Assessing the Feasibility and Impact of Substituting M-Sand with Natural Sand in Concrete Construction

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Abstract

The construction industry stands at a crossroads, challenged by the imperative to meet escalating demands while minimizing environmental impact. In this context, the quest for sustainable alternatives to traditional resources like natural sand has intensified, leading to the emergence of Manufactured Sand (M-sand) as a promising solution. This abstract offers a multifaceted exploration of the transition towards M-sand in construction applications. It unveils the intricate process behind M-sand production, where crushing of rocks and quarry stones yields sand particles tailored to precise specifications. Unlike its natural counterpart, M-sand boasts uniformity in quality, controlled gradation, and a diminished ecological footprint owing to its engineered genesis. Diving deeper, this abstract scrutinizes the mechanical robustness and durability of concrete and mortar compositions infused with M-sand. From compressive strength to resistance against chloride ingress and sulfate aggression, M-sand-incorporated mixes exhibit commendable performance metrics, underlining their efficacy as credible substitutes for traditional sand. Yet, no innovation is without its hurdles. This abstract candidly addresses the challenges accompanying M-sand utilization, encompassing concerns regarding workability, potential impurities, and economic viability. However, through meticulous analysis, it elucidates pathways to mitigate these obstacles, paving the way for seamless integration into construction practices. Furthermore, this abstract embarks on an exploration of the economic and environmental ramifications of M-sand adoption. From scrutinizing transportation efficiencies to assessing energy consumption and greenhouse gas emissions, it elucidates the comparative advantages of M-sand over its natural counterpart, while also navigating the regulatory landscape governing its usage. In summation, this abstract serves as a beacon for stakeholders navigating the transition towards M-sand. By synthesizing technical prowess with economic prudence and

environmental stewardship, it empowers decision-makers to embrace innovation, fostering a paradigm shift towards 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 of standard 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.

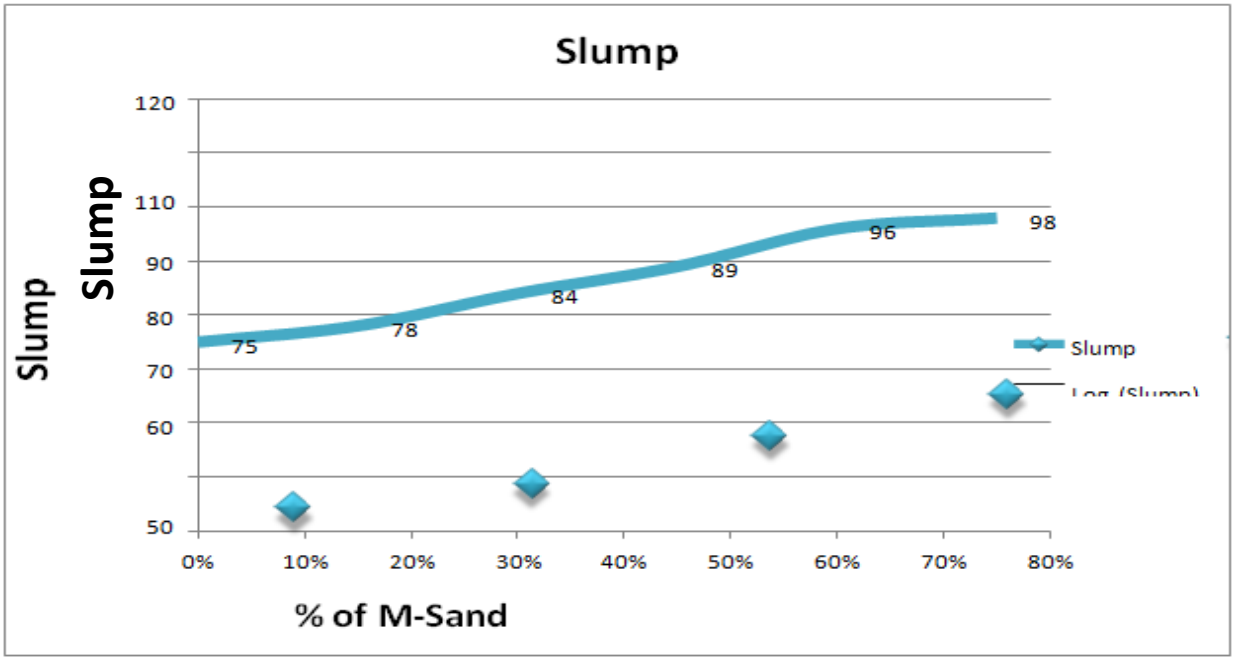
Objectives of the project

The objectives of this work is to prepare two M-Sand concrete mix proportions by replacing sand with quarry dust and in second one concrete mixture incorporating fly ash with a water reducer admixture basically a plasticizer and compare the strength parameters of quarry dust concrete samples with the conventional normal concrete.

