It can be engineered to satisfy a wide range of performance specifications, unlike other building materials, such as natural stone or steel, which generally have to be used as they are. Because the tensile strength of concrete is much lower than its compressive strength, it is typically reinforced with steel bars, in which case it is known as reinforced concrete.

c) Concrete is the only major building material that can be delivered to the job site in a plastic state. This unique quality makes concrete desirable as a building material because it can be molded to virtually any form or shape. Concrete is also designed to permit reliable and high quality fast-track construction. Structure built with concrete are more durable and can be engineered to withstand earthquakes and hurricanes.

d) Concrete is used to make pavements, architectural structures, foundations, motorways, bridges, multi-story parking, walls, and footings for gates, fences and even boats. Its biggest advantage is that it bonds together bricks and stones better than any other method known to mankind.

e) The amount of concrete used worldwide is twice that of steel, wood, plastics and aluminum combined. Is also the basis of a large commercial industry, Globally, the read-mixed concrete industry, the largest segment of concrete market.

f) In United States alone, concrete production is a $30 billion per year, considering only the value of the ready-mixed concrete sold each year. Given the size of the concrete industry, and the fundamental way concrete is used to shape the infrastructure of the modern world, it is difficult to overstate the role this material plays today.

INTRODUCTION TO GLASS

Glass is a rigid liquid i.e., super cooled liquid, static, not solid, not a gas but does not change molecularly between melting and solidification in to a desired shape. Glass is one of the most versatile substances on earth used in many applications and in a wide variety of forms. Glass occurs naturally when rock high in silicates melt at high temperature and cool before they can form a crystalline structure. Obsidian or volcanic glass is a well-known example of naturally occurring glass. When manufactured by human's the glass is a mixture of silica, sand, lime and other materials as shown in fig1.1. The elements of glass are heated to 9820 Celsius. Heat can return the glass to a liquid and workable form, making it easy to reuse and recycle. The glass powder is shown in fig1.2.

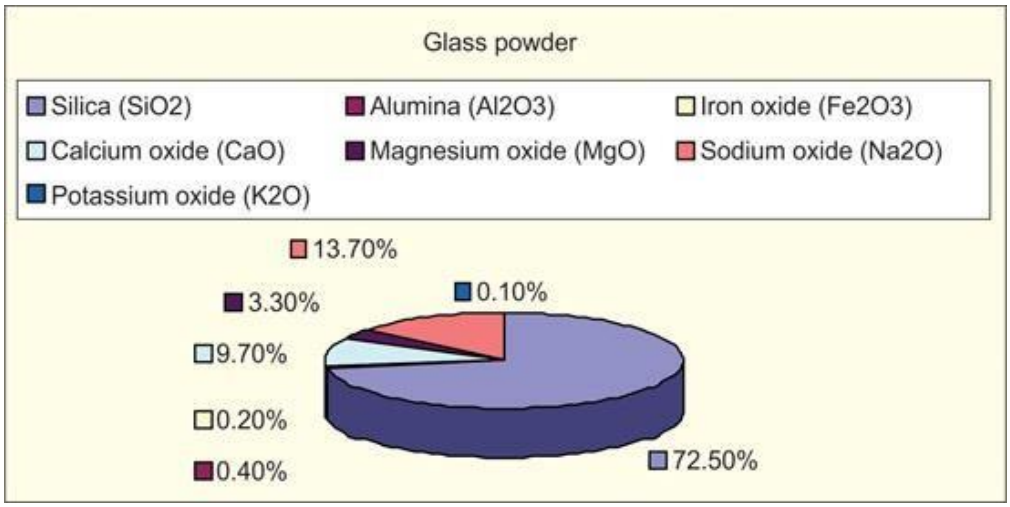


Fig 1.1 Composition of glass

Fig 1.2 Glass powder

1.2 HISTORY:

a) The time which concrete was first invented depends on how one interprets the term "concrete." Ancient materials wear crude cements made by crushing and burning gypsum or limestone. Lime also refers to crushed, burned limestone. When sand and water were added to these cements, they became mortar, which was a plaster like material used to adhere stones to each other. Over thousands of years, these materials were improved upon, combined with other materials and, ultimately, morphed into modern concrete.

