Strength and Durability Properties of Concrete Made with Partial Replacement of Cement by Marble Powder and M-Sand by Silica Sand

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Abstract :-**The thousands of tons of waste materials are dumbed on the valuable land in every year that results in the occupation and degradation of valuable land. Currently waste handling is big problem. Therefore, many investigations are carried out in order to utilize industrial, constructional and domestic waste for concrete mix. Manufactured sand is an alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the world. Another reason for use of M-Sand is its availability and transportation cost. Marble is industrially processed by being cut, polished, and used for decorative purposes, and thus, economically valuable. During the cutting process, 20-30% of a marble block becomes waste marble powder. Marble waste leads to a serious environmental problem as well. Therefore, the use of waste marble in the concrete production as an admixture material has increasingly become an important issue. The use of alternative aggregate like silica sand is a natural step in solving part of depletion of natural aggregates such as river sand. In this project, Marble powder and Silica sand had been used as replacement of cement and fine aggregate by different percentage for making concrete. The percentage replacement of marble powder will be 0%, 10%, 20% & 30% and silica sand will be 0%, 25%, 50% &75% with M Sand.**

Key words: ***Marble powder, Silica sand, M sand, Compressive strength, Split tensile Strength***

I. INTRODUCTION

Concrete is the material of choice that is widely used in the construction industry. The ingredients for making concrete have reached the demand of hour [5]. As the demand rises, the cost of each material reaches higher prices. Hence in this research a solution to make a economic concrete was obtained with a sustainable strength enhancing of concrete. In making conventional concrete, the demand for fine aggregate increase every day. As a solution to this prevailing condition, the cement and the fine aggregate have been replaced with the marble powder and silica sand which serves as a filler in concrete. Cement is one of the most produced materials around the world. Due to the importance of cement as a construction material, and the geographic abundance of the main raw material, limestone, cement is produced in virtually all countries. The wide spread production is also due to the relatively low price and high density of cement. However, the production of Portland cement, an essential constituent of concrete, leads to the release of a significant amount of CO_2 and other greenhouse gases (GHGs). The use of alternative aggregate like silica sand is a natural step in solving part of depletion of natural aggregate [16]. Silica is the most abundant mineral found in the crust of the earth. It forms an important constituent of practically all rock-forming minerals. It is found in a variety of forms, as quartz crystals, massive forming hills, quartz sand (silica sand), sandstone, quartzite, tripoli, diatomite, flint, opal, chalcedonic forms like agate, onyx etc. Silica sand contain a high proportion of silica (up to 99% SiO_2) in the form of quartz and are used for applications other than as construction aggregates. They are produced from both loosely consolidated sand deposits and by crushing weakly cemented sandstones. Silica sand is obtained from the r4aw material. After washing the raw material the silica sand is separated by sieve size 1.18 of raw material [17]. Silica sand of size less than 75 microns can be used in making concrete mix as the partial replacement of cement. Marble powder is produced from processing plants, sawing and polishing of marble blocks [2]. During its service life of concrete suffers deterioration mechanisms which cause durability problems [1]. The

cement is partially replaced with marble powder at 0%, 5%, 10%, 15%, 20% and 25%. and the fine aggregate is partially replaced with silica sand at 0%, 10%, 20%, 30%, 40% and 50%.

II. MATERIAL CHARACTERIZATION

2.1 Cement

Ordinary Portland cement confirming to IS 8112-1989 [43grade] is used for experimental work. Laboratory test were conducted on cement to determine specific gravity, consistency, initial and final setting time and fineness.[14] Fineness modulus of cement is 2.85%. Specific gravity of cement is 3.15

2.2 Fine Aggregate

Manufactured sand is an alternative for river sand. Aggregate which is passing through 4.75 IS sieve is termed as fine aggregate. Fine aggregate is added to concrete to assist workability and to bring uniformity in mixture [3]. For this project M- sand is used as fine aggregate. Specific gravity of M sand is 2.53. M sand which is used in this project is shown in fig 2.1.

