

**AN EXPERIMENTAL STUDY ON THE STRENGTH
PROPERTIES OF CONCRETE USING WASTE GLASS AND
GGBS**

A PROJECT REPORT

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Submitted by

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CERTIFICATE

This is to certify that **Abhinav kr. singh** under Reg. no. 11303554 has prepared the Dissertation - 2 Report Titled “**AN EXPERIMENTAL STUDY ON THE STRENGTH PROPERTIES OF CONCRETE USING WASTE GLASS AND GGBS**” under any direction. This is a bonafide work of the above competitor and has been submitted to me in fractional satisfaction of the prerequisite for the honor of MASTER OF TECHNOLOGY in CIVIL ENGINEERING.

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Signature of student

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DECLARATION

I **Abhinav kr. singh** (11303554), hereby declare that this submission is my own work and that to the best of my insight and conviction, its content no material beforehand distributed or composed by other individual or office. No material which has been acknowledged for reward of some other degree or certificate of the college or other organization of higher learning with the exception of where due affinitions have been made in the content. It was arranged and displayed under the direction and supervision of **Ms. Geeta Mehta** (Assistant Professor).

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ABSTRACT:

The usage of waste materials from the industries has been continuously emphasized within the research paintings. There is a developing interest of the usage of recycled beaten glass (RCG) as an aggregate in creation materials specifically for non-structural packages. Although the recycled beaten glass is capable of reduce the water absorption and drying shrinkage in concrete products because of its close to zero water absorption characteristics, the potential adverse effect of the use of glass because of alkali–silica reaction (ASR) in cementitious materials is a real issue. There exists an opportunity to enhance the sustainability of this industry via similarly exploring the usage of alternative substances. As an aggregate, glass bottle waste has faced precise challenges consisting of bond, ASR gel manufacturing and energy degradation of the concrete. There exists an opportunity to enhance the sustainability of this enterprise by further exploring the use of alternative substances. Demand for recycled glass has extensively decreased in current years, especially for combined glass. Glass is inexpensive to save than to recycle, as conditioners require prices for the recycling method. In order to provide a sustainable way to glass garage, a ability and incentive way might be to reuse this type of glass in concretes.

It is well known that Portland cement production is an power-in depth enterprise, being responsible for about 5% of the global anthropogenic carbon dioxide emissions worldwide. An critical contribution to sustainability of concrete and cement industries includes the use of pozzolanic additions, especially if obtained from waste such as waste glass. Depending on the dimensions of the glass debris utilized in concrete, adverse behaviors can be determined: alkali–silica response, which involves terrible results, and pozzolanic response, enhancing the residences of concrete. Waste glass creates severe environmental problems, in particular due to the inconsistency of waste glass streams. With growing environmental pressure to lessen strong waste and to recycle as a lot as feasible, the concrete industry has followed a number of methods to reap this intention. The properties of concretes containing waste glass as high-quality aggregate were investigated in this examine.

Ground granulated blast-furnace slag (GGBS) has been applied as constructing fabric because of the environmental, economic and technical advantages. The utilization of industrial waste produced with the aid of commercial tactics has been recognition of waste reduction studies for reasonable, environmental and technical reasons. GGBS (Ground Granulated Blast Furnace Slag) and GBF Slag Sand is one such waste made from the iron production enterprise, whose use and production has increased many folds all through remaining decades is used on this experimental painting as opportunity binder and filler materials for Ordinary Portland Cement (OPC) and River Sand respectively in concrete. Ground Granulated Blast Furnace Slag has been constantly in use as cementitious substitute for sustainable infrastructure.

CHAPTER- 1

INTRODUCTION

The idea utilizing material for building packages encompasses a roaring history, that has ash, slag, and oxide fume. These as shortly as troublesome, land stuffed waste materials measurement presently thought of to be valuable commodities to be utilized in up positive properties of concrete. A stuff that continues to face disputes as an element of concrete is bottle glass. the advantages of developing totally different or the supplementary cementing substances as partial replacements for daily cement (OPC) powder into ecological, economic, and engineering classes.

Ecological or environmental blessings of likelihood materials embody, the diversion of non-recycled waste of landfills for helpful packages, the discount inside the unhealthy specifically consumption of nonrenewable fixings assets, the reduction use of power for cement manufacturing and conjointly the corresponding emission of the greenhouse gasses.

The economic blessings of the usage of likelihood substances measurement first-rate accomplished in things where price of the possibility material of smaller quantity than cement powder whereas transmission comparable overall performance. This price got to be compelled to recall the supply of the selection artefact, its transportation, processing, and should recall cash savings through diversion, that embody tipping costs and lowland management charges.

The engineering or technical edges of likelihood substances measurement noted whereas a specialised use for such material is developed, such use of possibility material is extra wonderful than use of concrete created from OPC alone. There exists the probability to acknowledge these capability edges even in communities whereby employment applications unit of measurement in location.

Although a scale down side employment application has supposed increasing charges of employment in Ontario considering 1987, simplest sixty eighty two of alcohol bins, as associate instance, unit measurement recovered through employment packages, and lots of of this material is broken and of mixed coloration, making high price employment arduous and impractical. As a impact, waste glass can oft came back to landfills.

Alcohol bins on my terribly own make up 1 / 4 mile of decrease facet recycled artefact, and by 2015, those boxes unit measurement anticipated to contribute 116,000 tonnes of fabric to the gathering circulation. Early makes a trial to contain waste surround concrete attended attention on combination replacement. The glass appeared like of big combination in phrases of charter, energy and strength, and conjointly the larger size glass supposed decreas method costs.

