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A study on strength and durability characteristics of concrete with granite dust and marble sludge powder as fine aggregate

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Abstract-- Concrete sustainability involves continuously choosing low impact building materials. River sand was effectively used as fine aggregate in concrete, but because of improvement in construction industry there is shortage in natural sand and there is need to search for alternative. The experimental study has been carried out to investigate whether Granite dust and Marble Sludge Powder suitable as fine aggregate. Properties of concrete with mixture of both Granite dust and Marble sludge Powder as fine aggregate is also checked. For the study eight series of concrete mixtures were studied with different proportion of Granite dust and Marble sludge powder mix. Mechanical properties of marble sludge powder are reported with that of sand. The effect of Granite dust and Marble sludge powder on the compressive strength and split tensile strength were recorded at the curing age of 3,7,14,28 and 56 days. All the data were tabulated and compared. It was observed that marble sludge powder and Granite dust mix of particular proportions displaced enhancing effect on strength

Keywords: Granite dust, marble sludge powder,sand

INTRODUCTION

The immense development in the developing countries creates a greater opportunity for infrastructure growth. To cater these needs there is a huge scope of concrete technology. One of the major challenges of our present society is the protection of environment. Due to the growing of structures, availability of natural aggregates is relatively reduced. The reduction in the sources of natural sand and the requirement for reduction in the cost of concrete production has resulted in the increased need to identify substitute material to sand as fine aggregates in the production of concrete. Granite dust and Marble sludge powder can be used as substitute materials to sand.

The combination of Granite Dust and Marble sludge powder in place of River sand shall be very economical and can also help in the utility of Industrial wastes and in maintaining the ecological balance thus reducing the consumption of river sand.

This research is mainly focusing on to find the effect of Marble sludge powder and Granite dust on the properties of concrete mixture as a replacement of fine aggregate. The use of Marble sludge powder and Granite dust in concrete is to reduce some percentage of environmental effects and reduce the impact of waste materials on environment.

Sand was completely replaced with Granite dust and Marble sludge powder. Dosages of replacement of mixture of Granite dust and Marble sludge powder in place of sand used are 90%-10%, 80%-20%, 70%-30%,60%-40%,50%-50%,40%-60%.Concrete samples with only Granite dust as fine aggregates and concrete sample with only Marble sludge powder as fine aggregates is also prepared and compressive strength and split tensile test are found out.

MATERIALS AND METHODS

Rock dust or Granite dust is a by-product which can be obtained during the crushing of granite rocks .Attempts have been made to study the properties of concrete by partially or fully replacement of sand with quarry dust. Granite dust is known to enhance the strength of concrete over concrete made with equal quantities of river sand but it causes a reduction in the workability of concrete. Granite dust has been used for various activities in the construction industry such as manufacture of building materials such as light weight aggregates ,tiles and bricks ,road construction etc.

Marble is formed by transformation of pure lime stone and comes under metamorphic rock. Marble sludge powder is an industrial waste .Chemical composition of marble is calcite, dolomite or serpentine materials. The other mineral compositions are changing from origin to origin.

Both solid waste and stone slurry is generated in Marble stone industry. Solid waste results from rejects at the mine sites or at the processing units. Whereas water used to cool and lubricate the cutting, sawing and polishing process in

marble industry generates semi liquid substance called stone slurry. Stone slurry generated during processing corresponds to around 20 % of the final product from stone industry. Semi liquid waste can be dried and Marble sludge powder can be produced.

The physico-chemical properties of Cement, Sand, Coarse aggregate, marble sludge powder and Granite dust in this investigation were analysed based on standard experimental procedures laid down in standard codes, like IS, ASTM and BS codes. The experiments on Cement, Sand, Coarse aggregate, Marble sludge powder and Granite dust have been done in the laboratory. The standard experimental procedures were adopted for the determination of normal consistency, initial and final setting times, fineness, soundness, specific gravity, bulk density, sieve analysis, water absorption, impact value of coarse aggregate, compressive strength and split tensile strength. Mix design considered is M20.

