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Effects of Superplasticer (Conplast SP430) on Some Properties of Quarry Dust Concrete

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Abstract-This study investigates the effect of high water reducing agent on some properties of quarry dust concrete. Manufactures of high water reducing agent usually specify the ranges values for conventional concrete, little or no work has been done on how admixtures (high water reducing agent) affect compressive strength, durability and workability of quarry dust concrete, thus the need for this paper. Different mixtures were batched which are MIX A, MIX B, MIX C and MIX D, all had a mix ration of 1:2:3. we kept on increasing the percentage of the Conplast SP430 to cement ration, as determine effect that the high water reducing agent has on different mixtures. It was noticed that the superplasticizer initially increased the compressive strength of concrete up to a certain level where the compressive strength started declining. Studying the trends of this work, a range value of 1.4%-2.2% is recommended for optimum compressive strength, durability and workability for quarry dust concrete when using Conplast SP430. The maximum strength was found to be 30.07N/mm^2 and a minimum strength of 21.56N/mm^2 for mix A which is a mixtures of quarry dust and granite and a water cement ratio of 0.45.

Keywords- *Superplasticizer, Concrete, Quarry Dust*

I. Introduction

Concrete is the most widely used material in construction all over the world. It is the most important material in the field of construction and infrastructural development. With the increase in its demand and usage lots changes in concrete technology has taken place over past few years. Concrete is composed of an inert matrix of sand, gravel, crushed rock and other aggregates held together by a hardened paste of hydraulic cement and water. The thoroughly mixed ingredient when properly proportioned, make a plastic mass which can be cast or moulded into a predetermined size and shape. Upon hydration of the cement by water, concrete becomes stone like in strength and hardness with utility for many purposes.

Aggregates occupy about three-fourth of the space within a given mass of concrete and the rest is occupied by hydrated water-cement past and air void. According to Neville (1996) aggregates are mineral filler material used in concrete. Material like sand, gravel, crushed rock, quarry dust, and other mineral filler are used as aggregates. It consists of fine and coarse aggregates. Fine aggregates include sand, laterite, saw dust, quarry dust etc. while coarse aggregate includes gravel, crushed stone, cobble etc.

Admixtures are defined as material, other than cement, water and aggregates that is used as ingredient of concrete and added to the batch immediately before or during mixing

(Shety, 2000). These days' concrete is being used for wide varieties of purpose to make it suitable in different conditions. In these conditions ordinary concrete may fail to exhibit the required quality performance or durability. In such cases, admixtures are used to modify it, to make it more suitable for any situation. The workability and compressive strength of concrete increases with the use of super plasticizers (admixture) according to Malagavelli et al (2012).

Unfortunately, the use of plasticizers has not become popular in Nigeria. There are many reasons for the non-acceptance for wider use of plasticizer in Nigeria which are that ninety percent of concreting activities are in the hands of common builder or government department who do not generally accept something new.

The range of super plasticizer specified by manufacturer was based on all sand conventional concrete. There is no range specified for quarry dust concrete, which hinder the use of quarry dust concrete with the super plasticizer (conplast sp430).

The specific objective of the study is to provide a range value for superplasticizer (conplast sp430) when using quarry dust concrete that best suit some important properties of concrete like compressive strength, durability and workability of concrete. This is pursued by testing out different percentage content of the superplasticer to cement and comparing the effect on the properties of concrete.

II. RESEARCH METHOD

A. Materials and Methods

The materials that were used in this work are cement, water, quarry dust, coarse aggregate (river gravel and crushed granite), sand, and super plasticizer (conplast Sp430)

1) Cement

Dangota cement a brand of ordinary Portland cement with the properties in accordance with the British standard was used. Because it is c loosely the most available cement for construction in Nigeria.

2) Water

Portable water was used. The water was obtained from the school premises and it conforms to NIS 87:2004.

