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Exploring the Viability and Implications of Replacing M-Sand with Natural Sand in Concrete Construction: A Review

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Abstract
The global demand for construction materials, particularly sand, continues to surge, driven by *rapid urbanization and infrastructure development. However, the indiscriminate extraction of natural sand from riverbeds and beaches has led to environmental degradation and scarcity concerns. In response, the construction industry is increasingly turning to alternative materials such as Manufactured Sand (M-sand) as a sustainable substitute for natural sand.This abstract presents a comprehensive overview of the viability and implications of replacing traditional sand with M-sand in construction applications. It explores the production process of M-sand, which involves crushing rocks and quarry stones to produce sand particles of desired size and shape. Compared to natural sand, M-sand offers advantages such as consistent quality, controlled gradation, and reduced environmental impact due to its manufactured nature.*

Moreover, this abstract delves into the mechanical and durability properties of concrete and mortar mixes incorporating M-sand, highlighting their performance in terms of compressive strength, flexural strength, and durability aspects such as resistance to chloride penetration and sulfate attack. Additionally, it discusses the potential challenges associated with the utilization of M-sand, including its effect on workability, potential impurities, and cost considerations.Furthermore, this abstract examines the economic and environmental aspects of adopting M-sand in construction projects, analyzing factors such as transportation costs, energy consumption, and greenhouse gas emissions associated with M-sand production and utilization compared to natural sand. Additionally, it discusses the regulatory framework and standards governing the use of M-sand in various regions.

Overall, this abstract provides valuable insights into the feasibility and benefits of incorporating M-sand as a sustainable alternative to natural sand in construction activities. By considering technical, economic, and environmental factors, stakeholders can make informed decisions regarding the adoption of M-sand, contributing to the promotion of sustainable construction practices and resource conservation.
Keywords: *M-sand, Sand, Concrete, Workability, Environmental Factors*

Introduction

Rapid industrialization in developing countries is increasing in urbanized areas. To support the urbanization, new building, such as buildings for housing and industries, transit large scale for people to move, and all construction activities are required for facilities to deal with water and sewage. In developing countries, the lack of traditional building materials and abundant industrial waste products has encouraged the recent construction material. Natural river sand is the product of sedimentation. Asbestos, coal, fossils and other organic inaccuracies are present in the sand of the river above a few percent, which makes the sand unsuitable for concrete work. The natural river sand was the cheapest resource in sand. However, to meet the growing demand of sand in the construction industry, excessive mining of the river bed has given rise to ecological imbalance in the state. Now the sand available in the river is very thick and it has a lot of silt and soil. The presence of silt and soil in the sand reduces the power of concrete and keeps moisture.

Rapid increase in construction activities ends up in acute shortage ofstandard construction materials. It is standard that sand is being employed asfine aggregate combination in concrete.For the past 2 years, the escalation in cost of sand due to administrative restrictions in India, demands comparatively greater cost at around two to three times the cost for crusher waste even in places where river sand is available nearby. The large scale depletion of those sources creates serious environmental issues. So Governments are limiting the gathering of stream sand from stream bed. Rapid reduction of the river's sand and high value has led to the sinking of sand with salted sea sand, which has created serious concern for builders.In such a scenario the M-Sand will be a cheap different to stream sand. Stone dust or quarry dust is a waste material obtained from crusher plants. It has potential to be used as partial replacement of natural stream sand in concrete. Use of stone dust in concrete not only improves the quality of concrete but also conserve the natural river sand for future generations.

Literature Review Summary

In the following chapter, literature and reports related to use of M-Sand in concrete are studied. The results of previous research are analyzed. However, in this research, the concentration on the use of M-Sand as a full replacement of sand in concrete anyhow, was not found in any other documents. The purpose of most of the previous research was to partially use the river's sand into concrete, although the purpose of this research was to replace all the sand in concrete.