RESULTS AND DISCUSSIONS:

The effect of Marble sludge powder and Granite dust on compressive strength, Split tensile strength of concrete is studied in this investigation. Before these grain size distributions was done for Granite dust and marble sludge powder and are compared with that of natural sand. Fine aggregate is completely replaced with mixture of Granite dust and Marble sludge powder of varying proportions. Cubes and Cylinders prepared with different proportions have been cured for 3 days, 7 days, 14 days, 28 days and 56 days prior to testing. The average compressive strength of concrete of at least three cubes (150mm x 150mm x 150 mm) is noted down. For the split tensile test of concrete the cylinders, prepared with different admixtures percentages have been cured for 28 days prior to testing**.**

Results of Grain Size Distribution

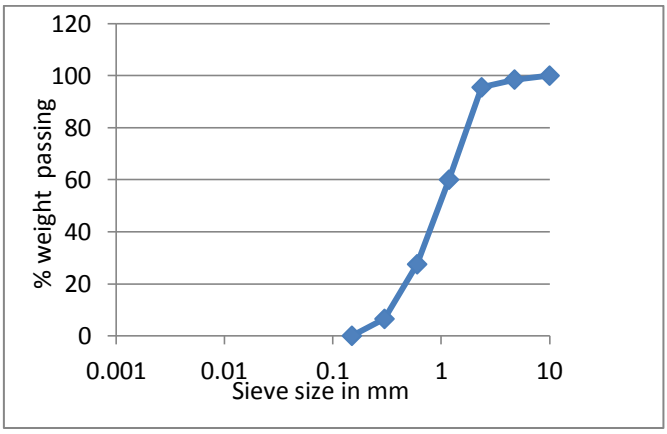

Fig 1: Grain size distribution of sand

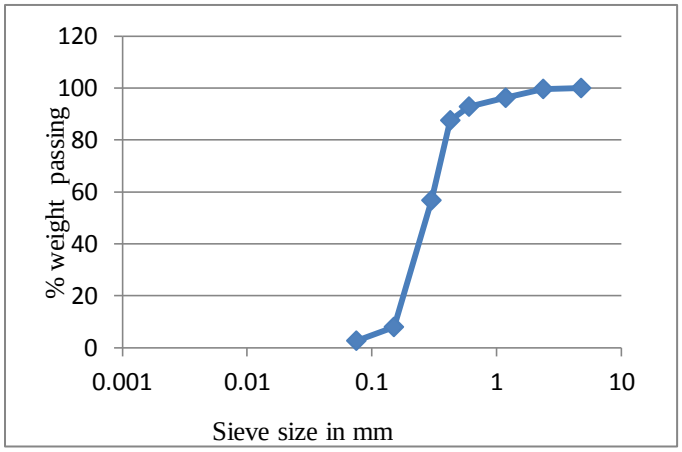

Fig 2: Grain size distribution of Granite dust

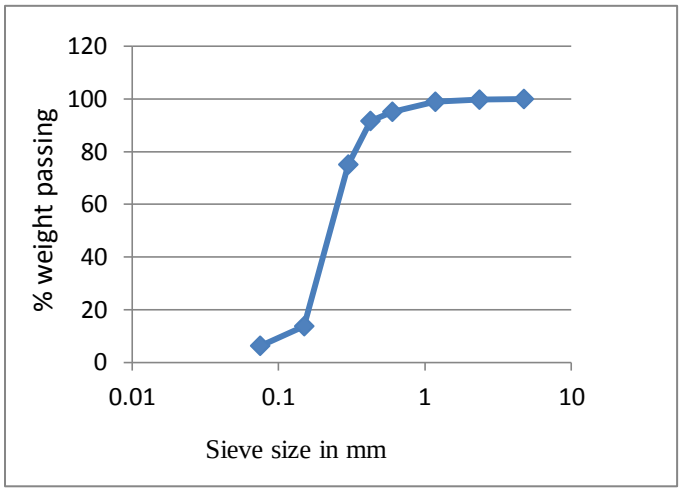

Fig 3: Grain size distribution of Marble sludge powder

The particles of Granite dust are in the range of 425 µ to 150 µ. The particles of Marble sludge powder are in the range of 300 µ to 75 µ. Alternate materials act as fillers and help to improve strength of concrete.

