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EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF COARSE AGGREGATE BY BAMBOO AND FINE AGGREGATE BY QUARRY DUST IN CONCRETE

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ABSTRACT

Concrete is the most used construction material across the world and in concrete maximum part is fine aggregate. Naturally available river sand is the commonly used as a fine aggregate in many countries. The more requirement for concrete has made this natural rive sand resource to get weakens. On one side the depletion of river sand in excess has shows very clear environmental impacts, on the other side, production of very huge amount of quarry dust is being produced during the process of quarrying and its leading to many environmental problems. It is necessary to carry out the research on identifying the feasibility of using alternative waste materials like bamboo and quarry dust. In this study, the laboratory investigation carried out on strength characteristics of bamboo and quarry dust on M40 concrete. The percentage of bamboo added by volume basis was 0, 5%, 10%, 15%, 20%, and 25% as replacement of coarse aggregate used in concrete. From the result it is concluded that 15 % of bamboo replacement in concrete shows good results on compressive strength, flexural strength, split tensile strength and durability characteristic compare to control concrete. Similarly the percentage of quarry dust added by weight was 0, 15%, 20% and 25%, respectively the fine aggregate replacement in concrete. From this experimental results it is observed that replacing coarse aggregate with 15% of Bamboo and fine aggregate by15 % of Quarry dust gave a satisfactory result when compared with conventional concrete for 7 days and 28 days. Hence the use of Bamboo and quarry dust as replacement for coarse aggregate and fine aggregate in concrete is reducing the Environmental wastes which pose a difficult problem in its disposal.

Key words: Coarse aggregate, Fine aggregate, Bamboo, Quarry dust, Compressive Strength, Flexural strength.

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1. INTRODUCTION

Concrete is a composite material made from cement, water, coarse and fine aggregate. The usage of concrete from global societies is after to water. Coarse aggregate is more essential in concrete which is used a compaction material in higher volume ratio. Now a day's river sand has become expansive owing to higher the cost to transfer from natural resources [1,2]. In large scale, depletion of river sand posses many environmental impacts due to fine aggregate in concrete is at its peak. Thus there is a requirement for option coarse and fine aggregates. Considering a worldwide temperature alteration, absence of assets and ecofriendly issues, the utilization of characteristic materials got to be distinctly dynamic in the development business [3-6].

There is a need to reduce the high cost of coarse aggregate and fine aggregate in order to provide low cost structure, researchers are always consider the use of some locally available materials for the partial replacement of coarse and fine aggregate in construction works. Bamboo is one of the generally utilized construction materials since old circumstances because of its less cost, high strength, attainability, low weight, seismic resistance, etc.. There are different types of waste materials being used in the industry [7].to produce fine aggregate, stone quarry blasting is essential and naturally production of quarry dust also associates with it. Quarry dust results in harmful disease like lungs cancer, Asthma, eye disease etc.[8,9].Several researchers have made an attempt to study the use bamboo as one of the reinforcement to replace the steel in construction works. Based on economic analysis and strength aspect of bamboo was used in design and construction of retrofit structures and construction materials [10].

In this present investigation is to study the effect of partial replacement of coarse aggregate by bamboo with 5, 10, 15, 20 and 25% and fine aggregate by quarry dust with 15, 20,25% respectively. The effect of replacement of bamboo and quarry dust was studied using basic properties, fresh concrete behavior and hardened concrete behavior based mechanical strength test results.

2. EXPERIMENTAL WORK

2.1. Material details

The ordinary Portland cement 43 grade was used source material in this instigation which having the specific gravity of 3.12. The river sand used as fine aggregates having the specific gravity of 2.63 and water absorption 1% as per Zone II of table4 IS 383:1960 [11].The coarse aggregates are having the 20mm nominal size, the specific gravity is 2.74 and water absorption 0.5%. The Bamboo is used as a replacement material of coarse aggregates, which obtain from Eastern & South Eastern part of India. Bamboo is having the specific gravity is 0.575, the Moisture content is 50 to 60 %, Diameter 100 to 150 mm, Wall thickness 10 to 15 mm, Distance to node 250 to 350 mm, Height 5.0 to 7.5 m, Age 3 to 5 years. Bamboo, which is used in this study were cut into small pieces of 12 mm and 20 mm to casting of the trial cubes, cylinders and beams. The bamboo used in this study is treated by applying a thin layer of epoxy solution on the surface and it is trailed by covering of fine sand. The fine aggregates was replaced by quarry dust obtained from local market which is having the specific gravity 2.54 to satisfy the as per Zone II part 3 IS 2386:1963 [12]. To achieve the workability of concrete the super plasticizer was used. The normal water was used for preparation of blended concrete specimens.

