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Strength Comparison of M20 and M25 Grade Concrete on Replacing Natural Sand with M-Sand and Partially Replacing Cement with Rice Husk Ash

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ABSTRACT: The wide growth of construction industry and construction activity leads to use of quality material is important to gain maximum strength. This study investigates the effect of replacing natural sand with manufactured sand (M-sand) and partially replacing cement with rice husk ash (RHA) and making normal mixes of concrete to check and compare the compressive strength, split tensile strength, flexural strength of M20 and M25 grade concrete. M-sand, a byproduct of crushing rocks, has gained attention as a sustainable alternative to natural sand, while rice husk ash, an agricultural waste material, has shown pozzolanic The research aims to evaluate the performance of concrete mixes with varying percentages of Natural sand (100%), M-sand (100%), M-sand and Natural sand (50-50%) and RHA (7.5%, 12.5%, and 17.5%) as partial and fully replacement for natural sand and partially replacement of cement or fly ash based cement with RHA respectively. The various strength of the concrete i.e. compressive strength, split tensile strength and flexural strength was tested at 7 and 28 days of curing, with results indicating the optimal mix ratios for achieving enhanced strength. The result suggests that the replacement of Natural sand with M-Sand and cement with RHA provides a sustainable solution for concrete production without compromising strength and durability. The results also contribute to the understanding of the role of M-sand and RHA in improving quality construction activities in future. Replacement of cement or fly ash based cement with RHA respectively. Nominal mixes prepared to check and compare the strength of concrete after the addition of the RHA in the concrete mix design. Here all the test based casting is done to check out various strength of concrete.

KEYWORDS: M-Sand, RHA, Natural Sand, Pozzolanic, Compressive Strength, Split Tensile Strength, Flexural Strength, Optimum mix ratio and quality construction.

I. INTRODUCTION

Concrete is one of the most commonly used construction material all over the world, primarily composed of cement, fine aggregate, coarse aggregate, admixtures and water. Manufactured sand (M-Sand) has emerged as a promising substitute for natural sand, offering advantages such as availability, cost-effectiveness, and uniform quality. Additionally, rice husk ash (RHA), a byproduct of rice milling, has demonstrated pozzolanic properties that enhance the strength and durability of concrete when used as a partial replacement for cement. M20 and M25 are two commonly used grades of concrete, characterized by their compressive strength. The strength of concrete is influenced by several factors, including the type of materials used, mix proportions, and curing conditions. The replacement of natural sand with M-Sand and cement with RHA in both M20 and M25 grade concrete offers a promising opportunity to enhance the mechanical properties of concrete while contributing to sustainability. The primary aim of this study is to compare the compressive strength of M20 and M25 grade concrete when natural sand is replaced with M-Sand and cement is substituted with Rice Husk Ash. This comparison will explore the effects of these substitutions on the workability,

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strength, and overall performance of the concrete mix by replacement and normal concrete mix.

II. MATERIAL USED

Material that are used in our work is discussed i.e. Cement (fly ash based cement), Rice husk ash, Natural Sand, M-Sand and Coarse aggregate. Now we discuss the properties of the material used by us in detail.

2.1 CEMENT:

Cement which comprises of fly ash and it is ordinary Portland cement which enhances the property of cement with waterproofing as well as strength properties. Majorly cement is used for binding the concrete materials. Here the initial setting time of the cement is found to be 35 minutes and final setting time of cement is found to be as 575 minutes. In our investigation Grade 53 cement is used.

Table1: Physical Properties of Cement

Sr. No.	CAHRACTERISTICS	UNITS	RESULTS	SPECIFIED VALUE
1.	Consistency of cement(fly ash based)	-	32%	25-35%
2.	Specific gravity	-	2.78	2.1-2.8
3.	Setting time (1) Initial (2) Final	 Minutes	 35 575	 30 or more 600
4.	Fly ash content	-	25%	15-35%

2.2 NATURAL SAND:

Natural sand is a granular fine material composed of finely divided rock and mineral particles that are formed through natural weathering and erosion processes. It is primarily extracted from riverbeds, streambeds, coastal shores, and pits. The most common constituent of natural sand is silica (SiO_2), usually in the form of quartz.