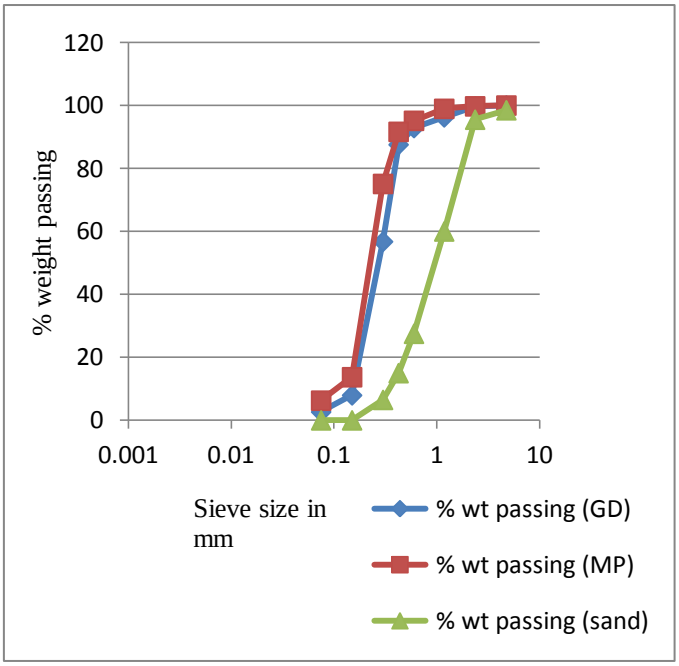

Fig 4: Comparison of Grain size distribution of sand, granite dust and marble sludge powder

Results of Compressive strength:

The compressive strength of different mixes is gradually increased as curing period increases from 3 to 56 days. Addition of Marble sludge powder and Granite dust as replacement of Fine aggregate have their influence on the compressive strength of concrete cubes.

Table 1: Variation of Compressive strength of different proportions of concrete at 3, 7, 14, 28 and 56 days of curing periods

Fine aggregate considered	Compressive Strength (N/mm^2)				
	3 Days	7 Days	14 Days	28 Days	56 Days
100% FA	15.55	20	23.55	24	26.66
100% MP	14.66	18.22	26.22	27.55	29.11
100% GD	12.88	14.66	22.22	23.11	27.11
90%GD+10%MP	13.33	15.55	22.66	23.55	26.66
80%GD+20%MP	16.88	19.55	24	24.44	27.55
70%GD+30%MP	18	20	25.33	26.22	28.88
60%GD+40%MP	19.11	20.22	28.44	28.88	34.66
50%GD+50%MP	15.11	17.77	26.66	27.11	29.33
40%GD+60%MP	13.33	15.55	24.88	25.77	26.66

FA= Fine aggregate (sand)

GD= Granite dust

MP= Marble sludge powder

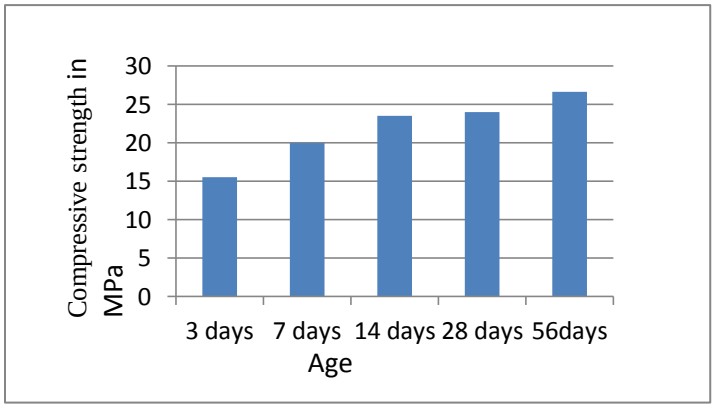

Fig 5: Variation of Compressive strength of control concrete with curing periods

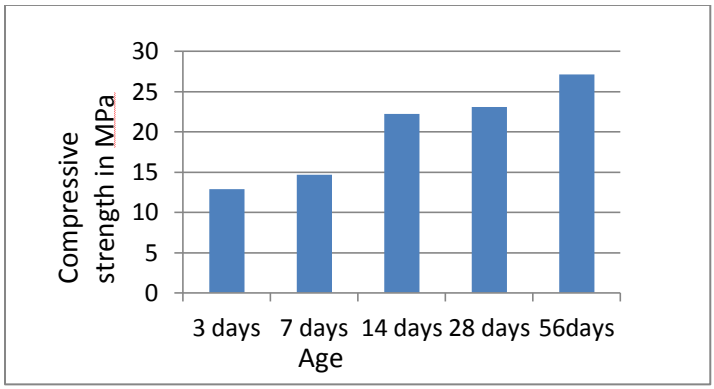

Fig 6: Variation of Compressive strength of concrete with complete Granite dust as fine aggregate for different curing periods

