VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“Jnana Sangama”, Belgaum-590 014

A Dissertation Project Report on

“EXPERIMENTAL STUDY OF PARTIAL REPLACEMENT OF ORDINARY PORTLAND CEMENT BY GLASS POWDER IN CONCRETE”

Submitted in partial fulfillment for the award of the degree of

BACHELOR OF ENGINEERING IN

CIVIL ENGINEERING

BY

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DECLARATION

We, Mr.NAGESH N , Mr.BASAVARAJU K M , Mr. SHIVARAJ D, Mr HOSAMANI SHASHANK,bonafide students of CMR Institute of Technology, Bangalore, hereby declare that dissertation entitled "EXPERIMENTAL STUDY OF PARTIAL REPLACEMENT OF ORDINARY PORTLAND CEMENT BY GLASS POWDER IN CONCRETE" has been carried out by us under the guidance of Mr. Guruprasad (Assistant Professor), Department of Civil Engineering, CMR Institute of Technology, Bangalore, in partial fulfillment of the requirement for the award of degree of Bachelor of Engineering in Civil Engineering of the Visvesvaraya Technological University, Belgaum during the academic year 2019-2020. The work done in this dissertation report is original and it has not been submitted for any other degree in any university.

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ABSTRACT

The research work is 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 behaviour. 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 0%, 2%,4%,8%,12% and 20% 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.

CHAPTER 1

INTRODUCTION

Concrete is one of the world's most used construction material due to its versatility,durability and economy. India uses about 7.3 million cubic meters of ready-mixed concrete each year. It finds application in highways, streets, bridges, high rise buildings, dams etc. Green house gas likeco2leadstoglobalwarminganditcontributestoabout65%ofglobalwarming.Theglobal cement industry emits about 7% of green house gas to the atmosphere. To reduce this environmental impact alternative binders are introduced to make concrete. Glass is an amorphous material with high silica content making it potentially pozzolanic when particle size is less than 75μm. The main problem in using crushed glass as aggregate in port land cement concrete are expansion and cracking caused by the glass aggregate due to alkali silica reaction.Duetoitssilicacontentgroundglassisconsideredapozzolanicmaterialandassuch canexhibitpropertiessimilartootherpozzolanicmaterial.Inthisstudy,finelypowderedwaste glasses are used as a partial replacement of cement in concrete and compared it with conventional concrete. Concrete mixtures were prepared with different proportions of glass powderrangingfrom10to40%withanincrementof10%andtestedforcompressivestrength after 3, 7 and 28 days of curing.

WHY THE WASTE GLASSPOWDER…?

Todaymanyresearchesareongoingintotheuseofportlandcementreplacements,usingmany waste materials and industrial by products, for example, pulverized fly ash (pfa) and ground granulated blast furnace slag (ggbs). Like pfa and ggbs, a glass powder (glp) is also used as a binder with partial replacement of cement which takes some part of reaction at the time of hydration;alsoitisactasafillermaterial.Thetermglasscomprisesseveralchemicalvarieties including binary alkali silicate glass, bore-silicate glass, and ternary soda lime silicate glass. Partialreplacementofcementwithmilledwasteglassbenefitsthemicrostructureandstability ofcementitiousmaterials.Adenser(lessporous)andmorehomogeneousstructureisproduced whenmilledwasteglassisusedaspartialreplacementforcement,whichbenefitstheresistance

to moisture sorption and thus the long-term durability of cementitious materials. Partial replacement of cement with milled waste glass also benefits the stability of cementitious materials when potentially deleterious reactions between cement hydrates and the reactive aggregates is a concern. Mixed-color waste glass, when milled to about the particle size of cement and used in concrete as replacement for about 20% of cement, improves the moisture barrier qualities, durability, and mechanical performance of concrete. These improvements resultfromthebeneficialchemicalreactionsofmilledwasteglasswithcementhydrates,which yield chemically stable products capable of refining the pore system in concrete. Major environmental,energy,andcostsavingscanberealizedbypartialreplacementofcementwith milled mixed-color waste glass. Extensive studies were undertaken to solve the alkali silica reaction (asr) problems. Replacing cement by pozzolanic material like waste glass powder in concrete, not only increases the strength and introduces economy but also enhances the durability.

MECHANISM OF POWDER PORTLAND CEMENT ANDGLASS

Glass wastes as a cullet are used in the production of building materials mainly as an inert aggregate. However, finely grained glass powder with its well developed surface cannot be regarded as passive toward cement solutions which has actually been proven in practice. Literary sources provide no information about chemical influence of finely grained glass on the process of hardening, especially in its early pre-induction hydration period – the period which considerably conditions the cement stone structure formation and its properties. It is wellknownthatglassisamaterialwithanamorphousstructure,characterizedbyalargesupply offreeenergy.Theglassthathasbeenusedinourinvestigations–containsapproximately14% of na2o and k2o. In the glass structure the ions of these metals have considerably less binding energy as compared to covalent bond of si-o in the structural fragment of si-o-+na or si-o-+k. Inwatersolutionna+andk+ionsareeasilydiffusedfromglasstothesolutionandformsodium andpotassiumhydroxidesinthesolution,correspondingly.Theyaredisplacedbyh+ionsfrom waterandthushydratethesurfacesofglassgrains.Thisisasocalledion-exchangemechanism of interaction between glass and water. Since the area of glass grain surface is very large, comparable to the area of cement grain surface, ionic exchange is very active.Titration