b) The precursor to concrete was invented in about 1300BC when Middle Eastern builders found that when they coated the outsides of their pounded-clay fortresses and home walls with a thin, damp coating of burned limestone. It reacted chemically with gases in the air to form a hard, protective surface. This wasn't concrete, but it was the beginnings of the development of cement. Early cementitious composite materials typically included mortar-crushed, burned limestone, sand, and water, which was used for buildings with stone.

c) The first concrete like structures were built by the Nabataea traders who occupied and controlled a series of oases and developed a small empire in the regions of southern Syria and northern Jordan in around 6500BC. They later discovered the advantages of hydraulic lime—that is, cement that hardens underwater – and by 700 BC, they were building kilns to supply mortar for the construction of rubble-wall houses, concrete floors, and underground waterproof cisterns. The cisterns were kept secret and were one of the reasons the Nabataea were able to thrive in the desert.

d) Modern structure concrete differs from old concrete in two important details. First, its mix consistency is fluid and homogeneous, allowing it to be poured into forms rather than requiring hand-layering together with the placement of the aggregate, which, in Roman practice, often consisted of rubble. Second integral reinforcing steel gives modern concrete assemblies great strength in tension, whereas old concrete could depend only upon the strength of the concrete bonding to resist tension.

1.3 REASON FOR SELECTING THE PROJECT

a) By using the glass powder in concrete will reduce the greenhouse effect produced by the cement manufacturing industry.

b) Glass powder concrete increases the compressive, tensile and flexural strength effectively, when compared with conventional concrete.

c) The maximum replacement level of Glass powder is 25% for M20 grade of concrete.

d) Glass powder can be used to replace portland cement, typically at a 10%-30% replacement level by weight.

e) While concrete is in its plastic phase, glass powder will increase its workability, so less energy, cost and time are required to place and consolidate the concrete.

f) While the concrete is in its hardened phase, concrete containing glass powder exhibits better strength, freeze-thaw resistance and sulfate resistance

g) The strength of concrete containing glass powder as a cement replacement material is approximately equal to that of concrete containing only portland cement. However, its durability properties outperform that of conventional concrete.

h) Glass waste is recognized to be increasing year by year in a large volume from shops, construction areas and factories hence it can be used effectively.

i) The smaller particle size of the glass powder has higher activity with lime resulting in higher compressive strength in the concrete mix.

1.4 PROBLEM IDENTIFICATION

a) The glass powder is the waste material that can be taken with good advantage by implement and turn them into building materials.

b) About million tons of glass are produced which are going waste after broken.

c) So, using glass powder, we can reuse glass in concrete.

d) Usage of glass powder is economical only when used in high quantity, for small scale construction it will costly.

e) Since glass is non-biodegradable material, it is very effective to the workers' health.

f) If grinding is done by manually precautions measures to be taken otherwise it will lead danger.

g) Finely grounded glass powder which is light in weight can easily mix up with the air leads cause respiratory problems for the workers.

h) It should be considered that using waste glass aggregates significantly reduces the concrete mixture's workability.

i) The glass culets' angular shapes negatively affect the concrete mixture's workability. Therefore, a superplasticizer is required to ease concrete placement and consolidation.

j) Beyond 25% there is a decrease in compressive strength and Split tensile strength for 28 and 7days curing period.

k) There is a decrease in workability as the replacement level increases, and hence water consumption will be more for higher replacements

l) It reduces flexural strength of the concrete.

1.5 MATERIALS REQUIRED

1. Ordinary portland cement (OPC): OPC is the most used cement worldwide. The cost of production is not expensive making it the sought-after cement in the building industry. They are widely used for the construction of high-rise buildings, roads, dams, bridges, flyovers. Also, Ordinary Portland Cement is used for making grouts and mortars. OPC is ideal for the construction of residential and industrial complexes.

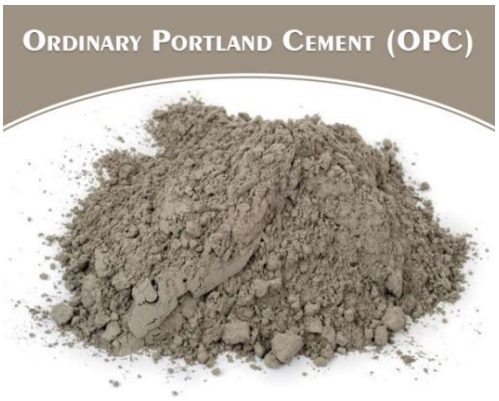


Fig 1.3 Ordinary portland cement (OPC)

2. Glass powder: It is a waste material, and it becomes granulated by sieving by means of sieves after they are crushed in the breaker and milled. Glass material when ground to a very fine powder shows pozzolanic properties which can be used as partial replacement for cement in concrete.