Detailed Literature Review

R. Anjali, G. Venkatesan (2022) Concrete is one of the broadly utilized materials due to the unavoidable nature of construction. The requirement for improvement in mechanical properties and environmental hazards with the usage of natural sand requires an alternative choice in raw materials. This research work is carried out to investigate the compressive and tensile strength properties of concrete prepared by adding manufactured sand (M-sand) sand and polyethylene terephthalate (PET) particles. Pullout test, Water Absorption (WA), Electrical Resistivity (ER), Rapid Chloride Permeability Test (RCPT), X-Ray Diffraction (XRD) and Scanning Electron

Microscopy (SEM) are also analyzed in addition to compressive and tensile strength. A suitable proportion of materials is studied from the preliminary investigation and produced five different concrete specimens for this study. New proportions of concrete mixes with cost-effective materials such as PET and M sand are contributed to enhancing the strength and tensile properties. Cylindrical-shaped concrete specimens are created with final mix proportions and their properties are studied for six different days. The results show that the final specimen has acquired a maximum compressive strength of 45.3 MPa, a maximum tensile strength of 3.77 MPa, a maximum flexural strength of 4.72 MPa, and a minimum water absorption of 8.087 were all obtained by 7.5P specimen after 90 days of synthesis. The X-Ray Diffraction (XRD) and Scanning Electron Microscopy (SEM) analysis results taken for 7.5P specimen after 90 days indicate the presence of PET provide more strength and tensile properties. The properties of the proposed concrete composition is validated and compared with predicted values obtained from Deep Neural Network-Horse herd Optimization Algorithm (DNN-HHO) to find accurate results. The proposed concrete indicates an enhanced result in mechanical properties along with the reduction in environmental issues and can be utilized in the construction field of small applications.

Nimitha Vijayaraghavan and A S Wayal (2013) A huge amount of concrete is consumed by the construction industry. About 35% volume of concrete is comprised of sand. A good quality concrete is produced by careful mixing of cement, fine and coarse aggregates, water and admixtures as needed to obtain an optimum quality and economy. Generally cement and coarse aggregates is factory made products and their quality and standards can be easily controlled and maintained. Water used for mixing of concrete is usually tap water. The fine aggregates or sand used is usually obtained from natural sources specially river beds or river banks. Now-a-days due to constant sand mining the natural sand is depleting at an alarming rate. Sand dragging from river beds have led to several environmental issues. Due to various environmental issues Government has banned the dragging of sand from rivers. This has led to a scarcity and significant increase in the cost of natural sand. There is an urgent need to find an alternative to river sand. The only long term replacement for sand is manufactured sand.

M.Adams Joe, A.Maria Rajesh, P.Brightson, M.Prem Anand (2013) The natural river sand was the cheapest resource of sand. However the excessive mining of river bed to meet the increasing demand for sand in construction industry has led to the ecological imbalance in the country. Now the sand available in the river bed is very coarse and contains very high percentage of silt and clay. The silt and clay present in the sand reduce the strength of the concrete and holds dampness. A few alternatives have come up for the industry to bank on of which manufactured sand or M-sand, as it is called, is found to be the most suitable one to replace river sand. M-sand has caught the attention of the construction industry and environmentalists alike for its quality and the minimum damages it causes to nature. Usage of M-Sand can drastically reduce the cost since like river sand, it does not contain impurities and wastages is nil since it is made with modern technology and machinery. Once the M-sand becomes more popular in the construction industry, the demand for river sand and illegal sandmining would come down. Compared to the

river sand, the M-sand has a better quality consistency high Strength concrete with signifance saving instrument. M-sand that is available is graded, sieved and washed. The particles are more rounded and granular and do not have sharp edges. Usage of M-Sand can overcome the defects occurring in concrete such as honey combing, segregation, voids, capillary, etc. The purpose of this research is to experimentally investigate the effect of M-Sand in structural concrete by replacing river sand and develop a high performance concrete. It is proposed to determine and compare the differences in properties of concrete containing river sand and M-sand. It is also proposed to use steel fibres and chemical admixtures to increase the strength and workability of concrete respectively. The investigations are to be carried out using several test which include workability test, compressive test, tensile test, and flexural test

