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Study of Properties of Concrete using Marble Powder and Dredged Sand

Sona K Raju
M Tech Student
ICET
Muvattupuzha, India

Basil Johny
Asst.Professor
ICET
Muvattupuzha, India

***Abstract* — Concrete is the most widely used construction material because of its high structural strength and stability. Its main constituents are cement, sand, fine ,coarse aggregates, and water. Most of the aggregates and raw materials for cement used in the manufacture of concrete come from quarries or alluvial rivers. Production of cement also involves large amount of carbon dioxide gas into the atmosphere, a major contributor for green house effect and the global warming . It is important to optimize the consumption of aggregates and also enhance their replacement by other alternative sources. The Marble industry has major environmental problems due to waste generation at different stages of mining and processing operation. It can be can be use as admixtures or used instead of cement so that resources are used more efficiently and the environment is protected from waste deposits. Dredged sand which is obtained from the removal of sediments and debris from the bottom of lakes, rivers, harbors, and other water bodies is used as a partial replacement for fine aggregate. The Dissertation work is carried out with M40 grade concrete for which the marble powder is replaced by 5%, 10%, 15%, by weight of cement and dredged sand replaced by 10%,15%,20%,25% by weight of fine aggregate The fresh properties and mechanical properties for all the mixes were studied. The aim of this work is to study the possible use of Marble powder and dredged sand in concrete production, which would reduce both the environmental impact and the production cost.**

Keywords-Fine aggregate, marble powder, dredged sand,

I. INTRODUCTION

Concrete is the important material in the construction other than steel and timber. Its main constituents are cement, sand, fine and coarse aggregates, and water. As there are several wastes coming from the industries we can use those wastes as the constituents of concrete by replacing or partially replacing the cement, sand or aggregates which makes it economical and also conserves the natural resources. With the increase in production of marbles it increases the waste that obtained from it. As marble powder is the waste product, obtained during the process of sawing and shaping of marble by parent marble rock, contains heavy metals which makes the water unfit for use. Marble powder creates environmental problems. Due to environmental problems, it has a great impact on human health as well as on nature. To control its effects we have to use this waste. In this study, we reviewed the waste marble powder obtained from the industry and investigate its effects on the concrete mix and also compare the compressive, flexure and split tensile strength, workability of concrete mix. Most of the aggregates used in the manufacture of concrete come from quarries or alluvial rivers. Nowadays, these sources of natural aggregates are in the process of depletion and their extraction also has harmful consequences for the environment. For these reasons, it is important to optimize the consumption of natural aggregates as well as to enhance their replacement by other alternative sources. This research will examine the potential use of fine marine aggregates resulting from maintenance dredging activities as substitutes for natural aggregates for the manufacture of concrete. In this study a sustainable concrete is proposed which consists of substantial amount of supplementary cementitious material as a replacement to cement and dredged sand instead of natural aggregates. Recycled marble powder is used as the supplementary cementitious material. The mix proportion is to be done to obtain a M40 grade concrete. Mixes with different contents of dredged sand (10%,15%, 20%, 25%,)as replacement to natural aggregates is examined and marble powder (5%, 10%, 15%,) as replacement to cement is 6 aggregates and marble powder to cement. The strength properties of concrete are also to be studied for various replacement percentages of marble powder and dredged sand. Different mixtures were produced using dredged sand (DS) in different proportions from 10%, 15%, 20%, and 25% as per the finalized trial of the design mix. The concrete were submitted to compressive strength tests after 3, 7 and 28 days of moist curing, as well as flexure and splitting tensile strength tests for M-40 grade.

A. Marble Powder

Marble is obtained from the transformation of pure limestone. The purity of marble depends upon the colour of the marble. Since the ancient times, marble is widely used in monuments and historical buildings for decorative purpose. In India, tons of waste has been produced from the industries. But there are some impurities present in the waste that cannot be easily disposed off. Such type of impurities mixed with soil and water. When they mix with soil, it reduces the porosity and permeability of the soil and also reduces the fertility of a soil. Also, if it mixes with water it pollute the water and make the water unfit for use. So it is necessary to use the waste in functional manner.

Advantages of Marble Powder

- Marble powder can be used as filler in concrete and paving materials and helps to reduce total void content in concrete.