Fig 1.4 Glass powder

3.Fine aggregate: Fine aggregates are essentially any natural sand particles won from the land through the mining process. Fine aggregates consist of natural sand or any crushed stone particles that are ¼" or smaller. This product is often referred to as 1/4"" minus as it refers to the size, or grading, of this aggregate.

Fig 1.5 Fine aggregate

4.Coarse aggregate: Coarse aggregates are a construction component made of rock quarried from ground deposits. Examples of these kinds of ground deposits include river gravel, crushed stone from rock quarries, and previously used concrete.

Fig 1.6 Coarse aggregate

CHAPTER-2

LITERATURE REVIEW

2.1 RELATED JOURNAL PAPERS

[1]"WASTE GLASS POWDER AS PARTIAL REPLACEMENT OF CEMENT FOR SUSTAINABLE CONCRETE PRACTICE" BY G.M. SADIQULISLAM, M.H.RAHMAN, NAYEMKAZI

Million tons of waste glass is being generated annually all over the world. Once the glass becomes a waste it is disposed as landfills, which is unsustainable as this does not decompose in the environment. Glass is principally composed of silica. Use of milled (ground) waste glass in concrete as partial replacement of cement could be an important step toward development of sustainable (environmentally friendly, energy-efficient, and economical) infrastructure systems. When waste glass is milled down to micro size particles, it is expected to undergo pozzolanic reactions with cement hydrates, forming secondary Calcium Silicate Hydrate (C–S–H). In this research chemical properties of both clear and colored glass were evaluated. Chemical analysis of glass and cement samples was determined using X-ray fluorescence (XRF) technique and found minor differences in composition between clear and colored glasses. Flow and compressive strength tests on mortar and concrete were carried out by adding 0–25% ground glass in which water to binder (cement + glass) ratio is kept the same for all replacement levels. With increase in glass addition mortar flow was slightly increased while a minor effect on concrete workability was noted. To evaluate the packing and pozzolanic effects, further tests were also conducted with same mix details and 1% super plasticizing admixture dose (by weight of cement) and generally found an increase in compressive strength of mortars with admixture. As with mortar, concrete cube samples were prepared and tested for strength (until 1 year curing). The compressive strength test results indicated that recycled glass mortar and concrete gave better strength compared to control samples. A 20% replacement of cement with waste glass was found convincing considering cost and the environment.

[2]"EFFECT OF USING GLASS POWDER IN CONCRETE " BY DR. P. R. KUMAR

The global warming is caused by the emission of greenhouse gases, such as CO2, to the atmosphere. Among the greenhouse gases, CO2 contributes about 65% of global warming. The global cement industry contributes about 7% of greenhouse gas emission to the earth's atmosphere. Consequently, efforts have been made in the concrete industry to use waste materials as partial replacement of coarse or fine aggregates and cement. Waste glass is one material when ground to a very fine powder shows pozzolanic properties which can be used as a partial replacement for cement in concrete. In this paper, an attempt has been made to find out the strength of concrete containing waste glass powder as a partial replacement of cement for concrete. Cement replacement by glass powder in the range 5% to 40% increment of 5% has been studied. It was tested for compressive strength and flexural strength at the age of 7, 28 and 90 days and compared with those of conventional concrete. Results showed that replacement of 20% cement by glass powder was found to have higher strength. Also, alkalinity test was done to find out resistance to corrosion.

[3]GLASS POWDER – A PARTIAL REPLACEMENT FOR CEMENT? BY ASHUTOSH SHARMA

The research work is (was done to) determination of the effect of the use of 'Glass Powder' as a replacement of cement to assess the pozzolanic nature of fine glass powder when mixed in concrete and compare the difference in performance with other pozzolanic materials are mixed in concrete like silica fume and fly ash. The present study shows that waste glass, if ground finer than 600µm shows a pozzolanic behavior. It reacts with lime at early stage of hydration forming extra CSH gel thereby forming denser cement matrix. Thus, early consumption of alkalis by glass particles helps in the reduction of alkali-silica reaction hence enhancing the durability of concrete. Numbers of test were conducted to study the effect of 5%, 10% and 15% replacement of cement by glass powder on compressive strength and durability. The particle size effect was evaluated by using glass powder of size 600µm-100µm.The results showed that the maximum increase in strength of concrete occurred when 10% replacement was done with glass powder.