Fig 2.1 M sand

2.3 Coarse Aggregate

The size of aggregate bigger than 4.75 mm is considered as coarse aggregate crushed stone obtained by crushing of granite that could pass through 20 mm sieve and retained on 4.75mm IS sieve and contained only so much of five materials as is permitted by specification along were produced [1]. Specific gravity of Coarse aggregate is 2.6 and Impact value is 9.45.

2.4 Marble powder

Marble is a metamorphic rock resulting from the transformation of pure lime stone (Malpani, Jegarkal, Shepur, Kiran,&Adi, 2014). The rock is also one of the most important materials used in buildings since ancient times, especially for decorative purposes (Soliman, 2013). Turkey has the 40% of total marble reserve in the world. 7,000,000 tons of marble have been produced in Turkey annually and 75% of these production have been processed in nearly 5000 processing plants. It can be apparently seen that the waste materials of these plants reach millions of tons. Stocking of these waste materials is impossible (Alyamac&Ince, 2009). These type solid waste materials should be inactivated properly without polluting the environment. The most suitable inactivating method nowadays is recycling [23]. Recycling provides with some advantages such as protecting the natural resources, energy saving, contributing to economy, decreasing the waste materials and investing for the futureThe purity of marble is depends upon its colour and appearance. It is white if the limestone is composed of solely of calcite (100%$CaCO_3$). Fineness of marble powder is 2.85 and specific gravity of marble powder is 2.63. Marble powder which is used in this project is shown in fig 2.2.

Fig 2.2 Marble Powder

2.5 Silica sand

Silica sand is obtained from the raw material. After washing the raw material the silica sand is separated by sieve size 1.18 of raw material. Raw material is washed for taking out the clay material which is useful for making the tiles. In the raw material about 10% is clay which is supplied to the ceramic factories. From the raw material different size of silica sand are separated by different size of sieve. Sand size of 30 mesh to 80 mesh (500 micron) is used in the glass industries. Sand size 1.18mm to 600 micron can be used in making concrete mix as the partial replacement of fine aggregate. Nearly about 200 tones of silica sand is obtained daily after washing the raw material. Sometimes it is used in the glass factories otherwise they dump them back into the mines [17]. Specific gravity of silica sand is 2.6. Silica sand which is used in this project is shown in fig 2.3.

Fig 2.3 Silica sand

III. MIX PROPORTIONS

An experimental program was conducted to study, with a constant ratio W/C (0.4) , the effect of marble powder and silica sand on the behavior of concrete. Partial substitution of Cement with marble powder and partial replacement of M sand with silica sand will complete the study. The tests began with mixing materials and water during 2 min in a concrete mixer. The concrete was cast in metallic moulds (150mm x 150mm x150mm). After 24 hours the wsamples underwent curing with conservation in tap water at 20 ± 2 °C for 14, 28 & 56 days. The grade of concrete is M30 and W/C ratio is 0.4 [1]. Mix ratio is 1:2.28:3.14.

IV. RESULTS AND DISCUSSIONS

4.1 Slump Test

The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete, and therefore the ease with which concrete flows. It can also be used as an indicator of an improperly mixed batch. The mix is prepared and placed in a clean slump cone mould and tamped by three layers of about 25 stokes each layer and the top of cone is levelled off. Then the mould is lifted up vertically and the nature of slump is analysed to get the workability of the given cement concrete[16]. Slump value is shown in fig 4.1.

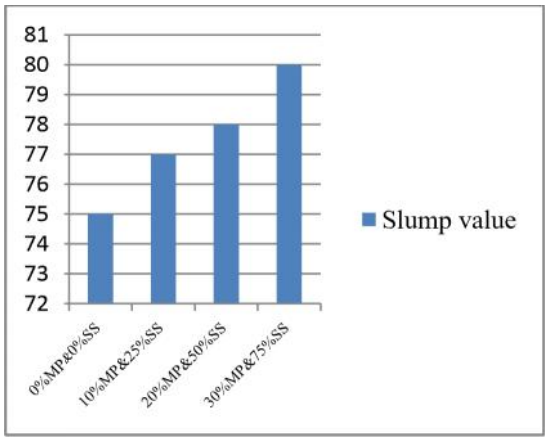

Fig 4.1 Slump value

4.2 Compression Strength Test

Compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength which withstands loads tending to elongate. [2]The test is conducted on the 14th day, 28th day and 56th day curing and its observation are listed below in the form of a graph. Compressive strength values with replacement for cement by marble powder with 0%, 10%, 20% & 30% and M sand by silica sand with 0%, 25%, 50% and 75% [1]. Compressive strength for 10%, 20% & 30% Marble powder and 25%, 50% & 75% silica sand is shown in fig 4.2.Compressive strength for 20% marble powder and 75% silica sand is shown in fig 4.3.