Sachin Kumars Roshan S Kotian (2018)A few alternatives have come up for the industry to bank on of which manufactured sand or M-sand, as it is called, is found to be the most suitable one to replace river sand. M-sand has caught the attention of the construction industry and environmentalists alike for its quality and the minimum damages it causes to nature. Usage of M-Sand can drastically reduce the cost since like river sand, it does not contain impurities and wastages is nil since it is made with modern technology and machinery. Once the M-sand becomes more popular in the construction industry, the demand for river sand and illegal sand mining would come down, A well processed manufactured sand as partial or full replacement to river sand is the need of the hour as a long term solution in Indian concrete industry until other suitable alternative fine aggregate are developed. In the present study, a comparison of the Compressive strengths of River Sand and M-sand is done with the hundred percent replacement of river sand by M sand.

P.Thamilselvi (2016) Natural or River sand are weathered particles from rocks which are of various shapes and sizes depending upon the weathering action of rivers. In the present scenario, natural sand with required properties is not easily/locally available. In most of the situations, the natural sand is being brought from faraway places to the construction site. Such type of transporting the river sand from faraway places will increase the construction costs. Also these natural river sand is also becoming unavailable due to many reasons. Hence it is very essential to find an alternate material that can substitute the natural river sand either partially or fully. In Tamil Nadu, stone quarries are found in abundance and are wide spread across the state. They are the good source for the coarse aggregate and manufactured fine aggregate. There is a need to make use of the stockpiles of quarry fines generated in those crushers. Hence to make use of these M-sand in the construction industry, a systematic study has to be carried out on the replacement with Natural River sand in making concrete. Experimental investigations carried out on the evaluation of properties of M-sand obtained from different locations (sources) is presented in this paper. Based on the experimental results, mix design for different grades of concrete was carried out using M-sand obtained from two sources by replacement of natural sand. Experimental studies carried out on the properties of fresh and hardened concrete made using the developed mix proportions is also presented in this paper.

S. Hima Venkata Mahalakshmi, Veerendrakumar C. Khed (2020) The major aim of this experimental study is to produce Self compacting concrete (SCC) by replacing 100% of river sand with M-sand (manufactured sand). Using M-sand instead of river sand in SCC gives a satisfactory strength, reduces environmental problems and used as an eco-friendly material. Actually, SCC requires high slump to avoid segregation the percentage of fine aggregates increased with that cement content should be increased. So to reduce adverse effects due to cement we partially replaced cement with 0 to 15% of pozzolanic material like Silica fume to reduce the content of cement. Different mix designs of SCC with and without silica-fume were developed to study the effects on mechanical and rheological properties under the guidelines of EFNARC (2002). A comparative study was done on both the SCC and SCC with silica-fume. Silica-fume more effective to produce the high strength performance concrete. Silica-fume enriches the workability of SCC. SCC modulus of elasticity was increased with an increase in the content of Silica fume. An increase in the content of Silica-fume increases viscosity of the SCC which decreases the ratio of L-box test. The mechanical properties of SCC increases by adding Silica-fume compared to normal SCC.