analyses show that alkalinity of cement solution without glass additives is near 6 ml of 0.1N hcl. Separate glass powder in water under normal conditions has alkalinity in the range from0.15 (colour less glass) to 0.55 ml of 0.1N hcl (green glass). Thus, the total alkalinityhas to increase, however alkalinity of cement mixture with glass additives is 35-40 % less. In our opinion,it is connected with high content of sio2 in the glass(near70%),which results in the formation of calcium hydro silicate (csh), as shown in chemical reaction: 2(3CAO.sio2)+6H2O=3 cao.2SIO2.3H2O+3CA (oh)2(tricalcium silicate)(calcium silicate hydrate) (calcium hydroxide)….(1)3CA(oh)2+sio2+ (n1) h2o=ao.sio2.nh2o (calcium hydroxide)(glass)(calciumsilicatehydrate)(2)as are sultofreaction(1) the amount of calcium hydroxide in the cement solution decreases .Consequently ,the alkalinity of solution with glass powder additives decreases as well and additional amount of ash crystal phase in a cement stoneisformed.Ithasbeenestablishedthatadditionoffinelygrainedglasstoportlandcement or to port land cement based concrete accelerates the binding process during pre induction periodofhydration(2–4min.)Butretardsitduringafter-inductionperiod.However,thisdoes notaffectthemechanicalstrengthoftheconcretesamplesafterthefirstdayofhardening.The strength of samples with glass is higher as compared to the control samples, because, as has been stated above, glass additives modify cement stone structure

RESEARCH SIGNIFICANCE ANDMECHANISM

Recent research finding have shown that concrete made with recycle glass aggregate have shown better long term strength and better thermal property of the glass aggregate. When concrete contain waste glass powder it gives high percentage of C3S, low C3A, C4A4, C3S/C2Scontentwhichresultinproductionandoffergreaterresistancetothesulphateattack. Glass powder content SiO2 when it reacts with alkaline in cement (pozzolanic reaction) to formcementationproductsuchproducthelpscontributetostrengthanddurabilityinconcrete. Glass article less than 90μm reacts and form cementation product When waste glasses are reusedinmakingconcrete,productioncostofconcretewillgodownInordertomakeconcrete industry sustainable, the use of waste materials in place of natural resources is one of the best approaches. An enormous quantity of waste glass is generated all around the world. In India, 0.7%oftotalurbanwastegeneratedcomprisesofglass.Theenvironmentalimpactofconcrete,

its manufacture and applications, is critical. Some effects are harmful; others good. Rest all depend on use circumstances of concrete. A main ingredient of concrete is cement, which has its own environmental impacts and contributes largely to those of concrete. The cement industryisoneoftheprimaryindustrialproducersofcarbondioxide(CO2),creatingupto6% ofworldwideman-madeemissionsofthisgas,ofwhich50%isfromthechemicalprocessand 40%fromburningfuel.Theinterestoftheconstructioncommunityinusingwasteorrecycled materialsinconcreteisincreasingbecauseoftheemphasisplacedonsustainableconstruction. Glass is an inert material which could be recycled and used many times without changing its chemical property. Efforts have been made in the concrete industry to use waste glasspowder as partial replacement of cement. Waste glass when ground to a very fine powder shows pozzolanicpropertiesasitcontainsSiO2thereforeitmayreplacedtothecementbt10%20% & 30% so on. This report will be the results of an experimental investigation on the use of glasspowderinpartiallyreplacementcementinfibrereinforcedconcreteandsummarizedthe behavior of concrete involving partial replacement of cement by waste glass powder 0% to 40%atintervalof5%or10%each.Glassisamorphousmaterialwithhighsilicacontent,thus making it potentially pozzolanic when particle size is less than 75 micron. Can be used in replacingcemnt.

