Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 03, March-2016

Study of Partial Replacement by Glass Powder and Crushed Spent Fire Bricks in Concrete

Nisha Devi. A
Assistant professor,
Asian College of Engineering and Technology.
Coimbatore

Abstract: **The reduction in natural resources requires a substitute for those materials. In order to replace the natural resources used in the concrete many replacements has been made such as replacement of cement by fly ash, silica flume, wood ash, etc., replacement of fine aggregates by quarry dust, copper slag, industrial waste etc., In the present investigation, concrete made of crushed spent fire bricks replacing fine aggregates up to 25% are used to study the strength parameters of M30 grade of concrete. Fine aggregates was replaced with crushed spent fire bricks in proportions 0%, 10%, 15%, 20% and 25% and cement can be replaced by glass powder in varies proportions of 10%, 20% & 30%. No additional catalyst/plasticizers have been used for this project for improving their workability. This paper recommends that glass powder and crushed spent fire bricks can be used as an alternative construction material to cement and sand in concrete.**

Key words: crushed spent fire bricks (CSFB), glass powder, concrete, M30

1. INTRODUCTION

Concrete is most widely used construction material which can be mould into different shapes. Concrete has been a brittle material and has dramatic disadvantage as poor deformability and weak crack resistance in practical usage. The concrete is made with the natural resources as Cement, fine aggregates, coarse aggregates, water. Those natural resources should be replaced by the artificial resources in order to replace the natural resources of cement in concrete many materials such as fly ash, silica flume, wood ash, etc. Such materials are dumped in land fill which becomes the environmental problem.

Much of the glass produced in the world is discarded and damped in land fill. Glass is widely used in our day to day life through manufactured products such as sheet glass, bottles, glassware and vacuum tubing. The amount of glass being discarded as well as find use to the non-cycled glass in new application, the waste glass can create more environmental problem. The glass is used in variety of application such as construction, automobiles, tube lights, bulbs, soft drink bottles, nose-diving submarines, doors and windows, waste containers, windows, wind screen, electronic equipments etc., hence, the usage of glass powder has increased considerably, Which results is increase of waste disposal. In addition, glass waste is considered as non-decaying material that pollutes the surrounding environment. From more research work has highlighted, the usage of glass in powdered form as a partial replacement of cement in concrete.

The paper investigates the limitations of glass concrete and its properties and the test results shows increasing strength compared to conventional concrete. If glass could be incorporated in cement products, it would greatly reduce the disposal of recycled glass and/or its use in lower valued markets such as land fill material. There is considerable interest in the use of recycled glass with Portland cement in making a variety of different types of cement products. Advantages of glass powder in concrete is better resistance to sulphate attack, Help to reduce the effects of Alikali silica reaction, increase compressive and flexural strength, Reduce the use of cement in concrete, Gives long term strength, Increase the chemical attack resistance. Fire bricks used as a construction material which are manufactured from refractory grog, plastic and non plastic clays of high purity. The different raw materials are properly homogenized and pressed in high capacity presses to get the desired shape and size. Finally these are fired in oil-fired kiln at a temperature of 1300^0c. Due to the exposure to continuous high temperature for a period of 10 to 15 days, some physical and mechanical properties are changed. They were physically cleaned and mechanically crushed to a size gradation conforming to fine aggregates.

2. SIGNEFICANCE OF WORK

The main aim of this work is to ascertain the performance of concretes with replacing of cement by glass Powder and sand by Crushed spent fire bricks and compare it with the performance of conventional concrete. Also investigate the strength with both combination of cement replacement by glass powder and sand by crushed spent fire bricks.

3. MATERIALS USED

The ingredients of concrete consist of Cement,fine aggregate, coarse aggregate and water. In this work we used waste glass powder as a partial replacement for cement and it act as a filler material in concrete. Also fine aggregates partially replaced by crushed spent fire bricks which have changed its mechanical properties while manufacturing of fire bricks. The requirement which forms the basis of selection and proportioning of mix ingredients are:

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 03, March-2016

3.1 Cement

The cement can be described as a material with adhesive and cohesive properties, which is capable of binding mineral fragment into compact mass. There are several types of cements available in market. Among which ordinary Portland cement (OPC) is most well-known. The 53 grade Ordinary Portland cement conforming to IS 12269:1987 was used in this project.