[4]"THE INFLUENCE OF WASTE GLASS POWDER AS A POZZOLANIC MATERIAL IN CONCRETE" BY ABDULLAH ANWAR

Concrete is a construction material composed of Cement, fine aggregate, coarse aggregate, and water with or without admixtures. The concrete industry is one of the heaviest consumers of natural resources due to which sustainability of concrete industry is under threat. The environmental and economic concern is the greatest challenge the concrete industry is confronting. Cement manufacturing industry is one of the carbon dioxide emitting sources besides deforestation and the combustion of fossil fuels. The global warming is induced by the emission of greenhouse gases, such as CO2, to the atmosphere. Among the greenhouse gases, CO2 contributes about 65% of worldwide heating. The global cement industry contributes about 7% of greenhouse gas emission to the earth's atmosphere. In club to address environmental effects associated with cement manufacturing, there is a demand to develop alternative binders to form concrete. Waste Glass powder shows pozzolanic properties as it contains high SiO2 and therefore, to some extent can replace cement in concrete and contributes strength development. In this research study, the Ordinary Portland Cement (Grade 43) has been partially replaced by Waste Glass Powder (GLP) accordingly in the proportion of 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45% & 50% by weight of M-40 grade concrete. Concrete mixtures were produced, tested and compared in terms of Compressive Strength, Split Tensile Strength and Flexural Strength of the conventional concrete at a period of 28 days. The role of GLP provides for considerable value-added utilization of waste glass in concrete and significant decreases in the output of greenhouse gases by the cement industry. This paper presents the feasibility of the substitution of waste glass powder for cement to achieve economical and environmentally friendly construction material.

[5] "PERFORMANCE OF CONCRETE BY USING GLASS POWDER" AN EXPERIMENTAL STUDY BY ER. MANOJ KUMAR MEENA, ER. JAGRITI GUPTA, DR. BHARAT NAGAR.

Portland cement is the most important ingredient of concrete and is a versatile and relatively high-cost material. Large scale production of cement is causing environmental problems on one hand and depletion of natural resources on other hand. This threat to ecology has led to researchers to use industrial by products as supplementary cementations material in making concrete. The main parameter investigated in this study is M35 grade concrete with partial replacement of cement by glass powder by 0, 10, 15,20 and 25%. This paper presents a detailed experimental study on Compressive strength, split tensile strength, flexural strength at age of 7 and 28 day. Test results indicate that use of Glass powder in concrete has improved the performance of concrete in strength.

[6] "ANALYSIS OF GLASS POWDER AS A PARTIAL REPLACEMENT OF CEMENT IN CONCRETE" BY HOSANA. S, SNEGA. S, PRASITHA. T.

Cement manufacturing industry is one of the carbon dioxides emitting sources besides deforestation and burning of fossil fuels. The global warming is caused by the emission of greenhouse gases, such as CO2, to the atmosphere. Among the greenhouse gases, CO2 contributes about 65% of global warming. The global cement industry contributes about 7% of greenhouse gas emission to the earth's atmosphere. In order to address environmental effects associated with cement manufacturing, there is a need to develop alternative binders to make concrete. Consequently, extensive research is ongoing into the use of cement replacements, using many waste materials and industrial by products. Efforts have been made in the concrete industry to use waste glass as partial replacement of fine aggregates and cement. In this study, finely powdered waste glasses are used as a partial replacement of cement in concrete and compared it with conventional concrete. This work examines the possibility of using Glass powder as a partial replacement of cement for new concrete. Glass powder was partially replaced as 0%, 25%, 35% and 50% and tested for its compressive, Tensile and flexural strength up to 7 days and 28 days of age and were compared with those of conventional concrete; from the results obtained , it is found that glass powder can be used as cement replacement material.

[7] "WASTE GLASS AS PARTIAL REPLACEMENT IN CEMENT" BY AL-JBURI NAJAD A. A., HASAN KAREEM, J.K. , NOOR AZLINE AND NIMA OSTOVAR.