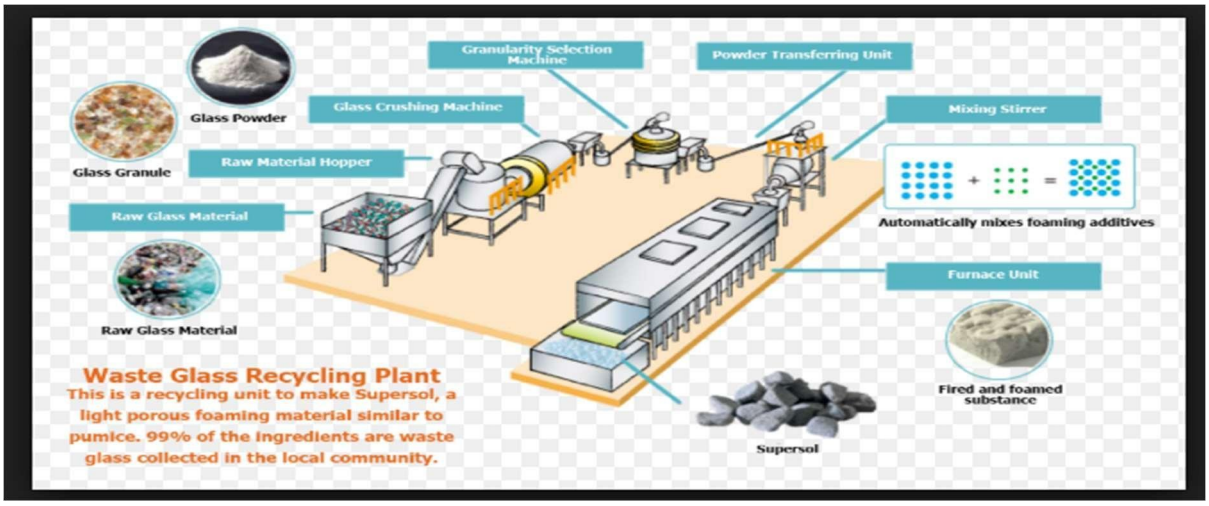

Figure – 1 (process of converting waste glass into powder form)

CHAPTER- 2

OBJECTIVES

OBJECTIVES

Experiments were conducted on concrete prepared by partial replacement of cement by waste glass powder of particle size 600 micron and downwards. The main objective of this investigationwastoevaluatetheeffectofwasteglasspowderonthecompressivestrengthand theotherpropertiesofconcreteandtoevaluatethepossibilityofusingglasspowderinconcrete without sacrificing the strength. The following were alsoconsidered.

Partial substitute for the ordinary port landcement

To investigate the structural behavior of such replaced concretecomponents

To determine the percentage of glass powder which gives maximum strength when compared to controlconcrete

To evaluate the utility of glass powder as a partial replacement of cement inconcrete.

To study and compare the performance conventional concrete and glass powder concrete.

To understand the effectiveness of glass powder in strengthenhancement.

SCOPE

This scope of study is part of comprehensive program where in experimental investigations have been carried out to evaluate the effect of partially replacement of cement by waste glass powderoncompressivestrength7and28days,workability,alkalinity.M25gradeofconcrete was considered for experimental study with specimens prepared along with partially replacement of cement by waste glasspowder.

FLOWDIAGRAM

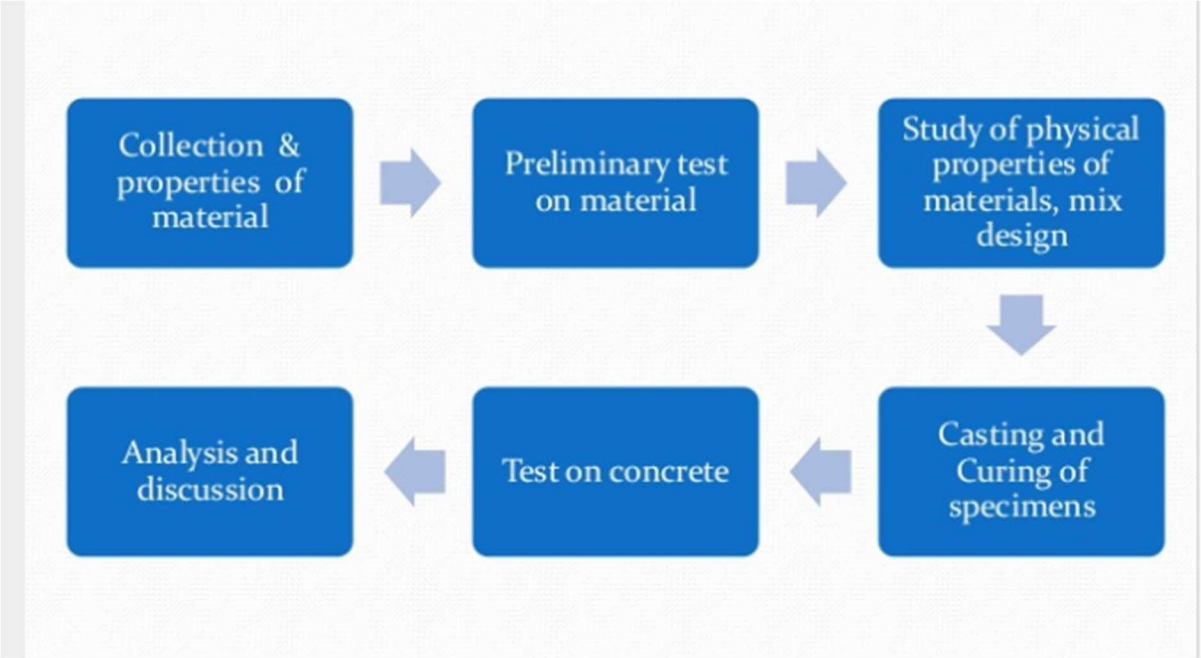

Figure – 2 (process to be carried out in project)

METHODOLOGY

The physical properties of ingredients are assessed as per relevant Indianstandards.

M25gradeconcretemixisdesignedasperIS10262:2009byconsideringtheproperties ofingredients.

Concrete mix is prepared by replacing at the intervals of 0,2,4,8,12,16,20% of cement by partially replacing the glasspowder.

Workability of all the mixes is assessed by conducting slumptest.