2.2. Mix Design

Generally the mix design methods being used in different places are based on chart and empirical relationship developed by the researchers based on the extensive laboratory investigations. The concrete mix has been designed for M40 grade as per IS 10262 :2009[13] given in Table 1.The control concrete was prepared by Ordinary Portland cement with fine aggregates and coarse aggregates without any replacement. The coarse aggregates was partially replaced by 5, 10, 15, 20 and 25% of bamboo. The fine aggregate was replaced by 15, 20 and 25% of Quarry dust with optimum replacement of 15% bamboo as coarse aggregate. The super plasticizer was used in all the mix apart from the control concrete.

Table 1 Mix proportion of M40 Concrete

Water	Cement	Fine Aggregate	Coarse Aggregate	Chemical admixture
168 liters	420 kg/m^3	773 kg/m^3	1112 kg/m^3	4.81 Kg/m^3
0.40	1	1.84	2.65	0.1
Mix design for M40 grade concrete = 1 : 1.84 : 2.65, 0.4				

2.3. Parameters Studied

The basic properties like specific gravity, moisture content and fresh concrete properties like slump value, compaction factors, Vee Bee consistency test, and workability test were performed in all mix combinations. The mechanical strength test are compressive strength test, split tensile strength test, flexural strength test were performed in hardened concrete.

2.4. Specimen Preparation and Testing

The basic properties of material and fresh concrete properties were performed according to the IS 516: 1959 [14]. To study the compressive strength of blended concrete, the cube specimens were prepared at the size150 x 150 x 150mm according to the IS 516:1959. To study split tensile strength of concrete the cylinder specimens were prepared in 100mm diameter x 200 mm height. The flexural behavior was studied by casting of prism size 100 x 100 x 500 mm. All the specimens were casted in steel moulds, after casting the specimens 24 hours later demoluded and kept in curing up to testing age of 7, 14 and 28 days.

3. RESULTS AND DISCUSSION

3.1. Bamboo - Physical and mechanical properties

The properties of bamboo were shown in Table 2. Generally the specific gravity is a measure of the density of a substance and the substance specific gravity is determined as a comparison of its density to that of density of water. The specific gravity of bamboo is 0.58 depending mainly on its anatomical structure. Fresh bamboo may have hundred percent moisture content measured by oven dry weight basis and it can be as high as 140 to 155% for innermost layers [15, 16].

Table 2 Properties of bamboo

Parameters	Values	Parameters	Values
Average weight	0.625 kg/m	Safe working stress in shear	115 to 180 kg/cm^2
Modulus of rupture	610 to 1600 kg/cm^2	Bond stress	5.6 kg/cm^2
Modulus of elasticity	1.5 to 2.0 x 10^5 kg/cm^2	Bending Strength, Fb	20.27 N/mm^2
Ultimate compressive stress	794 to 864 kg/cm^2	Compressive Strength, Fc	7.86 N/mm^2
Safe working stress in compression	105 kg/cm^2	Tensile Strength, Ft	14.96 N/mm^2
Safe working stress in tension	160 to 350 kg/cm^2	Longitudinal Shear Strength	1.41 N/mm^2

3.2. Chemical composition of Materials

The chemical composition of Quarry dust is shown in Table 3. From the results, Quarry dust is collected from local stone crushing units was used.Compared with wood, however, bamboo has higher alkaline extractives, ash and silica contents. Quarry dust physically displayed as grey in color and used as a fine aggregate [17, 18]. From the chemical composition analysis the Quarry dust is having less chemical composition values compare to the natural sand. The particle size analysis is carried out on the materials and it is shown in Fig. 1 and 2.