3) Quarry dust

The quarry dust that was used was obtained from asphalt unity construction limited company located at Eluama, Agunchara, and Abia state

4) River Sand

The sand that was used was river sand and it was obtained from Otamiri River which is within the school premises

5) Courses aggregates

The coarse aggregates that were used were crushed gravel and river gravel. The crushed gravel was obtained from market imo state, while the river gravel was obtained from Otamiri River within the school premises.

6) Super plasticizer (conplast sp430)

The super plasticizer that was used is conplast sp430 which is a high water reducing agent. It was obtained at FOSROC group of company in Lagos.

B. Laboratory testing of materials

The materials and cubes used for this research work were tested for the following properties: slump value, gradation, specific gravity, bulk density, water absorption properties and compressive test.

1) Sieve analysis

Sieve analysis was carried out in accordance to BS882 (1992). The mechanical sieve shaker at the civil engineering laboratory at Federal University of Technology Owerri was used.

2) Specific gravity

The specific gravity of a material is the ratio of the weight or mass of a volume of the materials to the weight or mass of an equal volume of water. It seeks to explain the volume of water displayed by the particles. The test was done in accordance BS 1377-2:1990

3) Bulk density test

Bulk density is the ratio of mass of aggregates to the volume occupied by the aggregates. It is the property of change of volume when water is added to material. Bulk density can be calculated using equation 2.4 and done in accordance to BS 1377-2:1990.

4) Slump test

Slump test is done to determine the slump value, which represent how workable or the workability of the concrete. Slump test was done in accordance to BS EN 12350-2:2009

5) Compressive strength test

Compressive test was done with machine conforming to the requirement of BS 1881-115 (1986) and in accordance to BS 1881-108:1983. The cubes were crushed after 28day of curing.

6) Water absorption test

Water absorption test was done after immersing the concrete cubes in water for 24 hours. The percentage water absorption was computed by taking the difference between the weight of the cubes when fully immersed in water and the weight when oven dried, divided by weight of air dried cube and multiplying by 100 According to BS 1881-122:2011.

7) Trial test

Trial mix was first carried out to determine the water cement ratio to be used. 0.4, 0.45, 0.5 and 0.55 were first tried with 1% content of super plasticiser. And finally we resorted to use 0.45 and 0.5 water cement ratio.

C. Concrete Cube production

The processes of cube production include the following:

1) Batching

The material that will be used will be batched in accordance to their mix ratio by weighing them on a scale before mixing. The mix ratio that was used was one part of cement to two parts of quarry dust and three parts of crushed granite and also one part of cement two parts of quarry dust and three parts of river gravel.

2) Casting

After batching the materials, mixing of the materials and casting the materials in a cube of 0.001M volume. This cube is to hold the concrete and give it the shape of the cube

3) Curing

After the component has all been mixed and cast, hydration of concrete starts, which causes loss of water, curing is done to keep the concrete moist so that the cracks will not develop. The curing that was used is the total immersion curing in which the cubes are totally immersed in water and left for 28days for the concrete to gain sufficient strength

III. RESULTS AND DATA ANALYSIS

A. Data Presentation

The result of the various test conducted are presented as follows

1) Specific gravity

The specific gravity of the fine aggregates sand and quarry dust are presented in Table 1 and 2 respectively.

TABLE I. SPECIFIC GRAVITY FOR SAND

Trial run	Trial 1	Trial 2	Trial 3
Mass of empty pyknometer bottle (M1),(g)	750.97	750.97	750.97
Mass of bottle + dry sample (M2), (g)	1151.17	1154.92	1154.80
Mass of bottle + dry sample + water (M3), (g)	2057.58	2073.32	2065.33
Mass of bottle filled with water only (M4), (g)	1814.90	1814.90	1814.90
specific gravity	2.54	2.78	2.63
average specific gravity	2.65		