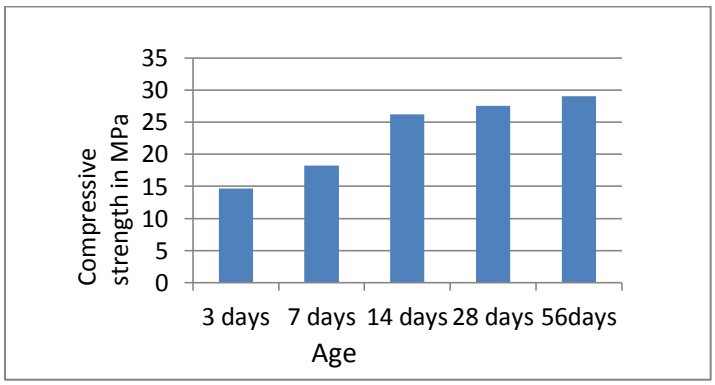

Fig 7: Variation of Compressive strength of concrete with complete Marble sludge powder as fine aggregate for different curing periods

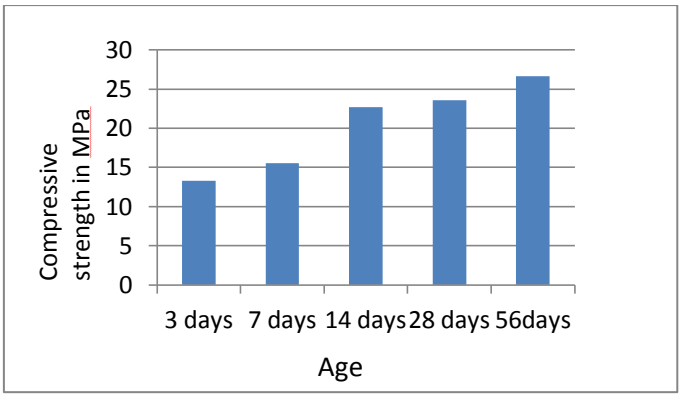

Fig 8: Variation of Compressive strength of concrete with 90% Granite dust and 10% Marble sludge powder as fine aggregate

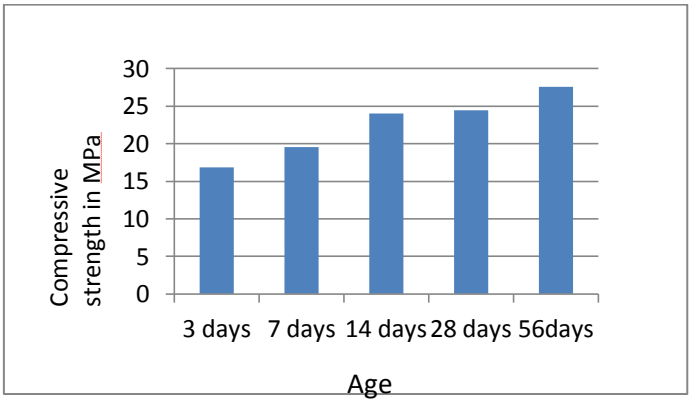

Fig 9: Variation of Compressive strength of concrete with 80% Granite dust and 20% Marble sludge powder as fine aggregate