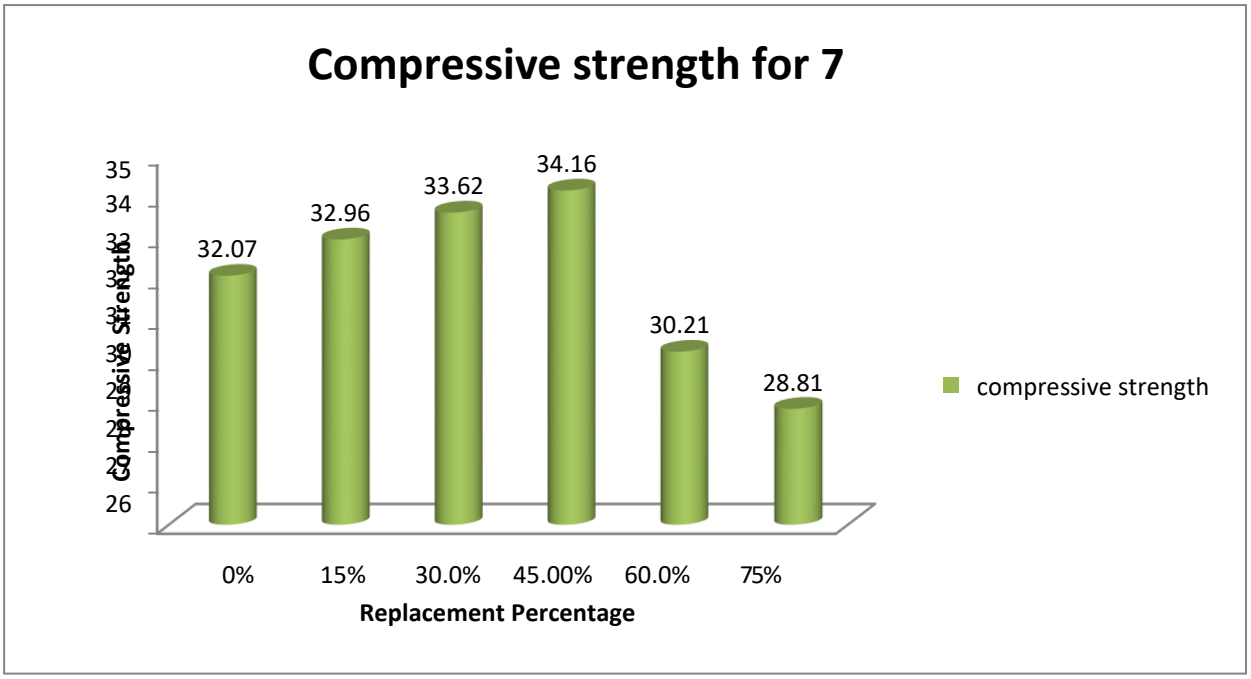
a) To check the plastic behavior of the M-Sand green concrete by workability test.
b) To check the behavior of quarry dust concrete M-Sand under compression, split tensile test & flexure test.
c) To investigate the effect of M-Sand, super plasticizer & fly ash on the behavior of M-Sand.