Table2: Physical Properties of Natural Sand

Sr. No.	PHYSICAL PROPERTIES	OBSERVATION
1.	Color	Grayish
2.	Size	0.90-3.95mm
3.	Shape	Round or Circular

2.3 M-SAND:

M-Sand commonly known as manufactured sand or crusher sand that is obtained from crushing of rocks or stones the fine particles that are left after the crushing process is termed to be M-Sand. M-Sand nowadays used by construction industry for the production of concrete or mortar due to its more strength and binding ability with the cement. As compare to river sand M-Sand has less silt impurity in it.

Table3: Physical Properties of M-Sand

Sr. No.	PHYSICAL PROPERTIES	OBSERVATION
1.	Color	Brownish
2.	Size	1.25-4.75mm
3.	Shape	Round or Circular

2.4 COARSE AGGREGATE:

CA of up to 20mm is used just to make concrete more workable. Construction material on of the most usage that is obtained from crushing of the hard rock in the crushers placed near the river or water bodies where rocks are obtained. These particles are retained on a 4.75 mm sieve and generally consist of crushed stone, gravel, or recycled concrete. Coarse aggregates are a key component of concrete, providing strength, volume, and stability to the mix.

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Table4: Physical Properties of Coarse Aggregate

Sr. No.	PHYSICAL PROPERTIES	OBSERVATION
1.	Color	Brownish and grayish
2.	Size	20mm
3.	Shape	Angular

2.5 RICE HUSK ASH:

Rice husk ash is termed as the byproduct of burnt outermost rice shell. It acts as the binding material when mixed with the cement in concrete.

Table4: Physical Properties of Coarse Aggregate

Sr. No.	PHYSICAL PROPERTIES	OBSERVATION
1.	Color	Black and Grey
2.	Size	Up to 65 µm
3.	Shape	Non uniform having sharp edges
4.	Specific Gravity	2.15

Fig. 3.2: Rice Husk Ash

III. EXPERIMENTATION

Compressive Strength: Compressive strength is the most important property of the concrete. Compressive strength is checked casting moulds i.e. cube moulds of size 150x150x150mm. After 7 days 28 days cubes were tested in the compression testing machine.

Fig. 4.2: Compressive Strength Test

Split Tensile Strength: Split tensile strength of concrete is testing in split tensile testing machine. As per standards tensile strength of concrete is very low as compare to the compressive strength.

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Cylindrical mould is prepared of 150mm diameter and of 300mm in height and casted as per standards of design mix. After opening of moulds cylinder placed into the curing tanks and tested in machine after 7 days, and 28 days. The value of load is applied which lead to failure is obtained.

Fig. 4.3: Split Tensile Strength Test

Flexural Strength: Flexural strength is used to measure the tensile strength of the concrete that is casted. Especially in beams flexural strength is calculated as beam is the flexural member. As in the investigation size of beam that is used is of 100 x 100 x 500 mm. Here after casting of the beam specimen is put into the curing tanks and after days testing is done by putting into flexural testing machine.

Fig. 4.4: Flexural Strength Test

IV. OBSERVATIONS

Table 5: Shows Compressive Strength of M20 and M25 grade concrete at 7 days in N/mm^2

MIX	Average compressive strength in N/mm2 (7Days)	
	M20	M25
M0	12.97	17.05
M1	12.55	16.37
M2	13.51	16.91
M3	12.31	14.43
M4	13.61	15.53
M5	11.84	14

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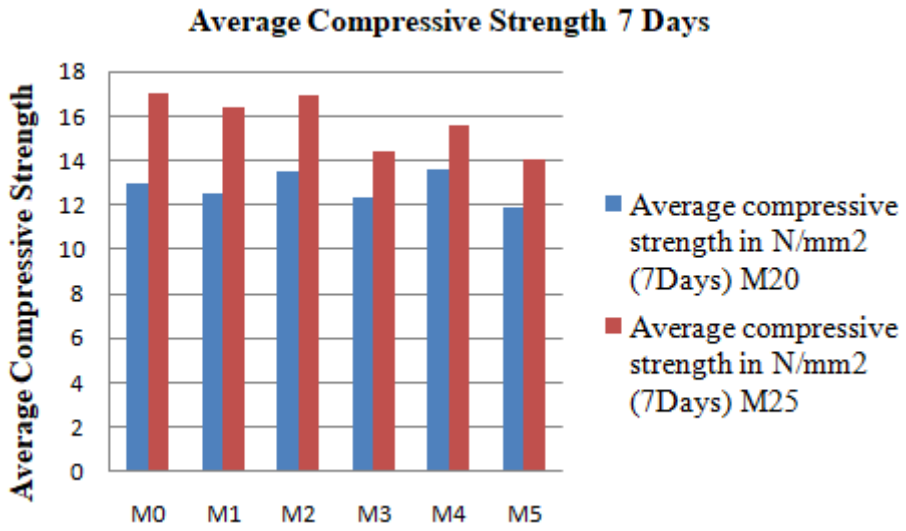

