Partial Replacement of Cement By Using Waste Glass Powder

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Abstract- *In industry also in cities , a larger propartion solid waste is produced and some of which is partially recycled or is disposed in landfills, they generating negative environmental effects. Glass is unreactive material which can be recycled and also used various without changing its chemical property. This research focuses on studying the effect of waste glass on the properties of concrete mixtures as a partial replacement of cement Large studies undertaken to resolved the alkalisilicareaction (ASR) problems. Replacing cement by material like waste glass powder in concrete is increases the strength and introduces economy but also enhances the durability.*

Keywords- Glass powder, Ordinary Portland cement, coarse aggregates and fine aggregates

I. INTRODUCTION

The interest of the construction community in using waste or recycled materials in concrete is increasing because of the emphasis placed on sustainable construction, the waste glass and disposed as landfill. Nowdays , many researches are going into the use of Portland cement replacements, by using many waste materials and industrial by products. for example, ground granulated blast furnace slag (GGBS) and a glass powder (GLP) is used as a binder with partial replacement of cement which takes part of reaction at the time of hydration.. Glass behove several chemical varieties including alkalisilicateglass, borosilicate glass, and tertiary sodalimesilicate glass. Partial supplanting of concrete with processed waste glass gives benefits the steadiness of cementitious materials when possibly pernicious responses between concrete hydrates and the receptive totals is a worry. Squander glass, when processed to about the molecule size of concrete at that point utilized in concrete as swap for about 20% of concrete, improves the dampness boundary characteristics, toughness, and mechanical execution of cement .These enhancements result from the useful substance responses of waste glass with concrete hydrates, which is synthetically steady items equipped for refining the pore framework in concrete. Environmental energy and cost investment funds can be acknowledged by halfway supplanting of concrete with blended shading waste glass. Broad examinations were attempted to illuminate the alkalisilicareaction (ASR) issues Replacing concrete by pozzolanic material like waste glass powder in concrete is builds the quality and presents economy yet in addition improves the durability.

II. PROBLEM STATEMENTS

- Concrete assembling industry is one of the carbon dioxide transmitting sources other than deforestation and consuming of petroleum derivatives. The an Earth-wide temperature boost is brought about by the emanation of green house gases, for example, CO2, to the climate
- .In huge infrastructure projects cement consumption is in mass proportion, which creates heavy material cost subsequently creates massive impact on the cost of whole project.
- As use of cement in mass proportion in concrete creating large amount of heat of hydration which further leads to formation of cracks in structure. Necessity of providing high strength with minimum impact on nature using optimum resources which can be easily available in surrounding.

III. OBJECTIVES

- To study the current strategies for removal of glass waste.
- To financially contrast regular cement and the concret emodified utilizing waste.
- The primary objective of this study is to investigate the practicality.
- Feasibility of utilizing recycled glass as a partial replacement to cement.
- This research focuses on studying the effect of waste glass on the properties of concrete mixtures as a partial replacement of cement.
- Identify the effects of adding waste glass on the fresh properties of concrete mixes such as workability by slump measures.

- Study the influence of waste glass on hardened properties of concrete mixes such as: density and compressive strength.
- Determine the optimum waste glass content to be added as a partial replacement of cement which gives maximum compressive strength.

IV. SCOPE OF THE PROJECT

- Replacement of cement with a glass powder in different water cement ratio.
- In the present study the ordinary Portland cement is going to be use, further its different properties can be compared by using different cements.
- Glass fiber can be introduce in concrete.
- Test for chemical properties, tensile strength, slump loss, workability and many others can be done.

V. LITERATURE REVIEW

RakeshSakaleet. al. [1]studied the replacement of cement by waste glass powder in steps of 5%, 10%, 15% and 20% respectively by volume of cement and its effects on compressive strength, split tensile strength, workability and flexural strength are determined. It is found that the compressive, flexural and split tensile strengths of concrete increase initially as the replacement percentage of cement by glass powder increases and become maximum at about 15% and later decrease. The workability of concrete reduces monotonically as the replacement percentage of cement by glass powder increases. The replacement of cement up to about 15% by glass powder can be done without sacrificing the compressive strength.