Modeling and Analysis

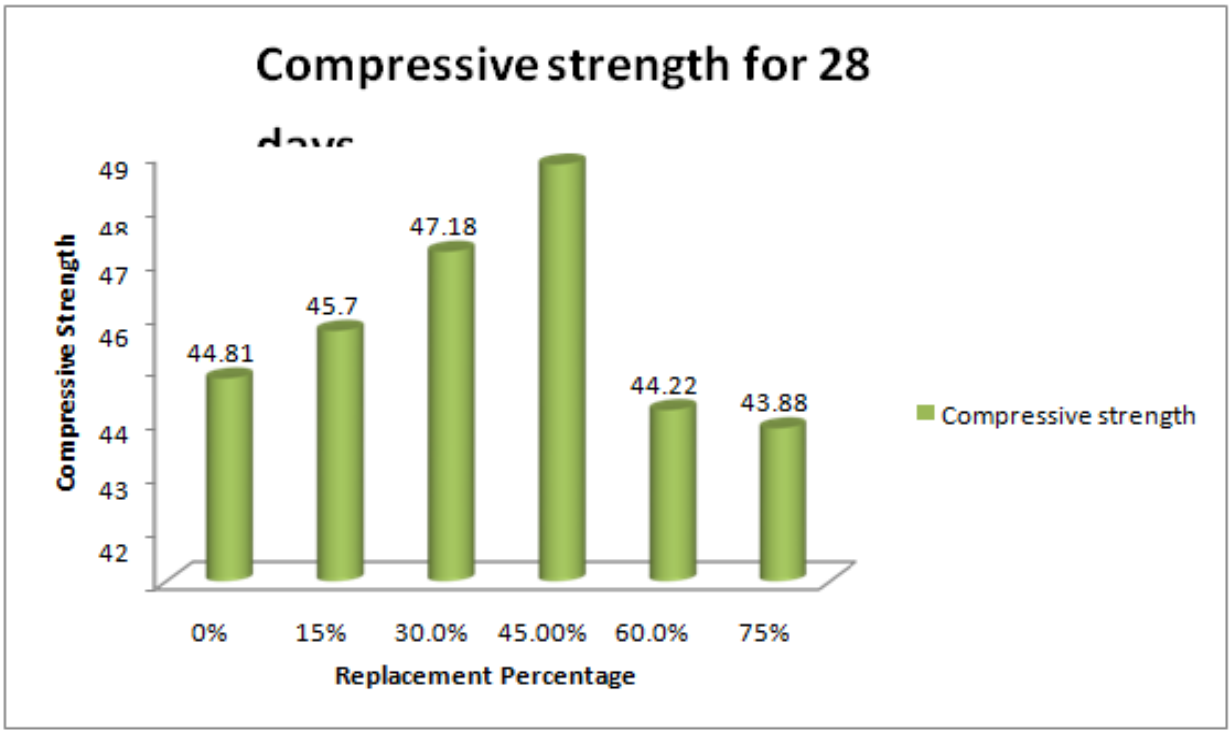
In this investigation, an experimental study will carried out to check the workability and compressive strength of concrete made up of stone dust as partial replacement of fine aggregate and a plasticizer. The grade of concrete, M40 shall be used as referral concrete mix. In this stage a batch of nominal concrete of grade M40 is prepared as usual and stone dust (M-Sand) was introduced as a partial replacement of fine aggregate. Test specimens were made for testing cured for 7 days and 28 days for strength properties at a maintained temperature. The data for the M-Sand concrete was compared with test data from a standard concrete mix.