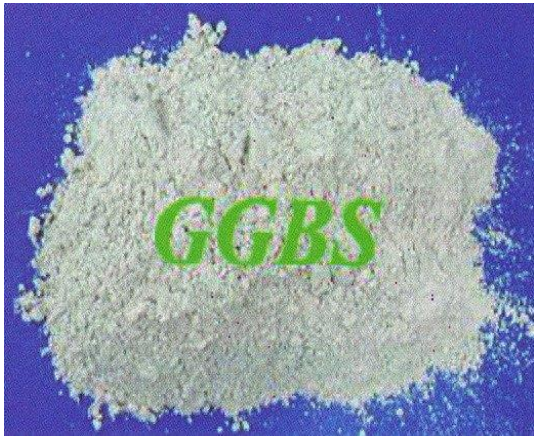
These early makes a trial but, area unit unsuccessful owing to the alkali–silica response (ASR) that takes place inside presence of amorphous waste glass and concrete pore answer. Additionally to ASR, varied completely different disputes exist in incorporating waste glass into concrete.

exploitation waste bottle glass limits the size and type of trash for coarse mixture. the utmost size of 1 dimension of the mixture will frequently be thickness of bottle. Crushed waste bottles will consequently have a bent to make giant combination that is flat and elongated, and will negatively have a bearing on workability, which has been attributed to discovered decreases in compressive electricity. Waste glass to boot affords a challenge in phrases of contamination and consistency at intervals the waste flow. Most waste glass which can not be recycled is broken and of combined color, that allows you to purpose variant at intervals the chemical composition of the waste. there's infection attributable to paper and plastic labels, caps and corks, and sugars remaining from the primary use and content material of the bottles. Moreover, seasonal fluctuation at intervals the waste circulation would be expected. thus on beat the constraints of ASR, several treatment techniques ar explored, that sometimes blanketed mechanical and chemical treatments. In exploring those methods, key developments were created. Experimentation the usage of mechanical remedies confirmed reducing the particle size of the waste glass through grinding. The results of this work indicated that as a result of the particle length of the waste glass become attenuate, the tendency for ASR formation additionally reduced. moreover, the outcomes yielded an increase at intervals the compressive energy of concrete created with really pleasant waste glass. Chemical remedies were to begin with explored in element throughout that a sequence of salts, acids, natural and proprietary compounds, and proteins ar utilized in mortar bars containing glass enclose an attempt to identify that substances also can cut back ASR. This assortment of assessments indicated that the use of metal compounds appreciably reduced ASR connected enlargement.

This paper provides a necessary value of analysis tasks reportable within the literature, the goal of that's to boost the practicableness of incorporating waste glass into concrete through various treatments. The summary is weighted at the progress created to broaden waste glass into a doable Supplementary Cementing Material (SCM). The cognizance of waste glass utilization has shifted in additional current years from mixture to mineral additive in gentle of the observations regarding particle size.

Ground coarse blast-furnace dross (certain as GGBS) has been applied as constructing material as a result of their environmental, economic and technical blessings. the employment of business waste created with the help of economic techniques has been recognition of waste reduction studies for cheap, environmental and technical reasons. GGBS (Ground coarse furnace dross) and GBF Slag Sand is one such waste made of the iron production enterprise, whose use and production has enhanced several folds during remaining decades is employed on this experimental paintings as chance binder and fillermaterials for standard Portland cement (OPC) and watercourse Sand severally in concrete. Ground coarse furnace dross has been perpetually in use as building material substitute for property infrastructure. GGBS and dross sand area unit stuff nonheritable from Iron and silver producing enterprise. thus the disposal trouble of waste material is solved side by manner of side the saving of cement and natural sand could also be completed. property concrete is that the main stress given to this technology to provide concrete so as to conquer the shortage of natural watercourse sand and also the environmental destruction (i.E. Worldwide warming) caused because of the emission of greenhouse emission throughout the association methodology of cement concrete. Hence, a concrete which will be sustained for a awfully protracted amount of time and for

the long run generations to return is to be focused and pressured on. Concrete, that's most versatile building artifact used all over within the globe within the assembly enterprise has to be inexperienced, low in value and property in terms of technical and non-technical aspects.



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GGBS and waste glass :

CHAPTER- 2

LITERATURE REVIEW

Corinaldesi et al. (2005)

They urged that no alkali-silica reaction has been detected with particle sizes up to one hundred lumen, as a consequence reflective the practicableness of glass apply as exceptional mixture in mortars, concrete.

Chenetal. (2006)

He discovered a vast improvement within the compressive energy of glass concrete mixes at later ages, however workability reduces and result of the glass content material elevated.

Shayan and Xu (2006)

He endorsed victimization glass and glass mixture on in 40-MPa concrete mixtures with none unfavorable response.

Metwally (2007)

They in addition same that usage of finely processed waste enclose concrete mixes had a terrible result at workability, then significantly improve in the mechanical strength of concrete at later a drawn-out time.

Vasudevan Gunalaan and Kanapathy pillay Seri Ganis [2013]

He investigated the take look at results at seven, 14, twenty-eight days of set of cubes containing glass with partial substitute with cement and outcomes shows that 2 hundredth glass mix quantity shows an attractive worth of compressive electricity at twenty-eight days compare to completely different quantitative relation that 10 and fifteen August 1945 isn't potential albeit have moderate increment from fourteen days consequences.

Vandhiyan R. Et al[2013]

He studied the substitute of cement through glass and finished that the sizeable increase at intervals the first energy profit specifically at Specimen fifteen August 1945glass powder gave a twenty ninth increase inside the ability at seventh day further than management specimen. At twenty eighth day this distinction in strength reduces to twenty three xmas. The electricity increment is foremost at ten substitute.

Kumarappan N. [2013]

They part replaced cement by suggests that of glass and same that upto 10 it's potential to interchange cement as a results of it shows higher compressive energy than the manage combine.

Vijayakumar G. Et al[2013]

He planned that cement replacement upto forty five by suggests that of glass showed increment in compressive electricity at each twenty eight days and sixty days age of set as compared to simple concrete.

Nwaubani Sunny O. And Poutos Konstantinos I. [2013]

He finished that increase in the amount of enclose mortar causes a contemporary decrease of compressive electricity, however the decrease will abate obvious with prolonged set time. The size distribution of glass used became the key facet influencing the electricity development.

Khatib J.M. Et al[2012]

They studied concrete performance with partial replacement with cement and finished that the foremost compressive power happens at spherical 10 glass powder and past 10 it's an inclination to decrease and is below that of management.

Patel Dharendra et al [2012]

They investigated the flexibility traits of pre solid blocks incorporating waste glass powder and studied that the slight stage decrease within the compressive strength at twenty eight days takes place.

Jangid Jitendra B. And Saoji A.C. [2012]

He finished that the upto ordinal replacement of cement, compressive energy growth upto 2 hundredth and cement changed on the so much facet that decreases compressive electricity.

Chikhalikar S.M. And Tande S.N. [2012]

He investigated at the traits properties of fibre concrete contains glass as pozzolona and shows the compressive power increase is carried out upto 30 minutes compared to manage mix, however the peak kaffir boom is at 2 hundredth replacement.