TABLE II. SPECIFIC GRAVITY FOR QUARRY DUST

Trial run	Trial 1	Trial 2	Trial 3
Mass of empty pyknometer bottle (m1),(g)	753.01	753.01	753.01
Mass of bottle e + dry sample (M2), (g)	1166.46	1160.65	1165.42
Mass of bottle e+ dry sample + water (M3), (g)	2076.05	2077.54	2070.37
Mass of bottle filled with water only (M4), (g)	1816.95	1816.95	1816.95
specific gravity	2.68	2.77	2.59
Average	2.68		

2) Sieve analysis test result

The sieve analysis results for materials used for this work are presentenced in the figure 1 and figure 2 below:

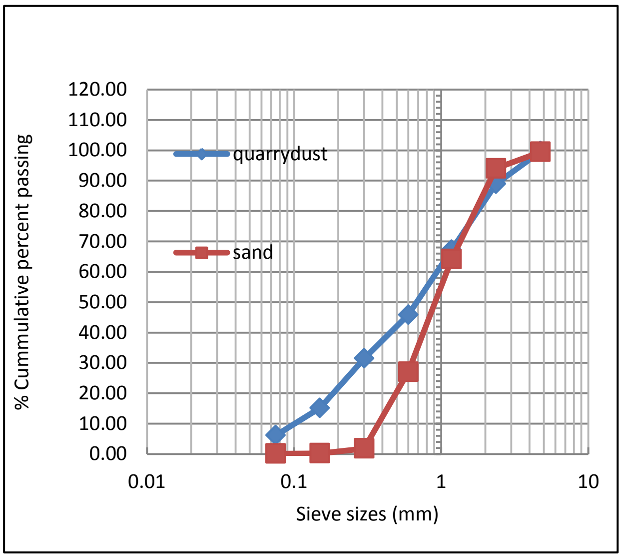

Figure 1. Particles distribution curve for quarry dust and sand

Gradation coefficient:

From fig 1 the coefficient of uniformity, Cu and coefficient gradation Cc are obtained as follows:

For sand:

$D_{10} = 0.4, D_{30} = 0.65, D_{60} = 1.1$

$C_U = \frac{D_{60}}{D_{10}} = \frac{1.1}{0.4} = 2.75$, $C_C = \frac{D_{30}^2}{D_{10}D_{60}} = \frac{0.65^2}{0.4\times0.95} = 0.96$

For quarry dust:

$D_{10} = 0.1, D_{30} = 0.3, D_{60} = 0.95$

$C_U = \frac{D_{60}}{D_{10}} = \frac{0.95}{0.1} = 9.5$, $C_C = \frac{D_{30}^2}{D_{10}D_{60}} = \frac{0.3^2}{0.1\times0.95} = 0.944.$

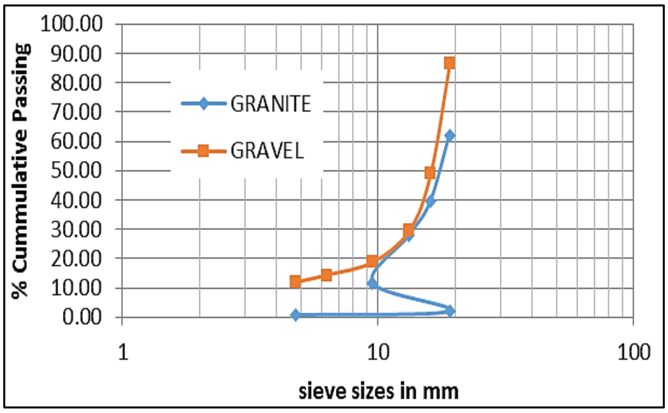

Figure 2. Particle size distribution for granite and gravel

3) Compressive test result

The compressive test for different mix is presented in the figure 3 below:

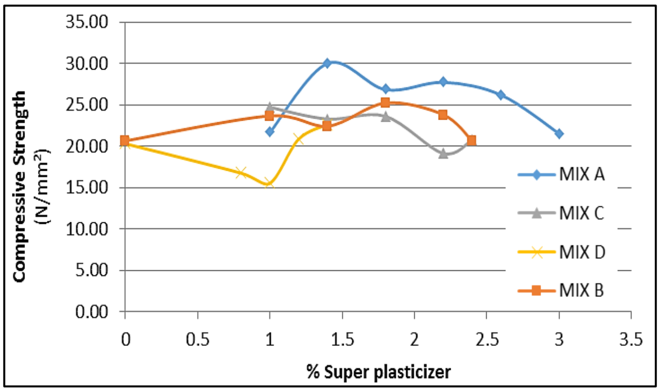

Figure 3. Compressive strength for different mixtures

4) Slump test

Slump test for different mix are shown in the figure 4 below:

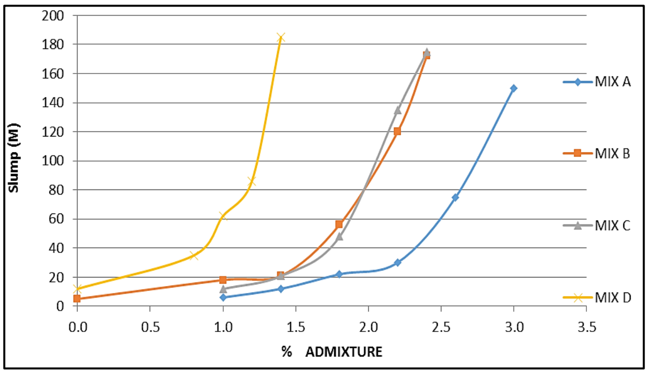

Figure 4. Slump size for different mixtures

5) Water absorption test

The results for the water absorption test are presented in the figure 5 below:

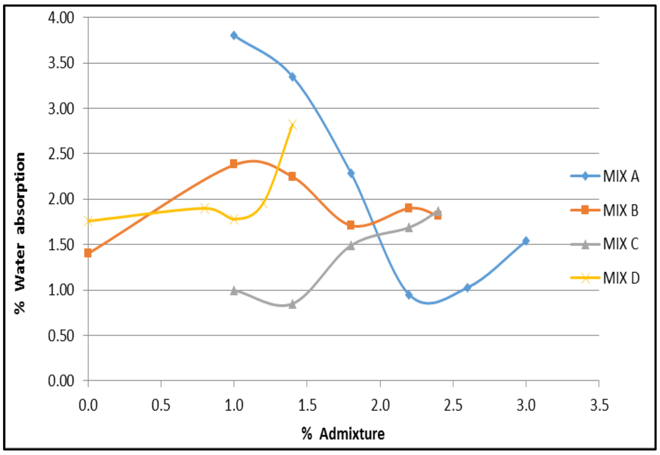

Figure 5. Water absorption of different mixtures

B. DISCUSSION OF RESULTS

1) Physical properties of aggregates

The aggregates used for this work are river sand, quarry dust, granite and river gravel.

a) Specific gravity and bulk density of aggregates

The specific gravity for sand, quarry dust, crushed granite and gravel were found to be 2.65, 2.68, 2.71 and 2.55 respectively. These values are within the normal range of materials specific gravity suitable for making concrete.

The bulk density aggregates used, loose and compacted were presented in table 4.2 for all aggregates. The values obtained are within the allowable range for bulk density of materials that are suitable for making concrete.

b) Gradation of aggregates

The sieve analysis shows of sand and quarry dust showed both fall in zone II of grading of fine aggregates as given in BS 882(1992) and are suitable for making concrete. The fineness moduli are 3.1 and 2.52 respectively for sand and quarry dust. These values are within range 2.3-3.1 which is recommended for fine aggregates in concrete works (AC, 1999). The coefficient of uniformity C_u and coefficient of gradation C_c for sand 2.75 and 0.96 respectively, while the corresponding values for quarry dust are 9.4 and 0.94. This result show that sand has smaller range of particles on but almost well graded C_u approximately equal to 1.on the other hand quarry dust has higher range of particles but approximately well graded when compared to sand.