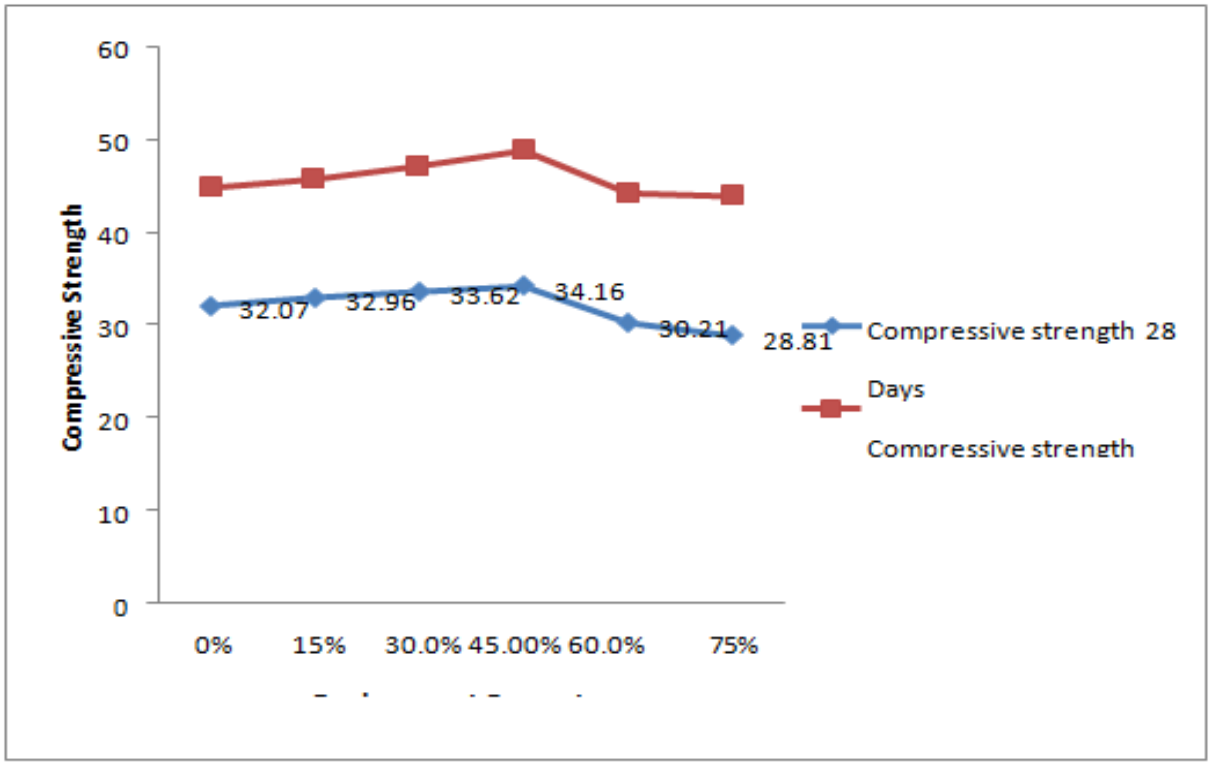
Graph 1: Variation in Slump value



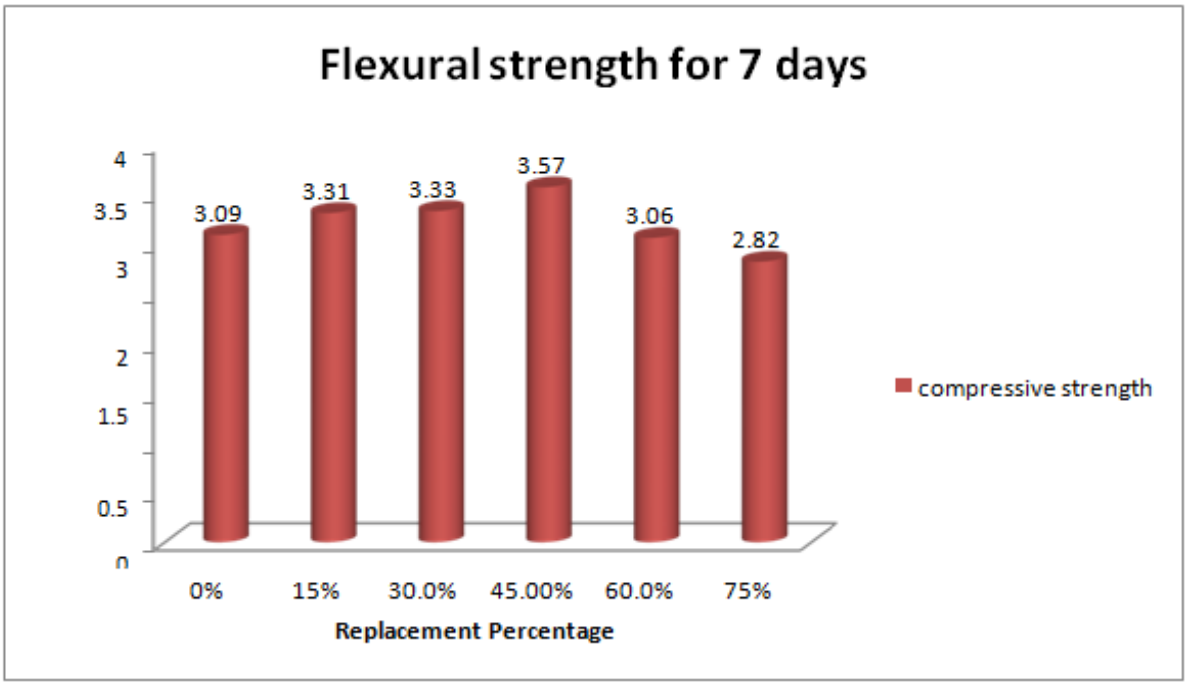
Graph: 2: Compressive Strength at 7 days (N/mm^2)



