International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

IJIEMR Transactions, online available on 3rd Mar 2021. Link :http://www.ijiemr.org/downloads.php?vol=Volume-10&issue=ISSUE-03

DOI: 10.48047/IJIEMR/V10/I03/01

Title **COMPARATIVE STUDY ON MECHANICAL PROPERTIES OF M30 GRADE CONCRETE AFTER PARTIAL REPLACEMENT OF SAND WITH WASTE GLASS AND FOUNDRY WASTE.**

Volume 10, Issue 03, Pages: 1-7.

Paper Authors

Dadala Aruna, Dr. Ch.Bhavannarayana

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

COMPARATIVE STUDY ON MECHANICAL PROPERTIES OF M30 GRADE CONCRETE AFTER PARTIAL REPLACEMENT OF SAND WITH WASTE GLASS AND FOUNDRY WASTE

Dadala Aruna*, Dr. Ch.Bhavannarayana **
*PG Scholar ,Kakinada Institute of Engineering and Technology - II, Korangi, Kakinada
** Professor PhD, Kakinada Institute of Engineering and Technology - II, Korangi, Kakinada

Abstract: Now a days the worldwide consumption of sand as fine aggregate in concrete production is very high. Several developing countries have encountered some strain in the supply of natural sand in order to meet the increasing need of the infrastructural development in recent year, to overcome the stress and demand of river sand, researchers and practitioners in the construction industry have identified some alternative. One of them is foundry sand; it is high quality silica sand with uniform physical characteristics and by product of ferrous and non-ferrous metal casting industry. It is proved that foundry sand used, as fine aggregate will enhance the strength of concrete to a greater extend. This paper presents an experimental investigation on the properties of concrete in which fine aggregate is partially replacing by used foundry sand and glass waste. The only variable considered in this study is volumetric replacement (10%, 20%, 30%, 40%, and 50%) of sand. Out of these five replacement levels best 3 were choose by trial works. The concrete was tested for slump test, compression test, flexural test, split tensile test for 7 & 28 days.

1. INTRODUCTION

The demand for concrete is next only to water. With the advancement of technology and increased field of application of concrete and mortars, various properties of the ordinary concrete needed modification to make it more suitable for various situations, economical and eco friendly. This has led to the use of cementitious materials such as fly ash, silica fume, metakaolin etc. which have contributed towards higher performance, energy conservation and economy. The use of fly ash and metakaolin partially replacing the cement in concrete results in reduction of cement used, reduction in the emission of carbon dioxide (Co2), conservation of existing resources along with the enhancement in the strength and durability properties of concrete. Depletion of natural sand deposits in our country is already causing serious threat to the environment as well as society. This along with shortage in natural good quality sand has made researchers to look for an alternative to river sand. The M.sand produced under controlled and well supervised conditions can a better substitute for river sand. In use of fly ash for partially replacing the Portland cement in concrete not only reduces the amount of cement used, but also significantly enhances the properties of concrete, reduces the emission of CO2, conserves the existing resources and greatly improves consistency [3]. The addition of Silica fume in concrete improves certain properties such as workability, later age strength development and a few durability characteristics [3].