3.2 Fine aggregate

A fine aggregate is increase the flowing ability and segregation resistance when used at a suitable amount. Aggregate which is passed through 4.75 IS Sieve and retained on 75micron (0.075mm) IS Sieve is termed as fine aggregate. The sand increases the volume of concrete and thus makes it cheaper. It fills the voids in concrete and gives density to concrete. It makes the mass homogeneous and improves the strength of concrete. In this project, the natural river sand conforming to IS: 383-1970 was used as fine aggregate.

3.3 Coarse aggregate

The size of aggregate bigger than 4.75mm is considered as coarse aggregate. It should be hard, strong, dense, durable, clean, and free from clay or loamy admixtures or quarry refuse or vegetable matter. The pieces of aggregates should be cubical, or rounded shaped. Coarse aggregates containing flat, elongated or flaky pieces or mica should be rejected. The grading of coarse aggregates should be as per the specifications of IS 383-1970. In this project 20mm nominal size of aggregate was used.

3.4 Water

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be taken very carefully. Water used should be free from impurities. Sea water shall not be used.

3.5 Glass powder

Glass is an ideal material for recycling. The glass powder is a pozzolanic material. The glass powder is increase the strength and durability of concrete when using suitable percentage. Glass is an inert material which could be recycled and used many times without changing its chemical property. The glass powder properties should be satisfying the cement properties. Glass is crushed into specified sizes for use as aggregate in various applications such as water filtration, grit plastering, and sand replacement in concrete.

Figure1 glass powder

Figure2 crushed spent fire bricks

3.6 Crushed spent fire bricks

The brick bats crushed in coarse powder from were used as a fine aggregate for making concrete. The crushed spent fire bricks are locally available material. The crushed spent fire brick which is passed through 4.75 IS sieve and retained on 75micron (0.075mm) sieve to get the grading of fine aggregate. The crushed spent fire bricks are satisfying the zone II gradation. The crushed spent fire bricks will be improves its structural characteristics such as flexural strength, impact strength, tensile strength, ductility and flexural toughness.

Table 1 Physical Property for Replacement Materials

Sl no	properties	Glass powder	crushed spent fire bricks
1	Fineness modulus	3.9	2.34
2	Moisture content	0.3%	-
3	Specific gravity	2.5	2.65
4	Water absorption	0.9%	0.9%

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 03, March-2016

4. EXPERIMENTAL WORK

In this experimentation, an attempt has been made to find out the concrete strength and replaced concrete strength for M30 grade of concrete. The properties of concrete materials and concrete strength were determined. The cement replaced with glass powder in various percentages ranging from 10% to 30% in increments of 10% and sand with crushed spent fire bricks in various percentages ranging from 10% to 25% in increments of 5%. Ordinary Portland cement (OPC) 43 grade, locally available sand and coarse aggregates were used in this experiments. The sand used was satisfies a zone II gradation had the specific gravity of 2.612. The coarse aggregate used were of 20mm and down size.

Mix design carried for M30 grade of concrete by IS 10262-2009 yielded a mix proportions of 1:1.452:2.774 with water cement ratio of 0.45. Specimens were prepared according to the mix proportion and by replacing cement with glass powder and sand replaced with crushed spent fire bricks in different proportions.To find out the compressive strength of cube with dimensions 150 x150 x150mm, split tensile strength of cylinder with dimension 150 x300 mm and flexural strength of prism with dimension 100 x100 x500mm were cast and tested.

5. TEST RESULTS

The compressive strength of the concrete is tested using compressive testing machine (CTM). Table 2 shows the slump value for fresh concrete and figures 3, 4, 5 shows the results obtained from experiment conducted over 7^{th} days 28^{th} days for cube and 28th days for cylinder and prism specimens

5.1 Workability:

The slump test indicates the behavior of a compacted concrete cone under the action of gravitational forces. The workability is the ability of the concrete to flow free from mixing to the place where it is to be placed finally. The workability increases with the increase of the glass powder but with increase of the Crushed spent fire bricks the workability gets decreased.