The industries of Cement and glass are dealing with a variety of demanding situations due to the excessive factories gases emissions, the extensive use of power and the intensive use of the earth's natural resources. The temporary landfills of dumping waste glass are now not providing a friendly environment, because of waste glass particle are nonbiodegradable. Furthermore, the chemical structure and the pozzolanic characteristics of waste glass are inspiring for using this waste in the cement industries and urban industries and to provide an environmentally friendly answer for the glass and cement industries. Thus, it can be used as a partial cement replacement in Portland cement concrete or as a partial replacement in the form of waste glass powder (WGP) or as waste glass sludge (WGS). The use of glass powder in Portland cement concrete does have some negative impact on characteristics of the concrete; however, waste glass in its crushed condition can be use in about 100 % and it can still be a practical applicability. This paper reviews the unusual uses of waste glass in cement and concrete and the effect of thermal and pozzolanic activity on the properties of waste glass the impact of the glass characteristics on the durability and performance of the produced cement and concrete.

.[8] "EXPERIMENTAL INVESTIGATION OF WASTE GLASS POWDER AS PARTIAL REPLACEMENT OF CEMENT IN CONCRETE" BY DHANARAJ MOHAN PATIL, KESHAV K. SANGLE.

Concrete is a construction material composed of cement, aggregates (fine and coarse aggregates) water and admixtures. Today many research are ongoing into the use of Portland cement replacements, using many waste materials like pulverized fly ash (PFA) and ground granulated blast furnace slag (GGBS). Like PFA and GGBS a waste glass powder (GLP) is also used as a binder with partial replacement of cement which take some part of reaction at the time of hydration, also it is act as a filler material. In this study, waste glass powders have been used as replacements to the concrete ingredient i.e., cement and the mechanical properties like compressive strength are measured. Also, we were studied the size effect of glass powder on strength of concrete. For checking strength effect of replacement of cement by glass powder, the cement is replaced at 10%, 20% and 30%. For study of size effect of glass powder the powder is divided in to two grades one is glass powder having size less than 90 micron and another is glass powder having particle size ranges from 90 micron to 150 micron. It is found from study; Initial strength gain is very less due to addition of GLP on 7th day but it increases on the 28th day. It is found that 20% addition of GLP gives higher strength. And also, GLP size less than 90 micron is very effective in enhancement of strength.

2.2 OBJECTIVES

a) Main objective of this research proposal is to evaluate the possibility of using "GLASS POWDER" which is a waste material as partial replacement for cement in concrete without sacrificing the strength.

b) To evaluate the effect of waste glass powder on the compressive strength and other properties of concrete.

c) To study the strength of glass concrete compared with conventional concrete.

CHAPTER-3

METHODOLOGY

3.1 TESTS ON CEMENT:

INTRODUCTION:

The heart of concrete lies in cement. Several tests should be performed to determine the characteristics of cement and its compatibility with other materials in the concrete mix design. Compressive strength testing of mortar cubes at 7-days, 14-days and 28-days of aging are used to observe the development of the strength gain of the mortar over time. A chemical analysis of the cement will provide a reasonable estimate of the composition of the cement. These are just a few of the tests that can be used to determine the quality of the cement.

List of tests on cement:

a) Specific gravity of cement

b) Consistency of cement

c) Fineness of cement

d) Initial and final setting time of cement

3.2 TESTS ON GLASS POWDER

INTRODUCTION:

Glass is one material when ground to a very fine powder shows pozzolanic properties which can be used as a partial replacement for cement in concrete.

List of tests on glass powder:

a) Specific Gravity of Glass Powder

b) Water Absorption. of Glass Powder

c) Fineness Modulus.

3.3 TESTS ON FINE AGGREGATES:

INTRODUCTION:

Fine aggregates are basically sands won from the land or the marine environment. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 9.5mm sieve.

List of tests on fine aggregates:

a) Specific gravity of fine aggregates.
b) Sieve analysis.
c) Determination of bulk density
d) Determination of Water absorption

3.4 TESTS ON COARSE AGGREGATES:

INTRODUCTION:

Aggregates are the important constituents in concrete. They give body to concrete; reduce shrinkage, and effect economy. The mere fact of that the aggregate occupy 70-80% of the volume of the concrete as it essential to know the properties of it

List of tests on coarse aggregates:

a) Determination of Aggregate Crushing Value.
b) Determination of Aggregate Impact Value.
c) Determination of Abrasion Value of Coarse aggregates.
d) Shape Test.
e) Specific gravity and water absorption.
f) Sieve analysis.
g) Determination of Bulk Density.