2. Literature review

Mehulkumar R. et al. Technical Review on Foundry Sand Used As Fine Aggregates in Mortar The purpose of the study is to replace the sand partially or fully by Foundry sand in mortar as in future there will be depletion of sand. Hence, it is necessary to find inexpensive and easily available alternative material to Natural River Sand. They evaluated the compressive strength of concrete by utilizing three types of used foundry sand; with bentonite clay, with sodium silicate and with phenolic resin as partial replacement of fine aggregates. 10, 20 and 30 % replacement level of river sand by used foundry sands was maintained in this study. A constant concrete proportion of 1:2:4 was used with a single water cement ratio of 0.6 for all the mixtures. Total 90 cubes of 100 mm size were casted and cured in curing tank for 7, 28 and 63 days for determination of their compressive strength. Workability, compressive strength and were measured and compared with the conventional concrete termed as control mixture. Compressive strength increases with increase in curing age in all cases and at 28 days of curing, 80% of compressive strength was reached in all concrete specimens. Strength decreased with increase in percentage replacement of UFS; compressive strength of control mixture was more than concrete mixtures with UFS at all curing ages. The comparative study of the properties of fresh & hardened concrete containing ferrous & non-ferrous foundry waste sand replaced with four (0%, 10%, 20% and 30%) percentage by weight of fine aggregate & tests were performed for M20 grade concrete. Result showed that the addition of both foundry sand gives low slump mainly due to the presence of very fine binders; Compressive strength at 7 days of both ferrous & nonferrous mixtures increases and maximum increase was observed with 20% WFS of both types of sand, at 28 days 30% addition of ferrous WFS & 10% addition of nonferrous WFS gives same strength as ordinary concrete and goes on decreasing for higher percentages of replacement; Split tensile strength gives maximum values with 20% WFS for both types of sand; water absorption is minimum with 20% ferrous WFS & with 10% nonferrous WFS. He also reported that both ferrous & nonferrous WFS can be suitably used in making structural grade concrete. Based on the above literature it is clear that many researchers have put their efforts to study different properties of concrete using Quarry stone dust and Foundry sand replaced with natural river sand. However, limited work has been done to study the possibility of using industrial solid waste materials like Quarry dust and Foundry sand as replacement to fine aggregate, to prepare Masonry mortar. In the present paper technical study has been done to fill this gap. Based on various researchers, it is observed that 20-30% replacement of foundry sand and up to 20-100 % of by natural river sand generally gives higher strength compared to normal concrete. All the researchers noticed fresh concrete behavior with foundry sand that workability is decreases with the increase of foundry sand content by slump test. Most of the researchers noticed positive changes in the concrete containing foundry sand concrete containing terms of compressive strength and tensile strength.

Amitkumar D et al investigated on foundry sand: utilization as a partial replacement of fine aggregate for establishing sustainable concrete In this study, effect of foundry sand as fine aggregate replacement on the compressive strength of concrete with a M25mix proportion investigated at different limited curing periods (7 days,14 day sand 28 days). The percentage of foundry sand used for replacement were 10%, 20%, 30%, 40% and 50% by weight of fine aggregate. Test showed impressive results, showing capability of foundry sand for being a component in concrete for imparting strength. Making concrete from recycled materials saves energy and conserves resources which lead to a safe sustainable environment. The main objective of this paper is to study the behavior of concrete in which fine aggregate in normal concrete is replaced with foundry sand at room temperature. The main parameters studied are compressive strength; durability studies and their results are studied and compared with control mix concrete. Tests were performed for Compressive strength of concrete for all replacement levels of fine aggregate at different curing period (7 days, 14 days and 28 days). Besides, the physical and chemical properties of the foundry sand are also studied Based on limited experimental investigation the following conclusions are made: Compressive strength, split tensile strength and flexural strength of concrete specimens increased, with increase in fine aggregate replacement by. Foundry sand, the increase in strength parameters may be due to fineness of the foundry sand. The foundry sand fineness is higher than fine aggregate and reduces the porous nature in concrete thereby increasing density and strength. But reduction in compressive strength of concrete specimen with replacement percentage beyond 30 % is attributed to binders present in foundry sand, composed of very fine powder of clay and carbon, which results in a weak bond between cement paste and aggregate. The replacement of natural sand with used foundry sand up to 30 % is desirable, as it is cost effective, reduces the amount of virgin fine aggregate, reduces land fill problems and preserves nature. Making concrete using recycled materials(foundry sand) saves energy and conserve primary resources and it is concluded that the more material was reused, the fewer resources were consumed which leads to a safe, sustainable environment.

Properties	**Test values**
Specific gravity	2.73
Bulk density	1.67
Water absorption	0.5
Fineness modulus	6.6
Aggregate impact value	24%
Aggregate crushing value	

3. Materials and proportions

Cement: OPC 53 JPJ cement is used in this project.

Table-1 physical properties of OPC-53grade cement

PROPERTITES	OPC 53
Fineness of cement	8%

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

Standard consistency	32%
Specific gravity	3.15
Initial setting time	40 minute
Final setting time	330 minute
Soundness	2mm

Fine aggregate: the sand used for our investigation is collected form Godavari river sand which is conforming to Zone II as per Indian Specification 383-1970 codal provisions.