Table 2 Slump Value for Fresh Concrete

Sl no	Description	%	Slump value
1	Conventional concrete	0	40
2	Fine aggregate replaced by crushed spent fire bricks	10	36
		15	34
		20	31
		25	28
3	Cement replaced by glass powder	10	44
		20	59
		30	64

5.2 Compressive strength:

The replacement of fine aggregate by crushed spent fire bricks at 20% gives higher strength compared to the conventional concrete by 1.16%and beyond 20% compressive strength gets decreased. The glass powder is replaced for cement by 20% gives higher strength compared to conventional concrete by 3.82% and beyond 20% the strength gets decreased. A specimens A was control specimen B, C, D and E was crushed spent fire bricks replaced concrete specimens B1,B2,B3,C1,C2,C3,D1,D2,D3 and E1,E2,E3 specimens was replaced concrete with crushed spent fire bricks and glass powder(CSFB 10%,15%,20%& 25% +GP with different percentages 10%,20% & 30%) respectively.

From the test results A1, A3 Cube shows 25.38%, 10.07% , decrease in compressive strength when compared to A cube. A2 Cube shows 3.826% increase in compressive strength when compared to A cube. B, B1, B2, B3 Cube shows 11.56%, 32.63%, 16.77% and 27.43%decrease in compressive strength respectively when compared to A cube. C , C1, C2, C3 Cube shows 9.67%, 30.55%,9,49 and 4.264% decrease in compressive strength when compared to A cube. D1, D3 Cube shows 8.712%, 27.17%, decrease in compressive strength when compared to A cube. D2 Cube shows 1.156% increase in compressive strength when compared to A cube E, E1, E2, E3 Cube shows 4.317%, 21.71%, 22.23% and 27.43%decrease in compressive strength respectively when compared to A cube. From the test results, it was observed that the compressive strength of concrete for 7 and 28 days of specimen D2 (20%crushed spent fire bricks +20%glass powder) was high than that of the control specimen.The specimen D2 (20%crushed spent fire bricks +20%glass powder) had a 28 days compressive strength of 38.91 N/mm^2 which is less than the compressive strength of control specimen 38.45 N/mm^2. However the specimen A2, D, D2 had high strength than control specimen.

The compressive strength of the concrete by replacement by combination of glass powder and crushed spent fire bricks gets decreased when compared to replacement of glass powder and crushed spent fire bricks separately at optimum percentage.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 03, March-2016