Compressive strength and durability characteristics of concrete mixes are assessed at 3,7,28days.

CHAPTER - 3

LITERATURE REVIEWS

3.1 PREVIOUS RESEARCH

EFFECT OF USING GLASS POWDER IN CONCRETE: (By shipa raju, Dr. PRKumar(ISO3297-2007certifiedorganization)(volume3,specialissue5,july2014):Cement replacementbyglasspowderinrangeof5%to40%incrementof5%hasbeenstudied.Itwas tested for compressive &flexural strength at the age of 7,14,28 &90 days & compared with those of conventional concrete. Result showed that replacement of 20% cement by glass powder was found to have higher strength. Also alkalinity test was done to find outresistance tocorrosion.

INFLUENCE OF GLASS POWDER ON THE PROPERTIES OF CONCRETE : (BY veena v. Bhat, n bhavani shankar rav(N M AM institute oftechnology ,nitte574110karanataka)(IJETI-VOL16NOV5-OCT2014):Todaytheconstructionindustry is in need of finding cost effective materials for increasing the strength of concrete structure. Glass powder finer than 600micron is reported to have pozzolanic behaviour. An attempts is madetoinvestigatethepossibilityofusingthewasteglasspowderasthepartiallyreplacement of ordinary mix of M25 with 53 grade ofcement.

A CRITICAL STUDY OF EFFECTIVENESS OF WASTE GLASS POWDERINCONCRETE:(bygouthamsingh,ashishkumarsimgh,akhilbhaskar,ajit singh attree (Iso9001-2008 certified organization)(volume 5(3)sept 2014:31-35): This experiment shown the properties of concrete containing waste glass powder as a cement replacementmaterial.Glassconstituteabout5%ofmunicipalsolidwastestreamwasteofglass contains 72.5% sio2,when ground to the fineness 600um, sio2 reacts with alkalis in cement to formcementationsproducts.Suchproductshelpcontributestrengthanddurabilityinconcrete. Glass powder was partially replaced 5%,10%,15%,20%,25% with sand and tested for compressive strength, slump and workability and alkalis test end compared with those conventional concrete with m20 propositionconcrete.

USE OF GLASS POWDER AS FINE AGGREGATE INHIGH STRENGTHCONCRETE:(byjostin.p.josh,S.Suganya,bhanupriya(volume2issue 7july 2014): This project examine the possibility of using glass powder as fine aggregate replacement in concrete. Natural sand was partially replaced (0%-30%) with glass powder in concrete. Tensile and compressive, flexural strength ware Compared with those of high performance concrete made with naturalsand.

EXPERIMENTAL INVESTIGATION OF WASTE GLASS POWDER AS PARTIAL REPLACEMENT OF CEMENT IN CONCRETE : dhanaraj mohan patil1, dr. Keshav k. Sangle21 Structural Engineering Department, Veermata Jijabai Technological Institute,Matunga, Mumbai, India. Concrete is a construction material composed of cement, aggregates (fine and coarse aggregates) water and admixtures. Today many researches are ongoing into the use of Portland cement replacements,usingmanywastematerialslikepulverizedflyash(PFA)andgroundgranulated 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 the cement is replaced at 10%, 20% and 30%. For studyofsizeeffectofglasspowderthepowderisdividedintotwograde s oneis glasspowder 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 ofstrength.

USEOFWASTEGLASSPOWDERASAPARTIALREPLACEMENTOF CEMENT IN FIBRE REINFORCED CONCRETE : MohammadShoeb Sayeeduddin1, Mr. F.I. Chavan2 1 e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 13, Issue 4 Ver. IV (Jul. - Aug. 2016), PP 16-21 : Cement was replaced by waste glass powder as0%to40%inincrementof5%inM20.Theconcretespecimensweretestedforcompressive strength,splittingtensilestrength,flexuralstrengthandworkabilityat7days,28days,60days, 90days and 180days of age and the results obtained were compared with those of normal concrete. The results concluded the permissibility of using waste glass powder as partial replacement of cement at 20% byweight.

INFLUENCE OF GLASS POWDER ON THE PROPERTIES OF CONCRETE : Veena V. Bhat 1, N. Bhavanishankar Rao 2 1M. Tech. final year student 2Professor, Civil Engineering Department 1,2N M AM Institute of Technology , Nitte , 574110, Karnataka, India : International Journal of Engineering Trends and Technology (IJETT)–Volume16Number5–Oct2014:Glassiscommonlyusedinbuilding/construction industries and large amount of glass is powdered daily. The disposal of waste glass is an environmental issue as waste glass causes disposal problem. Glass powder finer than 600 μ is reported to have pozzolanic behaviour. An attempt is made to investigate the possibility of using the waste glass powder as the partial replacement of ordinary Portland cement in concrete.Concrete withreplacementofcementbywaste glasspowdersuchas5%,10%,15% and 20% were produced and properties of this concrete has been compared with concrete of control mix with no replacement. Cube specimens of 24 numbers were cast, cured and tested for7dayand28daysstrength.Compressiontestwasconductedandtheresultswerecompared. Thefindingsrevealedanincreaseincompressivestrengthwiththeincreaseinthereplacement ofcementbyglasspowder.Toreducethedemandforcement,glasspowderreplacementscan beadopted.Thereplacementofglasspowderdecreasestheunitweightaswellastheporosity as indicated by the decrease in water absorption. It reduces the quantity ofcement.