Dali J.S. And Tande S.N. [2012]

They studied the property of concrete containing mineral admixtures, whereas it's subjected to likelihood wetting then drying and excessive temperature and resulted that the compressive energy increment is upto twenty fifth numerous of cement by suggests that of waste glass powder, but the height gain is at 2 hundredth substitute in every the cases, i.E. Concrete whereas not subjecting to change wetting and drying, and concrete subjected to change wetting and drying.

Dr. G. Vijayakumar et. Al.

He tested possibility of victimization powder with partial replacement with cement for complete recent concrete. Glass powder became half replaced as 10, 20%, 30 minutes and forty five and conducted tests for its compressive, tensile and flexural power the most quantity as sixty days aged and were as compared with those of ancient concrete; for the implications nonhereditary :-

- it became set that tumbler powder length below 75micro meter a lot of[to avoid wasting} lots of you alkali silicon oxide response. once the examine it became set that the quality concrete examined at twenty-eight day compressive electricity as thirty one.1 N/mm², split tensile electricity of 2.27N/mm² and flexural strength of 3.25N/mm² 1. Replacement with glass in cement via 2 hundredth, 30 minutes and ordinal will increase the compressive power by suggests that of 19.6%, 25.Three% and thirty 3.7% severally.
- Replacement of glass in cement by victimization forty five can increase the split strength by technique of 4.Four% severally. Replacement of glass powder in cement by victimization 2 hundredth, 30 minutes and ordinal can increase the flexural power by suggests that of eighty 3.07%, 99.07% and 100 p.c severally.

Mendes et al. (2009)

He reportable that the neat paste specimens provided no residual compressive strength once one week from message to 800 C, at identical time as specimens containing 5 hundredth and sixty fifth GGBS exhibited residual compressive electricity spherical eleven–13 MPa. this fashion higher fireplace resistance of paste specimens with the inclusion of GGBS.

Choi et al. (2013)

He pronounced that concrete containing 5 hundredth and seventieth GGBS changed with 10 and 2 hundredth utensil exhibited higher residual compressive power once being exposed to 1200 C for sixty min compared to that changed with baseball game utensil.

Rashad (2015b)

He reportable that despite the actual fact that the neat laptop computer paste compressive strength became one.Eighty five instances more than that containing eighty five - vi GGBS as cement totally different, the residual compressive energy of HVS paste was constant as that of the neat laptop computer paste once being exposed to six hundred C and 800 C for 2 h

Mendes et al. (2008)

He discovered higher residual compressive energy of paste specimens containing sixty fifth GGBS at 400–800 C as compared to the manipulate, whereas the management confirmed higher residual compressive energy at 100–300 C.

Wang (2008)

He same that at w/b relation of zero.23 for pastes containing HVS, the superior content material of GGBS to approach to extended temperatures starting from one hundred and five C to 1050 C for four h became among 5 hundredth and eightieth

Choi et al. 2013

He reportable that enhancing concretes containing 5 hundredth and seventieth GGBS with 10 and 2 hundredth utensil, as GGBS replacement, exhibited higher compressive energy than that changed with baseball game utensil. the advance at intervals the twenty eight days compressive power of concrete containing 5 hundredth GGBS changed with 10 and 2 hundredth utensil over that modified with baseball game utensil became 3.Fifty 600 and vi.94%, severally.

Gu neyisi et al. (2010)

He suggested that half dynamic GGBS with V-J Day SF in concrete specimens containing hour GGBS as cement totally different larger the twenty eight and ninety days compressive strength by eight.2% and 13.12%, severally.

Chabib and Ibrahim (2013)

They changed concrete specimens containing seventieth GGBS as cement totally different via part exchange GGBS with 10 SF. The inclusion of 10 SF plenty of fascinating the compressive electricity by technique of 3.1% and 5.62% at AN extended time of seven and twenty eight days, severally, at w/b relation of zero.Three, whereas the advance was eight.2% and 0.16%, severally, at w/b relation of zero.33.

Zhang et al. (2012)

He same 10, 17%, 14%, minute and 13 improvement inside the one, 3, 7, twenty eight and ninety one days compressive strength of mortars containing 5 hundredth GGBS with the inclusion of 1 Chronicles SF, with the assistance of weight of artefact substances. On identical line, they discovered fourth, 5%, 1 Chronicles and 1 Chronicles improvement inside the three, 7, twenty eight and ninety one days compressive energy of concretes containing 5 hundredth GGBS with the inclusion of twenty years SF

Mounanga et al. (2011)

They suggested that {the 2|the 2} and 7 days compressive electricity of cardinal GGBS mortar specimens is additionally higher through twenty two.Eighty during a row and twenty one.Eighty twenty years, severally, once FTO from GGBS was replaced with stone.

Patel Dharendra et al. [2012]

They studied the homes of cement sand mortar paste containing satisfactory and coarse glass powder as partial replacement of cement and effects confirmed that fifteen August 1945 dose for replacement is most advantageous.

Khmiria et al. [2012]

He planned his experimental work containing clear and colored glass of varied sizes (100 and eighty μm , eighty and forty μm and not up to forty μm) and dawned to a conclusion that compressive power index of floor waste glass reaches extra than eighty 2 atomic number 87 sizes decrease than forty μm .

Patil Dhanraj Mohan and Sangle Kehav K. [2012]

They studied the take a look at outcomes of waste glass powder mud ranging from length 150 μm to 90 μm and fewer than 90 μm . He confirmed that initial power advantage is extraordinarily less due to addition of GLP on seventh day however it will increase at the twenty eighth day. it's determined that 2 hundredth addition of GLP offers higher electricity. And additionally GLP size plenty of however ninety metric linear measure may be really powerful in sweetening of power.

Bajad M.N. Et al [2011]

He studied the energy homes containing glass once subjected to salt assault and showed that the heightcompressive power is dead at 2 hundredth substitute of cement by suggests that of waste glass powder everywhereas concrete is not subjected to salt assault and whereas concrete subjected to salt assault and thus theincrement continues upto twenty fifth substitute on the so much facet that it decreases.

Wang Her-Yung and Hou Tsung-Chin [2011]

He finished their examine of Elevated Temperatures on the Strength Properties of digital display Glass Powder Cement Mortars and finished that work 100 percent of cement by suggests that of glass powder might advantage a very promising compressive electricity of the mortars, notably once the brought glass incorporates a powder fineness $\geq 4500 \text{ cm}^2/\text{g}$. In real practices, this amount of glass powder substituent may be suggestively accustomed update cement.