Also sieve analysis for coarse aggregates crushed granite and gravel show that their fineness moduli are 3.9 and 4.56 respectively which is within the recommended limit for materials suitable for making concrete.

2) Compressive strength

It is observed that the compressive strength of the concrete cube generally increases on addition of super plasticizer. However as we kept on increasing the admixture the compressive strength up to a point start decreasing as shown in fig 3. The maximum strength was found to be 30.07N/mm^2 and a minimum strength of 21.56N/mm^2 for mix A which has a water cement ratio of 0.45 and a mix ratio of 1:2:3. It is also observed that for all the mixes the percentage of super plasticizer that gives the optimum compressive strength ranges 1.4-2.2% by mass of cement. Also the compressive strength for all the mixes with different content of super plasticizer is within the recommended strength for structural concrete with least strength of 20N/mm^2 for concrete having crushed granite as coarse aggregates while that for river gravel is 15.56N/mm^2.

Note:

MIX A is a mixture of quarry dust and granite @ 0.45 water-cement ratio.

MIX B is a mixture of quarry dust and granite @ 0.5 water-cement ratio.

MIX C is a mixture of quarry dust and gravel @ 0.45 water-cement ratio.

MIX D is a mixture of quarry dust and gravel @ 0.5 water cement ratio

3) Slump test

It was observed that as the percentage of the super plasticizer increases the slump values increase for all the mixes. This means that the super plasticizer (conplast sp40) increases the workability of fresh concrete made with quarry dust as sole fine aggregate. Maximum slump is 175mm which was achieved when using river gravel and 2.6% content of the super plasticizer, while the least slump is about 6mm, achieved when using crushed granite rocks and 1% content of super plasticiser.

4) Water absorption test

The water absorption for the various mixes reduces as the percentage of super plasticizer increase. This means that the super plasticizer general increases the durability of the concrete, as shown in fig 5, as the super plasticizer keeps on increasing up to a certain level, there was an increases in water absorption, which in turn gradually reduce the durability of concrete. The same trend was noticed for all the mixes. The maximum water absorbed was about 3.72% for mix A while the least was about 0.8%.

IV. CONCLUSION AND RECOMMENDATION

A. CONCLUSION

Based on the result obtained in the laboratory, analysis and discussion done in chapter 4, the following conclusions have been arrived at:

1. the cubes strength generally increase with increment in percentage of super plasticizer when compared to zero percent content (control) and start decreasing when it gets to a certain point. Also the workability of all the mix increase with increment in super plasticizer content. Also it can be said that increase in percentage of super plasticizer reduces water absorption of the cube, therefore super plasticizer generally increases the durability of the cubes but start decreasing when it get to a level.

2. A range of 1.4-2.2% of super plasticizer is to be used for optimum compressive strength, good workability and durability requirement when using quarry dust as fine aggregates.

3. 0.45 And 0.5 water cement ratio was used for MIX A and MIXB having mix ratio of 1:2:3 for both mix with crushed granite as coarse aggregate. It is observed that MIX A is better than MIX B on the basic that, it has higher compressive strength, better workability and durability. So therefore 0.45 water cement ratio should be used with super plasticizer. The same goes for MIX C and MIX D with water cement ratio of 0.45 and 0.5 with a mix ratio 0f 1:2:3 with river gravel as coarse aggregate.

4. concrete made with river sand has higher strength than concrete made with quarry dust when using crushed granite as coarse aggregate, however when using gravel as coarse aggregate quarry concrete gives higher strength than using river sand. However from their compressive strength and slump values quarry dust can be used as replacement for sand because it gives a comparatively high strength concrete.

B. RECOMMENDATION

Based on findings we recommend the following:

1. Super plasticizer conplast sp430 should be used within a range 1.4-2.4% by mass of cement for optimum compressive strength, good workability and low water absorption property of quarry dust concrete.

2. Quarry dust should be used as a whole replacement for sand especially when using river gravel as coarse aggregate because it increases the compressive strength of river gravel than that of granite. Though more research should have conducted on this to ascertain the veracity of the statement.