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- Marble powder can be used as an admixture in concrete, so that strength of the concrete can be increased.
- We can reduce the environmental pollution by utilizing this marble powder for producing the other products.
- Marble dust is mixed with concrete, cement or synthetic resins to make counters, building stones, sculptures, floors and many other objects.
- Marble dust is also used to make paint primer for canvas paintings, and as paint filler.
- Used as a component for manufacture of white cement.

Fig.1 Marble Powder

B. Dredged Sand

To meet the ever rising demand for fine aggregate in the construction industry, river sand has been exploited unconditionally in various parts of our country. This has led to various environmental issues. Hence we have to restrict river sand mining, mainly from rivers in which water level is decreasing. As a remedial measure, the government has imposed various restrictions on the extraction, but all of these leads to instability of the construction industry. The research reported here is on Dredged sand, which is considered the most viable alternatives to river sand, with respect to availability, ease of extraction, environmental impact and cost.

The dredged for this research work was obtained from the Cochin. The offshore sand was dredged to increase the sea bed depth of the Cochin port for the accessibility of mother ships. Nearly 21 million cubic meters of offshore sand should be dredged from Cochin port every year. The offshore sand obtained for this project work was subjected to rain and atmospheric conditions for a year.

Fig.2 Dredged sand

II. LITERATURE REVIEW

[1] Nitisha Sharma studied the properties of Waste Marble Powder as a Partial Replacement in Cement Sand Mix This was done by replacing cement by a percentage of marble powder. Four basic concrete mixes were considered. When cement is replaced with marble powder up to 10% weight, high strength concrete was achieved.

[2] A. Shirule Studied the Properties of Partial Replacement of Cement With Marble Dust Powder. IS 4031-1968 was adopted in this work. The result shows that the inclusion of Marble powders the strength of concrete gradually increases upto ascertain limit but it gradually decreases. With the inclusion of Marble powder up to 10%the initial strength gain in concrete is high. At 10% there is 17.7% increase in initial Compressive strength for 28 days.

[3] Dr. Ravindra, Anil Kumar Buraka .In this study. A unique design mix will be done based on the entire material test results. Different mixtures were produced using DMS in different proportions from 15% to 100% as per the finalized trial of the design mix. It is observed that flexural strength is increasing 90 days of age in all mixes except in 100% replacement. For split tensile strength also 15% replacement is showing the maximum value for 28days. Except an increase of 4.2% in DMS 15% rest of all mixes are observed to be decreasing w.r.t normal mix.

[3] Girish, Tensing and Priya K. L (2015).This paper deals with the study on the extent of using off shore sand as a partial replacement for fine aggregate in concrete. Partial replacement of offshore sand with river sand improved the grade of aggregate for use in concrete.

III. METHODOLOGY

A. Determination Of Material Properties

- Cement – Specific Gravity, Standard consistency, initial setting time, Final setting time
- Marble Powder- Specific Gravity, physical properties and chemical properties
- Fine Aggregates – Sieve analysis, Specific gravity, water content and water absorption, , Bulk density and Percentage voids
- Coarse Aggregates – Sieve analysis, Specific gravity, water absorption, Bulk density and Percentage voids,
- Dredged sand – Sieve analysis, Specific gravity, water absorption, Bulk density and Percentage voids
- Super Plasticizer – Master Glenium SKY 8233
- Water

B. Mix Proportioning (M40)

Mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required strength, durability and workability as possible. The mix design is carried out as per IS 10262:2000. The grade of concrete adopted for the study is M40.

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C. Mix Preparation And Specimen Preparation

- Preparation of control mix (M40)
- Preparation of concrete with partial replacement of marble powder for cement (5%, 10% , 15%,) and find out the optimum percentage
- Preparation of mix with partial replacement of dredged sand for fine aggregate (FA)(10%,15%, 20% , 25%,) and Find the optimum percentage
- Preparation of concrete with the optimum percentage of marble powder in cement and dredged sand as partial replacement for fine aggregate

D. Tests

a) Fresh properties
- Slump Test
- Compaction factor test

b) Mechanical properties
- Compressive strength
- Flexural strength
- Splitting tensile strength

IV. MATERIAL TESTING

A. Cement

An OPC 53 grade Dalmia cement was used in this study. The physical properties of the cement used were found based on the respective IS codes.