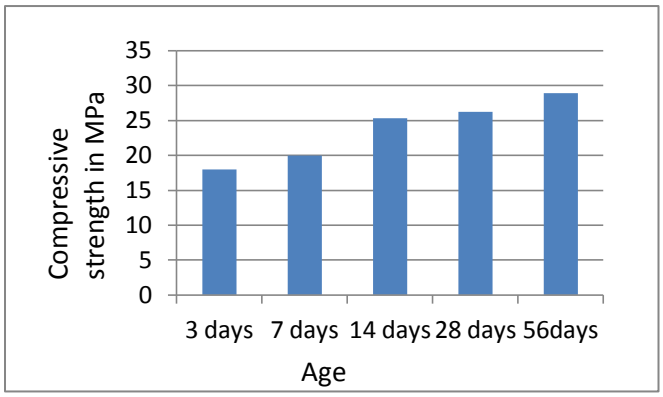

Fig 10: Variation of Compressive strength of concrete with 70% Granite dust and 30% Marble sludge powder as fine aggregate

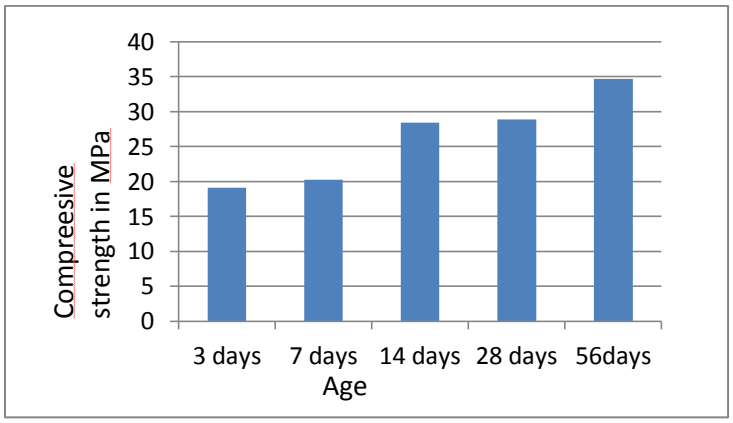

Fig 11: Variation of Compressive strength of concrete with 60% Granite dust and 40% Marble sludge powder as fine aggregate

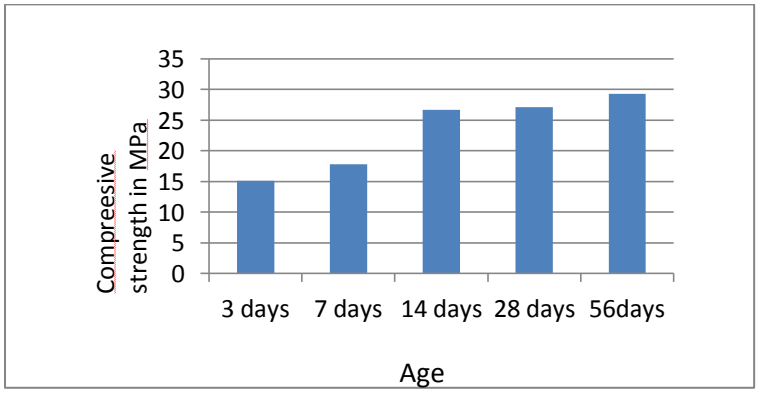

Fig 12: Variation of Compressive strength of concrete with 50% Granite dust and 50% Marble sludge powder as fine aggregate

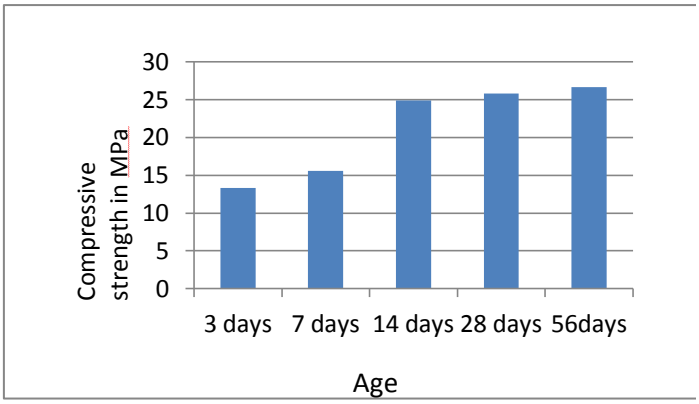

Fig 13: Variation of Compressive strength of concrete with 40% Granite dust and 60% Marble sludge powder as fine aggregate