3. I recommend a mix ratio of 1:2:3 with water cement ratio of 0.45 to be the mix that gives the best desirable property of concrete according to the result obtained for both crushed granite and river gravel.

4. For higher percentage of super plasticizer, water cement ratio should be reduced so that workability will be within allowable limit and concrete will not start following.

5. More research works should be carried out on the topic with different mix ratio and different water cement ratio and varying super plasticizer, so that a better result could be ascertained and probably result to developing a model.

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REFERENCES

[1] Balamurugan, G. and Perumal P. (2013). .Use of quarry dust to replace sand –an experimental study. International Journal of Scientific and Research Publications, Volume 3, Issue 12, December 2013 ISSN 2250-3153.

[2] British Standards Institution (1995). BS 812-2 Method for Determination of Density. London.

[3] British Standards Institution. (1985). BS 812-103 Method for determination of particles size distribution. London.

[4] British Standards Institution. (1990). BS 1377-1 General requirement for sample preparation. londom united kingdom.

[5] British Standards Institution. (1991). BS1377 Method of testing soil for civil engineering purpose. London.

[6] British Standard Institution. (1992). BS 882 Specification for aggregates from natural sources for concrete, 2 Park street, London.

[7] Celik T, Marar K. (1996). Effect of crushed dust on some properties concrete. Res, 26(7): 1121-1150.

[8] Chandana S., Katakam, B.K., Lakshmi, S.T., & Kanakambara S.R (2013). Partial replacement of sand with quarry dust in concrete. International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-2, Issue-6, May 2013.

[9] Chitlange M.R. and Pajgade, P.S. (2010). Strength appraisal of artificial sand as fine aggregate in SFRC. ARPN Journal of Engineering and Applied Sciences, vol. 5, no. 10, pp. 34–38, 2010

[10] Dhir, R.K. and Jackson, M. (1996).Civil Engineering materials, London: Macmillan.

[11] Dodoo-Arhin D., Konadu, D.S., Annan, E., Buabeng, F.P., Yaya, A. and Agyei-Tuffour, B. (2013). Fabrication and characterisation of the Ghanaian bauxite red mud-clay composite Bricks for construction Application. American journal of materials science. Vol. 3(5): pp. 110-119.

[12] Dehwah, H.F.A. (2012). Corrosion resistance of self-compacting concrete incorporating quarry dust powder, silica fume and fly ash. Construction and Building Materials, vol. 37, pp. 277–282, 2012.

[13] Deodhaar, S. (2009). Civil engineering materials .Darya Ganji. New Delhi: Khanna publisher.

[14] Devi M. and Kannan, K. (2011). Analysis of strength and corrosion resistance behaviour of inhibitors in concrete containing quarry dust as

fine aggregate. Journal of Engineering and Applied Sciences, vol. 6, no. 11, pp. 124–135, 2011.

[15] Dumne S.M. (2014). Effect of super plasticizer on fresh and hardened properties of self-compacting concrete containing fly ash. American Journal of Engineering Research (AJER), ISSN: 2320-0847 p-ISSN: 2320-0936 Volume-03, Issue-03, pp-205-211.

[16] Eze- Uzomaka, O.J. and Agbo D. (2010): Suitability of quarry dust as improvement to cement stabilized laterite for road bases. EDJE, Vol. 15 pp 1053-1064.

[17] Grundy, J. T. (1981). Construction Technology. Vol. 3, Edward Arnold, Mill Road, DontonGreen.

[18] Gupta, B.L and Gupta, A. (2004). Concrete Technology. Published by A.K. Jain Delhi, 2004.

[19] Ilangovana, R, Mahendrana N., & Nagamanib K. (2008). Strength and durability properties of concrete containing quarry dust as fine aggregate. ARPN journal of engineering and applied sciences, vol3, NO.5, ISSN 1819-6608.