Fig5.2: Bar Chart of 7 days Compressive Strength of M20 and M25 grade concrete

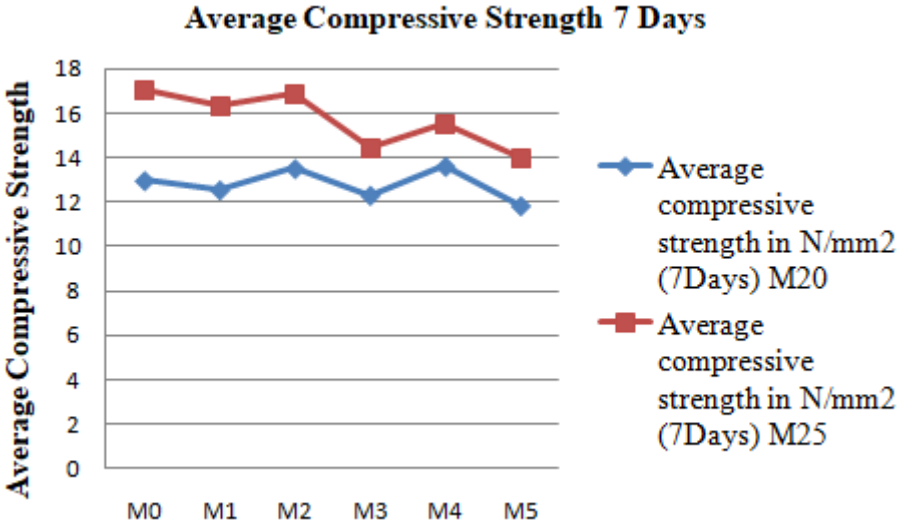

Fig.5.3: Line diagram of 7 days Compressive Strength of M20 and M25 grade concrete

Table 6: Shows Compressive Strength of M20 and M25 grade concrete at 28 days in N/mm^2

MIX	Average compressive strength in N/mm2 (28 Days)	
	M20	M25
M0	20.25	25.72
M1	24.33	30.29
M2	24.85	30.61
M3	24	29.32
M4	24.49	31.30
M5	22.89	26.28

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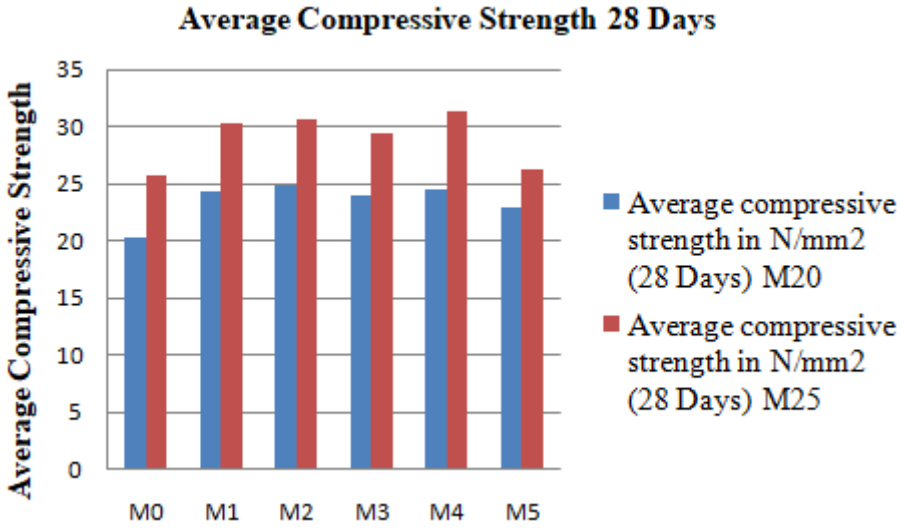