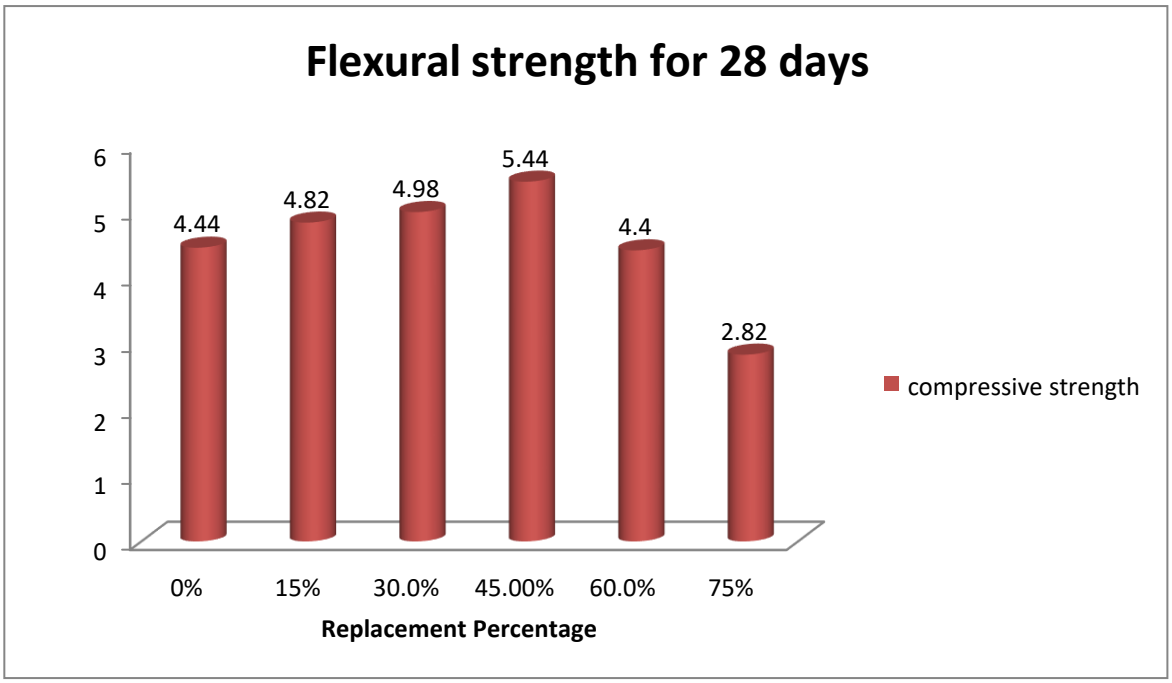
Graph 3:. Compressive Strength at 28 days (N/mm^2)



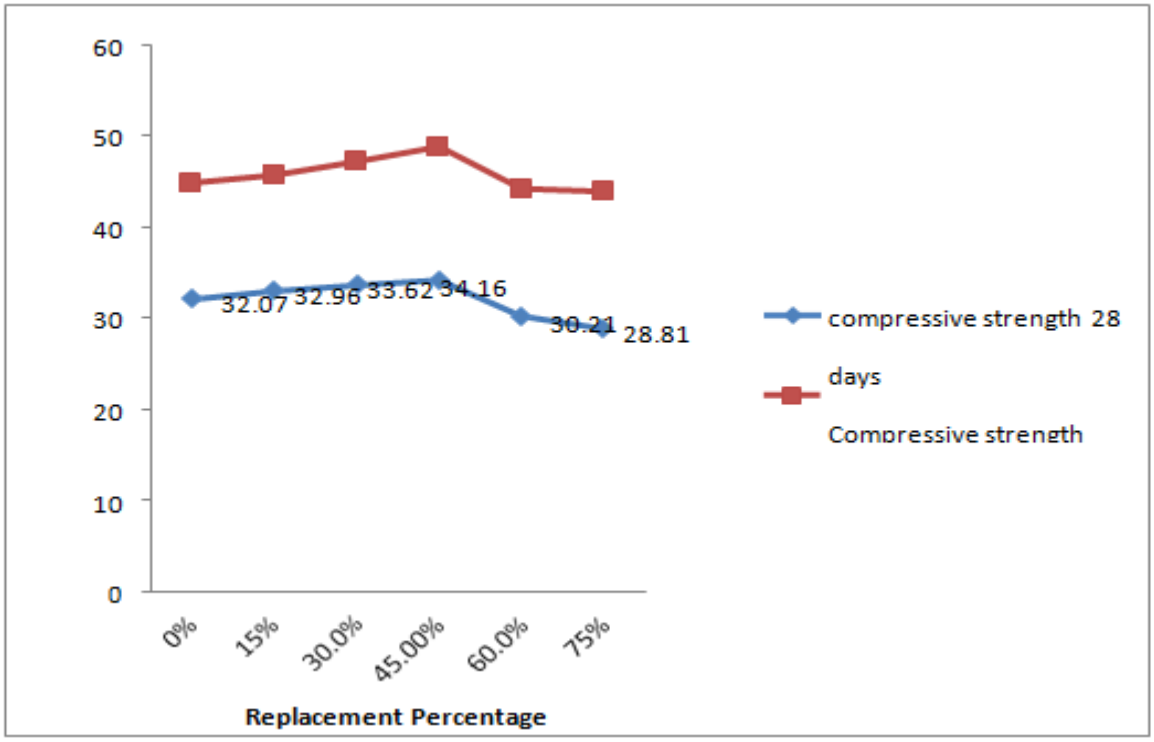
Graph 4: Compressive Strength in N/mm^2 at various age (Days)