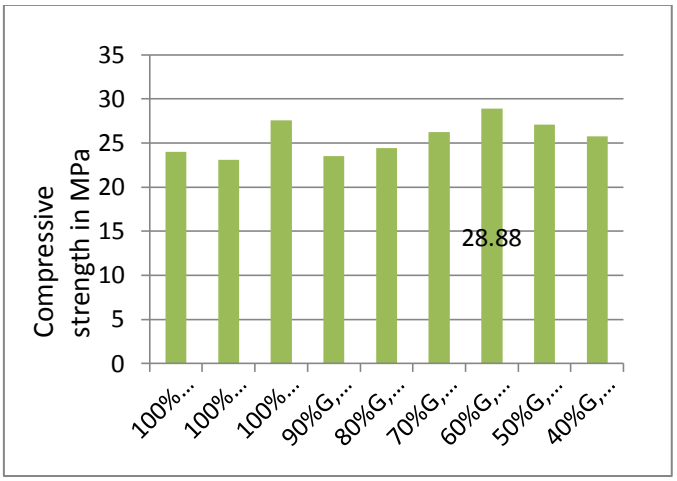

Fig 14: Variation of 28 days Compressive strength

From the above graph it is clear that 28 days compressive strength of concrete with fine aggregates replaced with 60% Granite dust and 40 % marble sludge powder showed maximum compressive strength of 28.88 N/mm^2 which is more than any other mix. The percentage increase in compressive strength of concrete with 60 % Granite dust and 40 % Marble sludge powder is about 20 %. The control concrete is considered as the reference mix. So concrete with fine aggregates replaced with 60% Granite dust and 40 % Marble sludge powder can considered as optimum mix from compressive strength point of view.

From the aforesaid discussion it is clear that the compression strength of concrete with 60 % Granite dust and 40 % Marble sludge powder not only enhances the strength but also produces cost effective concrete. The environmental hazards can also be reduced to certain extent by utilizing these by-products effectively in making concrete instead of disposing them on the land. The flora and fauna can also be unaffected to some degree

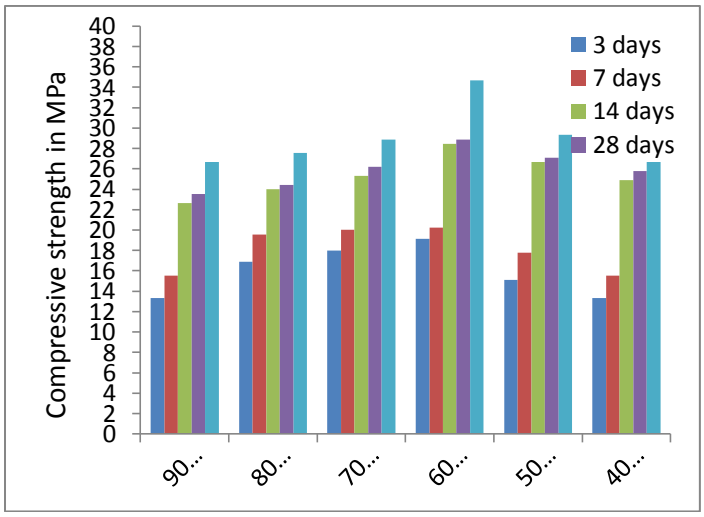

Fig 15: Variation of compressive strength of different mixes at different curing periods

SPLIT TENSILE TEST RESULT:

Table 2: variation of split tensile strength of concrete with fine aggregates completely replaced with mix of marble sludge powder and granite dust of different proportions

Mix Proportions	Split tensile Strength (N/mm^2)	Percentage increase/decrease in split tensile strength when compared with control concrete
	28 Days	
100% FA (Control concrete)	2.50	
100% GD	2.45	-2 %
100% MP	2.60	+4 %
90%GD+10%MP	2.40	-4 %
80%GD+20%MP	2.50	0 %
70%GD+30%MP	2.68	+7.2 %