Fig.5.4: Bar Chart of 28 days Compressive Strength of M20 and M25 grade concrete

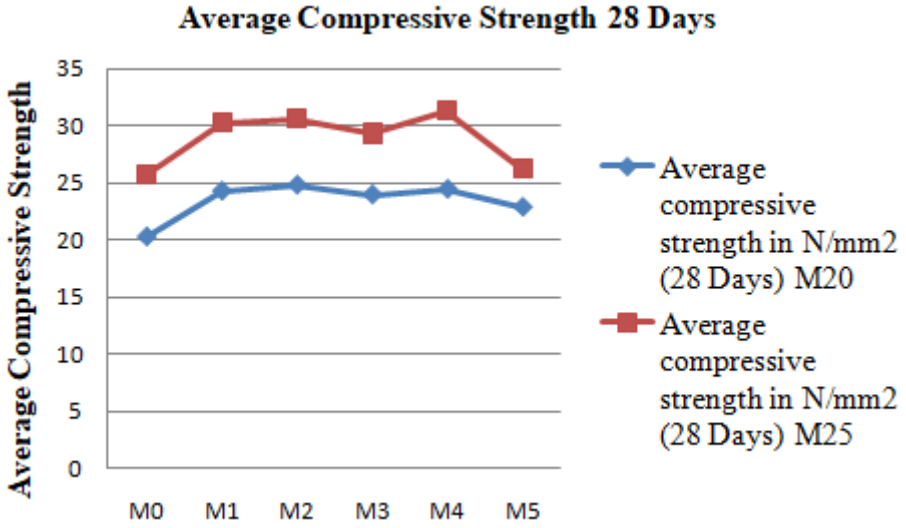

Fig.5.5: Line Diagram of 28 days Compressive Strength of M20 and M25 grade concrete

Table 7: Shows Split Tensile Strength of M20 and M25 grade concrete at 7 days in N/mm^2

MIX	Average split tensile strength in N/mm2 (7Days)	
	M20	**M25**
M0	1.62	1.81
M1	1.53	1.92
M2	1.41	1.72
M3	1.48	1.94
M4	1.62	2.07
M5	1.38	1.77

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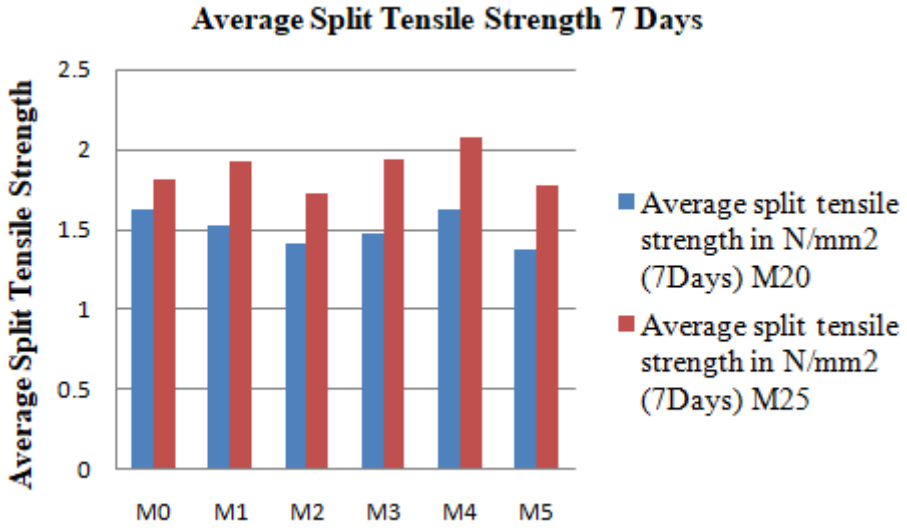

Fig.5.7: Bar Chart of 7 days Split Tensile Strength of M20 and M25 grade concrete