Oliveira L.A Pereira American state et.al [2010]

They targeted on the analysis of the pozzolanic hobby of inexperienced, amber and flint color waste glass of varied particle sizes (75µm – 150µm, 45µm – 75µm and < 4µm) as a component of artefact materials used as filler or binder in mortar and concrete. He finished that 30 minutes of 5|45} - seventy 5 µm ground waste glasses size choice may be encircled as cement substitute in mortar or concrete with none damaging effects as a results of the constant aggravated via the alkali silicon oxide response.

Shayan Ahmad [2002]

He finished that 30 minutes GLP could be incorporated as cement or mixture replacement in concrete with none long-time quantity unfavourable consequences. Up to 5 hundredth of every satisfactory and coarse mixture may additionally get replaced in concrete of thirty 2 MPa power grade with ideal energy development homes.

Rakesh Sakale et. al

He studied the substitute of cement with the assistance of waste glass powder in steps of 100 percent, 20%, 30 minutes and ordinal severally by pattern quantity of cement and its results on compressive electricity, split tensile electricity, workability and flexural strength unit of measurement set. it's discovered that the compressive, flexural and split tensile strengths of concrete growth first of all as a results of the cost of cement through glass powder can increase and become most at around 2 hundredth and later lower. The workability of concrete reduces monotonically because the different % of cement by suggests that of glass powder will increase. The substitute of cement the maximum amount as regarding two hundredth by manner of glass powder could also be dead while not sacrificing the compressive power.

Oluko et.al.

They investigated the compressive strength of Compressed stabilised Earth Block (CSEB) by partially exchange the cement (stabilizer) within the block with Waste Glass Powder (WGP) and it became discovered from the results that, as WGP is other to compressed stabilised earth block, its electricity reduces. Although, the electricity for CSEB with out waste glass had the most effective electricity, CSEB with WGP indicated strengths higher than 3N/mm² supported as borderline energy for CSEB at twenty eight days for the share of replacements used on this observe, the best of that become hour. No best fee became placed for WGP addition to the CSEB as different for cement, however, enough strengths correct enough for handling at early levels of the CSEB whether or not at particle size of 1 hundred fifty µm or seventy 5 µm were dole out at two hundredth substitute of cement with WGP in CSEB. It may be finished that the role of WGP in CSEB is additional of filler than a binder.

Shuhua Liu et. al

He performed a studies to look at the repressive impact of waste glass powder (WGP) on AlkaliSilica Reaction (ASR) enlargement prompted by suggests that of waste glass combination. These analysis showed that there could also be ASR probability with AN ASR enlargement worth over zero.2% while the sand includes additional than half-hour glass mixture. However, WGP will effectively manipulate the ASR enlargement and inhibit the expansion worth caused through the glass combination to be below zero.1%. The distinctive area of WGP and therefore the ASR growth have AN anti-correlation, that leads the pozzolanic reaction bigger intense and faster and better repressive impact on ASR growth. The ASR growth may be managed during a secure selection whereas WGP content material is 100%, two hundredth and half-hour with its distinctive floor place bigger than 1137.40, 604.37 and 71.34m²/kg, severally, or with low common particle size in line with the calculation.

Raghavendra K. And Virendra Kumara K. N.

He investigated regarding the compressive strength, slash tensile electricity and water absorption of M40 grade of concrete mixes with 2 hundredth constant replacement of waste glass powder in cement and partial replacement of waste mill sand in excellent combination. From the check results, power was accomplished terribly less on seventh and ordinal days however it will increase on the twenty eighth day. High energy values are discovered at four-hundredth replacement degree in strength parameters. The compressive power and split durability of concrete at seven, fourteen and twenty eight days will increase at first because the share of replacement of waste glass powder and waste mill sand can increase and can become most at a share severally spherical A40, A40.

Ana Mafalda Matos

They aimed to assess the usage of waste glass powder in powder kind SCC. It will be ended that waste glass powder is also used effectively in SCC any enhancing chloride penetration and water absorption by manner of capillary action, retentive power tiers. though mixture glass offers a excessive alkali content, use of ground waste glass as cement various in mortar, advanced resistance to ASR. These effects corroborate the pozzolanic nature of glass powder and its behaviour with time. though glass powder could be a bit coarser than cement, it notwithstanding brings blessings whereas enclosed in cement.

Jitendra B. Jangid and A.C. Saoji

They studied the substitute of Glass Powder numerous partly from zero to four-hundredth, at a language of 100 percent and examined for its Workability, Compressive Strength, Split durability, pH check, Density measure, Water Absorption check, Volume of porousness check and unhearable Pulse rate check for the age of seven, twenty eight and fifty six days and was as

compared with those of ancient concrete. the quality check upshot confirmed that Waste Glass Powder is also used in concrete as a decent replacement of cement. It become additionally found that Workability of concrete decreases as share of glass powder can increase. Slump worth of test's concrete ranges from sixty to eighty millimetre most compressive strength became found once Glass Liquid Powder (GLP) substitute is regarding 2 hundredth. Highest split tensile electricity was discovered once GLP various is about 2 hundredth.

Ashutosh Sharma and Ashutosh Sangamnerkar

They showed that waste glass, if floor finer than 600 μ m indicates a pozzolanic behaviour. It reacts with lime at early stage of association forming additional CSH gel there through forming denser cement matrix. therefore early intake of alkalis with the help of glass particles helps within the discount of alkali-silica response for this reason enhancing the sturdiness of concrete. Numbers of check were dole out to review the result of 5, 100 percent and V-J Dayreplacement of cement by victimisation glass powder on compressive electricity and strength. The particle length result become evaluated via the employment of glass powder of size 600 μ m-100 μ m. The results showed that the foremost growth in energy of concrete materialized whereas 100 percent replacement was finished glass powder. Then placed upshot :-

- Conventional concrete shows a 3 days compressive electricity as 9 N/mm and a try of 5% various of glass powder in cement elevated the compressive power through thirty seventh in three days.
- 10% various of glass powder increment accelerated the compressive strength by victimisation fifty 2.6% in 3 days. \rightarrow V-J Day replacement of glass powder in cement extended the compressive electricity by means that of thirty-nine.8% in three days.