60%GD+40%MP	2.97	+18.8 %
50%GD+50%MP	2.81	+12.4 %
40%GD+60%MP	2.68	+7.2 %

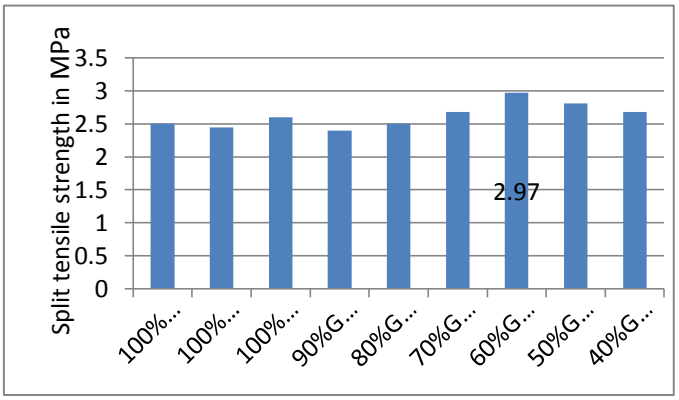

Fig 16: Variation of Split tensile strength at 28 days

Split tensile strength of concrete mix with 60 % Granite dust and 40 % Marble sludge powder as fine aggregate is 18.8 % more when compared with control concrete.

Water absorption test results:

The Water absorption test is conducted at 28 days according to standard procedure ASTM C 642-11. For the water absorption test , 150x150x150mm size concrete cubes are used and dried in a oven at 100^0C for not less than 24 hours. After removing cube specimen form oven allow it to cool in dry air to temperature of 20^0C to 29^0C and determine the mass

Water absorption is measured in increase in weight percent

Percentage of water absorption= ((wet weight-dry weight)/dry weight)x100

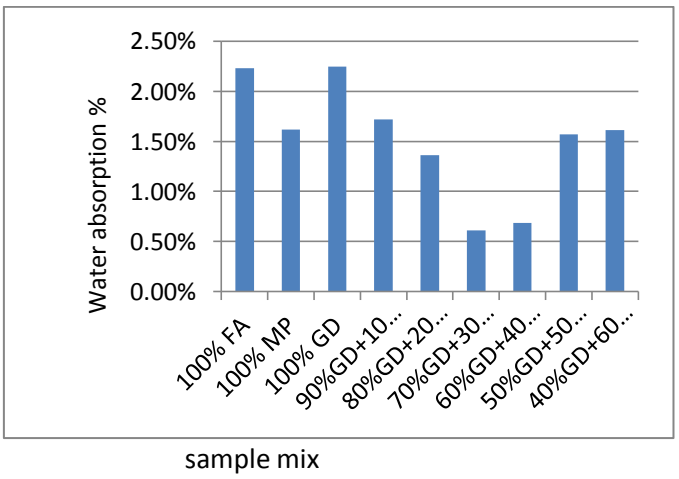

Fig 17: Water absorption test result

The results of water absorption test of concrete mixes with different proportions tested are within the permissible values either considered individual test results or mean test results.

CONCLUTIONS

- All mixes gain strength irrespective of curing period
- From the results it is clear that Granite dust and Marble sludge powder can be used as fine aggregate in place of sand
- Industrial wastes are capable of improving hardened properties of concrete
- Workability is slightly less when compared to control concrete but it has improved with increase percentage of marble sludge powder
- Compressive strength of concrete with 60% Granite dust and 40 % Marble sludge powder as fine aggregate is about 20 % more than the control concrete and is considered as optimum mix
- Concrete with 60% Granite dust and 40% Marble sludge powder as fine aggregate is considered as optimum mix in terms of split tensile strength also
- Water absorption of concrete with a mix of Granite dust and Marble sludge powder as fine aggregate is less compared to control concrete. Decrease in total void content helped in improving strength of concrete
- Concrete prepared with 60 % Granite dust and 40 5 Marble sludge powder is the best among all mixes not only from strength point of view but also from the durability point of view
- Replacement of sand with proper proportion of Granite dust and Marble sludge powder not only enhances strength of concrete, but also reduces cost of production and at the same time, it also reduces environmental pollution and hazards caused due to disposal of this waste by-products on land

SCOPE FOR FUTURE WORK

- The other mechanical properties tests like flexural strength and durability tests like acid attack can also be determined.

- For use of granite dust and marble sludge powder in concrete as a structural material, it is necessary to investigate the behaviour of reinforced concrete under flexure, shear, torsion and compression.