CHAPTER- 4

MATERIALS AND PROPERTIES

MATERIALUSED

In this investigation the following are materials are used

Ordinary Portland cement of 53 grade confirming to IS:269-2015

Fine aggregate confirming to IS:383-2016

Coarse aggregate confirming to IS:383-2016

Water[portable]

Waste glass powder less than75micros

CEMENT:

The cement used in this study was 53 grade ordinary port land cement (OPC) confirming to IS: 269-2015 Ordinary Portland cement is the most common type of cement in general use all aroundtheworldasabasicingredientofconcrete,mortarandnon-speciallygrout.Itdeveloped from other types of hydraulic lime in England in mid 19thcentury and usually originates from lime stone. As bureau of standard (BIS) the grade number of cement highlights the minimum compressive strength attains within 28days. For 53 grade OPC cement, the minimum compressive strength achieved by the cement at end of the 28thday should not be less than 53mpa or 53 kg/sq.cm the color of cement will begrey.

TheRamco53gradebrandcementavailableinthelocalareainlocalmarketwasused forinvestigations.Careshouldbetakentoseetheprocurementwasmadefromsinglebatching in air tight containers to preventit.

Sl. No.	*Test Conducted*	Results	*Requirements as per IS: 269-2015*
1.	Brand of cement	*Ramco*	-
2.	Type of cement *	OPC 53 Grade	-
3.	Consistency	28.5 %	Not specified
4.	Initial setting time	150 Minutes	Shall not be less than 30 Minutes
5.	Final setting time	320 Minutes	Shall not be more than 600 Minutes
6.	Compressive strength: (Average of threeresults)		
	3 days	30.2 MPa	Shall not be less than 27.0 MPa
	7 days	42.7 MPa	Shall not be less than 37.0 MPa
	28 days	58.4 Mpa	Shall not be less than 53.0 MPa
7	FINENESS (by Blaine's air permeability method)	309 m^2/kg	Shall not be less than 225 m^2/kg

Table – 1 [physical properties of cement]

FINEAGGREGATE

Fine aggregate: 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 size of manufactured sand (M-Sand) is less than 4.75mm. Locally available clean, well graded M-sand was used as fineaggregate.Thepropertiesofthefineaggregatearerepresentstheparticlesizedistribution curve of the M-sand.

The aggregate was tested for its physical characteristics such as gradation, fineness modulus,specificgravity,moisturecontent,bulkdensity,waterabsorptioninaccordancewith IS:383-2016

Figure – 3 (M-Sand less than 4.75mm IS sieve)

CHARACTERISTICS OF FINE AGGREGATE (CRUSHED STONE SAND)					
1.	a) Dry rodded bulk density		1805 kg/cu.m		
	b) Loose bulk density		1686 kg/cu.m		
2.	Specific gravity		2.52		
3.	Water absorption		4.0 %		
4.	Material finer than 75 microns		9.8 %		
5.	Sieve Analysis				
IS Sieve Designation	Cumulative PercentageRetained	Passing	Specification as per IS:383-2016 (Percentage Passing) ZoneI	ZoneII	ZoneIII
4.75 mm	0.7	99.3	90-100	90-100	90-100
2.36 mm	9.4	90.6	60-95	75-100	85-100
1.18 mm	23.2	76.8	30-70	55-90	75-100
600 µm	55.8	44.2	15-34	35-59	60-79
300 µm	71.6	28.4	5-20	8-30	12-40
150 µm	84.9	15.1	0-10	0-10	0-10

REMARKS: 1). The sample supplied satisfies the requirements of grading Zone II as per IS:383-2016. According to IS: 383-2016 for Crushed Stone Sands, the permissible limit on 150 micron IS Sieve is increased to 20%. This does not affect the 5% allowance permitted in Cl. 4.3

2). As per Table 1, Sl. No. 3 of IS: 383 – 2016), for Crushed stone sands, the Material finer than 75 microns IS sieve is Maximum 15% by weight.

Table – 2 [characteristics of M-Sand]

COARSEAGGREGATE

Coarse aggregate used was 20MM and down size and specific gravity. Testing was done as perIndianstandardspecificationIS:383-2016.Crushedaggregateof20mmand12.5mmsize produced from local crushing plants were used. The aggregate exculusully passing through 20mm sieve size and retained on 6.3 mm sieve is selected. The aggregate were tested for characteristics or physical requriments such as fineness modulus, water abruption, specific gravity and bulk density and dry density , moisture content accordance with IS383-2016

