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AN EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF FINE AGGREGATE BY MANUFACTURED SAND IN CONCRETE

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Abstract: One of the main substitute materials that can be utilized in place of natural sand in concrete is the manufactured sand that is available in surplus in various quarries. The crushing and screening procedure in the quarries produces the produced sand as a by-product. A significant amount of fines are produced during the production of aggregates from crushed rocks. The clay/silt fraction known as the "filler" grade is included in the graded mixture of coarse, medium, and fine sand particles that make up quarry fines. The industry defines filler grade material as that which is smaller than 0.075mm (75 microns) in size. These fine materials are washed in water to remove the filler grade content, leaving behind a clean, marketable "sand" product. The objective of the current study is to determine how the physical and chemical characteristics of produced sand affect the performance of concrete of the M20, M30, and M40 grades. On concrete properties, an attempt has been made to concentrate on replacing natural sand with manufactured sand to varying degrees (0–100%). Experimental analysis and comparison with natural sand's physical characteristics of manufactured sand's specific gravity, fineness modulus, water absorption, surface moisture, size, and shape. The specific gravity, fineness modulus, water absorption, and surface moisture values of various quantities of manufactured sand have been incorporated into the mix design. The fresh and hardened properties of concrete, including workability, compressive strength, splitting tensile strength, flexural strength were examined for different replacement levels of manufactured sand at various curing times, and the ideal replacement level was found. When the replacement level of manufactured sand content also rose, it was seen that the mechanical qualities of concrete with manufactured sand improved. These characteristics of the concrete with manufactured sand, however, are higher when there is a proportion of 70% manufactured sand and 30% natural sand.

***IndexTerms* – Manufactured Sand, specific gravity, fineness modulus, water absorption, workability, compressive strength, Splitting tensile strength, flexural strength**

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1. INTRODUCTION

1.1 GENERAL

For concrete, both coarse and fine aggregate of the highest calibre are crucial. The fresh and hardened properties of concrete are impacted by the aggregates, which make about 65 to 80% of the total volume of concrete. The volume of fine aggregate makes up 20 to 30 percent of the overall volume of concrete.

1.2 MANUFACTURED SAND

The Manufactured Sand (MS), i.e. quarry sand which is available in abundance in various quarries is one of the key alternative material that may be utilized instead of natural sand in concrete. The varied characteristics of manufactured sand concrete and those of natural sand concrete are contrasted in this paper.

The crushing and screening procedure in the quarries produces manufactured sand (MS), which is a by-product. During the process of converting rock into aggregates, quarries produce large amounts of quarry fines. It is also known as crushed fine aggregate, crushed rock sand, stone sand, and crusher sand. Quarry fines are made up of a graded mixture of coarse, medium, and fine sized sand particles as well as the "filler" grade of clay/silt. The industry defines filler grade material as having a size of less than 0.075mm (75 microns).

The filler content is very crucial because it significantly affects the technical qualities. The passing 75 micron limit in natural sand standards for concrete is a response to the presence of harmful clay minerals in this fraction size. Clay minerals enhance the water demand in the mix design and are prone to produce cracking, dusting, and shrinkage in hardened concrete. Designing concrete with natural sand requires limiting the passage 75 micron to a level that eliminates the chance for clay minerals to be present in concentrations that would lead to the potential problems mentioned.

With the advent of artificial sand, it has gradually been apparent that a large portion of the materials from the past 75 micron are pulverised into primary minerals rather than clay minerals. These components have advantages in the concrete mix and serve as rock flour or filler. Careful monitoring of this material's impact on water usage is still necessary, and mix design must take this into account. These fine materials are washed with water to remove the filler grade content and create a clean, marketable "sand" product.

1.3Objectives of Using Manufactured Sand

- To minimize the waste To generate revenue
- To minimize volumes accumulating and taking up space in a quarry
- To reduce the costs of storage and disposal
- To satisfy the customer demand for products for which fines are a by-product
- To achieve sustainability
- To ensure landscape restoration
- To reduce the extraction of natural sand.

1.4 Scope of the Work

The scope of the present work includes the study of the following topics:

- Mix design for M 20, M 30 and M 40 grade concrete with various replacement levels of manufactured sand.
- Study on properties of fresh and hardened concrete with the replacement of fine aggregate by various proportions of manufactured sand.

II. LITERATURE REVIEW

M.Adams Joe et al (2013) 'Experimental Investigation on the Effect of M-Sand in High Performance Concrete' had proposed the natural river sand was the least expensive resource of sand. The silt and clay show in the sand decrease the strength of the concrete and holds dampness. A couple of choices have come up for the business to count on of which manufactured sand or M-sand, as it was called, was observed to be the more appropriate individual to supplant river sand. Utilization of MS can radically lessen the cost since, as river sand, it does not include contaminations and wastages was nil as it is create with present day innovation and machinery. The reason for this examination was tentatively explore the impact of MS in structural concrete by supplanting river sand and build up a high performance concrete. The examination done by utilizes few tests, which incorporate workability test, compressive test, tensile test, and flexural test.

P Daisy Angelin et al (2015) 'Durability Studies on Concrete with Manufacturing Sand As A Partial Replacement of Fine Aggregate In HCL Solution' had anticipated that manufactured sand was individual among such materials to supplant river sand which can be utilized as an option fine aggregate in mortars and concrete. An endeavor had been completed in the current analysis to talk about the properties of concrete for example, workability and compressive strength of concrete, which was set up by supplanting natural sand with artificial sand at various substitution levels (0%, 20%, 40%, 60%, 80% and 100%). The outcomes had anticipated that supplanting of natural sand with manufactured sand in order of 60% deliver cement of acceptable workability and compressive strength. Durability of the concrete was additionally tried through immersing the cubes in 5% hydrochloric acid solution.