M. Adaway and Y. Wang

They aimed to determine the amount of glass substitute succeeding in optimum compressive strength. 3 concrete samples are tested at seven and twenty eight days for glass replacement proportions of fifteen, 20, 25, 30 and 40%. Compressive power became found to growth up to grade of half-hour at that issue the facility evolved became 9 and 6 June 1944 higher than the manipulate once seven and twenty eight days severally. This demonstrates that concrete containing the maximum amount as half-hour superior glass combination well-known shows higher compressive energy improvement than ancient concrete. The choicest p.c substitute of sand with satisfactory glass mixture became set to be half-hour. Compressive power became found to boom with the addition of waste glass to the mixture up until the optimum degree of replacement.

Veena V. Bhatt and N. Bhavanishankar Rao

They studied the impact of other of cement by glass powder and determined that there was a rise of twenty seventh power once substitution two hundredth glass powder, whereas w/c quantitative relation was hold on consistent. Slump take a

glance at became achieved and therefore the droop became discovered to be seventy to 72mm in spite of two hundredth replacement. it absolutely was in addition discovered that with the expansion in glass content material, proportion of water absorption decrease. Considering the energy standards, the replacement of cement by means that of glass powder is possible upto two hundredth.

Prema Kumar W P et. al

They all over that cement in concrete is modified through waste glass powder in steps of fifty from third to 45 through volume and its results on compressive strength, chop up tensile power, workability and weight density area unit set. the implications were determined to be-

- The seven days, twenty eight days and sixty days compressive strengths of concrete boom to start with because the substitute proportion of cement with glass powder can increase, and emerge as most at concerning two hundredth and later decreases.
- The slash tensilepower of concrete can increase to start with because the substitute proportion of cement with glass powder will increase, and can become most at concerning two hundredth and later decrease.
- The stoop and weight density of concrete decrease monotonically as a result of the replacement proportion of cement with glass powder can increase. The workability decreases while cement is modified part with glass powder.
- The examine showed that there's an amazing capability for the usage of glass powder in concrete as partial substitute of cement.

concerning half-hour of cement is also modified with glass powder of length a lot of but 100 μm with none sacrifice at the compressive power.

CHAPTER- 3

METHODOLOGY

Materials Used: In gift work numerous materials is employed with their individual homes specifically: OPC fifty three Grade, GGBS, waste Glass , Fine aggregates: Natural stream sand and scum sand (SS) Coarse combination, Water.

A. **Cement:** normal hydraulic cement of fifty three grades orthodox to IS: 12269-1987 has been used the cement nonheritable on winding upapplicable exams as to keep with IS: 12269-1987.

B. **GGBS:** GGBS is employed on this experimental paintings. GGBS and scum sand arwaste matter obtained from Iron and steel producing enterprise.The coarse furnacescum used within the investigation.The assessments on coarse furnace scum can beachieved: 383-1970.

C. **Fine Aggregates:** domestically to be had clean stream sand passing via IS-480 sieves had been used. the consequences of sieve analysis allotted as in step with IS: 383-1970.

D. **Waste glass powder:** Waste glass like:- broken glasses of home windows , doors, LED bulbs, tubelights, cfl bulbs, mirrors,etc. Is ued on this studies for the investigation.

E. The coarse combination used is crushed (angular) combinationorthodox to IS 383: 1970. the most length of mixture taken into thought is 20mm IS sieve passing and minimum length of combination thought of is twelve.5mm IS sieve passing. the results of sieve analysis may be carried out as to keep with of IS: 383-1970.

F. **Water:** Clean potable water is employed for casting and activity operation for the paintings. The water equipped within the field is of the potable in style of pH scalecost= seven.50 can be used.

combine Proportion:

Concrete combine layout of M25 grade become designed orthodox to IS: 10262-2009 is ready and trial combinees are tried to achieve getableconcrete mix. Cubes of modern size 150x150x150mm, Prisms of length 500x100x100mm and cylinders of diameter 150mm and height 300mm is also casted and cured at temperature and are examined at seven, twenty eight and ninety days.

contemporary Concrete Properties:

to appreciate the contemporary homes of concrete, slump take a look at are going to be allotted. chiefly this check tells concerning the segregation and hemorrhage of the concrete.

Hardened Concrete Properties:

Compressive strength, flexural electricity and ripping tensile power of various mixes is also determined.

Compressive Strength:

The cubes of length one 50mm×150mm×150mm are casted for numerous potentialities of GGBS modified with cement through (50%, 55%, 60%, sixty fifth and 70%) and (WG) may be constant at 2 hundredth replaced with glorious sand. The cubes are cured and tested for seven, twenty eight and ninety days. Testing became created in 2000kN testing device with loading fee of 140kg/cm/m². The typical of three cubes for each activity and each various is cited right all the way down to get the compressive energy of concrete.

Split Tensile Strength:

The ripping enduringness is wide illustrious indirect take a look at used for determinative the tensile power of concrete as it's miles one among the most essential essential properties of concrete. 3 cylinders 300mm long are casted for varied percentages of GGBS replaced with cement with the help of (50%, 55%, 60%, sixty fifth and seven0%) and (WG) may be mounted at 2 hundredth replaced with nice sand and cured for 7, twenty eight and ninety days for each replacement of GGBS and (WG). Testing became created in 2000kN testing machine at worth of loading as (1.2 to 2.4) ($\pi/2$) l*d, N/min. The typical of three cylinders for each various is noted all the way down to get the strength split tensile of concrete.

Flexural Tensile Strength:

Flexural electricity is represented as a substances potential to face to deformation beneath load. 3 beams of length 100mm×100mm×500mm are casted for numerous potentialities of GGBS replaced with cement by suggests that of (50%, 55%, 60%, sixty fifth and seven0%) and (WG) are going to be mounted at 2 hundredth replaced with fine sand and cured for 7, twenty eight and ninety days for each various of GGBS and (WG). Testing became achieved underneath 2 purpose loading in flexural attempting out device.

PROPERTY OF AGGRIGATE

PARTICLE FORM AND SIZE

Particle length, kind and texture will have large results on numerous layout homes and are ordinarily distinct within sure limits. Rounded combination will result in instability during a hydrocarbon combination however be excellent as a concrete combination wherever right workability of the mixture is crucial for putting and compaction. The form and have a bearing on considerably the energy of

concrete, particularly the flexural power. this is often as a result of they each influence the bonding among the mixture and therefore the cement paste. A rougher texture floor which has those of crushed particles leads to bigger adhesion between the particles within the cement matrix. smooth surfaced particles have terribly poor bond consequently provides concrete of lower power that is dissatisfactory. form of combination may be delineated as traditional, irregular, angular, rounded or flaky. Surface texture is delineated as smooth or laborious.