Olukoet. al. [2]investigated the compressive strength of Compressed Stabilized Earth Block (CSEB) by partially replacing the cement (stabilizer) in the block with Waste Glass Powder (WGP) and it was found from the results that, as WGP is added to compressed stabilized earth block, its strength reduces. Although, the strength for CSEB without waste glass had the highest strength, CSEB with WGP indicated strengths higher than 3N/mm2 recommended as minimum strength for CSEB at 28 days for the percentage of replacements used in this study. No optimum value was observed for WGP addition to the CSEB as replacement for cement, however, sufficient strengths good enough for handling at early stages of the CSEB whether at particle size of 150 μm or 75 μm were achieved at 15% replacement of cement with WGP in CSEB. It could be concluded that the role of WGP in CSEB is more of filler than a binder.

Shuhua Liu et. al. [3]carried out a research to ascertain the inhibitory effect of waste glass powder (WGP) on Alkali-Silica Reaction (ASR) expansion induced by waste glass aggregate. These studies showed that there is ASR risk with an ASR expansion rate over 0.2% when the sand contains equal or more than 20% glass aggregate. However, WGP can effectively control the ASR expansion and inhibit the expansion rate induced by the glass aggregate to be under 0.1%. The specific surface area of WGP and the ASR expansion have an anti-correlation, which leads the pozzolanic reaction more intense and faster and higher inhibitory effect on ASR expansion. The ASR expansion can be controlled in a safe range when WGP content is 5%, 10% and 15% with its specific surface area greater than 1137.40, 604.37 and 71.34m2/kg, respectively, or with low average particle size according to the calculation.

Raghavendra K. and Virendra Kumara K. N [4]investigated about the compressive strength, split tensile strength and water absorption of M40 grade of concrete mixes with 5% constant replacement of waste glass powder in cement and partial replacement of waste foundry sand in fine aggregate. From the test results, strength was achieved very less on 7th and 14th days but it increases on the 28th day. High strength values were found at 15% replacement level in strength parameters. The compressive strength and split tensile strength of concrete at 7, 14 and 28 days increases initially as the percentage of replacement of waste glass powder and waste foundry sand increases and becomes maximum at a proportion respectively around A15.

Ana Mafalda Matos [5]aimed to evaluate the use of waste glass powder in powder type SCC. It could be concluded that waste glass powder can be used successfully in SCC further improving chloride penetration and water absorption by capillarity, maintaining strength levels. Although soda lime glass presents a high alkali content, use of ground waste glass as cement replacement in mortar, improved resistance to ASR. These results corroborate the pozzolanic nature of glass powder and its behaviour with time. Although glass powder is a little coarser than cement, it still brings advantages when incorporated in cement.

Ashutosh Sharma and AshutoshSangamnerkar [6]showed 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 there by 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 results showed that the maximum increase in strength of concrete occurred when 10% replacement was done with glass powder. Then found result

1. Conventional concrete shows a 3 days compressive strength as 9 N/mm and 2.5% replacement of glass powder in cement increased the compressive strength by 37% in 3 days.
2. 2.10% replacement of glass powder increment increased the compressive strength by 52.6% in 3 days.
3. 3.15% replacement of glass powder in cement increased the compressive strength by 39.8% in 3 days.

M. Adaway and Y. Wang [7]aimed to determine the level of glass replacement resulting in optimal compressive strength. Three concrete samples were tested at 7 and 28 days for glass replacement proportions of 5, 10, 15, and 20%. Compressive strength was found to increase up to a level of 15% at which point the strength developed was 9% and 6% higher than the control after 7 and 28 days respectively. This demonstrates that concrete containing up to 15% fine glass aggregate exhibits higher compressive strength development than traditional concrete.The optimum percentage replacement of sand with fine glass aggregate was determined to be 15%.Compressive strength was found to increase with the addition of waste glass to the mix up until the optimum level of replacement.

VasudevanGunalaan and Kanapathypillay Seri Ganis [8] studied slump property in his research and resulted that compared to control mix, by using waste glass powder will give another benefit which is the workability of concrete which is much higher. R.Vandhiyan et al[2013] investigated that the workability was reduced due to the replacement and it reduced with increase in replacement, this is due to the increase in the surface area of the glass powder and also the angular shape of the glass particles. Kumarappan N. [2013] presented that there is a systematic increases in the slump as the glass powder in the mix increases. The slump ranged from around 40mm for the reference mix (i.e. 0% glass powder) to 160mm at 40% glass powder. Khatib J.M. et al [2012] in his study showed that there was a systematic increase in the slump as the glass powder content in the mix increases. JangidJitendra B. and Saoji A.C. [2012] resulted that the workability decreases as the percentage glass powder in the mix increases. . Chikhalikar S.M. and Tande S.N. [2012] studied the properties of SFRC (SteelFibre Reinforced Concrete) containing waste glass as pozzolona and concluded that the 20% replacement of cement by waste glass powder gives better workability to SFRC. Nassar Roz-Ud-Din and SoroushianParviz [2012] utilized milled waste glass in his experimentation and resulted that slump is observed to slightly increase with the introduction of milled waste glass. This could be attributed to the low water absorption of glass. The slump of recycled aggregate concrete mixes (at both levels of w/cm ratio) is higher than that of corresponding control mixes.