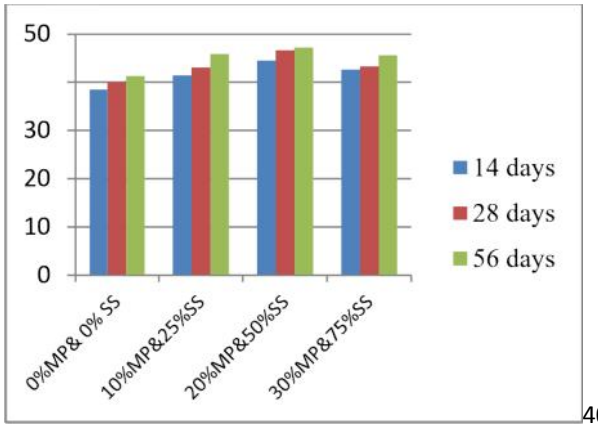

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Fig 4.2 Compressive strength value

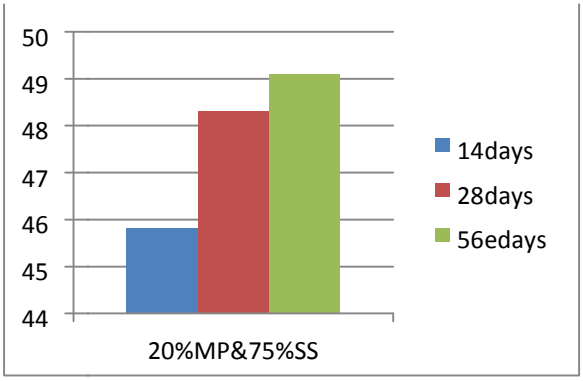

Fig 4.3 Compressive strength values of 20% MP and 75% SS

4.2 Split tensile Test

Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. It is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack. The test is conducted on 14th day, 28th day and 56th day. The cylinder is held in horizontal position and the load is applied gradually and value is recorded if the cylinder fails while applying the load in it [9]. Values are taken for concrete made by marble powder with 0%, 10%, 20% & 30% and M sand by silica sand with 0%, 25%, 50% and 75%. Split tensile results for various mix is shown in the fig 4.3.

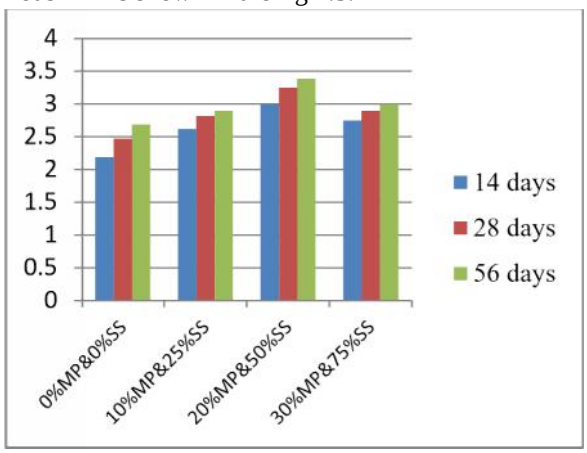

Fig 4.3 Split tensile value

V. DURABILTY OF ALCCOFINE CONCRETE

5.2 Sulphate attack test

This test was carried out on the 150x150x150 mm Concrete cube. Total 12 cubes are casted and demoulded after 24 hours and at the ends of 28 days of normal curing period tested. The specimens were taken out from the curing tank and initial weight was taken. 5% of sodium sulphate (Na2SO4) by weight of water was added with water as per earlier investigators. The concentration of the solution was maintained throughout this period by changing the solution periodically.[10] The specimens were taken out from the sulphate solution after 28 days of continuous soaking. The surface of the Cube were cleaned, weighed & then tested in the compressive testing machine under the uniform rate of loading of 120 kg/cm2/min. The changes in strength of the
concrete cube were calculated as per IS codes[2]