TOUGHNESS AND HARDNESS

Toughness is outlined because the resistance of AN combination to failure by result. Hardness is that the resistance of the combination to place on. Hardness is AN essential assets of concrete used particularly in roads and floor surfaces subjected to serious traffic.

CLEANLINESS OF MATERIALS

ORGANIC IMPURITIES

The aggregates to be used need to be simple and free from natural impurities that intervene with association. The natural matter determined in combination unremarkably includes merchandise of degradation of vegetable count variety acting in variety of humus or natural dirt. Such substances are most likely to be found in sand than in coarse aggregates. laundry of first-rate aggregates should be done to try to get away with natural impurities.

SILT AND FINE MATERIALS

They intervene with combination and cement paste. Since an honest bond is important to make sure quality electricity and strength of concrete, the matter of clay and silt coatings got to be self-addressed. Silt and first-rate dirt could be bootfoam coatings or is also gift in variety of free rubble not guaranteed to the coarse mixture. Silt and nice dirt got to no longer be gift in inordinate quantities as a result of as a result of their fineness and consequently massive surface regions, silt and nice dirt boom the amount of water necessary to dampish all of the rubble within the combo as a consequence reducing the electricity concrete. The aggregates should so be washed to place off those impurities. laundry need to no longer be thorough therefore as to not subtract the fines passing sieve of 300µm. this is often as a result of deficiency of those fines results in harshness within the combo.

LABORATORY TESTING OF AGGRIGATE

Introduction

This take a look at consists of dividing up and separating by a sequence of take a glance at sieves, a material into varied particle size classifications of reducing sizes. Mass of the rubble maintained at the varied sieves is related to the initial mass of the fabric. The accumulative percentages passing each sieve are mentioned in numerical and graphical kind.

Objective

- To decide the particle length distribution of selected aggregates.

Apparatus

- Sieves of various length.

Procedure

The take a look at sieves had been organized from pinnacle to bottom so as of lowering aperture sizes and form a sieving column. the combination sample column and agitated fine manually. Sieves are eliminated one when the opposite starting with the most important aperture sizes (top most) , and every sieve agitated manually guaranteeing no artifact is lost. All the material that exceeded every sieve was back to the column before continued with the operation therewith sieve. The maintained artifact became then weighed for the sieve with the largest aperture size and its weight recorded. The equal operation was performed for all of the sieves within the column and their weights recorded. The screened artifact that remained among the pan became weighed and its weight recorded.

SPECIFIC GRAVITY

Introduction

There are varied types of specific gravities of aggregates.

1. Absolute specific gravity

It refers back to the magnitude relation of the load of the robust declared vacuum, to the burden of a standardized volume of gas loose H₂O each taken at aforesaid temperature.

Amount of the amount the degree of robust referred is that the quantity aside from all of the pores.

so therefore one will eliminate the result of whole clathrate imperviable pores, the material should be small-grained. This take a look at is each heavy and sensitive and it's not ordinarily needed in concrete era.

2. Apparent distinctive gravity

This is the magnitude relation of the load of the combination dried in AN kitchen appliance at 100°C – 100 ten°C for twenty-four hours to the load of the water occupying a amount same thereto of the robust which has the imperviable pores. The latter weight is determined employing a vessel (pycnometer) which may be befittingly packed with water to a precise amount. the plain relative density of combination depends upon at the precise gravity of the minerals of that the mixture consists and on the amount of voids.

Three. Gross relative density

This is the particular gravity received on saturated floor - dry state of affairs of combination. Calculations with regards to concrete are ordinarily based mostly whole at the saturated surface - dry condition of the mixture as a result of the water contained all told the pores within the mixture will no longer participate in chemical reactions of cement and will so be taken into thought as a part of the mixture. This relative density is most often used and certainly determined and necessary for calculation of yield of concrete or {the amount|the amount|the number} of mixture needed for a given quantity of concrete.

Objectives

- To decide the gross and obvious specific gravities for the desired coarse and nice aggregates.

Apparatus

- Drying kitchen appliance capable of maintaining temperatures of 100 and ten°C and higher than.
- A twine basket ideally 3mm mesh, 200mm diameter and 400mm peak.
- A water tight tank containing water at 22±three°C.
- A dry absorbent cloth.

Procedure for coarse aggregates

Approximately 2Kg of a advisor sample of combination maintained on a 10mm take a glance at sieve became taken and therefore the sample became totally washed with water to eliminate dirt on the surface of the grains. This became discovered through soaking in water at 22±three°C for 24 hours. The specimen became eliminated from water, agitated off and rolled in massive absorbent till all the seen films of water were removed.

massive rubble are wiped in my read. The pattern became weighed and recorded as Wsd. The pattern became then placed during a twine basket, immersed in water at temperature and tapped to eliminate entrapped air at the surface and among the grains and weighed the pattern at an equivalent time as immersed. This weight became recorded as Ww.

The sample become later off from water; dried during a drying kitchen appliance to a gradual weight at a temperature of 1 zero five°C – 100 ten°C and cooled to temperature.

Analysis

Specific gravity on saturated floor-dry basis, $Ssd = Wsd \div (Wsd - Ww)$
Absolute dry relative density, $Sap = Wod \div (Wsd - Ww)$

AGGREGATE CRUSHING worth (ACV)

Objective

To decide the relative degree of the resistance of AN combination to crushing beneath more and more allotted compressive load.

Apparatus

- An open finished steel cylinder 150mm internal diameter with plate.
- Round finished silver tamping rod 16mm and 600mm extended.
- A weighing machine.
- Sieves of 14mm, 10mm and a try of .36mm size.
- A compressive finding out system ready to applying 400KN, at a consistent loading fee.
- A cylindrical steel live of internal dimensions; 115mm Ø via 180mm deep.