Dr. G. Vijayakumar [9] considered that finely powdered waste glasses are utilized as a partial substitute of bond in concrete and contrasted it and conventional cement. This study inspects the likelihood of utilizing Glass powder as a fragmentary substitute of bond for new cement. bond was in part supplanted as 10%, 20%, 30% and 40% by glass powder and tried for its compressive, flexural and Tensile quality up to 60 days of period and were contrasted and those of conventional solid; results demonstrates that that waste glass powder can be utilized as concrete substitution material up to molecule size littler than 75μm to maintain a strategic distance from salt silica response. Inferred that supplanting of bond with glass powder by 20%, 30% and 40% upgrade the compressive quality by 19.6%, 25.3% and 33.7% correspondingly. substitution of glass powder in bond by 20%, 30% and 40% improve the flexural quality of cement by 83.07%, 99.07% and 100% correspondingly.

W P Prema Kumar (10) mulled over that waste glass powder supplant the bond in solid in ventures of 5% from 0% to 40% by volume and impacts of this substitution on compressive quality, split elasticity, weight thickness and workability are figure out. This demonstrates that the compressive and split resistances of solid upgrade at first as the substitution rate of bond with glass powder builds and get to be most extreme at around 20% and after that abatements. The weight thickness and workability of solid lessening all the while as the substitution rate of concrete with waste glass powder increments. The substitution of bond up to around 30% with waste glass powder can be made with no diminishing in compressive quality of cement in compressive quality at 28 days. With expansion in waste glass content, rate water ingestion diminishes.With expansion in waste glass substance, normal weight diminishes by 5% for blend with 40% waste glass content therefore making waste glass solid light weight. Workability of solid glass content.

VI. EFFECTS ON VARIOUS TESTS RESULTS

A. SLUMP TEST -

Vasudevan Gunalaan and Kanapathypillay Seri Ganis [2013] considered droop property in his examination and came about that contrasted with control blend, by utilizing waste glass powder will give another advantage which is the functionality of solid which is a lot higher. R.Vandhiyan et

al[2013] researched that the functionality was decreased because of the supplanting and it diminished with increment in substitution, this is because of the expansion in the surface territory of the glass powder and furthermore the precise state of the glass particles. Kumarappan N. [2013] introduced that there is an orderly increments in the droop as the glass powder in the blend increments. The droop went from around 40mm for the reference blend (for example 0% glass powder) to 160mm at 40% glass powder. Khatib J.M. et al [2012] in his examination indicated that there was a methodical increment in the droop as the glass powder content in the blend increments. Jangid Jitendra B. also, SaojiA.C. [2012] came about that the usefulness diminishes as the rate glass powder in the blend increments. Chikhalikar S.M. also, Tande S.N. [2012] contemplated the properties of SFRC (Steel Fibre Reinforced Concrete) containing waste glass as pozzolona and inferred that the 20% substitution of concrete by squander glass powder gives better functionality to SFRC. Nassar Roz-Ud-Din and Soroushian Parviz [2012] used processed waste glass in his experimentation and came about that droop is seen to somewhat increment with the presentation of processed waste glass. This could be ascribed to the low water assimilation of glass. The droop of reused total cement blends (at the two degrees of w/cm proportion) is higher than that of relating control blends.