Table 3 Chemical properties of quarry dust

Constituents	Quarry Dust (%)	Natural Sand (%)
SiO_2	65.73	82.37
Al_2O_3	19.31	8.23
Fe_2O_3	5.27	1.39
CaO	3.64	2.79
MgO	2.16	1.47
Na_2O	Nil	1.63
K_2O	2.26	1.81
TiO_2	1.28	Nil
Loss of ignition	0.35	0.31

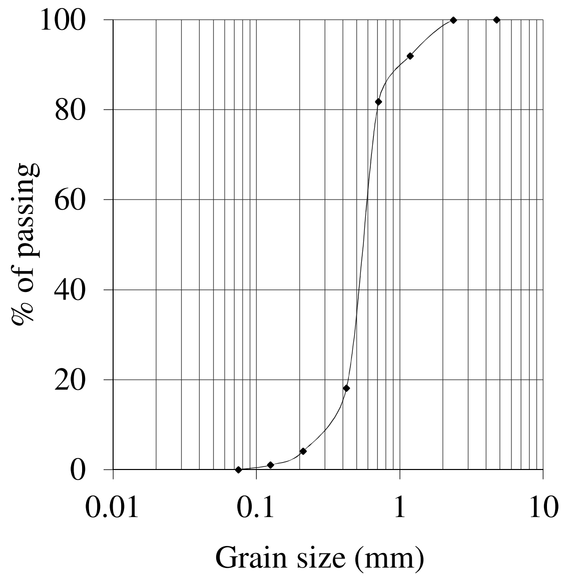

Figure 1 Particle Size Distribution for sand

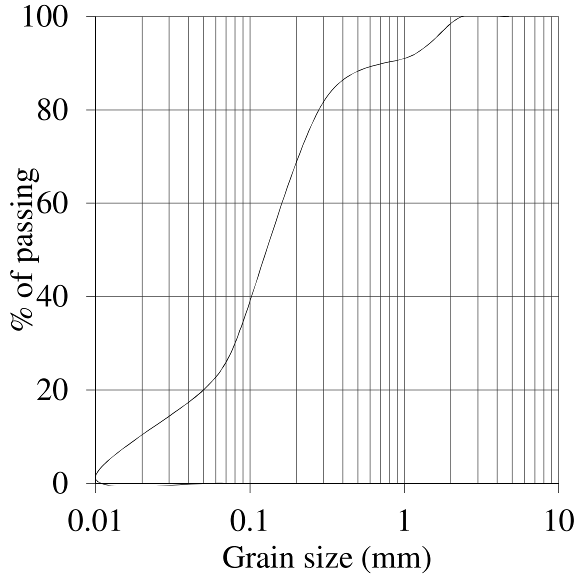

Figure 2 Particle Size Distribution for quarry dust

3.3. Behaviour of Fresh Concrete Properties

To study behaviour of fresh concrete the following parameters were performed, such as slump vale, compaction factor, workability in flow table test, Vee Bee consistency test are conducted and results are given Table 4. The fresh concrete mix were prepared by OPC as source material and the coarse aggregates with optimum replacement of 15% bamboo in addition to this the fine aggregates was replaced by quarry dust 15, 20, 25% respectively and investigated the fresh concrete behaviour. From the results, the slump values are gradually decreasing while increasing the quarry dust percentage. Similar results were found in compaction factor and workability flow table values. The Vee Bee consistency values are increased while increasing the addition of Quarry dust. The results shows the addition of quarry dust increase the water demand as well as decreasing the flow vales [22,23].