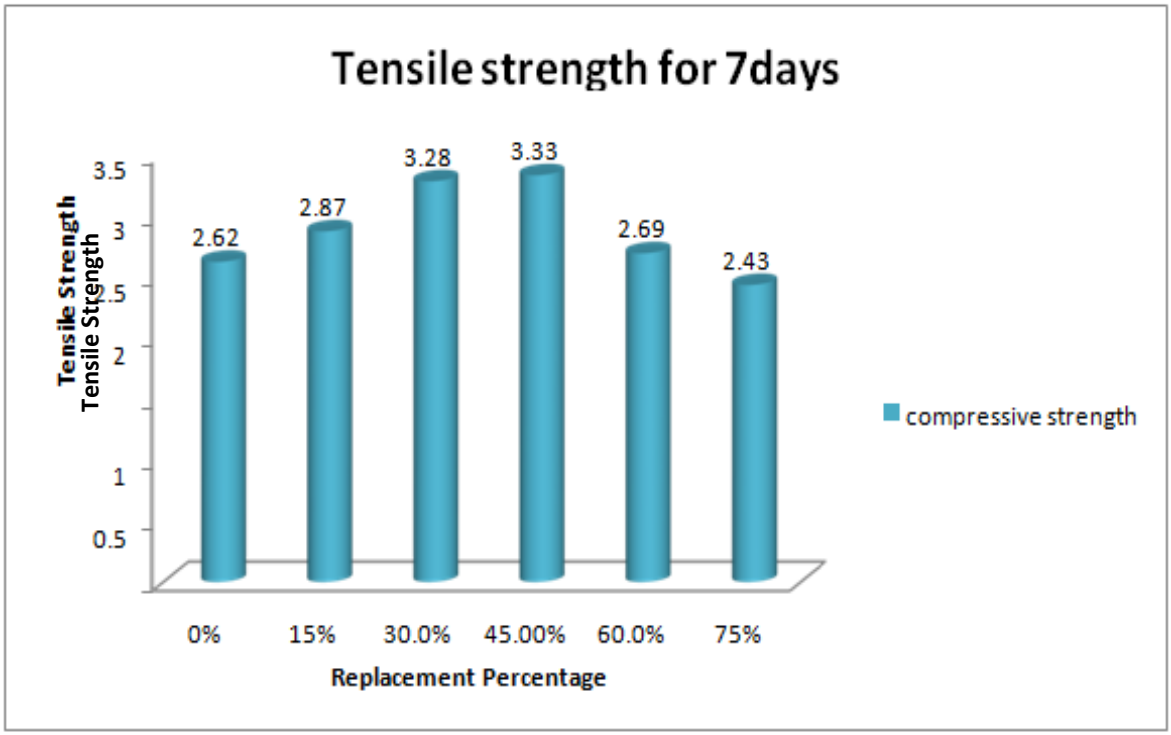
Graph: 5. Flexural Strength at 7 days(N/mm2)