B. COMPRESSIVE STRENGTH -

Numerous works have been done to investigate the advantages of utilizing waste glass powder in making and improving the properties of cement. Vasudevan Gunalaan and Kanapathypillay Seri Ganis [2013] examined the test results at 7, 14, 28 days of relieving of examples containing waste glass powder as incomplete substitution of concrete and his outcomes indicated that the 20% glass powder blend sum shows a positive estimation of compressive quality at 28 days contrast with other proportion which 10% and 15% isn't feasible despite the fact that have slight augmentation from 14 days results. VandhiyanR. et al[2013] examined the substitution of concrete by squander glass powder and reasoned that the extensive increment in the early quality addition especially at Specimen 15% GP invigorated a 29% expansion in the at seventh day more than control example. At 28th day this distinction in quality diminishes to 23 %. The quality augmentation is ideal at 10% substitution. Kumarappan N. [2013] mostly supplanted concrete by glass powder and expressed that upto 10% it is attainable to supplant concrete as it indicated higher compressive quality than the control blend.Vijayakumar G. et al[2013] suggested that concrete supplanted upto 40% by glass powder demonstrated addition in compressive quality at both 28 days and 60 days time of relieving when contrasted with customary cement. Nwaubani Sunny O. furthermore, PoutosKonstantinos I. [2013] inferred that expanding the measure of glass in mortar causes an overall lessening of compressive quality, yet the diminishing turns out to be less apparent with drawn out relieving time.

The molecule size conveyance of waste glass utilized was the key factor impacting the quality turn of events. Khatib J.M. et al[2012] considered the presentation of concrete as halfway substitution of concrete and presumed that the greatest compressive quality happens at around 10% glass powder and past 10% it will in general decline and is lower than that of control. Patel Dhirendra et al [2012] examined the quality attributes of precast squares consolidating waste glass powder and contemplated that the moderate level diminishing in the compressive quality at 28 days happens.

Jangid Jitendra B. also, Saoji A.C. [2012] presumed that the upto 40% substitution of concrete, compressive quality increment upto 20% and concrete supplanted past which diminishes compressive quality. Chikhalikar S.M. furthermore, Tande S.N. [2012] examined on the attributes properties of fiber fortified cement containing waste glass as pozzolona and demonstrated that the compressive quality increment is accomplished upto 30% when contrasted with control blend, however the pinnacle % expansion is at 20% substitution. Dali J.S. furthermore, Tande S.N. [2012] contemplated the properties of cement containing mineral admixtures, when it is exposed to elective wetting and drying and high temperature and came about that the compressive quality augmentation is upto 25% substitution of concrete by squander glass powder, however the pinnacle % addition is at 20% substitution in both the cases, for example concrete without exposing to interchange wetting and drying, and concrete exposed to substitute wetting and drying. Patel Dhirendra et al [2012] examined the properties of concrete sand mortar glue containing fine and coarse glass powder as fractional substitution of concrete and results demonstrated that 15% measurements for substitution is ideal. Khmiri A. et al[2012] proposed his test work containing clear and hued glass of various sizes (100 and 80 μm, 80 and 40 μm and lower than 40 μm) and went to an outcome that compressive quality list of groundwaste glass arrives at over 82% for sizes lower than 40 μm.Patil Dhanraj Mohan and SangleKehav K. [2012] contemplated the test aftereffects of waste glass powder particles extending from size 150μm to 90μm and under 90μm. He indicated that underlying quality addition is less because of expansion of GLP on seventh day however it increments on the 28th day. It is discovered that 20% expansion of GLP invigorates higher. And furthermore GLP size under 90 micron is extremely successful in upgrade of solidarity. Bajad M.N. et al [2011] examined the quality

properties containing glass when exposed to sulfate assault and indicated that the pinnacle compressive quality is accomplished at 20% substitution of concrete by squander glass powder both when cement isn't exposed to sulfate assault and when cement exposed to sulfate assault and the addition proceeds upto 25% substitution past which it diminishes. Gopalakrishnan Ramasamy and Govindaraja Dharshnamoorthy [2011] completed tests on squander glass admixture concrete and came about that the compressive quality outcome is an affirmation of hindering impact of WG in the hydration of Portland concrete.

C. SPLIT TENSILE STRENGTH -

Vijayakumar G. et al [2013] examined that the glass powder solid builds the rigidity adequately when contrasted and customary cement. Vandhiyan R. et al [2013] indicated that there was a peripheral improvement in the rigidity. Chikhalikar S.M. furthermore, Tande S.N. [2012] in their investigation on Steel Fiber Reinforced Concrete (SFRC) introduced that the rigidity accomplishes a pinnacle an incentive at 20% substitution of concrete by squander glass powder.Dali J.S. what's more, Tande S.N. [2012] performed tests on concrete containing mineral admixtures at high temperatures and inferred that 20% substitution level is ideal when cement isn't exposed to elective wetting and drying and furthermore when cement exposed to elective wetting and drying.