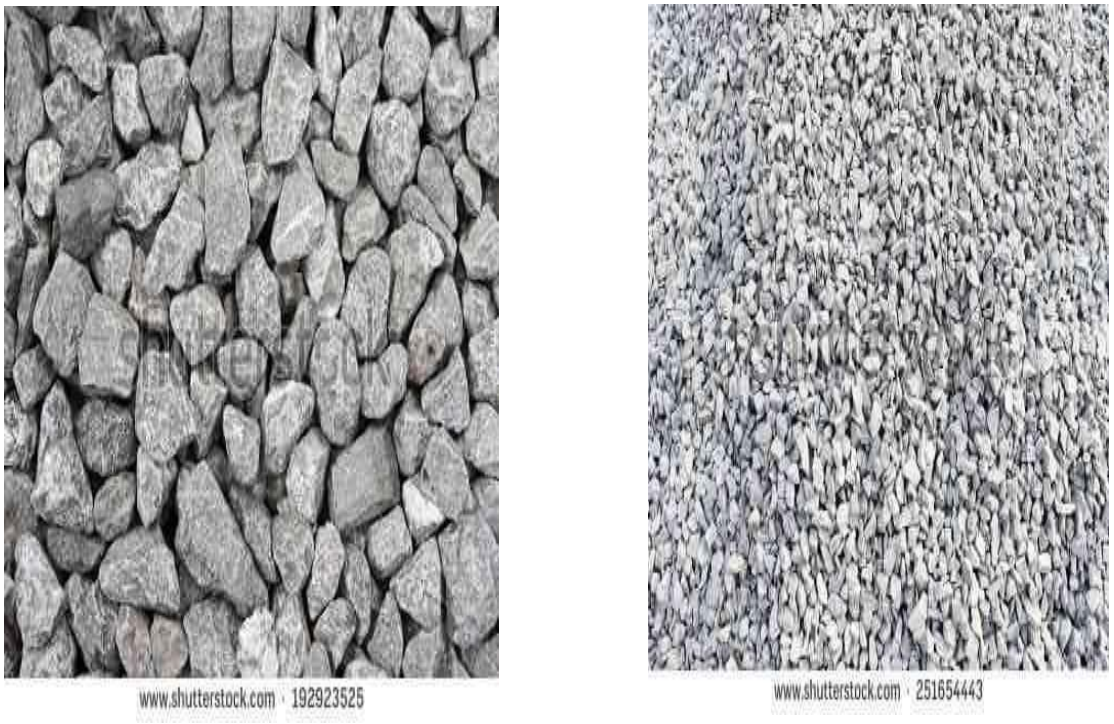

Figure – 4 (coarse aggregate of 20mm and 12.5mm down size)

CHARACTERISTICS OF COARSE AGGREGATE OF 20 mm DOWN SIZE

	Shape		Angular	
2.	a) Dry rodded bulk density		1602 kg/cu.m	
	b) Loose bulk density		1481 kg/cu.m	
3.	Specific gravity		2.67	
4.	Water absorption		0.3 %	
5.	Sieve analysis			
IS Sieve Designation	Cumulative percent ---------- Retained	Passing	Specification as per IS:383-2016 in respect of 20mm nominal size aggregate (% passing) *Graded*	*Single sized*
40.00 mm	0	100	100	100
20.00 mm	7.4	92.6	90-100	85-100
10.00 mm	95.5	4.5	25-55	0-20
04.75 mm	98.8	1.2	0-10	0-5

REMARKS: Sample conforms to the requirement of single sized aggregate as per IS: 383-2016.

Table – 3 [characteristics of coarse aggregate 20mmdown size]

CHARACTERISTICS OF COARSE AGGREGATE OF 12.5 mm DOWN SIZE				
1.	Shape		Angular	
2.	a) Dry rodded bulk density		1624 kg/cu.m	
	b) Loose bulk density		1503 kg/cu.m	
3.	Specific gravity		2.66	
4.	Water absorption		0.6 %	
5.	Sieve analysis			
IS Sieve Designation	Cumulative percent ---------- Retained	Passing	Specification as per IS:383-2016 in respect of 12.5mm nominal size aggregate (% passing) *Graded*	*Singlesized*
16.00 mm	0	100	-	100
12.5 mm	5.2	94.8	90-100	85-100
10.00 mm	43.3	56.7	40-85	0-45
04.75 mm	98.2	1.8	0-10	0-10
REMARKS: Sample conforms to the requirement of graded aggregate as per IS:383-2016.				

Table – 4 [characteristics of coarse aggregate 12.5mmdown size]

GLASSPOWDER

Waste glass available locally was collected and made into glass powder The specific gravity of 2.54 less than 90microns. Glass is a transparent material produced by melting a mixture of materials such as silica, soda ash, and caco3 at high temperature followed by cooling during which solidification occurs without crystallization. Glass is widely used in our lives throughmanufacturedproductssuchassheetglass,bottles,glassware,andvacuumtubing.The amount of waste glass is gradually increased over the recent years due to an ever-growinguse of glass products. Most waste glasses have been dumped into landfill sites. The land filling of waste glasses is undesirable because they are not biodegradable, which makes them environmentallylessfriendly.Soweusethewasteglassinconcretetobecometheconstruction economical as well as eco-friendly. Composition of cement and glass powder is as shown in table1