TABLE 1 PROPERTIES OF CEMENT

Sl.No	Property	Result
1	Specific gravity	3.125
2	Standard consistency	35%
3	Initial setting time	240 minutes
4	Fineness of cement	Residue 5%

B. Fine Aggregate

Aggregates are important constituents in concrete. Manufacture sand was used as fine aggregate

TABLE 2 PROPERTIES OF FINE AGGREGATE

SL.NO	PROPERTY	MAGNITUDE AND UNIT
1	Specific gravity	2.69
2	Sieve Analysis	Zone II.
4	Bulk Density	1.22
5	Percentage Air Voids	54.44%
6	Water absorption	1.5%

C. Coarse Aggregate

Coarse aggregate with 20mm size was used for the study. The tests for specific gravity, bulk density, void ratio, % voids and water absorption were conducted as per IS 2386-1970.

TABLE 3 PROPERTIES OF COARSE AGGREGATE

Sl.No	Property	Magnitude and unit
1	Specific gravity	2.67
2	Water Absorption	0.8%
3	Bulk density of aggregate (kg/l)	1.4kg/l

D. Dredged Sand

Dredged sand is available in plenty across the globe in the shores of seas.

TABLE 4 PROPERTIES OF DREDGED SAND

Sl.No	Property	Magnitude and unit
1	Specific gravity	2.6
3	Water Absorption	4.5%

E. Marble Powder

TABLE 5 PROPERTIES OF MARBLE POWDER

Sl.No	Property	Magnitude and unit
1	Specific gravity	2.8

V. MIX PROPORTIONING

TABLE 5 MIX PROPORTIONING

Mix grade	M40
Mix designation	CM
Water-cement ratio	0.38
Cement	414kg/m^3
Fine aggregate	801kg/m^3
Coarse aggregate	1095kg/m^3
Chemical admixture	1.24
Water	178kg/m^3

VI. TESTING OF CONCRETE

A. Compressive Strength Test

The compression test is carried out on a specimen cubical or cylindrical in shape. For compressive strength, cubes of size 150mm x 150mm x 150mm were casted.

1. Conventional Mix

Cubes for compressive strength are tested at 3 day, 7 days, and 28 days using compression testing machine.

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TABLE 6 AVERAGE COMPRESSIVE STRENGTH OF CM

Mix ID	Average compressive strength		
	3-day	7-day	28-day
CM	28.9	39.99	50.22

2. Replacement of Fine Aggregate with Dredged Sand

Mixes are made by replacing fine aggregate with 10%, 15%, 20%, 25% dredged sand.

TABLE 7 AVERAGE COMPRESSIVE STRENGTH OF DS

Mix ID	Average compressive strength(N/mm^2)		
	3-day	7-day	28-day
CM	28.9	39.9	50.2
DS-10	22.46	33.1	44.93
DS-15	29.5	40.1	54.44
DS-20	26.84	36.6	49.8
DS-25	24.83	33.7	46.96

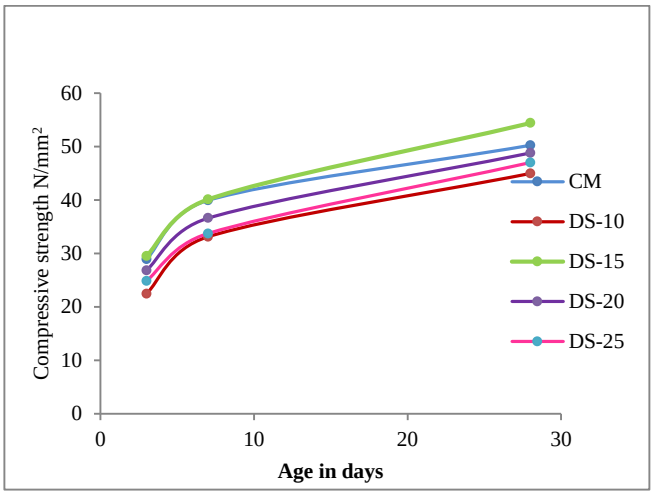

Fig 3 Variation of compressive strength with age for DS mixes

The result shows that, for DS-15 compressive strength increases at all ages compared with CM. The obtained value of compressive strength for the DS-20 mix is more than the theoretical value. But for DS-10, and DS-25 compressive strength decreases at all ages. The result obtained for 28-day compressive strength confirms that the optimal percentage for replacement of fine aggregate with dredged sand is about 15%. So for further studies DS-15 is used.