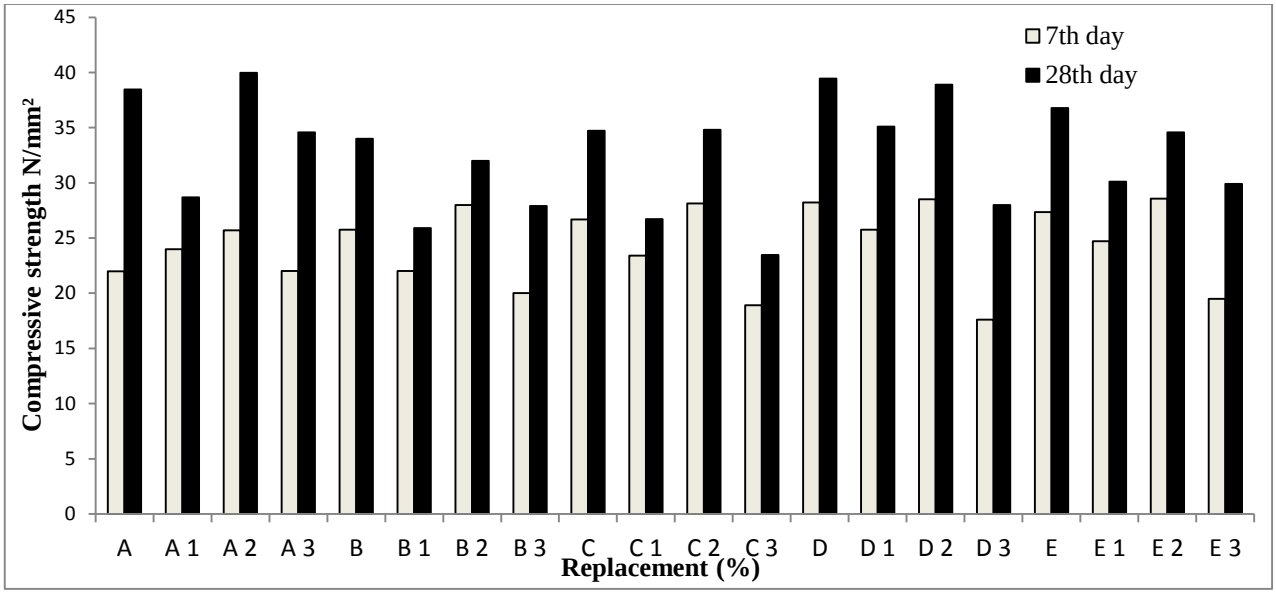

Figure 3 Compressive Strength of Concrete

5.3 Split Tensile Strength:

The replacement of fine aggregate by crushed spent fire bricks at 20% gives higher strength compared to the conventional concrete by 1.16%and beyond 20% split tensile strength gets decreased. The glass powder is replaced for cement by 20% gives higher strength compared to conventional concrete by 6.452% and beyond 20% the strength gets decreased.A1, A3 cylinder shows 17.24%, 4.13%, decrease in split tensile strength when compared to A cylinder. A2 cylinder shows 6.452% increase in split tensile strength when compared to A cylinder. B, B1, B2, B3 cylinder shows 36.89%, 31.37%, 26.55% and 47.58% decrease in split tensile strength respectively when compared to A cylinder. C, C1, C2, C3 cylinder shows 14.13%, 55.17%, 46.89 and 66.2% decrease in split tensile strength when compared to A cylinder. D1, D2, D3 cylinder shows 66.89%, 22.41%, 74.13%, decrease in split tensile strength when compared to A cylinder.E, E1, E2, E3 cylinder shows 42.82%, 67.24%, 62.06% and 76.89% decrease in split tensile strength respectively when compared to A cylinder.

From the test results, it was observed that the split tensile strength of concrete for 7 and 28 days of specimen D2 (20%crushed spent fire bricks +20%glass powder) was low than that of the control specimen.

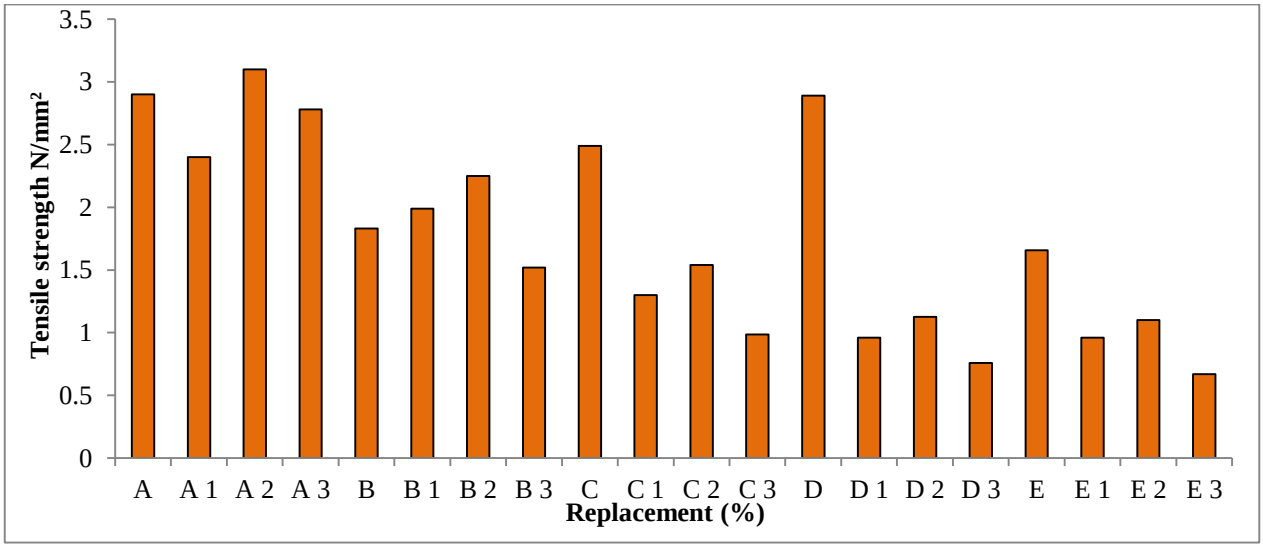

Figure 4 Split Tensile Strength of Concrete

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 03, March-2016

The replacement of fine aggregate by crushed spent fire bricks at 20% gives higher strength compared to the conventional concrete by 1.16%and beyond 20% split tensile strength gets decreased. The glass powder is replaced for cement by 20% gives higher strength compared to conventional concrete by 6.452% and beyond 20% the strength gets decreased.