Table 4 Fresh Concrete properties

Sample	**Slump Value (mm)**	**Compaction Factor**	**Flow (%)**	**Vee Bee Degree (sec)**
Control Concrete	80	0.89	73	28
Fine aggregate + 15% of quarry dust	74	0.85	69	31
Fine aggregate + 20% of quarry dust	70	0.81	63	35
Fine aggregate + 25% of quarry dust	68	0.75	59	38

3.4. Compressive strength of blended concrete

The compressive strength blended concrete was conducted for the OPC as source materials, coarse aggregates replaced with bamboo 5, 10, 15, 20 and 25% respectively mix proportion specimens tested at the age of 7, 14, 28 days and shown the results in Fig.3. form the results it is observed that replacement of CA with bamboo gives considerably good results. The replacement of CA by bamboo at 15 % gives 5% higher compressive strength at the age of 28 days. Similarly, for optimum replacement of CA by 15%of bamboo were prepared with replacement of fine aggregates by quarry dust 15, 20 and 25% respectively and results shown in Fig.4. The replacement of fine aggregates by QD gives significant improvement in strength. This also gives 15% replacement is optimum replacement of fine aggregates [24,25].

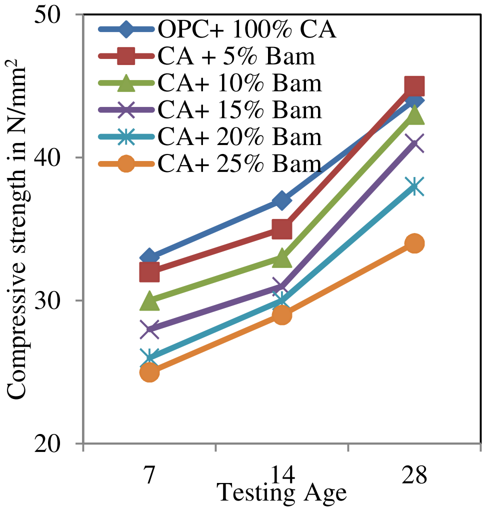

Figure 3 Compressive Strength of CA replaced by different % of bamboo

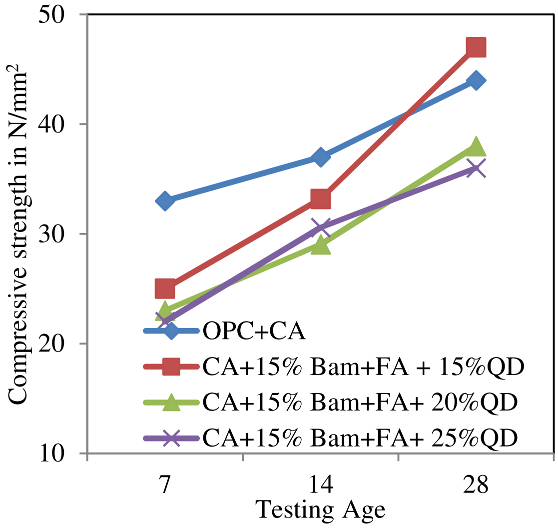

Figure 4 Compressive Strength of OPC replaced by different % of Quarry Dust

3.5. Split Tensile Strength of Blended Concrete

To study the split tensile strength of blended concrete was conducted for the OPC as source materials, coarse aggregates replaced with bamboo 5, 10, 15, 20 and 25% respectively mix proportion specimens tested at the age of 7, 14, 28 days and shown the results in Fig.5. Form the results it is observed that replacement of CA with bamboo gives considerably good results [26]. The replacement of CA by bamboo at 15 % gives 2% higher split tensile strength at the age of 28 days. It is clear that the tensile strength of concrete was improved by adding the bamboo instead of CA. Similarly, for optimum replacement of CA by 15%of bamboo were prepared with replacement of fine aggregates by quarry dust 15, 20 and 25% respectively and results shown in Fig.6. The fine aggregates replacement by QD gives relatively similar results. The concrete behavior at tension was improved while adding CA with bamboo and FA with QD.