Table -2 physical properties of fine aggregate

Properties	**Test results**
Specific gravity	2.52
Fineness modulus	2.2
Bulk density	1.69

Coarse aggregate: the coarse aggregate of max20mm size with an angular shape which is well graded.

Table -3 Determined physical compositions of coarse aggregate:

Foundry Waste: It is collected from Bhavani castings a foundry industry in Kakinada.

Table Fehler! Kein Text mit angegebener Formatvorlage im Dokument.**-7** Physical properties of foundry sand

Property	**Value**
Specific gravity	2.447
Fineness modulus	3.057
Bulk density: Loose Compacted	 18.2kN/m^3 19kN/m^3
Grading	Zone-II

Glass waste: locally available glass bottles are collected and glass powder is prepared by using los angles abrasion machine.

Physical properties of glass powder

Property	**Value**
Specific gravity	2.59
Fineness modulus	3. 37

4. MIX DESIGN

Design of M30 grade concrete

Stipulations for proportioning

a) Grade designation : M30
b) Type of cement : OPC 53grade confirming IS: 12269
c) Maximum Cement content : 320 kg/m^3
d)Maximum nominal size of aggregate : 20 mm
e) Maximum water – cement ratio : 0.45
f) Workability : 100 mm (slump)
g) Exposure condition: Severe (for reinforced concrete)
h) Method of concrete placing : Pumping
i) Degree of supervision : Good
j) Type of aggregate : Crushed angular aggregate

Test data for materials

a) Cement: OPC 53 grade confirming IS: 12269
b) Specific gravity of cement : 3.10
c) Mineral admixture : foundry sand
d) Specific gravity of
1) Coarse aggregate : 2.7
2) Fine aggregate : 2.6
e) Water absorption
1) Coarse aggregate : 0.5%
2) Fine aggregate : 1.0%
f) Free (Surface) moisture
1) Coarse aggregate : NIL
2) Fine aggregate : NIL
g) Sieve analysis
Fine aggregate : Confirming to grading Zone II of Table 4 of IS: 383

Target strength for mix proportioning

$f'_{tk} = f_{ck} + 1.65\text{x } S$

= 30+1.65x5 = 30+1.65x (5) = 38.25 N/mm^2

Where,
f'_{tk} =target average compressive strength at 28 days
f'_{ck} = characteristic compressive strength at 28 days
s = standard deviation

From Table 1, standard deviation(s) = 5 N/mm²
Target strength = 30+1.65x (5) = 38.25 N/mm^2

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

Selection of water-cement ratio

From Table 5 of IS 456, maximum water cement ratio= 0.45

Based on experience, adopt w/c=0.43

0.43< 0.45 hence O.K

Selection of water content

From Table 2 maximum water = 186 litres (for 25 to 50 mm Slump range) for 20mm aggregate

Estimated water content for 100mm slump = 186 + $\frac{6}{100}\times 186$ = 197 litre

Calculation of cement content

Water-cement ratio

= 0.45

Cement content = $\frac{197}{0.45}$ = 437.77kg/m³

From Table 5 of IS 456 minimum, cement content For 'Severe' exposure condition

= 320kg/m³

437.77 kg/m³ > 320 kg/m³, hence, O.K

Proportion of volume of coarse aggregate and fine aggregate content

From Table 3 of IS: 10262-2009 Volume of coarse aggregate corresponding to 20mm size aggregate &fine aggregate (Zone II)

For water-cement ratio of 0.50=0.60

Volume of Coarse aggregate for the water - cement ratio 0.45 = 0.55

Volume of fine aggregate

= 1- 0.55 = 0.451

Mix calculations

The mix calculations per unit volume of concrete shall be as follows:

a) Volume of concrete = 1 m³

b) Volume of cement $= \frac{\text{Mass of cement}}{\text{Specific gravity of cement}} \times \frac{1}{1000}$

$= \frac{437.77}{3.10} \times \frac{1}{1000} = 0.141\text{m}^3$

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

$= \frac{197}{1} \times \frac{1}{1000} = 0.197\text{m}^3$

d) Volume of all in aggregate = (a – b + c)

= (1-0.141+0.197)