A1, A3 cylinder shows 17.24%, 4.13%, decrease in split tensile strength when compared to A cylinder. A2 cylinder shows 6.452% increase in split tensile strength when compared to A cylinder. B, B1, B2, B3 cylinder shows 36.89%, 31.37%, 26.55% and 47.58% decrease in split tensile strength respectively when compared to A cylinder. C, C1, C2, C3 cylinder shows 14.13%, 55.17%, 46.89 and 66.2% decrease in split tensile strength when compared to A cylinder. D1, D2, D3 cylinder shows 66.89%, 22.41%, 74.13%, decrease in split tensile strength when compared to A cylinder.E, E1, E2, E3 cylinder shows 42.82%, 67.24%, 62.06% and 76.89% decrease in split tensile strength respectively when compared to A cylinder.

From the test results, it was observed that the split tensile strength of concrete for 7 and 28 days of specimen D2 (20%crushed spent fire bricks +20%glass powder) was low than that of the control specimen.

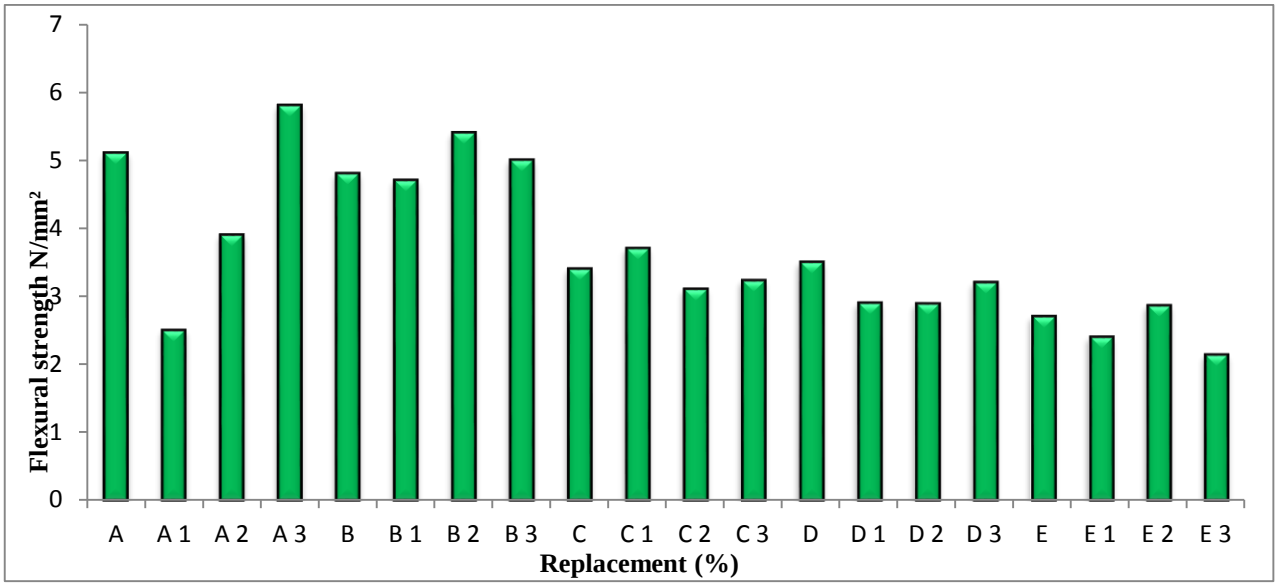

Figure 5 Modulus of Rupture of Concret

6. CONCLUSION

- The workability of concrete increases with replacement of glass powder by cement and when fine aggregate replaced with crushed spent fire bricks, it gets decreased.
- The optimum percentage for fine aggregate replaced with crushed fire bricks achieved at 20%
- The optimum percentage for cement replaced with glass powder achieved at 20%
- The optimum percentage of replacement was observed that 20% crushed spent fire bricks+20% glass powder gives maximum compressive strength.
- From the results it was concluded that,

➢ Compared to conventional concrete the compressive strength increases 3.826% while 20% replacing of cement by glass powder and beyond that it gets decreased and with replacement of fine aggregate by crushed spent fire bricks compressive strength increase 2.57% while 20 % replacing and beyond it decreased

➢ Split tensile strength is increased by 0.344% with 20% glass powder and 20% crushed spent fire bricks.