D. WATER ABSORPTION TEST -

Malik M. Iqbal et al [2013] in their investigation of cement including utilization of Waste Glass as Partial Replacement of Fine Aggregates did this test and came about that the rate water retention diminished with increment in squander glass content. The most reduced estimation of water retention was found for solid blend in with 40% waste glass content. Nwaubani Sunny O. furthermore, Poutos Konstantinos I. [2013] in their exploration because of Waste Glass Powder Fineness on the Properties of Cement Mortars introduced that Water assimilation expanded with expanded glass powder content. Moderate replacement levels, for example, Mix 2 with 5% of glass powder and Mix 3 with 20% of glass powder content accomplished comparative qualities to that of control blend. Nassar Roz-Ud-Din and Soroushian Parviz [2012] in their experimentation on quality and sturdiness of reused total cement containing processed glass as incomplete trade for concrete Concluded that water assimilation of cement is seen to be essentially decreased with presentation of processed waste glass as fractional substitution for concrete in both low and high w/cm proportion blends.

W P Prema Kumar et al (2014) considered that waste glass powder supersede the bond in strong in adventures of 5% from 0% to 40% by volume and effects of this replacement on compressive quality, part flexibility, weight thickness and usefulness are make sense of. This exhibits the compressive and split protections of strong redesign from the start as the replacement pace of bond with glass powder constructs and get the chance to be generally outrageous at around 20% and after that decreases. The weight thickness and functionality of strong decreasing at the same time as the replacement pace of cement with squander glass powder increases. The replacement of bond up to around 30% with squander glass powder can be made with no reducing in compressive nature of concrete. M. Iqbal Malik and Muzafar Bashir et al (2013) mulled over that fine sums were replaced by squander glass powder as 10%, 20%, 30% and 40% by weight for M-25 mix. The strong models were pursued for compressive quality, part versatility, toughness (water ingestion) and thickness at 28 days old enough and the results got were differentiated and those of normal concrete. 20% replacement of fine aggregates by squander glass exhibited 15% extension in compressive quality at 7 days and 25% augmentation in compressive quality at 28 days. Fine aggregates can be superseded by squander glass up to 30% by weight exhibiting 9.8% development in compressive quality at 28 days. With extension in squander glass content, rate water ingestion diminishes.With development in squander glass substance, ordinary weight lessens by 5% for mix with 40% waste glass content accordingly making waste glass strong light weight. Functionality of strong mix increases with development in squander glass content. Part flexibility lessens with extension in squander glass content.

VII. METHODOLOGY

A. Phase -I:

Characteristics of materials –The characterization of basic material of concrete as follows: Glass powder, Ordinary Portland cement (53 grade), coarse aggregates and fine aggregates**.**

Cement –The cement required for this experiment will be grade 53 of ordinary Portland cement confirming the requirements of Indian standard determinations IS:1489 (Part 1) 1991.

Glass powder –The waste glass were collected from the scrap market. Then it was crushed in powder form. We consider two types of glass powder soda lime glass and borosilicate glass from waste scrap. Primarily glass is comprised made up of

sand, soda ash, limestone, and additives like iron, chromium, alumina, lead, and cobalt**.**

Aggregates –Crush sand passing through 4.75mm is used as fine aggregate10mm and 20mm metal is used as coarse aggregate **.**

Admixture -BASF Master Rheobuild 822 is used in concrete mix.

B. Phase –II :

Investigation on glass powder -

As before use of powdered waste glass powder, it is necessary to get the properties of it so that we come to know the various result due to its constituents. Thus we tested the glass powder and found the result

Table 1. Test Report of Glass powder

Sr.no	Test parameter	Unit	Results	
			Lime soda glass powder	Borosilicate glass powder
1.	Bulk density	Kg/cm3	0.0014	0.0012
2.	Chemical composition			
a.	Silica content	Percent	89.3	62.9
b.	Calciumoxide content	Percent	1.1	1.3
c.	Sodiumoxide content	Percent	0.5	0.26
d.	Fe2O3+AL2O3 content	Percent	3.8	1.5

Preparation of glass powder -

The glass powder is prepared from scrap glass wastages from various sources like glassware dealers. At first glass is collected from sources and it is crushed in los angels machine. Both the soda lime and borosilicate glass is squashed in this machine, then the formed powder is passed through the 150micron and 75 micron. The powder which is retained on 75micron and passed through 150micron is taken for the mix of concrete in experiment.