3.5 TESTS ON FRESH CONCRETE:

INTRODUCTION:

Fresh concrete are plastic concrete is a freshly mixed material which can be molded into any shape. The relative quantities of cement, aggregates and water mix together, control the properties of concrete in the wet state as well as in the hardened state.

List of tests on Fresh Concrete

a) Slump Test for Conventional and Glass Powder Concrete

3.6 TESTS ON HARD CONCRETE

INTRODUCTION:

Hardened concrete is a concrete which must be strong enough to withstand the structural and service loads which will be applied to it and must be durable enough to the environmental exposure for which it is designed. It will be the strongest and durable building material.

List of tests on hard concrete

a) Compressive Strength.

b) Flexural Strength

c) Split-tensile test.

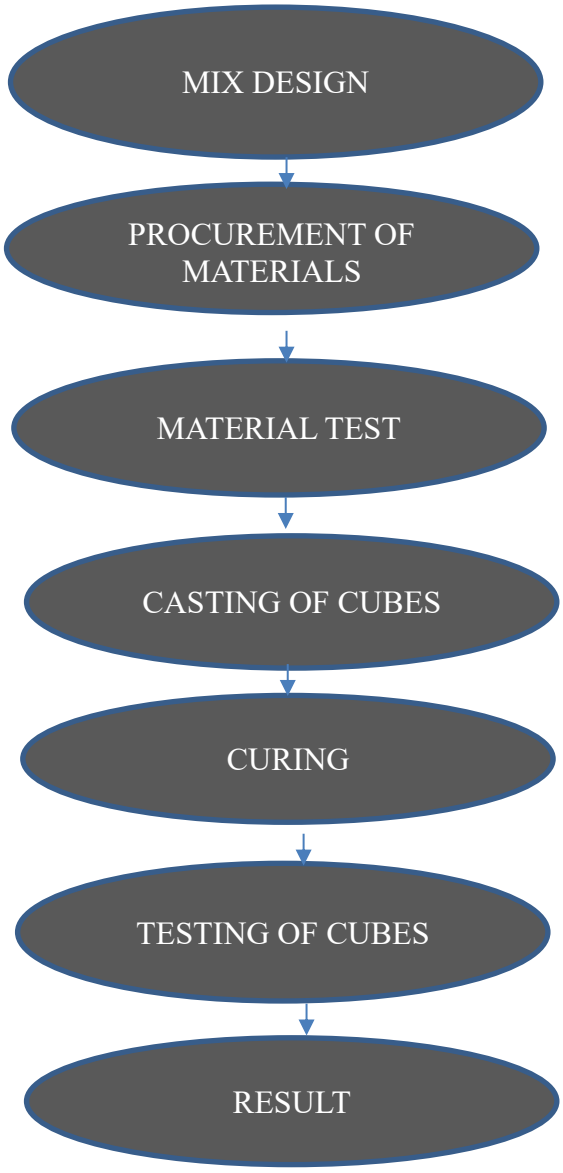
3.7 SUMMARY OF ALL BASIC TESTS

SL NO	TESTS	COARSE AGGREGATE	FINE AGGREGATES	CEMENT
1.	SPECIFIC GRAVITY	1.97	2.61	3.02
2.	BULK DENSITY	1.26Kg/m^3 1.61 Kg/m^3	1.75 Kg/m^3 2.01Kg/m^3	_
3.	FINENESS	-	-	8%
4.	SIEVE ANALYSIS	2.39	3.08	-
5.	NORMAL CONSISTENCY		-	28%
6.	WATER ABSORPTION	0.0059%	0.4%	
7.	CRUSHING VALUE	24.75%	_	_
8.	AGGREGATE IMPACT VALUE	24.5%	_	_
9.	FLAKINESS INDEX	8.38	_	_
10.	ELONGATION INDEX	10.076	_	_
11.	LOS ANGELES ABRASION	35.02%	_	_
12.	ANGULARITY NUMBER	7.05	_	_
13.	SETTING TIME	_	_	55min