= 0.662 m^3

e) Mass of coarse aggregate= d x volume of CA x Specific gravity

Coarse aggregate x 1000 = 0.662 x0.55 x2.7 x 1000

= 983.07 kg

f) Mass of fine aggregate = f x volume of fine aggregate x Specific Gravity of FA x 1000 = 0.662x0.45x2.6x1000 = 774.5kg

Mix proportions for trail

Cement = 437.77kg/ m³

Water = 197 liters

Fine aggregate: = 774.54 kg/ m³

Coarse aggregate = 983.07 kg/ m³

Water Cement ratio = 0.45

Mix per 1Cum C: FA: CA= 1:1.77:2.24

5. RESULTS AND DISCUSSIONS

5.1 COMPRESSIVE STRENGTH:

Result representing the compressive strength values from 7days and 28 days at various replacement levels i.e. at 0 % to 50 % replacement of foundry waste & glass waste in Fine aggregate

By considering the M 30 mix proportions the different mix are casted the mix details are shown the table

Mix methodology table:

Table – 5.1mix proportions for 1 m^3

Mix designations	Cement content	F.A content	C.A content	Foundry waste	Glass waste	Water
M0	437.77	774.54	983.07	0	0	197
MF10	437.77	697.05	983.07	77.45	0	197
MF20	437.77	619.24	983.07	154.91	0	197
MF30	437.77	542.18	983.07	232.36	0	197
MF40	437.77	464.72	983.07	309.82	0	197
MF50	437.77	387.27	983.07	387.27	0	197
MG10	437.77	697.05	983.07	0	77.45	197
MG20	437.77	619.24	983.07	0	154.91	197
MG30	437.77	542.18	983.07	0	232.36	197
MG40	437.77	464.72	983.07	0	309.82	197
MG50	437.77	387.27	983.07	0	387.27	197

Note : M0is the conventional concrete, MF10 is the 10% of Fine aggregate Replacement with Foundry waste, MF20 is the 20% replacement of Fine aggregate with Foundry waste, MF30 is the 30% of Fine aggregate Replacement with Foundry waste, MF40 is the 40% replacement of Fine aggregate with Foundry waste, MF50 is the 50% of Fine aggregate Replacement with Foundry waste, MG10 is the 10% replacement of Fine aggregate with Glass waste, MG20 is the 20% replacement of Fine aggregate with Glass waste, MG30 is the 30% replacement of Fine aggregate with Glass waste, MG40 is the 40%

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

replacement of Fine aggregate with Glass waste, MG50 is the 50% replacement of Fine aggregate with Glass waste.

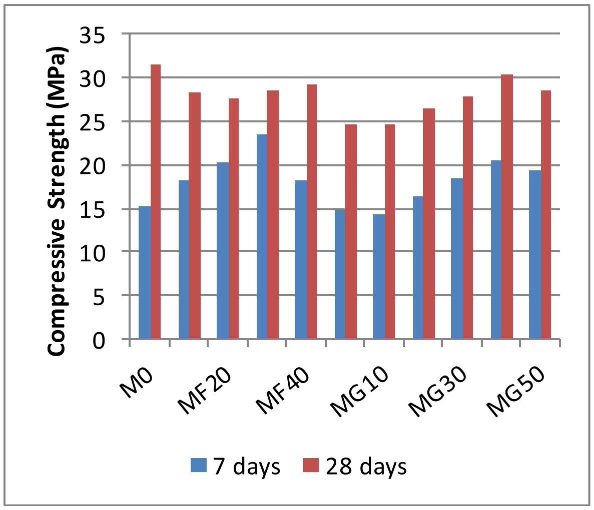

Fig: 5.1 shows compressive strength of conventional concrete verses various proportions of foundry waste and glass waste Mix for 7days and 28 days

In figure, 5.1 shows that control mix (M0) give highest compressive strength. The compressive strength of mix MF40 (40% replacement of foundry waste) is 7.1% lesser than control mix. Similarly The compressive strength of mix MG40 (40% replacement of glass waste) is 3.6% lesser than control mix. The compressive strength of mix MF300 (30% replacement of foundry waste) is 9.5% lesser than control mix. Similarly The compressive strength of mix MG40 (40% replacement of glass waste) is 11.7% lesser than control mix. Compressive strength of remaining mixes is above 10% lesser than control mix.