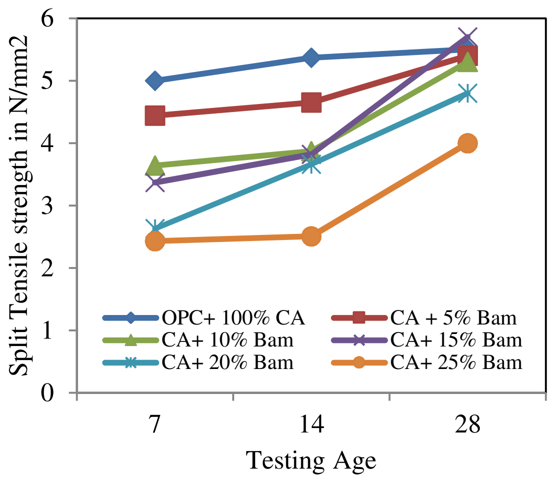

Fig.5 Split Tensile Strength of CA replaced by different % of bamboo

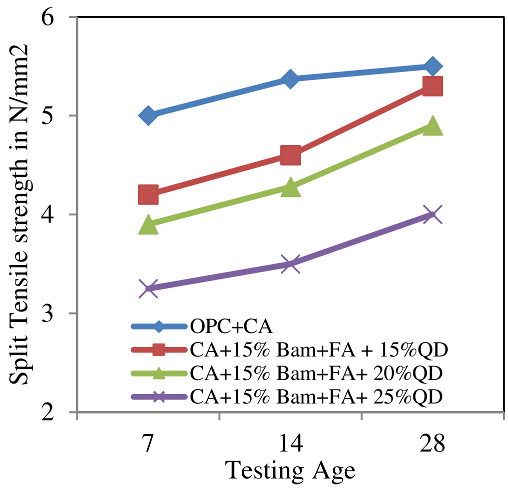

Fig.6 Split Tensile Strength of OPC replaced by different % of Quarry Dust

3.6. Flexural Strength of Blended Concrete

The concrete beams flexural behavior were studied for blended concrete was prepared for the OPC as source materials, coarse aggregates replaced with bamboo 5, 10, 15, 20 and 25% respectively mix proportion specimens tested at the age of 7, 14, 28 days and shown the results in Fig.7. Form the results it is observed that replacement of CA with bamboo shows improved flexural behavior while compare to the control specimens. The replacement of CA by bamboo at 15 % gives 3% higher flexural strength at the age of 28 days. Similarly, for optimum replacement of CA by 15%of bamboo were prepared with replacement of fine aggregates by quarry dust 15, 20 and 25% respectively and results shown in Fig.8. While the addition CA with bamboo shows considerable results compare with control specimens, same way FA replacement with QD shows the similar behavior.

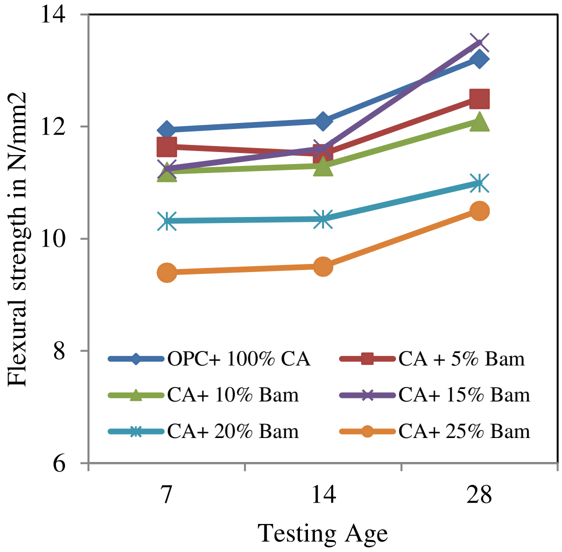

Fig.7 Flexural Strength of CA replaced by different % of bamboo

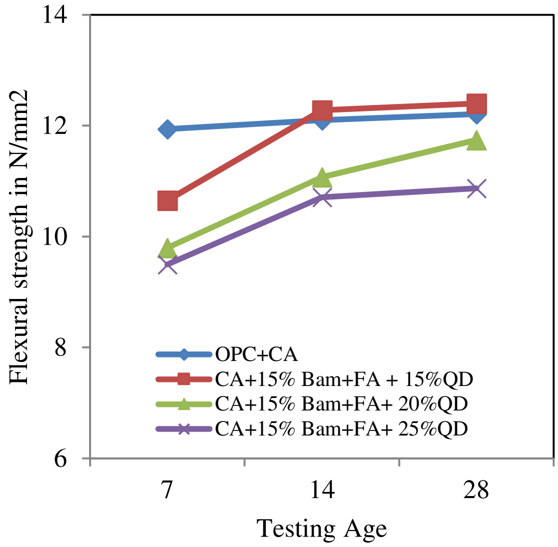

Fig.8 Flexural Strength of OPC replaced by different % of Quarry Dust

4. CONCLUSION

From the experimental study with the replacement of coarse aggregate and fine aggregate by bamboo and quarry dust, the following conclusions are drawn:

- Form the compressive strength result the optimum replacement of coarse aggregates and fine aggregates by bamboo and quarry dust is 15% respectively.
- Flexural strength of blended concrete prisms tested when subjected to two point loading were approximately nearer at control concrete
- Based on mechanical strength results the optimum partial replacement of coarse aggregate with bamboo and fine aggregate with quarry dust 15% , which clear evident form the 28 days strength results.
- The secondary cementitious wastes which pose a difficult problem in its disposal can be efficiently addressed through the result from this study for various application in the construction industry.

REFERENCES

[1] AdomAsamoah Mark and AfrifaOwusu Russell, "Comparative Study of Bamboo Reinforced Concrete Beams Using Different Stirrup Materials for Rural Construction", *International Journal of Civil and Structural Engineering*, 2011, Vol- 2.

[2] Agbode, U.N., and Joel, G.K., "Quarry Dust Concrete", *Engineering Science and Technology; An International Journal*, Vol-2, 2001, pp 67 – 71.

[3] Anithaselvasofia.S.D, Gayathri.R,Swathi.G, Prince Arulraj.G, "Experimental Investigation of Quarry Dust Concrete with Chemical Admixture", *International Journal of Latest research in Science and Technology,* Vol-**2**, Iss 2,2013, pp.91-94.

[4] A.V.S.Sai Kumar, Krishna Rao B., "A Study on Strength of Concrete with Partial Replacement of Cement with Quarry Dust", *International Journal of Innovative Research in Science, Engineering and Technology,* Vol-**3**, 2014.

[5] AhsanSabbir, Md., and Ashfaqul, S. M., "Determination of Tensile Property of Bamboo for Using as Potential Reinforcement in the Concrete", *International Journal of Civil and Environmental Engineering - International Journals of Engineering and Sciences IJCEE-IJENS*, Vol- **11**, 2001, pp 05.

[6] Ahmed E. Ahmed and Ahemed A. E. kourd, "Properties of Concrete Incorporating Natural and Crushed Stone Very Fine Sand", *ACI material journal*, vol-**86**, Iss 4, 1989, pp 417 – 424

[7] Anithaselvasofia S.D, Gayathri R, SwathiG and Prince arulraj G, "Experimental Investigation On Quarry Dust Concrete with Chemical Admixture", *International Journal of Latest Research in Science and Technology,*Vol- **2**, Iss 2, 2013, pp 91 – 94.

[8] ChandanaSukesh, KatakamBala Krishna, P.Sri Lakshmi SaiTeja, S.KnakambaraRao, "Partial Replacement of Sand with Quarry Dust in Concrete", *International journal of Innovative Technology and Exploring Engineering,* Vol-**2,** Iss 6, 2013,pp 254 – 258.

[9] Ghavami, K., Rodrigues, C.and. Paciornik, S., "Bamboo: Functionally Graded Composite Material", *Asian Journal of Civil Engineering (building* &housing),Vol- **4,**2003, pp 1 – 10.

[10] Ilangovan R, Mahendrana N and Nagamanib K, "Strength and Durability Properties Concrete Containing Quarry Rock Dust as Fine Aggregate", *ARPN Journal of Engineering and Applied Sciences*, Vol- **3,**Iss 5, 2008.

[11] IS 456-2000, "Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standards, New Delhi.

[12] IS 10262: 2009, "Recommended Guidelines for Concrete Mix design", Bureau of Indian Standards, New Delhi.

[13] IS: 2386 (Part III): 1963 Methods of Test for Aggregates for Concrete: Specific gravity, density, voids, absorption and bulking, Bureau of Indian Standards, New Delhi.

[14] IS: 2386 (Part IV): 1963 Methods of Test for Aggregates for Concrete: mechanical properties, Bureau of Indian Standards, New Delhi.