R Hidayawanti ,Yuhanah , D Mayasari and B Wicaksono(2016) Concrete is a construction material composed of cement, water, and aggregate in the form of sand and gravel. Furthermore, Indonesia experiences a yearly increase in the need for building material, including concrete, due to the rise in development. Smooth and coarse aggregate materials are required to manufacture concrete with the inappropriate disposal of waste marble, adversely impacting environmental pollution. Therefore, tremendous efforts need to be carried out to reduce environmental problems associated with the disposal of waste marble to provide adequate economic value for construction and reduce the collection of rough aggregates in the river. A lot of industrial companies are needed to produce a coarse aggregate with various size variants, thereby, manufacturing waste, also known as M-Sand. The stone ash is one of the numerous coarse aggregate materials that are less desirable in concrete production. Therefore, this study was carried out to determine the compressive strength and water absorption content between fine and coarse concrete using a variety of coarse aggregate replacement materials from the waste marble with a 40% M-Sand substitute. The results showed waste marble variations of 0%, 25%, 50%, 75%, 100% substitution of coarse aggregate with 40% M Sand substitution of fine aggregate. The optimum compressive strength was found in variation 3 (40% M Sand + Waste Marble 50%) of 35.801 MPa at 28 days, with the optimum water absorption obtained at variation 1 (40% M-Sand + 0% Waste Marble) at 1.77%. By analysing the waste marble result of R close to 1, it is concluded that this variation can act as an alternative to the composition of a concrete mixture.

B. Udayasree G. Shravan Kumar (2023) Due to significant industrialization, many countries have adopted the practice of industrial symbiosis, which involves utilizing the waste produced by one industry as a resource for another industry. The utilization of spent foundry sand (SFS), which is derived from the metal casting industry, poses a significant risk to both the environment and living organisms as a result of the existence of inorganic and organic substances. Nevertheless, this waste material can serve as a valuable resource for the construction sector. The

utilization of SFS is significantly restricted due to insufficient comprehension of its concrete performance, despite its extensive range of applications. It is imperative to comprehend the behavior of spent foundry sand in concrete, particularly in relation to achieving a structure that is both strength-efficient and durable. The current study explores the usability of M-sand and spent foundry sand in self-compacting concrete. Reference concrete was produced by replacing river sand with 100% M-sand. M-sand was substituted with spent foundry sand in ratios ranging from 0 to 30%. Compared to the reference mix, SCC's mechanical and durability properties with 20% SFS were better. In comparison to the reference mix, SCC containing 20% SFS had higher mechanical and durability characteristics at 3, 7, 28 days, and 28 days, respectively. With 20% SFS, replacement showed better mechanical properties at all curing ages and better durability performance at 28 days of the curing period.

N. Sathyakumar; A. Divya (2019) Nowadays getting river sand is major problem in our country for construction purpose. So the alternate to river sand is must at this moment. There are lot of alternatives are available for river sand such as Manufactured sand (M-sand), Artificial sand (A-sand), Eco sand etc. Among the above M-sand is most widely used in construction, since it is easily available and cost wise economical. Much technical information is not available for M-sand. This paper deals about the properties of M-sand such as Fineness, specific gravity, sieve analysis, grain size distribution etc. By this paper a clear idea about M-sand is obtained and the results are compared with river sand in zone-II.

Jency Christy E, Jenifer Dharshini Raj.M ,Kavipriya. A , Sabari. D, Premalatha. K (2019) Now-a-days good sand is not readily available, there is a need to find some substitute to natural river sand. The practice of replacing natural river sand with M-Sand is taking a tremendous growth M-Sand is produced from hard granite stone by crushing. M-sand can contain larger amounts of fine particles than natural sand, this can affect the strength and workability of the concrete and this fine particles are dumped as a waste by-product called M-Sand dust which cannot be used in any civil engineering applications. Thus, the main objective of this study is to find the suitability of M-sand silt in civil engineering application by conducting tests such as grain size distribution, specific gravity, standard proctor test, permeability test, direct shear and CBR test. Based on the results, the suitability of M-Sand dust for plastering, concrete, pavement, filter media, landfilling and reinforced earth wall backfill are discussed.