Split tensile strength results

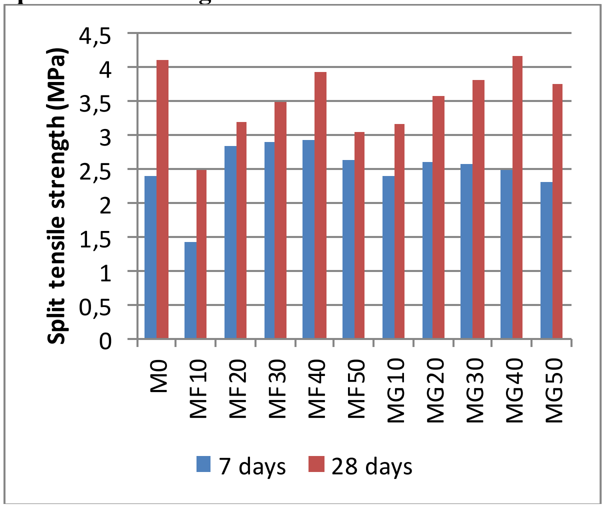

Fig: 5.2 shows split tensile strength of conventional concrete verses various proportions of foundry waste and glass waste Mix for 7days and 28 days

In figure, 5.2 The Split tensile strength of MG40 (40% replacement of glass waste) is 1.95% higher than control mix. Similarly, mix MF40 (40% replacement of foundry waste) is 3.9% lesser than control mix. Except mix MF10 all other mixes have give higher strength than control mix.

Flexural strength results

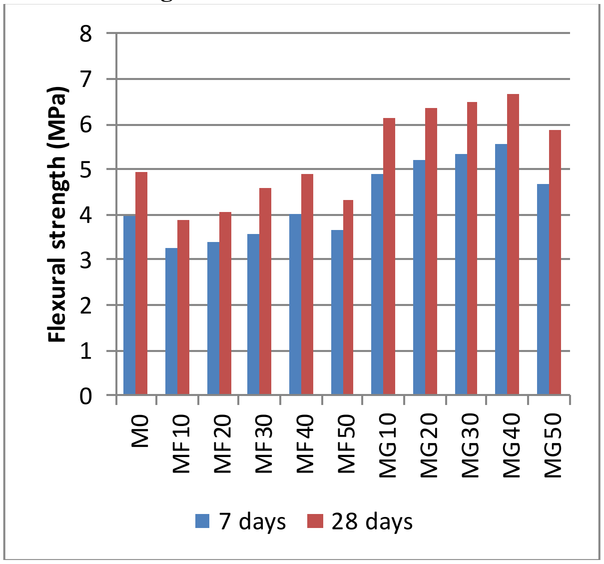

Fig: 5.3 shows Flexural strength strength of conventional concrete verses various proportions of foundry waste and glass waste Mix for 7days and 28 days

In figure, 5.3 Flexural strength of MG40 (40% replacement of glass waste) is 35% higher than control mix. Similarly, mix MF40 (40% replacement of foundry waste) is 319% lesser than control mix. The mixes containing glass waste give higher flexural strength than control mix and foundry waste mixes.

6. CONCLUSIONS

- The maximum compressive strength, flexural strength and split tensile strength is obtained for 40% replacement of glass waste for other mixes of glass waste.
- The maximum compressive strength, flexural strength and split tensile strength is obtained for 40% replacement of Foundry waste for other mixes of foundry waste.
- There is a compressive strength decrease of 3.6% and 7.6% in 28 day curing for mix MF40 and MG40 respectively than conventional concrete.
- There is a split tensile strength increase of 1.95% and 3.9 % in 28 day curing for mix MF40 and MG40 respectively than conventional concrete.

• There is a Flexural strength increase of 35% with glass waste and 3.19% decrease at 28 day curing for than conventional concrete.

• When compared to foundry waste replacement of sand glass waste replacement of sand give better results.

REFRENCES

[1]. A.seeni, dr.c.selvamony, dr.s.u.kannan, dr.m.s.ravikumar "experimental study of partial replacement of fine aggregate with waste material from china clay industries" International Journal Of Computational Engineering Research (ijceronline.com) Vol. 2 Issue.8.dec-2012,p-p-167-171.