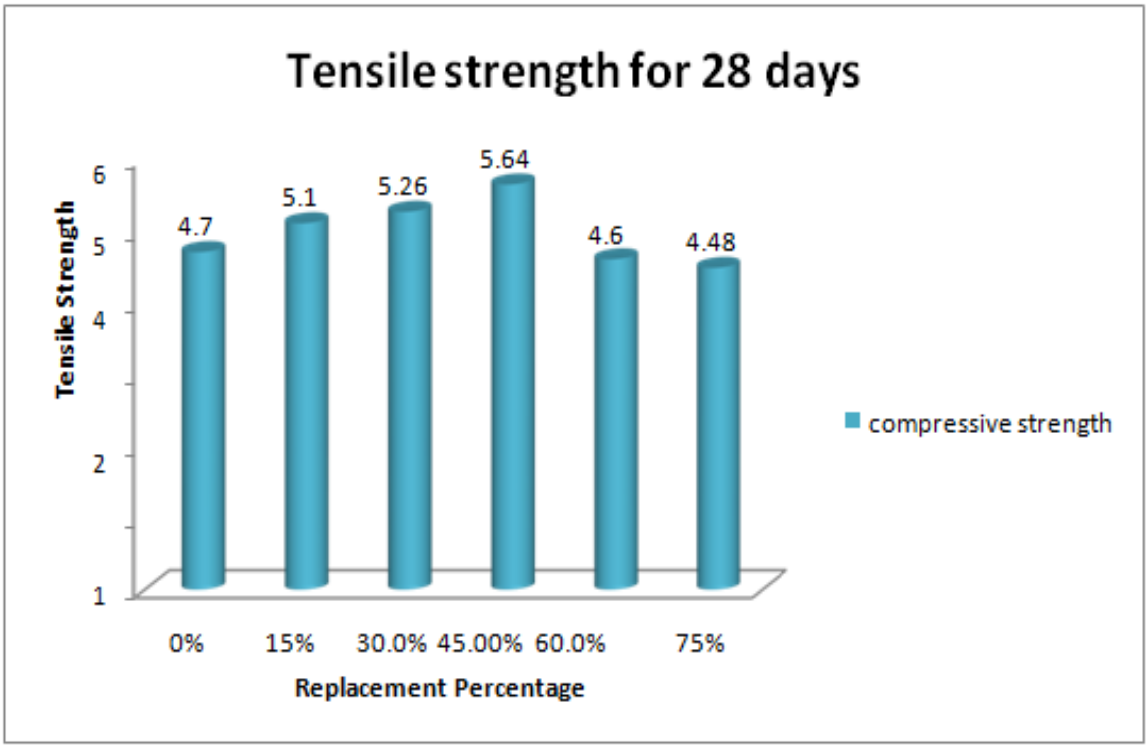
Graph: 6. Flexural Strength at 28 days(N/mm2)



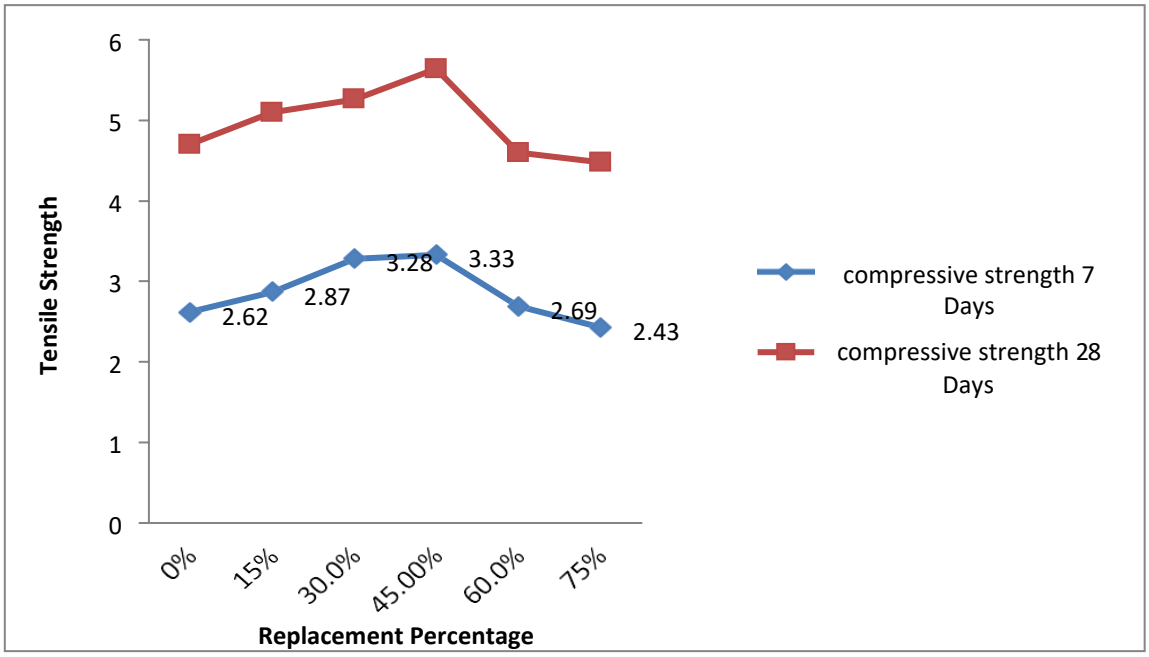
Graph 7: Flexural Strength in N/mm^2 at various age(Days)