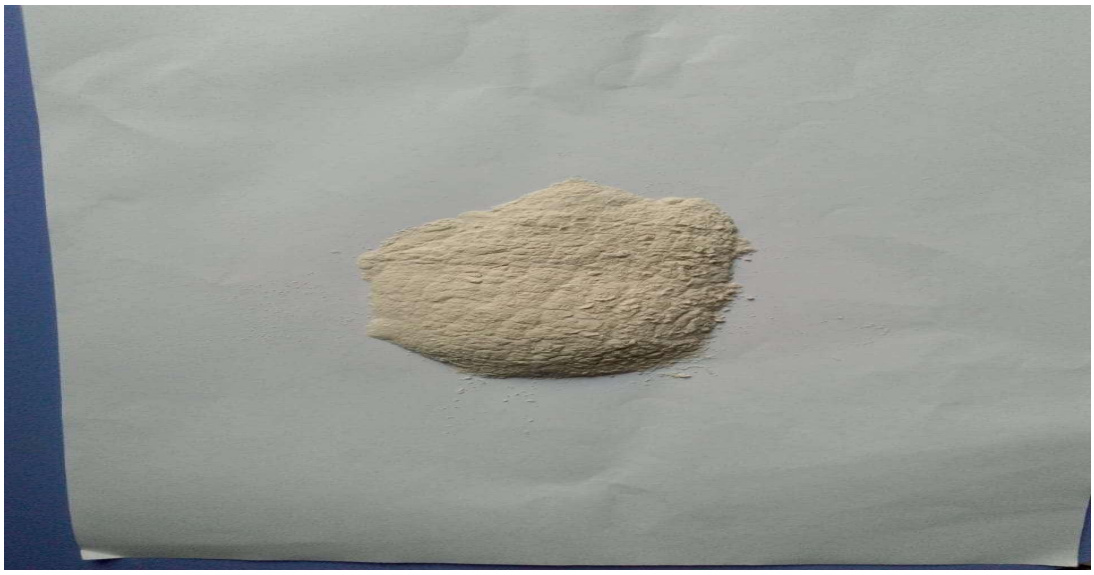

Figure – 5 (Glass powder less than 75microns)

CHEMICALCOMPOSITION

Table 1. Chemical composition of cementing materials

Composition (% by mass)/ property	Cement	Glass powder
Silica (SiO_2)	20.2	72.5
Alumina (Al_2O_3)	4.7	0.4
Iron oxide (Fe_2O_3)	3.0	0.2
Calcium oxide (CaO)	61.9	9.7
Magnesium oxide (MgO)	2.6	3.3
Sodium oxide (Na_2O)	0.19	13.7
Potassium oxide (K_2O)	0.82	0.1
Sulphur trioxide (SO_3)	3.9	-
Loss of ignition	1.9	0.36
Fineness % passing (sieve size)	97.4(45 µm)	80 (45 µm)
Unit weight,Kg/m^3	3150	2579

Figure – 6 (chemical composition between cement and glass powder)

PROPERTIES OF MATERIALS USEDARE

Specific gravityofcement = 2.98

Specific gravity of fine aggregate = 2.52

Specific gravity of coarse aggregate = 2.66

Specific gravity of glass powder =2.54

CHAPTER - 5

MIX DESIGN

MIXDESIGNFORM25GRADECONCRETEASPERIS:10262-2009

Characteristic compressive strength required in th fied at 28days:30days

A. TARGET

MEANSTRENGTH

FCK=fck+Ks

=30+(1.65x4)

=31.6 MPA

B. SELECTION OF WATER -CEMENTRATIO

From table 5 IS 456, maximum water-cement ratio 0.5

From OPC adopting water-cement ratio 0.5

C. SELECTION OF WATERCONTENT

From table number 5 of IS 10262-2009, maximum water content for 20mm aggregate is 186liters

Estimated water content for 85mm slump = 160x+6/100x160=169.6

Adopting a water content of 170liters

D. CALCULATION OF CEMENTCONTENT

Water-cementratio=0.50

Cement content, C= 170/0.50=340KG/CUM

IS :456-2000 the minimum cement content is 300kg/cum for sever exposure.

From table 3 of IS:10262-2009 volume of coarse aggregate corresponding to 20mm size aggregate and fine aggregate(ZONE11) for water-cement ratio of 0.50=0.62% in the present case water-cement ratio is 0.50. therefore volume of coarse aggregate is required to be increased to decreased the fine aggregate cement. Thus corrected proportion of volume of coarse aggregate for the water-cement ratio of 0.50=0.62

Volume of fine fine aggregate = 1- volume of CA

= 1-0.62

= 0.38

MIXCALCULATION

a) Volume of concrete =1cum

b) Volume ofcement= $\frac{\text{massofcement}}{\text{Specific gravity of cement}} \times 1/100$

$= \frac{340}{3.12} \times 1/1000$

= 0.1089cum

c) Volume ofwater= $\frac{\text{massofwater}}{\text{Specific gravity of water}} \times 1/1000$

$= \frac{170}{1} \times 1/1000$

=0.170cum

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

= 1-(0.1089+0.170)=0.7211cum

e) Massofcoarseaggregate=dxvolumeofcoarseaggregatexspecificgravityofcoarse aggregate x1000

= 0.721 x 0.558x2.66x1000= 1070.16kg/cum

f) Massofcoarseaggregate=dxvolumeofcoarseaggregatexspecificgravityofcoarse aggregate x1000