TEST RESULT OF GLASS POWDER

TESTS	RESULTS
SPECIFIC GRAVITY	2.58
WATER ABSORPTION	0.68
FINENESS MODULUS	2.65

3.8 FLOW CHART



CHAPTER-4

IMPLEMENTATION

4.1 MIX DESIGN OF CONCRETE USING IS 10262:2009

CONVENTIONAL MATERIALS

Stipulation for proportion

Sl No	Particulars	Used /obtained
1	Grade designation	M25
2	Type of cement	OPC 53 GRADE
3	Maximum nominal size of agg	20mm
4	Minimum cement content	320Kg/m3
5	Maximum water content	0.45
6	Workability	100mm
7	Exposure condition	Severe
8	Method of concrete placing	Hand mixed and placed
9	Degree of supervision	Good
10	Type of aggregates	Crushed angular aggregate

Tests data of materials

Sl. no	Particulars	Used / obtained
1	Type of cement used	OPC 53 grade
2	Specific gravity of cement	3.02
3	Specific gravity of fine aggregate	2.6
4	Specific gravity of coarse aggregate	2.39
5	Water absorption	
	Coarse aggregate	0.59
	Fine aggregate	0.4

MIX PROPORTION

Cement	403 kg
Fine aggregate	666 kg
Coarse aggregate	1332 kg
Glass powder	81 kg
Water	182 litres

4.2 Slump cone test values

Fig 4.1 Slump cone test

W/C RATIO	SLUMP (mm)	
	Conventional	Glass Powder
0.40	0	0
0.45	90	100

4.3 Compression strength test values

Fig 4.2 Compression strength test

Formula used:

Compressive strength = Load at failure

C/s area

	Compressive strength (N/mm^2)		
	7 days	**14 days**	**28 days**
Conventional concrete	12.05	15.16	19.1
5% replacement	15.34	19.56	24.65
10% replacement	14.61	17.33	23.61
15% replacement	10.69	14.56	19.28