✓ For Fine Aggregate Replacement by Crushed Spent Fire Bricks

- Compressive strengths of concrete at 7 days increase to 22.11% from the conventional concrete.
- Compressive strengths of concrete at 28 days increase to 2.955% from the conventional concrete.
- Flexural strength of concrete increases to 12.36% from the conventional concrete.
- Split tensile strength of concrete increases to 0.343% from the conventional concrete.

✓ For cement replacement by glass powder

- Compressive strengths of concrete at 7 days increase to 14.47% from the conventional concrete.
- Compressive strengths of concrete at 28 days increase to 3.825% from the conventional concrete.
- Flexural strength of concrete increases to 5.55% from the conventional concrete.
- Split tensile strength of concrete increases to 6.45% from the conventional concrete.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 03, March-2016

- ✓ The replacement is made with the combination of both cement replacement with glass powder and sand replaced with cushed spent fire bricks replacement. Hence the test results, compression strength gets increased but tensile strength and flexural strength gets decreased with the combination of 20% both replacements because of the increase in moisture content and increased fineness of concrete.

REFERENCES

[1] Specification for Coarse and Fine Aggregate from Natural Sources for Concrete, IS 383:1970, Bureau of Indian Standard, New Delhi.
[2] IS Method of Mix Design IS 10262:1981, Bureau of Indian Standard, New Delhi.
[3] Method of Tests for Strength of Concrete IS 516:1959, Bureau of Indian Standard, New Delhi.
[4] Code of Practice for Plain and Reinforced Concrete. IS456:2000, Bureau of Indian Standard, New Delhi.
[5] Abdus Salam M., Kowsur Hasan M., Mohammad Abdur Rashid and Sukanta Kumar Shill F. (2012), "Effect of Replacing Natural Coarse Aggregate by Brick Aggregate on the Properties of Concrete" *DUET Journal*, vol :1, Issue :3, pp.17-21.
[6] Bajad M.N., Desai A.K. and Modhera C.D. (2011), "Effect of Glass on Strength of Concrete Subjected to Sulphate Attack", *International Journal of Civil Engineering Research and Development (IJCERD)*, Vol:1, pp.1-12.
[7] Brakash K.B. and Patagundi B.R. (2012), "Effect of Temperature on the Properties of Concrete Containing Glass Powder as Pozzolana" *Journal of materials in civil Engineering ASCE*, VOL:18, pp.518-526.
[8] Dhanaraj Mohan Patil and Keshav.k.Sangle (2013), "Experimental Investigation of Waste Glass Powder as Partial Replacement of Cement in Concrete", *International Journal of Advanced Technology in Civil Engineering*, ISSN: 2231 –5721, Vol:2, Issue:1, pp. 112-117.
[9] Govindarajulu D., Vijayakumar D. and Vishaliny H. (2013), "Studies on Glass Powder as Partial Replacement of Cement in Concrete Production" *International Journal of Emerging Technology and Advanced Engineering* (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Vol:3, Issue :2, pp. 152-157.
[10] Jafar Bolouri Bazaz., Mahmood Khayati S. and Navid Akrami D. (2006), "Performance of Concrete Produced with Crushed Bricks as the Coarse & Fine Aggregate" *The Geological Society of London*, IAEG:2006, pp. 616 - 622.
[11] Keerthinarayana S. and Srinivasan R. (2010), "Study on Strength and Durability of Concrete by Partial Replacement of Fine Aggregate using Crushed Spent Fire Bricks" *Journal of construction and building materials* vol:1, pp. 18-23.
[12] Kannan S.U., Ravikumar M.S., Seeni A. and Selvamony C. (2013), "Experimental Study of Partial Replacement of Fine Aggregate with Waste Material from China Clay Industries" *International Journal of Computational Engineering Research* (vol :2,Issue:8), pp.167-171.
[13] Konstantions Poutos I. and Sunny Nwaubani O. (2013), "The Influence of Waste Glass Powder Fineness on the Properties of Cement Mortars", *International Journal of Application or Innovation in Engineering & Managemant*, Vol :2, No.2, pp. 110-116.
[14] Patel Anoop and Tiara Darshita (June 2014), "Study of Strength and Workability of Different Grades of Concrete by Partial Replacement of Fine Aggregate by Crushed Brick and Recycled Glass Powder" *International Journal of science and Research*, vol:3 Issue: 6, pp. 141-145.