[15] IS 383: 1970, "Specification of Coarse Aggregate and Fine Aggregate from Natural Sources for Concrete", Bureau of Indian Standards, New Delhi.

[16] Joseph O.Ukpata, Maurice E.Ephraim and Godwin A.Akeke, Compressive Strength Of Concrete Using Lateritic Sand And Quarry Dust As Fine Aggregate", *ARPN Journal of Engineering and Applied Sciences*, Vol**7**, Iss 1,2012.

[17] Joseph O.Ukpata, Maurice E.Ephraim and Godwin A.Akeke, "Flexural and Tensile Strength Of Concrete Using Lateritic Sand And Quarry Dust As Fine Aggregate", *ARPN Journal of Engineering and Applied Sciences,* Vol-7, I ss 3, 2012.

[18] J.SelwynBabu, N. Mahendran, "Experimental Studies on Concrete Replacing Fine Aggregate with Blast Furnace Slags", *International Journal of Engineering Trends and Technology,* Vol- **10,**Iss 8, 2014.

[19] KhosrowGhawami, “Bamboo as Reinforcement in Structural Concrete Elements Bamboo”, *Cement and concrete composites*, 2005, pp 637 – 649.

[20] K.Subramanian and A.Kannan, (2013), “An Experimental Study on Usage of Quarry Dust as Partial Replacement for Sand in Concrete and Mortar”, *Australian Journal of Basic and Applied Sciences*, Vol- 7, Iss 8, pp 955 – 967.

[21] Lohani.T.K, Padhi.M, Dash K.P, Jena.S, “Optimum Utilization Of Quarry Dust as Partial Replacement Of Sand in Concrete”, *International Journal of Applied Sciences and Engineering Research,* Vol-1, Iss 2,(2012).

[22] Masakazu Terai and Koichi Minami, “Fracture Behavior and Mechanical Properties of Bamboo Reinforced Concrete”, *Procedia Engineering*,2011, pp 2967 – 2972.

[23] M. Devi, V. Rajkumar and K. Kannan, “Inhibitive Effect of Organic Inhibitors in Concrete Containing Quarry Dust As Fine Aggregate”, *International Journal of Advances in Engineering Sciences,* Vol.2, Iss 1, 2012.

[24] Mangiuru.G.N, Karugu.C.K, Oyawa.W.O, Abuodha.S.O and Mulu.P.U, “Partial Replacement of Natural river Sand with Crushed rock Sand in Concrete Production”, *Global Engineers & Technologists Review,* 2013.

[25] P.B.Sakthivel, C.Ramya and M.Raja, “An Innovative Method of Replacing River sand by Quarry Dust waste in Concrete for Sustainability”, *International Journal of Scientific & Engineering Research,*Vol- 4, Iss 5, 2013.

[26] Vipin Kumar, Sugandh Gupta and Ankur Sachdeva Experimental and Numerical Analysis of Ground Effect of A Typical RIV (Reusable Launch Vehicle). International Journal of Mechanical Engineering and Technology, 8(7), 2017, pp. 1763–1774

[27] S. Kavitha and Dr. T. Felix Kala, Effect of Bamboo Fiber in Self Compacting Concrete Partially Replacing Cement with GGBS and Alccofine. International Journal of Civil Engineering and Technology, 8(3), 2017, pp. 158–166

[28] Suresh Barmavath, Kiran M V, CH Narendra Naik, G Sai Kumar, E Hari Naik, V Amulya and V Divya. Flexural Strength of Concrete by Replacing Bamboo in RCC Beam. International Journal of Civil Engineering and Technology, 8(6), 2017, pp. 10–18

[29] Emerging Fiber of The Century- Bamboo, Shivaraj R. Kulkarni and Shaheeda Banu. S, Volume 5, Issue 11, November (2014), pp. 19-25, International Journal of Advanced Research in Engineering and Technology

[30] Radhikesh P Nanda., Amiya K Das and Moharana N C, “Stone Crusher Dust as A Fine Aggregate in Concrete for Paving Blocks”, *International Journal of Civil and Structural Engineering* ,Vol- **1**, Iss 3,2010, pp. 613 – 620.