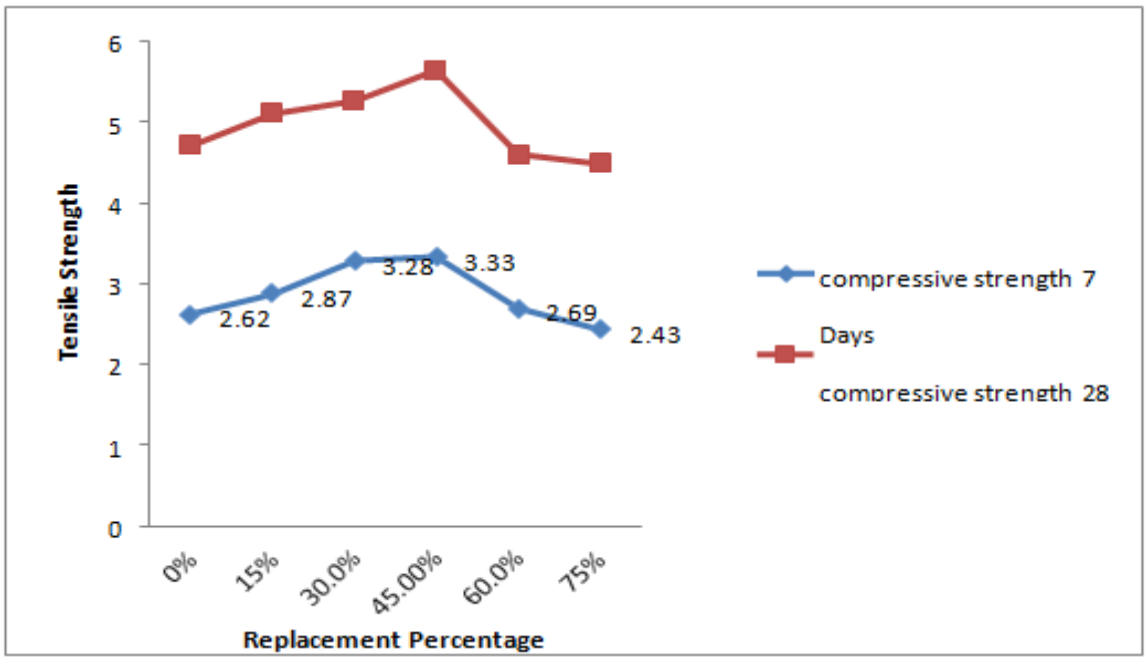
Graph 8: Tensile Strength at 7 days(N/mm2)



Graph 9: Tensile Strength at 28 days (N/mm2)



Graph 10: Tensile Strength at 28 days (N/mm2)



Graph: 11 Tensile Strength in N/mm^2 at various age (Days)

Conclusions

M-Sand as a fine aggregate, increased the concrete slump and the flow of the concrete mixture, because the demand for water was reduced due to the surface area of the M-Sand but it did not affect the unit weight and air content of fresh concrete. Due to the deficient grading and excessive flakiness of M-Sand; the compressive strength of the concrete decreased. Thus we use a certain quantity of fly ash as a admixture and add a super plasticizer to the second stage concrete mixture, which is used to fulfill all the requirements arising due to use of M-Sand in the concrete, as a replacement of natural fine aggregate.

Also, the combined use of both M-Sand fine aggregate and fly ash demonstrated excellent performance due to efficient micro-filling capacity and pozzolanic activity of fly ash. Therefore M-Sand can be used as a good alternative to natural sand in concrete mix.

Compressive strength, Flexural strength, Split tensile strength test of concrete Mixes made with and without M-Sand has been determined at 7 & 28 days of curing. The strength gained has been determined of quarry added concrete with addition of 15%, 30%, 45%, 60% & 75% for M40 grade as a partial replacement of sand in conventional concrete. After performing all the tests and analyzing their result, the following conclusions have been derived:

- Workability of concrete increases as proportion of M-Sand increases.
- Maximum compressive strength was observed when M-Sand replacements about 45%.
- Maximum split tensile strength was observed when M-Sand replacement is about 45%.
- Maximum flexural strength was observed when M-Sand replacement is about 45%.

REFERENCES

- 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

- 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
- 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.
- 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
- 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.
- 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.
- 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
- T.Subramani , K.S.Ramesh (2019) 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
- 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.
- 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, August 2013,ISSN 2250-3153

- Venkata Sairam Kumar N., Dr. B. Panduranga Rao, KrishnaSai M.L.N. (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
- 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.
- 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.
- 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].
- 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.
- 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.
- 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.
- Agarwal SK. Utilization of industrial waste and unprocessed micro-fillers for making cost effective mortars. Construction and Building Materials 2006; 20:999-1004.
- 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.
- Carey PR, Sturtz G. Sand binder systems part IV urethane binders. Foundry Management and Technology 1995; 123:25–9.
- Cwirzen A. Controlling physical properties of cementitious matrixes by nanomaterials. Advanced Materials Research 2010; (123-125):639-642.