= 0.721 x 0.442x2.57x1000 = 819.01kg/cum

5.3 MIX PROPORTION

Cement	=	340kg/cum
Water	=	170 kg/cum
Fine aggregate	=	819.01 kg/cum
Coarse aggregate	=	1070.16 kg/cum
Water-cement ratio	=	0.50

MIX CALCULATION ADDING GLASSPOWDER

Glass powder 10% by cement material = (10/100) x 340

= 34kg

= (34/2.54) x 1/1000

= 0.0133 cum

Glass powder 20% by cement material = (20/100) x 340

= 68kg

= (68/2.54) x 1/1000

= 0.0267 cum

Glass powder 30% by cement material = (30/100) x 340

= 102kg

= (102/2.54) x 1/1000

= 0.0401 cum

Glass powder 10% by cement material = (10/100) x 340

= 136kg

= (136/2.54) x 1/1000

= 0.0535 cum

MIX PROPORTION AFTERADDING GLASSPOWDER

GLASS POWDER IN %	Cement (kg/m3)	Fine aggregate (kg/m3)	Coarse aggregate (kg/m3	Water content (kg/m3)	Mix proportion
0	340	819.01	1070.16	170	1 : 2.4 : 3.14
10	306	834.23	1090.05	170	1 : 2.72 : 3.59
20	272	849.45	1109.94	170	1 : 3.12 : 4.11
30	238	864.67	1129.83	170	1 : 3.63: 4.74
40	204	879.89	1149.72	170	1 : 4.13 : 5.63

Table – 5 [mix proportion]

CASTING ANDCURING

The150mmconcretecubeswerecastforcompressivestrengthand150x150x700mmbeams were cast for flexural strength according to the mix proportion and by replacing cement with glass powder (gp) in differentproportion.

The properties of materials used are

Specific gravityofcement = 2.98

Specific gravity of fine aggregate = 2.52

Specific gravity of coarse aggregate = 2.67

Specific gravity of glass powder =2.54

CHAPTER – 6

EXPERIMENTAL DETAILS

GENERAL

This chapter deals with the various mix proportions adopted in carrying out the experiments and experimental results obtained with respect to their compressive strength, workability and alkalinity.

Different types of mixes were prepared by changing the percentage of replacement cement by waste glass powder various types of mix prepared with conventional mixes. The cement is replaced 0,2,4,8,10,12,16% along with glass powder.

COMPRESSIVE STRENGTH TEST: using a compression testing machine (CTM) of capacity 2000KN in accordance with the provisions of the Indian standard specification IS: 516-1959, strength of specimens were tested at 7, 14, 28, 45..

ORDINARY PORTLAND CEMENT

Mix proportion	Curing in Days	Compression strength KN
1:2:4	7	198
1:3:6	7	148

CEMENT REPLACED WITH GLASS POWDER

Mix proportions	Percentage of replacement in %	Curing in days	Compression strength (KN)
1:2:4	4	14	153
1:3:6	8	14	126

WORKABILITY TEST: workability is the property of freshly mixed concrete that

determines the ease with which it can be properly mixed, placed, consolidated and finished without segregation. Workability depends on water content, aggregate cementations content andageandcanbemodifiedbyaddingchemicaladmixtures.Theworkabilityoffreshconcrete was measured by means of the conventional slump test as per is: 1199-1989. Beforthefresh concretewascastintomould,theslumpvalueofthefreshconcretewasmeasuredusingSlump cone.

ALKALINITYTEST:forconductingthealkalinitytestspecimenaretakenoutfrom curing tank after 28 days of curing. Then oven dry the specimens at 105°c for 24 hours. The dry specimens are cooled to room temperature. Mortar was separated from the concrete by breakingdownthedryspecimen.Thenthemortarisgrindedintopowderform.Thepowdered mortar is sieved in 150M. 10 gm of mortar is taken and it is diluted in 50ML distilled water and stirred it completely. Then immerse the ph meter into the solution and ph value of the solution is noted. The general ph value of the solution and the level of inducing corrosion in the concrete werenoted.

CHAPTER-7

TEST RESULTS AND FUTURE SCOPE

May be 30% replacement of cement by waste glass showed max compressivestrength for both 7 and 28 days of curing.

It might be with increase in waste glass content, percentage of water absorption decreases.

Workability of concrete mix increase with increase in waste glass content. durability decreases.

Useofwasteglassinconcretecanprovetobeeconomicalasitisnonusefulwasteand free ofcost.

Use of waste glass in concrete will eradicate the disposal problem of waste glass and prove to be environment friendly thus paving way for greenerconcrete.

use of waste glass in concrete will preserve natural resources particularly river sand thus make concrete construction industrysustainable.

CHAPTER-8

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2.	SP:23(S&T)-1982	Handbook on concrete mixes.
3.	IS:456-2000	Code of Practice for plain & reinforced concrete.
4.	IS:516-1959 (Reaffirmed 2013)	Method of test for strength of concrete.
5.	IS:383-2016	Indian Standard specifications for coarse and fine aggregates from natural sources for concrete.
6.	IS:1199-1959 (Reaffirmed 2004)	Indian Standard specifications for methods of sampling and analysis of concrete.
7.	IS: 269 – 2015 Clause 7 for OPC 43	Indian Standard Specifications for 43 grade ordinary portland cement.
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