3. Replacement Of Cement With Marble powder

Mixes are made by replacing cement with 5%, 10%, 15% marble powder

TABLE 8 AVERAGE COMPRESSIVE STRENGTH OF MP

Mix ID	Average compressive strength(N/mm^2)		
	3-day	7-day	28-day
CM	28.9	39.9	50.2
MP-5	26.6	32.95	38.6
MP-10	29.44	40.33	51.11
MP-15	18.24	32.3	37.2

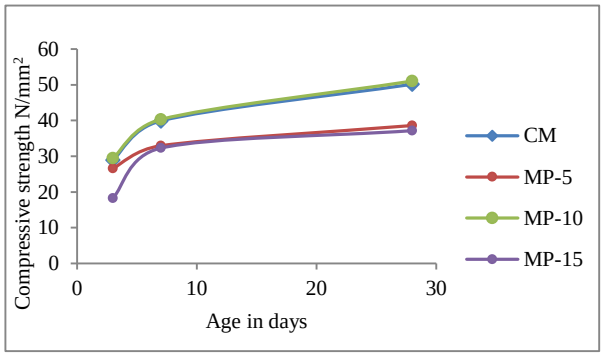

Fig 4 Variation of compressive strength with age for MP mixes

The result shows that, for MP-10 compressive strength increases at all ages compared with CM. But for MP-5, and MP-15 compressive strength decreases at all ages.

4. Replacement of Cement With 10 % Marble Powder And Fine Aggregate With 15 % Dredged Sand (DS+MP)

Mixes are made by replacing 10% cement with marble powder and 15% fine aggregate with dredged sand (MP+DS).

TABLE 7. AVERAGE COMPRESSIVE STRENGTH OF DS+MP MIX

Mix ID	Average compressive strength(N/mm^2)		
	3-day	7-day	28-day
CM	28.9	39.9	50.2
DS+MP	29.1	40.4	52.4

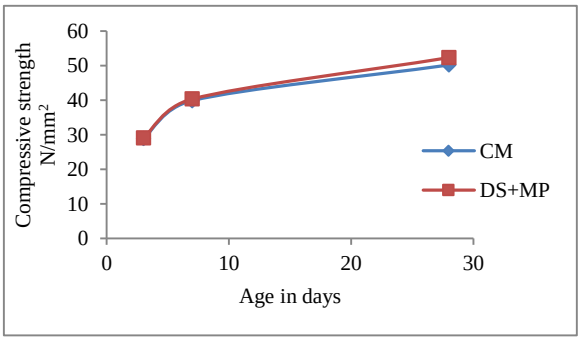

Fig 5 Variation of compressive strength

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B. Flexural Strength

1. Conventional Mix

Beams are casted for determining flexural strength of concrete and they are tested 7 day and 28 day.

TABLE 8 AVERAGE FLEXURAL STRENGTH FOR CM

Mix ID	Average flexural strength(N/mm2)	
	7 day	28 day
CM	7.5	10.5

2. Replacement of Fine Aggregate with Dredged Sand

TABLE 9. AVERAGE FLEXURAL STRENGTH FOR DS

Mix ID	Average flexural strength(N/mm^2)	
	7 day	28 day
CM	7.5	10.5
DS-10	5	6.75
DS-15	6.25	8.5
DS-20	6	8
DS-25	5.2	6.25

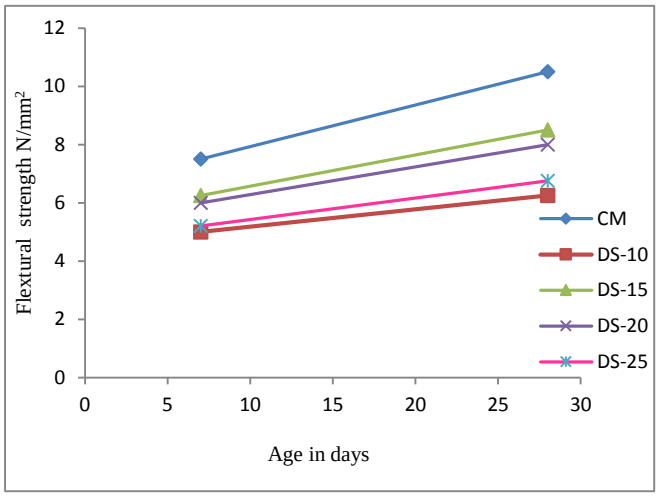

Fig.6 Variation of strength with age for DS mixes

The result shows that, for DS-10, DS-15 DS-20 and DS-25 flexural strength decreases at all ages compared with CM but it is greater than the theoretical values.