Dr. Shankar H. Sanni , Prabhu GurunathappaSheelavantar(2021) The natural river sand was the cheapest resource of sand. However the excessive mining of river bed to meet the increasing demand for sand in construction industry has led to the ecological imbalance in the country. Now the sand available in the river bed is very coarse and contains very high percentage of silt and clay. The silt and clay present in the sand reduce the strength of the concrete and holds dampness. A few alternatives have come up for the industry to bank on of which manufactured sand or M-sand (manufactured sand), as it is called, is found to be the most suitable one to replace river sand. M-sand has caught the attention of the construction industry and environmentalists alike for its quality and the minimum damages it causes to nature. Usage of M-

Sand can drastically reduce the cost since like river sand, it does not contain impurities and wastages is nil since it is made with modern technology and machinery. Once them-sand becomes more popular in the construction industry, the demand for river sand and illegal sandmining would come down. M-sand that is available is graded, sieved and washed. The particles are more rounded and granular and do not have sharp edges. Usage of M-Sand can overcome the defects occurring in concrete such as segregation, voids, capillary, etc. The main purpose of this investigation is to replace sand in concrete with M-Sand for both M-30 and M-40 grades. The test results were compared to that of conventional concrete for 7 days and 28 days. Thus from result it is concluded that m-sand can be effectively used instead of river sand in concrete.

AltamashuddinkhanNadimalla , Siti Aliyyah Masjuki , Siti Asmahani Saad , Ean Lee Woen , Siti Maisarah Ali1 , Naseer Ulla (2020) This, research work was to study the potential of M-sand as compared to river sand in concrete, here M-sand is replaced by river sand 0%,45%,50%,55% and 100% in the concrete mix, Mix design is designed as per IS Standards. In this research a mix 1:2.32:2.82 (M20) was considered. The test specimen was casted for 7days, 28 days and 90days. The performance of M-sand was determined by several experiments such as slump test, impact strength test, flexural Strength, and compressive strength test. The results attained from each test states that as M-sand increases the slump value decreases. flexural strength, compressive strength and impact test of concrete at 7 days, 28 days and 90 days is greater at 100% and 50% replacement of M sand by river sand.

Aggerwal et al. (2007), Kim et al. (2011) and Bilir (2012) reported the effect of coal bottom ash as replacement of fine aggregate in concrete. Aggarwal et al. (2007) carried out experimental investigation to study the effect of bottom coal ash. Compressive strength, flexural strength and splitting tensile strength tests were carried out with 0% to 50% replacement. They concluded that compressive strength of concrete containing 50% bottom ash is acceptable for most structural application. Kim et al. (2011) investigated the mechanical properties of high strength concrete. The compressive strength was unchanged and the flexural strength of concrete almost linearly decreased as the replacement ratio of the fine bottom ash was increased. The modulus of rupture was decreased to 19.5% and 24.0% in accordance with 100% replacement of normal aggregates with coarse bottom ash (CBA). It was also found that compressive strength was not affected by the replacement of fine aggregate with CBA. Bilir (2012) investigated the effect of non-ground coal bottom ash (NGCBA) and non-ground granulated blast furnace slag (NGGBFS) on durability properties of concrete. He concluded that replacement of fine aggregate up to 40% NGGBFS and up to 30% NGCBA, concrete has very low chloride permeability.

Khatib (2005), Rakshvir and Barai (2006), Evangelista et al. (2007), Rao et al. (2007) and Soutsos et al. (2011) studied the properties of concrete incorporating recycled aggregate. used recycled fine aggregate to study mechanical properties. The fine aggregate in concrete was replaced with 0, 25, 50 and 100% recycled aggregate. Beyond 28 days of curing, the rate of strength development in concrete containing recycled aggregate was higher than that of the

control mix indicating cementing action in the presence of fine recycled aggregate. Rakshvir and Barai (2006) studied on recycled aggregate based concrete. They studied various physical and mechanical properties of recycled concrete. It was observed that compressive strength showed a decrease up to 10% with the increase in recycled aggregate content.

Evangelista et al. (2007) concluded that the use of fine recycled concrete aggregates does not jeopardize the mechanical properties of concrete, for replacement ratios up to 30%. Rao et al. (2007) reported the use of aggregate from construction and demolition waste in concrete. They reported that the use of these waste is suitable for making good qualityconcrete. Soutsos et al. (2011) concluded that compressive and tensile splitting strength of paving blocks made with recycled demolition aggregate determined levels of replacement which produced similar mechanical properties to paving blocks made with newly quarried aggregates.