5.2 Acid Resistance test

The concrete cubes of size 150mm were cast and cured for a period of 28 days. After 28 days curing of specimens, cube surfaces were cleaned using standard preliminary surface cleaning process and weighed. The identified specimens were immersed in prescribed acid solution. The solution was checked periodically[20]. After the prescribed duration, the specimens were removed from the solution. Using weight loss method, percentage weight loss was determined.

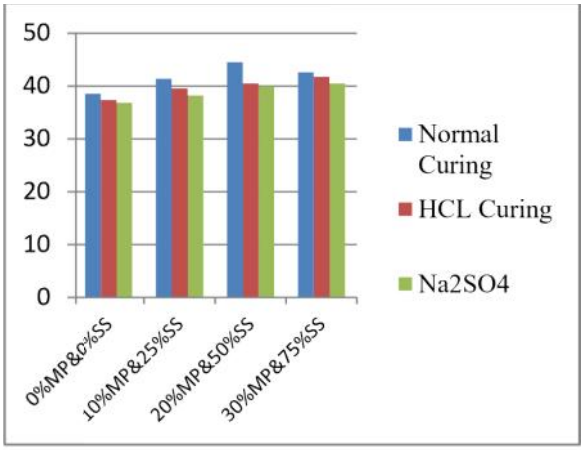

Fig 5.1 Durability test values

VI. CONCLUSION

The effects in concrete with the partial replacement of cement by marble powder and M sand by silica sand is investigated and conclusions were achieved.

- The addition of marble powder as a partial replacement increases the compressive strength of concrete at 10% & 20% and silica sand as partial replacement of M sand increases the compressive strength of concrete at 25% & 50% increases the compressive strength.
- The addition marble powder at 30 % and silica sand 75% decreases the strength.
- By maintaining the marble powder at 20% and increases the percentage of silica sand increases the strength.
- A percentage of tensile strength of concrete with replacement of marble powder and silica sand increases the strength with some extend.
- The durability of concrete after 28 days of curing with HCL and Na_2SO_4 solution shows the better result on strength.

REFERENCES

[1] HanifiBinici, OrhanAksogan, "Durability of concrete made with natural granular granite, silica sand and powders of waste marble and basalt as fine aggregate- Journal of Building Engineering 19 (2018) 109–121
[2] A. Talah, F. Kharchi, R.Chaid"Influence of Marble Powder on High Performance Concrete Behavior - Procedia Engineering 114 (2015) 685 -690
[3] Mohamed LyesKamelKhouadjiaBouzidiMezghiche, MounsifDrissi "Experimental evaluation of workability and compressive strength of concrete with several local sand and mineral additions" –Construction and Building Materials 98 (2015) 194–203
[4] N.M. Azreen, Raizal S.M. Rashid, M. Haniza, Y.L. Voo, Y.H. MugahedAmran"Radiation shielding of ultra-high-performance concrete with silica sand, amang and lead glass" – Construction and Building Materials 172 (2018) 370–377
[5] Deepankar Kumar Ashish"Feasibility of waste marble powder in concrete as partial substitutionof cement and sand amalgam for sustainable growth"-Journal of Building Engineering 15 (2018) 236–242.
[6] Mehmet Gesog, ErhanGüneyisi , Mustafa E. Kocabag, VeyselBayram, KasımMermerdas ,"Fresh and hardened characteristics of self compacting concretes made with combined use of marble powder, limestone filler, and fly ash" Construction and Building Materials 37 (2012) 160–170