3. Replacement of Fine Aggregate with Marble Powder

TABLE 9. AVERAGE FLEXURAL STRENGTH FOR MP

Mix ID	Average Flexural strength(N/mm^2)	
	7 day	28 day
CM	7.5	10.5
MP-5	5.75	7
MP-10	7.2	8.5.
MP-15	5.65	6.25

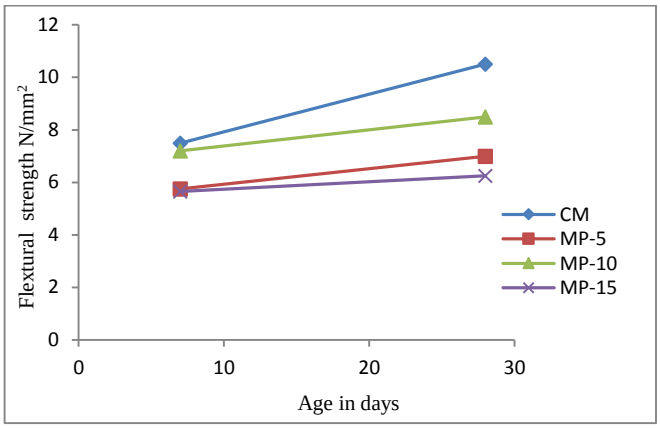

Fig.7 Variation of strength with age for MP mixes

The result shows that, for MP-10 flexural strength increases at all ages compared with CM. But for MP-5, and MP-15 flexural strength decreases at all ages.

4. Replacement Of Cement With 10 % Marble Powder And Fine Aggregate With 15 % Dredged Sand (MP+DS)

Mixes are made by replacing 10% cement with marble powder and 15% fine aggregate with dredged sand.

TABLE 11: AVERAGE FLEXURAL STRENGTH OF DS+MP

Mix ID	Average flexural strength(N/mm^2)	
	7 day	28 day
CM	7.5	10.5
DS+MP	6.75	7

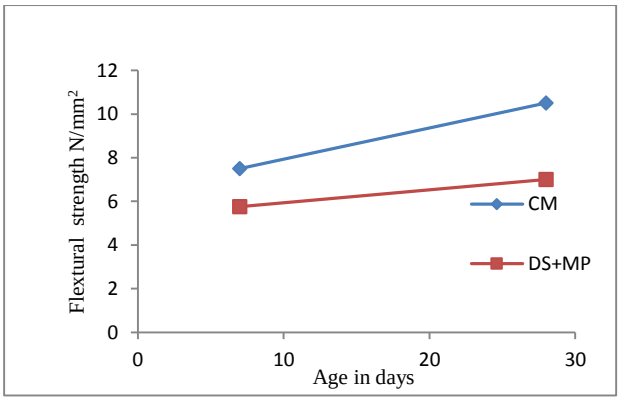

Fig 8 Average Flexural Strength of DS+MP

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The result shows that, for DS+MP flexural strength decreases at all ages but it is greater than the theoretical value.

C. *Splitting Tensile Strength*

1. *Conventional Mix*

TABLE 12 AVERAGE SPLITTING TENSILE STRENGTH OF CM

Mix ID	Average splitting tensile strength	
	7 day	28 day
CM	2.26 N/mm^2	2.82N/mm^2

2. *Replacement of Fine Aggregate with Dredged Sand*

TABLE 12 AVERAGE SPLITTING TENSILE STRENGTH OF DS

Mix ID	Average splitting tensile strength	
	7 day	28 day
CM	2.26 N/mm^2	2.83N/mm^2
DS-10	1.81 N/mm^2	2.4 N/mm^2
DS-15	2.51N/mm^2	3.03N/mm^2
DS-20	2.43N/mm^2	2.68 N/mm^2
DS-25	2.12N/mm^2	2.5N/mm^2

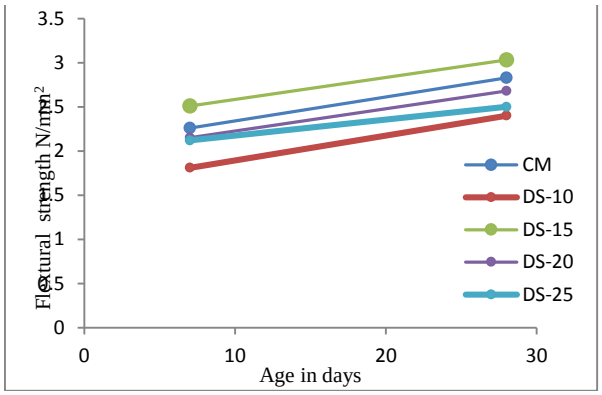

Fig 9.Variation of splitting tensile strength with age for DS mixes

The result shows that, for DS-15 splitting tensile strength increases at all ages compared with CM. But for DS-10, DS-20 and DS-25 splitting tensile strength decreases at all ages.