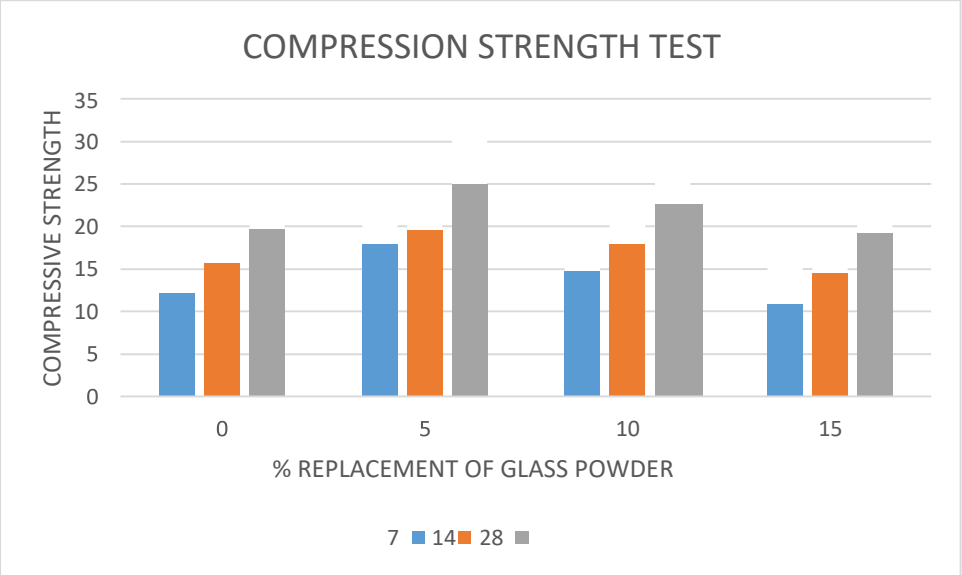
CHAPTER 5

DISCUSSION

TABLE 5.1: RESULT COMPARISION BETWEEN CONVENTIONAL CONCRETE AND GLASS POWDER CONCRETE

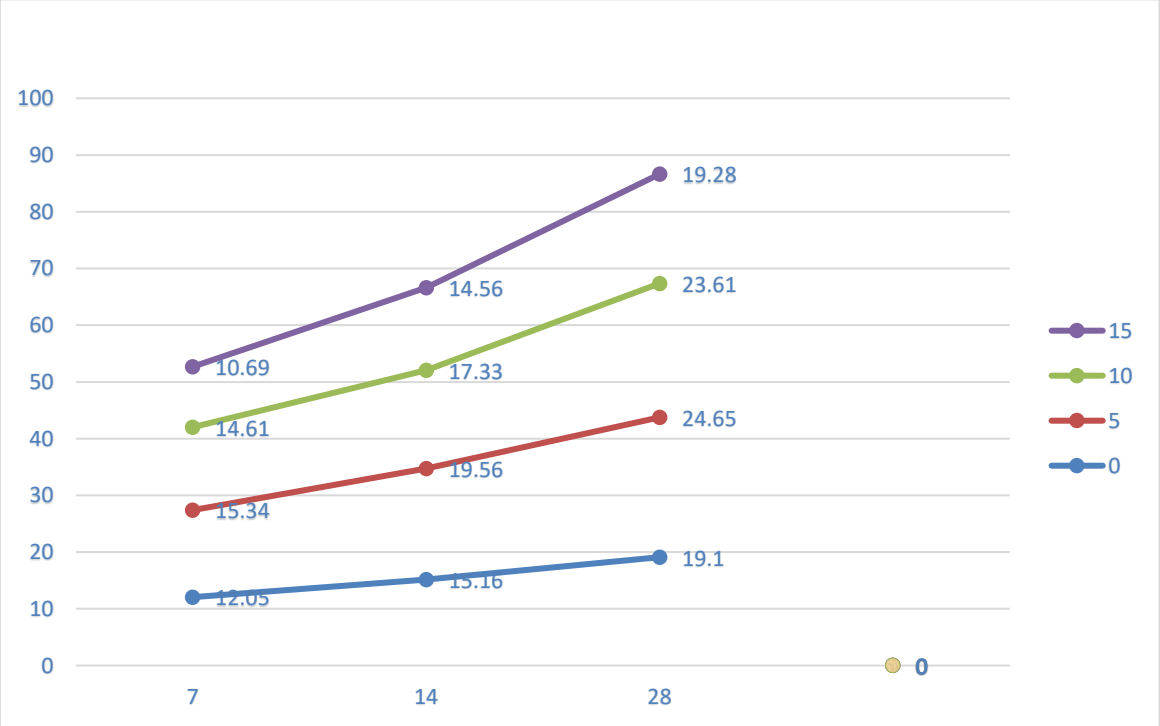
Strength	Durations	Conventional Specimens (N/mm^2)	Glass powder concrete specimens (N/mm^2)	
Compressive strength	7 days	12.05	5%	15.34
			10%	14.61
			15%	10.69
	14 days	15.16	5%	19.56
			10%	17.33
			15%	14.56
	28 days	19.1	5%	24.65
			10%	23.61
			15%	19.28

GRAPH 1 COMPRESSION STRENGTH TESTS OF CUBES AT 7, 14, 28 DAYS



GRAPH 2:- COMPARSION OF CONVENTIONAL CONCRETE WITH 5, 10 AND 15% REPLACEMENT OF GLASS POWDER

THIS GRAPH IS CURING DAYS VS COMPRESSIVE STRENGTH



CONCLUSIONS

- The compressive strength of M20 grade concrete increases by adding glass powder up to a certain replacement and then decreases.
- Based on the results obtained, compression strength of concrete is maximum at 5% replacement with glass powder.
- In addition, production of every six-ton glass powder concrete result in the reduction of each ton CO2 emission from cement production and save the environment significantly byreducing green-house gas and particulate production.
- It is found that workability increases with increase in glass powder content.

FUTURE SCOPE

- The main scope of this research proposal is to evaluate the possibility of using Glass powder which is waste product.
- Higher grade concrete can be casted and tested for the same.
- The admixtures (mineral and chemical) can be used to increase the strength of the concrete.
- It is recommended for future studies that the research on use of glass powder is required to extend to a wider perspective in order to know the actual behavior and effective utilization of glass powder which gives an idea to study more parameters and different governing effect of glass powder on engineering properties of fresh and hardened concrete.

  i. To know the effect of different type of glass powder on concrete strength.

  ii. Effect of glass powder on high strength concrete.

  iii. Effect of glass powder on strength of concrete with various w/c ratios.

  iv. Effect of glass powder on strength of concrete with combination of glass powder with different strengthening agent.

  v. To know the exact reason behind the increment in strength of concrete.

  vi. To know the effect of glass powder on bond strength between inter-materials and between materials and steel.

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