Procedure

The surface-dry combination become sieved through 14mm and 10mm sieves and therefore the material maintained on 10mm sieve followed for check. The maintained artifact was positioned among the cylindrical live and its weight set and recorded as Wt (A). The cylinder of the take a glance at equipment become place in position and therefore the check sample positioned in three layers every layer being subjected to twenty five strokes of the tamping rod. The surface of the mixture was then levelled and therefore the plunger inserted and ensured it reinvigorated horizontally on the surface of the aggregates. The equipment with the take a look at sample and plunger had been then placed in position among the platens of the finding out device and loaded at a consistent fee to the desired load. when loading, the crushed cloth became eliminated from the cylinder and sieved via a pair of .36mm sieve. The fraction passing the two .36mm sieve became then weighed and recorded as Wt (B).

Analysis

Aggregate crushing value = $Wt (A) / Wt (B) \times \text{one hundred percent}$

DESIGN OF CONCRETE MIXES

This is the way of selecting the most effective proportions of cement, first-rate and coarse combination, water and now and again admixtures to produce concrete having the properties distinct and desired i.E. Workability, compressive strength, density and strength necessities via specifying the token or most water/cement magnitude relation.

PRINCIPLES OF STYLE

Strength margin

Due to variability of concrete strengths, the combo ought to be designed to own higher counsel strengths than the operate energy. the excellence between the 2 is that theMargin. The margin is based totally on the range of concrete strengths from preceding producing info expressed as a most popular deviation.

Workability

The workability of the concrete mix become determined with the help of the hunch certifyis additional appropriate for higher workability mixes.

Free-water

The overall water during a concrete combine includes water absorbed by suggests thatof the mixture to hold it to saturated surface – dry state of affairs and therefore theunfastened – water to be had for association of cement and for the workability of the sparkling concrete. The workability of sparkling concrete depends upon on an enormousvolume on its loose – water content material. In follow, aggregates ar usually wet whichthey contain each absorbed water and loose floor water in order that the water delivered to the mixer is a smaller amount than the free – water content material. The electricity of concrete is healthier associated with the loose – water/cement magnitude relationconsidering the actual fact that during this basis the electricity of concrete doesn't rely on the absorption characteristics of the aggregates.

Types of aggregates

Two characteristics of aggregates rubble that have a bearing on the residences of concrete ar particle form and surface texture. Particle kind impacts workability of the concrete and therefore the floor texture affects the bond among the cement matrix and therefore the aggregates particles and so the strength of concrete. 2 kinds ofaggregates ar thought of for layout on this foundation; Crushed and Uncrushed.

STAGES IN COMBINE STYLE

STAGE 1: choice of target water/cement (w/c) magnitude relation

STAGE 2: choice of unfastened water-content

STAGE three: Determination of cement content material

STAGE four: Determination of total combination content material

STAGE five: choice of best and coarse mixture content material

STAGE 6: combine proportioning

PRODUCTION OF TRIAL MIXES

The necessary goal to create trial mixes is to examine whether or not or now not the actual aggregates or cement hand-picked to be used can behave as anticipated. changes is also created to the distinctive mix proportions, if vital, can vary according to however AN awful ton the results of the trial mixes fluctuate from the layout values. supported these, the courses of moves which can be pondered are;

- To use trial combine proportions within the producing of mixes
- To regulate the trial mix proportions barely within the production of mixes
- To place along equally trial mixes incorporating foremost changes to the mixture proportions

The mix style adopted gave the weights in kilograms of the exclusive substances needed to supply one metric capacity unit of compacted concrete. The batch weights for the trial combine had been nonheritable directly by mistreatment multiplying every of the ingredients contents by approach of the quantity of the combo needed. for example, among the producing of the regular blend;

- Volume of one cube; $0.10\text{m} \times 0.10\text{m} \times 0.10\text{m} = 1 \times 10^{-3}\text{m}^3$
- Wastage = 15 August 1945. Therefore, overall extent = $0.15 \times 1 \times 10^{-3} = 1.15 \times 10^{-3} \text{m}^3$
- Volume of combine required; $9 \times 1.15 \times 10^{-3} = 0.01035\text{m}^3 \cong 0.011\text{m}^3$

Trial mixes are organized consistent with the necessities of IS 10262-2009, which allow the usage of aggregates in any of the subsequent wet conditions;

- Oven – dry conditions
- Air – dried conditions
- Saturated surface – dry things
- Saturated by suggests that of soaking in water for a minimum of twenty four hours

The aggregates used were initial delivered to saturated surface – dry conditions as setgo in IS 10262-2009

During the blending manner of the trial mixes, changes to the water contents are deadby approach of examination of the workability of the combo. Initially, atiny lowproportion of the mixture water (approximately 100 percent of the to start with designed value) became withheld because the integration system endured. once by suggests that of visible workability, the mixture needed addition of water; water became delivered with outstanding care. moreover, once at the designed water content material, the workability of the combo appeared below that needed, additional water become delivered to until the desired workability become completed.

DETERMINATION OF THE COMPRESSIVE STRENGTH

CASTING CUBES

The cubes had been cast in iron moulds generally 100mm cubes. This conforms to the specifications of IS 10262-2009. The moulds surfaces were initial cleaned and oiled on their interior surfaces therefore on forestall improvement of bond between the mold and therefore the concrete. After preparing trial mixes, the moulds are full of concrete in three layers, every layer being compacted usage of a poker vibrator to urge obviate as masses entrapped air as possible and to supply complete compaction concrete with out segregation. The moulds were crammed to overflowing and excess concrete eliminated by suggests that of sawing movement of silver rule. Surface finishing was then dead by employing a trowel. The check specimens had been then left among the moulds undisturbed for 24 hours and guarded con to surprise, vibration and dehydration.

CURING CUBES

Curing is also represented as a result of the processes use for merchandising the association of cement, and includes a manipulate of temperature and of the wet movement from and into the concrete.

The goal of activity become to stay concrete as nearly saturated as viable, till the at the beginning water – crammed area within the contemporary cement paste was stuffed to the popular amount with the help of the merchandise of association of cement. The temperature at some stage in activity conjointly controls the fee of development of the reactions of association and thus influences the advance concrete.

The cubes had been positioned during a activity pond/tank at a temperature of $20 \pm 2^{\circ}\text{C}$ for the desired amount of your time.

COMPRESSIVE take a look at-

After activity the cubes for the desired amount, they need been removed and wiped to try to to away with surface wet in readiness for compression take a glance at. The cubes are then settled with the forged faces to bear with the platens of the testing machine this is often the location of the dice whereas tested should be at right angles thereto as cast. The load became allotted at a gradual rate of stress of concerning capable fifteen N/mm^2 to failure. Readings on the dial gauge had been then recorded for each dice.