[7] I.Narasimha Murthy, J. BabuRao, "Investigations on Physical and Chemical Properties of High Silica Sand, Fe-Cr Slag and Blast Furnace Slag for Foundry Applications"-I. Narasimha Murthy and J. BabuRao / Procedia Environmental Sciences 35 (2016) 583 – 596
[8] Ali Ergün, "Effects of the usage of diatomite and waste marble powder as partial replacement of cement on the mechanical properties of concrete"- Construction and Building Materials 25 (2011) 806–812.
[9] ShehdehGhannam, HusamNajm, Rosa Vasconez, "Experimental study of concrete made with granite and iron powders as partial replacement of sand"- Sustainable Materials and Technologies 9 (2016) 1–9
[10] Nancy A. Soliman, ArezkiTagnit-Hamou, "Using glass sand as an alternative for quartz sand in UHPC"- Construction and Building Materials 145 (2017) 243–252
[11] Manpreet Singh, KailashChoudhaAnshuman-Srivastava, Kuldip Singh Sangwan, DipenduBhunia, "A study on environmental and economic impacts of using waste marble powder in concrete"- Journal of Building Engineering 13 (2017) 87–95
[12] Mateusz Popek, ŁukaszSadowski, "Selected physical properties of concrete modified using mineral powders"- Procedia Engineering 172 91 – 896
[13] AnkushPendhari, Dr.PrashanthNagaranik,T. Manoharan "Engineering properties of concrete with partial utilization of used foundry sand" Waste Management 71 (2018) 454–460.
[14] Jianzhuang Xiao, ChengbingQiang , Antonio Nanni , Kaijian Zhang, "Use of seasand and seawater in concrete construction: Current status and future opportunities"- J.
[15] Xiao et al. / Construction and Building - Materials 155 (2017) 1101–1111
[16] KeraiJignesh,ShraddhaR.Vaniya, "Effect of use of Silica Sand as Fine Material in Concrete"-IJIRST/ Volume 2 / Issue 01 / 037.
[17] J.V.Kerai, S.R. Vaniya, "Use of Silica Sand as Fine Material in Concrete"- IJSRD/Vol. 3/Issue 01/2015/195.
[18] Gulden CaginUlubeylia, TurhanBilira, RecepArtir, "Durability Properties of Concrete Produced by Marble Waste as Aggregate or Mineral Additives"- Procedia Engineering 161 (2016) 543 – 548
[19] Ali A. Aliabdo, AbdElmoaty M. AbdElmoaty ,Esraa M. Auda, "Re-use of waste marble dust in the production of cement and concrete" –Construction and Building Materials 50 (2014) 28–41.
[20] A.S.E. Belaidi, L. Azzouz , E. Kadri, S. Kenai, "Effect of natural pozzolana and marble powder on the properties of selfcompacting concrete"- Construction and Building Materials 31 (2012) 251–257
[21] Valeria Corinaldesi, GiacomoMoriconi, Tarun R. Naik, "Characterization of marble powder for its use in mortar and concrete"- Construction and Building Materials 24 (2010) 113–117.
[22] Ali Khodabakhshian, Jorge de Brito, Mansour Ghalehnovi, ElyasAsadiShamsabadi"Mechanical, environmental and economic performance of structural concrete containing silica fume and marble industry waste powder"- Construction and Building Materials 169 (2018) 237–251.
[23] Gulden CaginUlubeylia, RecepArtir, "Properties of Hardened Concrete Produced by Waste Marble Powder"- Procedia - Social and Behavioral Sciences 195 (2015) 2181 – 2190.
[24] Ms.Ruchi Chandrakar1, Mr.Avinash Singh, "Cement Replacement in concrete with Marble Dust Powder-(IRJET)Volume 04 Issue: 05 | May -2017.
[25] Manpreet Singh, AnshumanSrivastavaDipenduBhunia, "An investigation on effectthe influence of load"of partial replacement of cement by wastemarble slurry –M. Singh et al. / Constructionand Building Materials 134 (2017) 471–488.
[26] Shetty M.S., "Concrete Technology – Theory & Practice",S. Chand & Company Ltd., 2002.
[27] IS 516:1959. Methods of tests for strength of concrete, New Delhi, India: Bureau of IndianStandard
[28] IS: 383 – 1970, Indian Standard Specification for Coarse& Fine Aggregates from Natural Sourcesfor Concrete, B.I.S., New Delhi.
[29] IS:10262 – 2009, Indian Standard Recommended Guidelines for Concrete Mix Design, B.I.S., and New Delhi