3. *Replacement of Fine Aggregate with Marble Powder*

TABLE 13 AVERAGE SPLITTING TENSILE STRENGTH OF MP

Mix ID	Average splitting tensile strength	
	7 day	28 day
CM	2.26 N/mm^2	2.83N/mm^2
MP-5	2.23N/mm^2	2.6 N/mm^2
MP-10	2.4N/mm^2	2.97 N/mm^2
MP-15	2.25 N/mm^2	2.8 N/mm^2

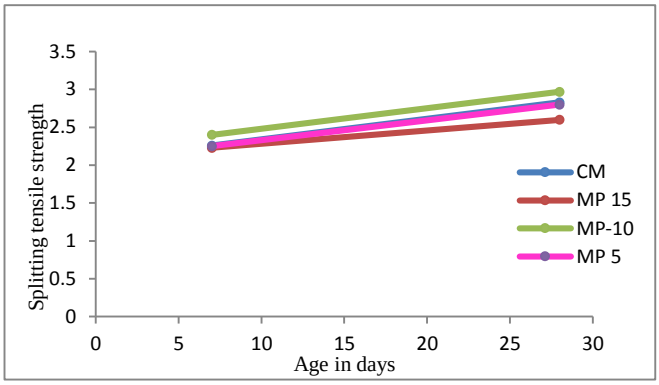

Fig 10.Variation of splitting tensile strength with age for MP mixes

The result shows that, for MP-10 splitting tensile strength increases at all ages compared with CM. But for MP-5, and MP-15 splitting tensile strength decreases at all ages

4. *Replacement of Cement with 10 % Marble Powder and Fine Aggregate with 15 % Dredged Sand*

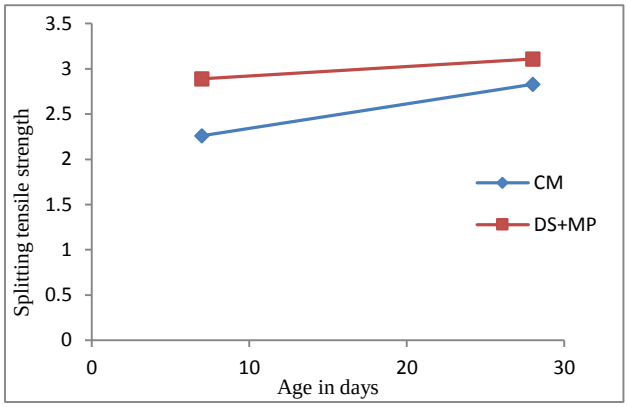

Fig11 Variation of splitting tensile strength with age for DS+MP mixes

The result shows that, for DS+MP splitting tensile strength increases at all ages compared with CM.

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VII. CONCLUSIONS

- The material properties of cement, natural aggregate, dredged sand and marble powder used for the study was conducted.
- Slump testes and compaction factor test were used to find out the workability of concrete. All mixes prepared show adequate workability.
- Mix design was done to obtain M40 grade mix according to IS 10262:2009. The mix show adequate strength in terms of Compressive strength, flexural strength and splitting tensile strength
- Mixes were made by replacing 10%, 15%, 20%, 25% fine aggregate with dredged sand (DS-10, DS-15, DS-20, DS-25). Compared to CM for DS-15 the compressive strength and splitting strength increased, while the flexural strength decreased but it is greater than the target strength. The increase in compressive strength may be due to fineness of dredged sand.
- Mixes were made by replacing 5%, 10%, 15%, cement with marble powder shows good result in -terms of compressive, splitting and flexural strength
- Mixes were made by replacing fine aggregate with 15% by dredged sand and cement by 10% marble powder. The mix shows a good result in terms of compressive, splitting and flexural strength.

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