Park et al. (2004), Shayan et al. (2005) and Idir et al. (2011) studied the use of waste glass as a partial replacement of fine aggregate in concrete. Park et al. (2004) reported that compressive, tensile, and flexural strength of concrete containing waste glass aggregates demonstrated a decreasing tendency along with an increase in the mixing ratio of the waste glass aggregates. The concrete containing waste glass aggregates of 30% mixing ratio gave the highest strength properties. Shayan et al. (2005) concluded that strength gain was slower in glass powder bearing concrete up to 28 days, but at the age of 404 days all the mixtures exceeded the 40 MPa target and achieved about 55 MPa strength and glass powder also reduced the chloride ion penetrability of the concrete.

Idir et al. (2011) investigated the pozzolanic properties of fine and coarse mixed glass cullet. The result showed that the pozzolanic activity increases with glass fineness. Due to this activity compressive strength of mortar is increased by 10%.

Aggarwal et al. (2006) investigated the use of fly ash, slag, silica fume and marble dust as replacement of cement on the compressive strength of cement mortar. The result showed that the replacement of various industrial wastes (up to 20%) improved the compressive strength of mortar.

Mishra et al. (1994) investigate the effect of blast furnace slag, fly ash and silica fume on permeability of concrete. Rapid chloride permeability test was performed to check the quality of concrete. They concluded that use of these waste in concrete decreased the permeability of concrete and increases the quality of concrete.

Cwirzen A. (2010) reported the effect of nano-materials on physical properties of cementations matrixes. The results showed that mechanical properties such as compressive and flexural strength can be increased up to 50% by addition of 0.23wt% of carbon nano-tubes

Conclusions

In all the literature review, we found that concentration was given to detect the maximum percentage of the M-Sand to replace the natural sand. In order to produce concrete all the researchers used M-Sandin different ways, but there was no focus on finding new way to use M-Sand to replace all the natural sand. The objectives of some researchers were close to the objectives of this research study and many ideas came out about the use of stone dust with their results and ideas.

Future Scope

The following future worked as carried out to get the knowledge of M-Sand and to find deeper concept and new considerable idea through it. There are as follows

- Outputs based on the M-Sand.
- Use of different type's concrete.
- Cost analysis.

References

[1] N N Priya Darshini*, D Rambabu (2019): An Experimental Study On The Use Of Quarry Dust As A Replacement Material In Concrete International Journal Of Advance Civil Engineering And Technology Volume 4 Issue 1 PP 27- 53

[2] K. Shyam Prakash1 And Ch. Hanumantha Rao2(2019) Study On Compressive Strength Of Quarry Dust As Fine Aggregate In Concrete Hindawi Publishing Corporation Advances In Civil Engineering Volume 2016, PP1-5

[3] Bruce Roy ThulaneVilane, Thandeka Lucia Dlamini. (2016). "The Structural Integrity Of Concrete Quarry Dust Blocks (Cqdb) Manufactured In Matsapha, Swaziland." American Journal Of Environment And Sustainable Development. Vol. 1, No. 1, 2016, Pp. 6-10.

[4] K. Shyam Prakash And Ch Hanumantha Rao. (2016) "Study On Compressive Strength Of Quarry Dust As Fine Aggregate In Concrete." Hindawi Publishing Corporation Advances In Civil Engineering Volume 2016, Article ID 1742769, 5 Pages

[5] Vinay M., Dr. V Ramesh, Geena George. (2015). "Experimental Study On Strength Characteristics Of Concrete Using Flyash Aggregate And Quarry Dust". International Journal Of Civil And Structural Engineering Research ISSN 2348- 7607 (Online) Vol. 3, Issue 1, Pp: (355-359), Month: April 2015 – September201.