[20] Inkia, F.A (2000). Basic civil engineering. bamenda: vishu publishers".Pp, 43-48

[21] Jayawardena, U.De S. and Dissanayake, D.M.S (2006). Use of quarry dust instead of river sand for future construction in Sri Lnaka . IAEG paper No.38, Geological society of London, U.K.

[22] Manasseh J. (2010). Use of crushed granite as replacement to river sand in concrete production. Leonardo electronics journal of practise and technologies 17, 85-96.

[23] Mather, B. (2004). Concrete Aggregates Shape, Surface Texture, and Coatings. vol. 223, ACI Special Publication, Farmington Hills, MI, pp. 57-78.

[24] McNally, G.H (1998). Soil and rock construction material. first edition, rout ledge, New York, NY.147.

[25] Mehta O. and Monteiro, P. (1993). Portland cement and its chemical composition. Construction and Building Materials, vol. 37, pp. 277–282, 2012. April 1993.

[26] Nanda, R.P., Das, A. K. and Moharana, N. (2013). Stone crusher dust as a fine aggregate in concrete for paving blocks," International Journal of Civil and Structural Engineering, vol. 1, no. 3, p. 613, 2010

[27] Nevile, A.M (1996). Properties of concrete, (4th ed). London: Longman group limited

[28] Nevile, A.M. and Brooks J.J (1987). Concrete technology. pearson Ltd partpargani, delhi 110 092, india

[29] Nigeria Industrial Standards NIS 444-1:2003- Standard for Ordinary Portland Cement, approved by Standard Organization of Nigeria (SON).Lagos Nigeria.

[30] Nigeria Industrial Standard NIS 87:2004- Standard for Potable Water, approved by Standard Organization of Nigeria (SON). Lagos Nigeria

[31] Omopariola, S.S. (2014). A study of the hygroscopic properties of hallows sandcrete blocks. American journal of engineering research Vol. 3 (5). Pp. 93-97. ISSN: 2320-0847.

[32] Rahul, D. and Kumar P. (2012). Effect of super plasticizer dosages on compressive strength of self compacting concrete. International journal of civil and structural engineering Volume 3, No 2, 2012, ISSN 0976 – 4399.

[33] Ravin, D. (1997). Properties of fresh concrete incorporating high volume of fly-ash as partial fine sand replacement. Materials and Structures/ Materiaux et construction, vol.30, Pg.No. 473 to 479, October 1997.

[34] Salahaldein, A. (2015). Effect of Super plasticizer on Fresh and Hardened Properties of Concrete" Journal of Agricultural Science and Engineering Vol. 1, No. 2, 2015, pp. 70-74.

[35] Shetty, M.S. (2006). Concrete technology theory and practice. (6th ed) new delhi: schand publisher and company Ltd. India

[36] Sivakumar, J. and prakash, M. (2011). Charactertics studies on the mechanical properties of quarry dust addition in conventional concrete. Journal of civil engineering and construction technology 2:210-233

[37] Sudhir, S.K. and.Satone, S.R (2013). Effect of quarry dust as partial Replacement of sand in concrete. Indian Streams Research Journal, Volume 3, Issue. 5, June. 2013, ISSN:-2230-7850.

[38] Tamrakar R., Konso G., and Nisaro F. (2013). Experimental Studies on Property of Concrete due to Different Ingredient based Super Plasticizer. International Journal of Science, Engineering and Technology Research (IJSETR) Volume 2, Issue 5, May 2013.

[39] Ukpata, J.O. and Ephraim, M.E. (2012). Flexural and tensile strength properties of concrete using lateristic sand and quarry dust. ARPN Journal of Engineering and Applied Sciences, vol. 7, pp. 324–331, 2012.

[40] Vazirani, V.N. And Chandola, S.P. (2009), Concrete Technology. 6th edition Khanna Publisher, New Delhi India.

[41] Venu M. and Tim N. (2012). Strength and Workability Characteristics of Concrete by Using Different Super Plasticizers" International Journal of Materials Engineering, 2(1):pp 7-11, 2012.

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