[2]. Amitkumar D. Raval, Arti Pamnani, Alefiya I. Kachwala "**foundry** sand: utilization as a partial replacement of fine aggregate for establishing sustainable concrete" international journal of engineering sciences & research technology [raval, 4(1): january, 2015] Issn: 2277-9655 p-p- 308-311.

[3]. Amitkumar d. raval, dr. Indrajit N. patel, Arti pamnani, Alefiya I and Kachwala effect of waste foundry sand as partial replacement of sand in concrete international journal of advance engineering and research development volume 2,issue 1, january -2015,p-p-19-22.

[4]. D. pradeep kumar, dr. p. eswaramoorthi, basil baby "strength characteristics of structural concrete elements using foundry sand" international journal of engineering research and applications (ijera) issn: 2248-9622 trends and recent advances in civil engineering (trace- 24th-25th january 2014),p-p-64-68.

[5]. Dushyant R. Bhimani Jayeshkumar Pitroda Jaydevbhai J. Bhavsar "A Study on Foundry Sand: Opportunities for Sustainable and Economical Concrete"volume-2, issue-1, jan-2013,issn no-2277-8160,p-p-60-63.

[6]. Dushyant R. Bhimani, Jayeshkumar Pitroda, Jaydev J. Bhavsar " innovative ideas for manufacturing of the green concrete by utilizing the used foundry sand and pozzocrete" International Journal of Emerging Science and Engineering (IJESE) ISSN: 2319–6378, Volume-1, Issue-6, April 2013,p-p-28-32.

[7]. Dushyant Rameshbhai Bhimani, Jayeshkumar Pitroda Jaydevbhai J. Bhavsar "used foundry sand: opportunities for development of eco-friendly low cost concrete" International Journal of Advanced Engineering Technology Vol. IV/ Issue I/Jan.-March., 2013/63-66.

[8]. Eknath P .Salokhe, D.B.desai " Application of foundry waste sand in manufacture of concrete" IOSR journal of mechanical and civil engineering (IOSR-JMCE) ISSN: 2278-1684, pp: 43-48

[9]. Jagannathan saravanan, G. srinivasan and B. palani "strength properties of concrete incorporating foundry sand and ceramic aggregates" international seminar, innovation & valorization in civil engineering & construction materials : 1p-137.

[10]. Khuram rashid1, dr. muhammad akram tahir , sana nazir "evaluation of concrete compressive strength by incorporating used foundry sand"American Journal of Engineering Research (AJER) e-ISSN : 2320-0847 p-ISSN : 2320-0936 Volume-03, Issue-02, 2014,pp-109-116.

[11]. M. kacha, abhay v. nakum, ankur c. bhogayata use of used foundry sand in concrete: a state of art review international journal of research in engineering and technology eissn: 2319-1163 | pissn: 2321-7308.

[12]. M. RANJITHAM, B. PIRANESH, A. VENNILA "Experimental Investigation on High Performance Concrete with Partial Replacement of fine aggregate by Foundry Sand with cement by Mineral Admixtures" International Journal of Advanced Structures and Geotechnical Engineering ISSN 2319-5347, Vol. 03, No. 01, January 2014,p-p-28-33.

[13]. M. attar and a. k. gupta "Application of foundry sand in civil construction" IOSR journal of mechanical and civil engineering (IOSR-JMCE) ISSN: 2278-1684, pp: 38-42.

[14]. Muhammad Umar Farooq, Tauqir Ahmed, Usman Akmal And Nauman Khurram "utilization of non-ferrous recycled foundry sand as a partial replacement of fine aggregate in concrete" Sci.Int.(Lahore),26(40,1527-1431,2014 ISSN 1013-5316; CODEN: SINTE 8.

[15]. Pathariya Saraswati C, Rana Jaykrushna K, Shah Palas A, Mehta Jay G,. Patel Ankit N "Application of Waste Foundry Sand for Evolution of Low-Cost Concrete" International Journal of

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

Engineering Trends and Technology (IJETT) – Volume 4 Issue 10 - Oct 2013,p-p-4281-4286.

[16]. Adarsh Dubey, Sanjay Saraswat, Devansh Jain, "Study of properties of concrete when its fine aggregate is replaced by glass powder". International Journal for Scientific Research and Development, 2014.