REFERENCES

1. Allam M.E., Bakhoum E.S. and Garas G.L.(2014), "Re-Use of Granite sludge in producing green concrete". ARPN Journal of Engineering and Applied Sciences.Vol , no12, December 2014
2. ASTM C 642-06 Test methods for density, Absorption and voids in hardened concrete
3. Balamurugan and Perumal (2013). "Use of Quarry Dust to Replace Sand in Concrete- An Experimental Study", International Journal of scientific and research publications, Volume 3 Issue 12, December 2013
4. Bhikshma.V, Kishore.R & Raju.N.H.M (2010)," Flexural behavior of high strength stone dust concrete", Challenges, Opportunities and Solutions in Structural Engineering and Construction – Ghafoori (ed.) ISBN 978-0-415-56809-8, 2010.
5. Garas G.L., Allam M. E. and Bakhoum E. S. (2014), "Studies Undertaken to incorporate Marble and Granite Wastes in Green concrete production". ARPN Journal of Engineering and Applied Sciences.Vol 9, no9, September 2014
6. IS 10262:2009 Code for Concrete Mix Proportion, Bureau of Indian Standards, New Delhi, India
7. IS 12269:1987 Code for 53 grade of ordinary Portland cement, Bureau of Indian Standards, New Delhi, India
8. IS 2386 (Part-1)-1983- Methods of test for aggregates for concrete
9. IS 383:1970, IS 2386:1983 Code for specifications of test for aggregates, Bureau of Indian Standards, New Delhi, India.
10. IS 383-1970-Specification for coarse aggregate and fine aggregate from natural sources.
11. IS 4031 (Part-1)-1996- Methods of physical tests on hydraulic cement
12. IS 456-2000 Code of practice for plain and reinforced concrete structure, Bureau of Indian Standards, New Delhi, India
13. IS 650-1966-Specification for standard sand for testing of cement.
14. 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, ISSN 1819-6608.
15. Lohani T. K, Padhi M, Dash K .P and Jena S(2012), "Optimum utilization of Quarry dust as partial replacement of sand in concrete", International Journal of Applied Science and Research, Vol. 1, No. 2, pp:159-167,2012
16. Monica.C,Dhoka (2013),"Green Concrete: Using Industrial Waste of Marble Powder, Quarry and paper pulp". International journal of Engineering Science Invention, volume 2,0ctober 2013/pp.67-70
17. Nagabhushana and Sharada bai, H. (2011), Use of Crushed Rock Powder as replacement of Fine aggregate in Mortar and Concrete, Indian Journal of Science and Technology, Vol. 4, No. 8.
18. Oyekan G.L and Kamiyo O.M (2008), "Effect of Marble fines on some engineering properties of sandcrete blocks".
19. R.Ilangovana et al. (2008), "Strength And Durability Properties Of Concrete Containing Quarry Rock Dust As Fine Aggregate" ARPN Journal of Engineering and Applied Sciences.Vol 3 , no5, December 2008
20. Ronak Malpani, Sachith Kumar Jegarkal, Rashmi Shepur, Ravi Kiran H.N, Veena kumara (2014), "Effect of Marble Sludge Powder and Quarry Dust as Partial Replacement for Fine Aggregate on Properties of Concrete", International Journal of Innovative Technology and Exploring Engineering, ISSN 2278-3075,Volume-4, Issue-1, June 2014
21. Shahul Hameed.M, Sekar A.S.S (2009). "Properties of Green Concrete Containing Quarry Rock Dust and Marble Sludge Powder as Fine Aggregate". ARPN Journal of Engineering and Applied Sciences.Vol 4 , no4, June 2009
22. Shahul Hameed.M, Sekar A.S.S (2010),"Self Compaction High Performance Green Concrete For Sustainable Development". Journal of Industrial Pollution Control 26 (1)(2010) pp 49-55
23. Shahul Hameed.M, Sekar A.S.S (2012), "Self-Compacting Concrete Using Marble Sludge Powder and Crushed rock dust", KSCE Journal of civil Engineering
24. Shetty M.S., (2004), Concrete technology, Chand S. and Co Ltd, India.
25. Sivakumar et al. (2010), " Experimental study on replacement of fine aggregate by Quarry Dust in Concrete", ISSN 2319-6009 Vol. 3, No.2, May 2014

Wilson M.A, Carter M.A. and Hoff W.D "British standard and RILEM water absorption tests: A critical evaluation"