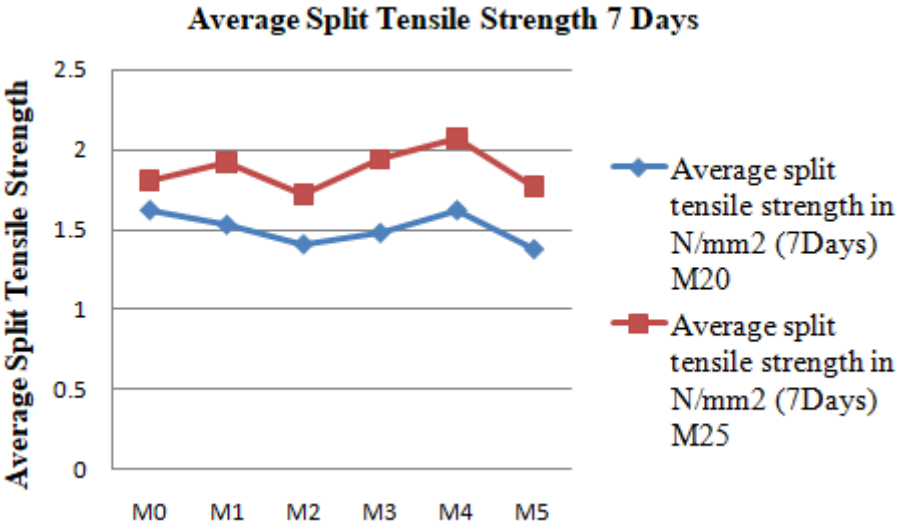

Fig.5.8: Line Diagram of 7 days Split Tensile Strength of M20 and M25 grade concrete

Table 7: Shows Split Tensile Strength of M20 and M25 grade concrete at 28 days in N/mm^2

MIX	Average split tensile strength in N/mm2 (28Days)	
	M20	M25
M0	2.44	2.74
M1	2.41	2.62
M2	2.26	2.70
M3	2.58	2.66
M4	2.75	2.92
M5	2.41	2.40

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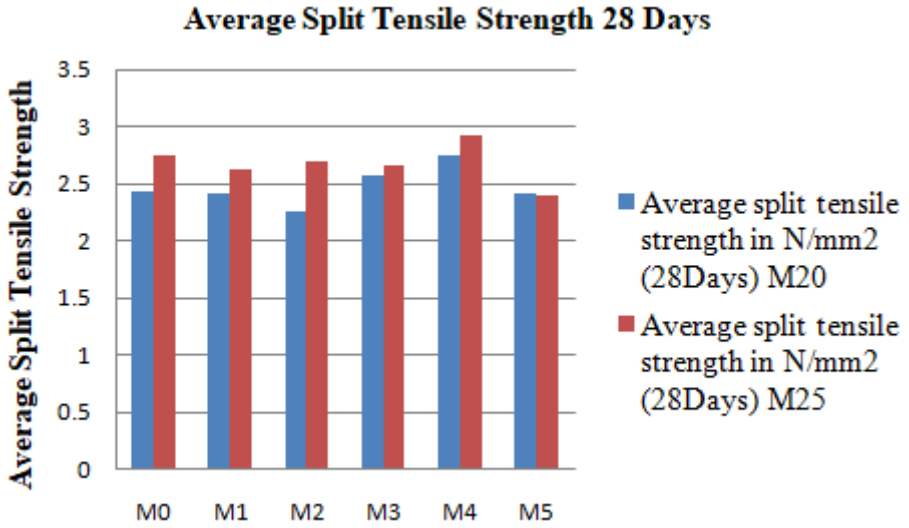

Fig.5.9: Bar Chart of 28 days Split Tensile Strength of M20 and M25 grade concrete

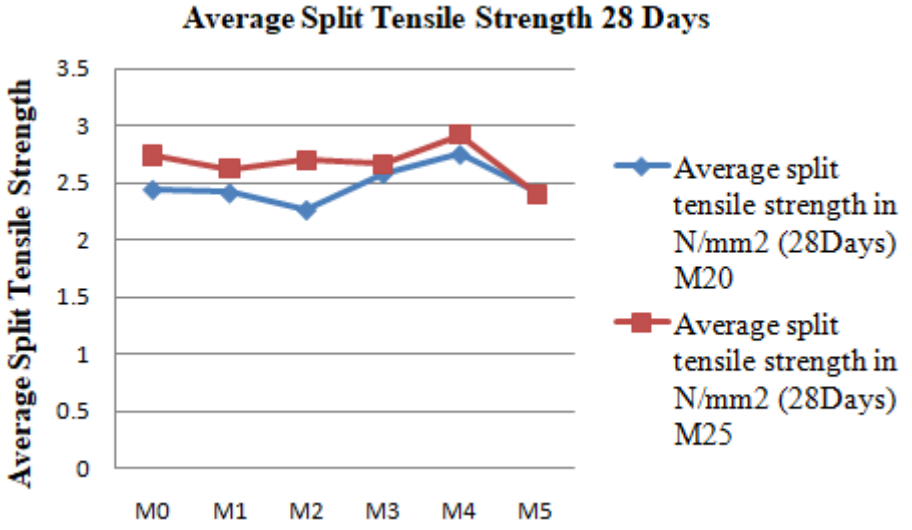

Fig.5.10: Line Diagram of 28 days Split Tensile Strength of M20 and M25 grade concrete