Chemical compositions:

• Chemical composition of bottle glass (in percentage):

SiO₂ (silica) seventy - seventy four

Na₂O (sodium oxide) twelve - sixteen

CaO (calcium oxide) five – eleven

MgO (magnesium oxide) one – 3

Al₂O₃ (aluminum oxide) 1- three

• Chemical composition of GGBS (in percent):

CaO (calcium oxide) (30-50%)

SiO₂ (silica) (28-38%)

Al₂O₃ (aluminum oxide) (eight-24%)

MgO (magnesium oxide) (1-18%)

CHAPTER- 4

REFERENCES:

- 1) <https://www.google.co.in/search?q=Waste+glass+powder+image&oq=Waste+glass+powder+image&aqs=chrome..69i57.12231j0j7&sourceid=chrome&ie=UTF-8>
- 2) https://www.google.co.in/search?ei=Q64YWqisGcnxvgTK6bOoDA&q=GGBS+image&oq=GGBS+image&gs_l=psy-ab.3..0.56667.61921.0.63501.22.11.0.0.0.0.313.1390.0j4j2j1.7.0....0...1c.1.64.psy-ab..16.4.817...35i39k1j0i67k1j0i7i30k1j0i8i7i30k1j0i30k1j0i5i30k1j0i8i7i10i30k1.0.dEZZa9jbUuM
- 3) <http://icjonline.com/>
- 4) <http://www.sciencedirect.com/>
- 5) ASTM C 289, 1994. Test method for potential alkali reactivity of aggregates (chemical method).
- 6) Ducman, V., Mladenovic, A., Šuput, J.S., 2002. Lightweight aggregate based on waste glass and its alkali–silica reactivity. *Cement and Concrete Research* 32 (2), 223–226.
- 7) Meyer, C., Baxter, S., 1998. Use of recycled glass and fly ash for precast concrete. Final Report to New York State Energy Research and Development Authority, Report 98-18, Albany, NY, October 1998.
- 8) Shao, Y., Lefort, T., Moras, S., Rodriguez, D., 2000. Studies on concrete containing ground waste glass. *Cement and Concrete Research* 30 (1), 91–100.
- 9) Wang H, Gillott JE. Competitive nature of alkali–silica fume and alkali– aggregate (silica) reaction. *Mag Concr Res* 1992;44(161):235–9.
- 10) Thomas MDA, Hooper R, Stokes D. Use of lithium-containing compounds to control expansion in concrete due to alkali–silica reaction. In: 11th International conference on alkali–aggregate reaction. Quebec, 2000. p. 783–91.
- 11) Terro MJ. Properties of concrete made with recycled crushed glass at elevated temperatures. *Build Environ* 2006;41:633–9.
- 12) Topcu IB, Raif Boga A, Bilir T. Alkali–silica reactions of mortars produced by using waste glass as fine aggregate and admixtures such as fly ash and Li₂CO₃. *Waste Manage* 2007.
- 13) Malhotra VM, Mehta PK. Pozzolanic and cementitious materials. In: *Advances in concrete technology*. New York: Gordon and Breach Publishers; 1996.
- 14) Siddique R. *Waste materials and by-products in concrete*. New York: Heidelberg; 2008.
- 15) Shayan A, Xu A. Value-added utilization of waste glass in concrete. *Cem Concr Res* 2004;34(1):81–9.
- 16) Jin W. Alkali–silica reaction in concrete with glass aggregate – a chemo– physico–mechanical approach. PhD thesis. New York: Columbia University; 1998.

- 17) Shao Y, Lefort T, Moras S, Rodriguez D. Studies on concrete containing ground waste glass. *Cem Concr Res* 2000;30(1):91–100.
- 18) Wang HY. A study of the effects of LCD glass sand on the properties of concrete. *Waste Manage* 2009;29(1):335–41
- 19) Dhir R, Dyer T, Tano A, Cui Y. Towards maximizing the value and sustainable use of glass. *Concrete* 2004;38(1):38–40.
- 20) Corinaldesi V, Gnappi G, Montenero A. Reuse of ground waste glass as aggregate for mortars. *Waste Manage* 2005;25(2):197–201.
- 21) Wang HY, Chen JS. Study of thin film transition liquid crystal display (TFT– LCD) optical waste glass applied in early-high-strength controlled low strength materials concrete. *J Comput Concr* 2008;5(5):491–501.
- 22) Topcu IB, Canbaz M. Properties of concrete containing waste glass. *Cem Concr Res* 2004;34(2):267–74.
- 23) Liao ZC, Luo CY, You WH. Behavior of self-compacting concrete member. Taipei: Taiwan Construction Research Institute; 2000. p. 43–57.
- 24) M.S Rao et al, “application of blast furnace sand in cement concrete-A case study” *international journal of civil engineering research*, volume 5, No 4(2014), pp.453-458, ISSN 2278-3752 .
- 25) Sagar Patel et al, “Flexural behavior of reinforced concrete beams replacing GGBS as cement and slag sand as fine aggregate” *international journal of civil and structural engineering research* , vol 2, issue 1, pp 66-75, April-September 2014.
- 26) Suresh babu N et al, “Bond characteristics of rebar in concrete with manufactured sand As fine aggregate” *American journal of engineering research (AJER)* e-ISSN:2320- 0847 p-ISSN:2320-0936 volume-1, pp-54- 58.
- 27) M. Shariq, et al, “Strength development of cement mortar and Concrete incorporating GGBFS”, *Asian journal of civil engineering (building and housing)* vol. 9, no. 1, (2008), pages 61-74.
- 28) M. Mithra et al, “Flexural Behavior of Reinforced Self Compacting Concrete Containing GGBFS”, *International Journal of Engineering and Innovative Technology (IJEIT)*, Volume 1, Issue 4, (2012), pp- 124-129.
- 29) Mrs. Veena G. Pathan, et al, “Evaluation of concrete properties using ground granulated blast Furnace slag”, *International Journal of Innovative Research in Science, Engineering and Technology* Vol. 1, Issue 1, (2012) , pp 71- 79.
- 30) Ozbay, E., Erdemir, M., Durmus, H. I., 2016. Utilization and efficiency of ground granulated blast furnace slag on concrete properties – a review. *Constr. Build. Mater.* 105, 423–434.
- 31) civilblog.org/2014/04/08/is-10262-2009-concrete-mix-design.

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