C. Phase - III :

Casting of normal specimen -

Four types of mix will be consider; of which one control mixture S-1 (Without glass powder) will be designed according to Indian standard specification IS:10262 (1982) to achieve 28 days strength 35 Mpa. The all materials are properly weight as per their proportions and design mix of M35 in batch mixer. The cubes are casted in dimensions 150 mm x 150 mmx 150 mm.

Table 2. SCON RMC PLANT MIX DESIGN (PER M3) CEMENT AND FLYASH

SCON RMC PLANT MIX DESIGN (PER M3) CEMENT AND FLYASH		
Sr.No.	Materials	Grade M35
1.	Cement (Kg)	350
2.	Flyash (Kg)	50
3.	Crush sand (Kg)	804
4.	10mm metal (Kg)	471
5.	20mm metal (Kg)	707
6.	Water (LTR)	205
7.	Admixture (Kg)	4.0
	Total weight density (Kg/m3)	2591

Casting of specimen using glass powder –The other three concrete mixes will be made by substituting cement with 5%, 10%15% glass powder weight. The cubes are casted using both soda lime and borosilicate glass powder in each of three numbers to get result as average of the

Table 2. Mix proportions of concrete

Mix Identity	Mix proportions
S1	100% cement
S2	95% cement + 5% WGP
S3	90% cement + 10% WGP
S4	85% cement + 15% WGP
S5	80% cement + 20% WGP

D. Phase –IV :

Testing of specimen

Tests will be will be done as follows :-

Workability test - The workability is find out usingslump cone test.The test is carried out on 7th day and 28th day from day of casting.

VIII. MODELING AND ANALYSIS

Tests carried out on casted specimens -

Apparatus - Slump Cone (diameter 200 mm, top diameter 100 mm & height 300mm) standard tamping rod 16mm in diameter and 600mm in length with bullet end.

Procedure:

1. Internal surface of the slump cone should be thoroughly clean and made free from moisture and set concrete before starting the test. The slum cone shall be place on smooth horizontal, rigid and non-absorbent metal surface of size 0.3m×0.6m.The slump cone shall be firmly held while it is being filled.
2. The slump cone shall be filled in layers each approximately one third of its height. Each layer should be tamped 25 times by the standard tamping rod by its rounded end. The tamping should be uniformly distributed over each layer. The tamping rod should not penetrate into the previous layer.
3. After the top layer is tamped scrap off excess of concrete from top of the cone and clean the spilled concrete from around the bottom using the tamping rod.
4. The slump cone is then lifted vertically and slowly allowing the concrete to subside and the slump of concrete should be immediately measured with the help of scale or measuring tape by determining the difference between the height of the slump cone and the height of the slumped concrete. The test should be performed at a place free from vibrations or shocks.

Slump:

The slump shall be recorded in mm of subsidence of the concrete during the test. Any slump in which one half of the cone slides down in an inclined plane is called a shear slump, in such case the test shall be repeated, if the shear slump persists, as may be in the case of harsh mixes, this is an indication of lack of cohesion of the mix. If the slump slides evenly on all sides, it is called as true slump. In case of concrete mixes with high workability a collapse slump is possible. The values of slump test obtained are interpreted as follows:

Table 3. Degree of workability

Degree of workability	Slump value in mm	Suitability
Low	25-50	Mass concrete foundations, lightly reinforced sections
Medium	50-100	Manually compacted flat slabs
High	100-175	For sections with congested sections

IX. RESULTS AND DISCUSSION

Workability Results

MIX DETAILS	INITIAL	60 MIN	120 MIN	150 MIN
SCON Normal Mix	190mm	160mm	130mm	90mm
Soda Lime Glass Powder				
5% Replacement	175mm	150mm	125mm	85mm
10% Replacement	180mm	165mm	130mm	90mm
15% Replacement	180mm	160mm	135mm	95mm
20% Replacement	200mm	170mm	135mm	110mm
Borosilicate Glass Powder				
5% Replacement	170mm	155mm	120mm	90mm
10% Replacement	190mm	160mm	130mm	85mm
15% Replacement	190mm	160mm	145mm	100mm
20% Replacement	195mm	175mm	145mm	100mm

X. CONCLUSION

- In this chapter we are concluding the comparative results obtained by various trials..
- Thus replacement of cement decreases overall cost of concrete.
- Utilizing glass powder can diminish the utilization of concrete and the related vitality request sway on air contamination and CO2 discharge.
- The slump of concrete seems to increment in glass powder in the concrete mix.
- Slump gradually decreased with increase in glass percentage.
- Workability of concrete mix increments in with increment in waste glass content.

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