Table 7: Shows Flexural Strength of M20 and M25 grade concrete at 7 days in N/mm^2

MIX	Average flexural strength in N/mm2 (7Days)	
	M20	M25
M0	2.20	1.92
M1	2.31	2.78
M2	1.92	2.71
M3	2.96	3.88
M4	3.38	4.25
M5	2.66	3.49

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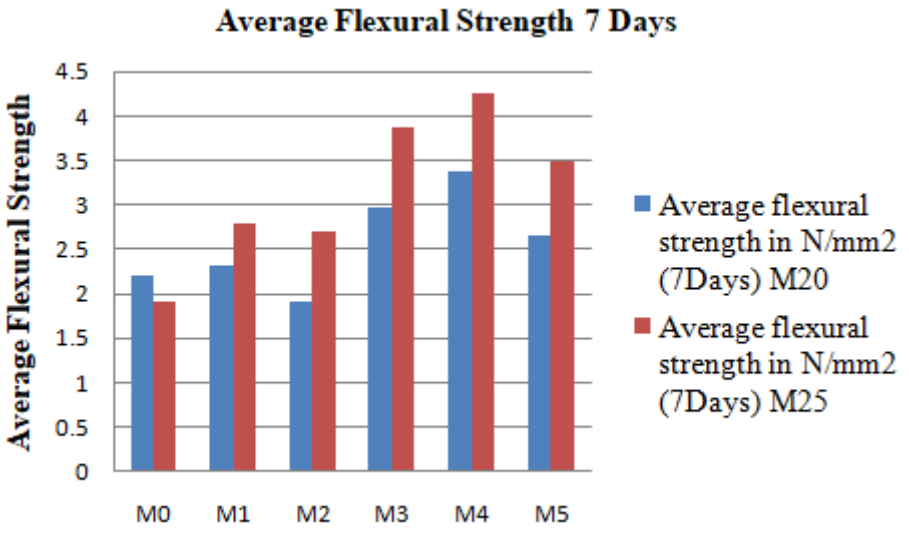

Fig.5.12: Bar Chart of 7 days Flexural Strength of M20 and M25 grade concrete

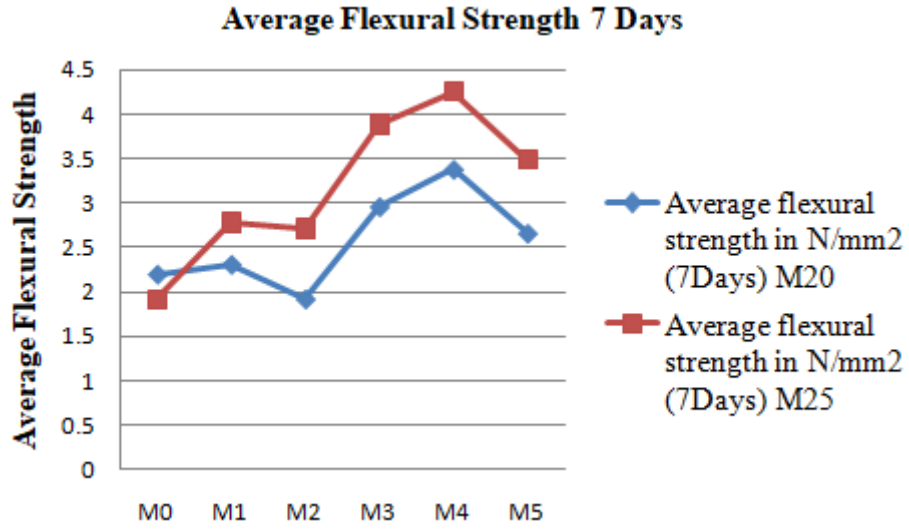

Fig.5.13: Line Diagram of 7 days Flexural Strength of M20 and M25 grade concrete

Table 8: Shows Flexural Strength of M20 and M25 grade concrete at 28 days in N/mm^2