[6] Dr. A. Vijaya Kumar, Revathi K., Bharathi C. (2015). "Strength And Durability Studies On Concrete Using Quarry Dust As Fine Aggregate." International Research Journal Of Engineering And Technology (IRJET) E-ISSN: 2395 -0056 Volume: 02 Issue: 07 Oct-2015 Www.Irjet.Net P-ISSN:2395-0072.

[7] Amit Kumar Singh, Vikas Srivastava, V.C. Agarwal (2015): Stone Dust In Concrete: Effect On Compressive Strength International Journal Of Engineering And Technical Research (IJETR) ISSN: 2321-0869 (O) 2454-4698 (P),Volume-3, Issue-8, August 2015 PP: 115-118

[8] 1T.Subramani , K.S.Ramesh2; Experimental Study On Partial Replacement Of Cement With Fly Ash And Complete Replacement Of Sand With M Sand International Journal Of Application Or Innovation In Engineering &Management (IJAIEM)PP:313-322

[9] Sandeep Kumar Singh, Vikas Srivastava, V.C. Agarwal, Rakesh Kumar And P.K. Mehta (2014). "An Experimental Investigation On Stone Dust As Partial Replacement Of Fine Aggregate In Concrete." Journal Of Academia And Industrial Research (JAIR) Volume 3, Issue 5 October2014.

[10] Dr. Pofale A.D., Quadri Syed Raziuddin (2013). "Effective Utilization Of Crusher Dust In Concrete Using Portland Pozzolana Cement". International Journal Of Scientific And Research Publications, Volume 3, Issue 8, August2013, ISSN 2250-3153

[11] Venkata Sairam Kumar N.1, Dr. B. Panduranga Rao2, KrishnaSai M.L.N.3 (2013): Experimental Study On Partial Replacement Of Cement With Quarry Dust Sairam Kumar Et Al, International Journal Of Advanced Engineering Research And Studies PP 1-3

[12] Joseph O Ukpata, Maurice E. Ephraim And Godwin A. Akeke. (2012). "Compressive Strength Of Concrete Using Lateritic Sand And Quarry Dust As Fine Aggregate". ARPN Journal Of Engineering And Applied Sciences. VOL.7, NO.1, JANUARY 2012 ISSN1819-6608.

[13] Radhikesh P. Nanda, Amiya K. Das, Moharana N. C. (2010). "Stone Crusher Dust As A Fine Aggregate In Concrete For Paving BlockS." INTERNATIONAL JOURNAL OF CIVIL AND STRUCTURAL ENGINEERING Volume 1, No3, 2010, ISSN0976–4399.

[14] Rajapaksha R. W. C. N. And Sooriyaarachchi H.P. (2009). "Feasibility Of Quarry Dust To Replace River Sand As Fine Aggregate Of Concrete". The Institution Of Engineers, Sri Lanka. Vol. XXXX1I, No. 04, Pp. [30-37].

[15] K. Subramanian, Kannan A. (2009). "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(8): 955-967, 2013 ISSN 1991-8178.

[16] S. N. Ramana, M. F. M. Zainb, H. B. Mahmuda, K. S. Tanb (2005):Influence Of Quarry Dust And Fly Ash On The Concrete Compressive Strength Development PP1-5.

[17] Aggarwal P, Aggarwal Y, Gupta S M. Effect of bottom ash as replacement of fine aggregate in concrete. Asian Journal of Civil Engineering 2007; 8(1):49-62.

[18] Agarwal SK. Utilization of industrial waste and unprocessed micro-fillers for making cost effective mortars. Construction and Building Materials 2006; 20:999-1004.

[19] Colombo P, Brusatin G, Beranerdo E, Scarinci G. Inertization and reuse of waste material by Vitrification. Current Opinion in Solid State and Material Science 2003; 7:225-239.

[20] Carey PR, Sturtz G. Sand binder systems part IV urethane binders. Foundry Management and Technology 1995; 123:25–9.

[21] Cwirzen A. Controlling physical properties of cementitious matrixes by nanomaterials. Advanced Materials Research 2010; (123-125):639-642.