MIX	Average flexural strength in N/mm2 (28Days)	
	M20	M25
M0	2.72	3.18
M1	3.12	3.16
M2	3.39	3.87
M3	3.88	4.52
M4	4.25	5.16
M5	3.49	4.47

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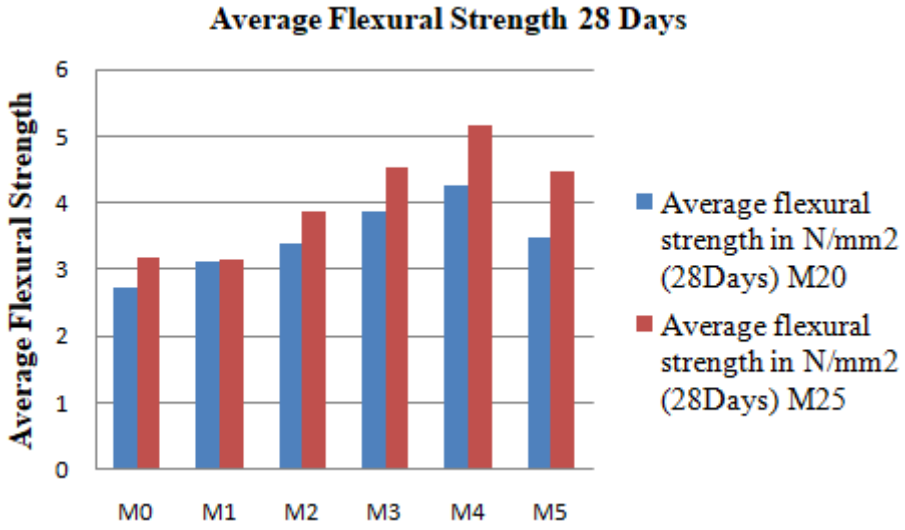

Fig.5.14: Bar Chart of 28 days Flexural Strength of M20 and M25 grade concrete

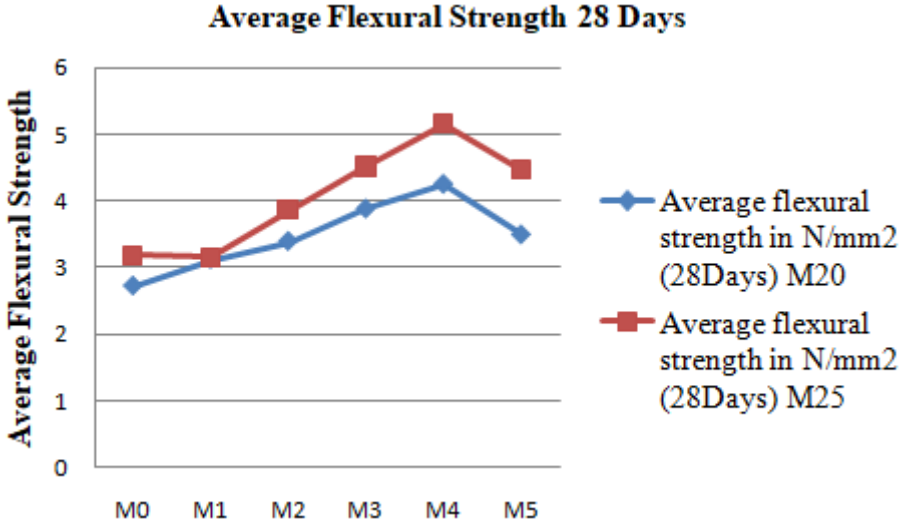

Fig.5.15: Line Diagram of 28 days Flexural Strength of M20 and M25 grade concrete

V. CONCLUSION

RHA used as replacement of cement at various percentage and M-Sand used as fully replacement of Natural Sand in some mixes. We also used nominal concrete mixes to compare the strength of the concrete mixes. In trail M4, replacement of cement up to 12.5% of RHA and 100% replacement of M-Sand shows better strength results as compare to other design mixes in both concrete mixes of M20 and M25 grade. Overall results of M25 grade concrete is high than M20 grade concrete, which shows that M25 grade concrete is better option in concrete industry as compare to M20 and adding up to 12.5% of RHA can also leads to increase in strength of concrete. Also on adding 17.5% of RHA it overall show decrease in strength of both grade concrete.

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