Yajurved Reddy et al. (2015); In this experiment, it is examined how well concrete works, how strong it is, and how long it lasts when M-sand is used in place of natural sand in amounts of 0%, 20%, 40%, 60%, and 100%. A total of 450 specimens were used in the studies, which were done on concrete grades M 20 and M 30. The Slump cone, compaction factor, and vee-bee time tests are used to assess workability. The findings demonstrated that the workability decreases as natural sand replacement with M-sand increases. To measure the strength of concrete, tests for compressive strength, split tensile strength, and flexural strength were performed. The strength increased by around 20% with the 60% replacement, while other replacements reached an order of at least 0.93% in both M 20 and M 30 grades.

Xinxin Ding et al (2016) 'Experimental study on long-term compressive strength of concrete with manufactured sand' had proposed test contemplates on compressive strength improvement of cement through manufactured sand be completed. Impacts of stone powder substance on long-standing compressive strength of concrete among various water-to-cement ratios be investigated. Experiments comes about demonstrated that while substance of stone powder was under 13%, it fundamentally had affirmative connection with the long-standing compressive strength of MSC. In light of experiments information, predict form of long-standing compressive strength of MSC regarding curing age, density and cement's compressive strength and water-to-cement ratio are planned.

Hayla Miceli et al (2017) 'Contaminant removal from manufactured fine aggregates by dry rare-earth magnetic separation' had suggested that manufactured fine aggregates had turned into a reasonable contrasting option to natural sands in building and structure everywhere throughout the earth, specifically somewhere a supportable resource of the afterward was not accessible. Though composition normally makes no significant problems in their use as coarse aggregates, the utilization of these stones in construction of MS be able to symbolize a test, for the most part related to the nearness of calculable measures of contaminating minerals, specifically micas, which can negatively affect together rheology and strength of concrete and mortars. The effort exhibits the change in the attributes of three manufactured fine aggregates throughout dry rare-earth attractive division. It exhibits that the mica/biotite substance has been diminished altogether, foremost additionally to a huge change fit as a fiddle in the item.

Prasanna et al. (2017) conducted trials using M-sand in place of natural sand in proportions of 0%, 25%, 50%, 75%, and 100% in M-60 grade concrete. M-sand-cast cubes and cylinders are used to determine the concrete's compressive strength, split tensile strength, and ultrasonic pulse velocity. M-sand should be used in place of natural sand in special concrete, such as high performance concrete, where a replacement of 75% is advised. They came to the conclusion that produced sand may be utilised without a doubt in high performance concrete, which will also benefit the environment and the long-term viability of the building sector.

The goal of Sachin Kumar et al.'s study from 2018 was to determine whether M-Sand could be used as fine aggregates in the production of concrete. M-20 grade concrete was taken into consideration for the investigation. In concrete, river sand with various fractions took the place of MS. A thorough experimental examination was conducted to look into the strength characteristics of CMS and the physical characteristics of MS. The applications of MS in grade 20 concrete elements showed promise in the outcomes.

III MATERIALS

For this experiment, Portland pozzolana cement that complied with IS 1489 - 1991 was used. Coarse aggregate of 20mm downsized crushed aggregate that complies with IS: 383 - 1970 graded aggregate standards was locally accessible. The findings of the coarse aggregate test, which was conducted in accordance with the instructions in IS: 2386 - 1963.

As a fine aggregate, river sand that was accessible locally was employed. The manufactured sand was used in place of the river sand. The manufactured sand in this case ranged from 0% to 100% in ten-percent increments, and was given the letters A, B, C, D, E, F, G, H, I, J, and K, respectively. Figure 3.1 depicts the fine aggregate's particle size distribution curve.

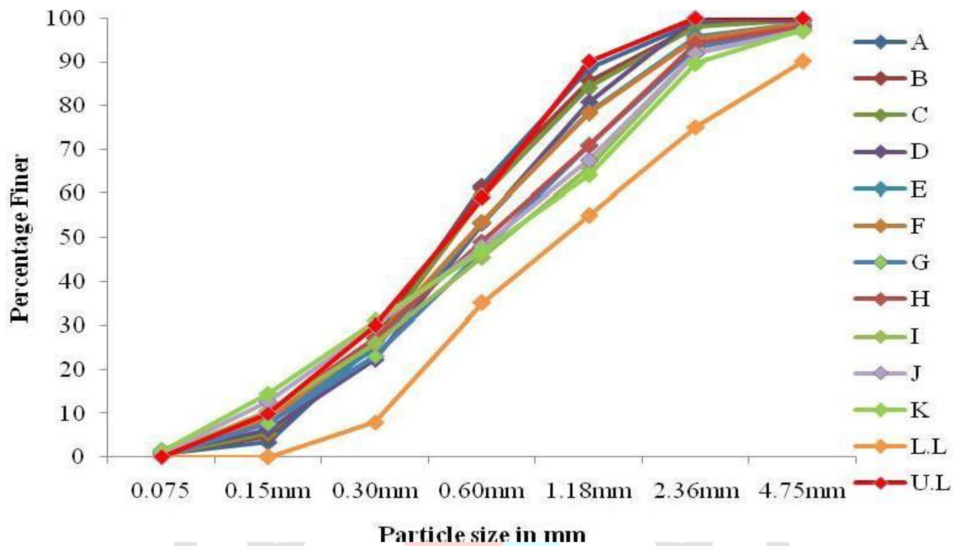


Figure 3. 1 Particle size distribution analysis of MS

The curves for grading natural sand and the different ratios of produced sand are shown in Figure 3.1. The lower limit (L.L) and upper limit (U.L) of the sand particle size distribution curves are depicted in the picture, respectively. The figure shows that for the proportions of 80%, 90%, and 100% produced sand, the amount of particles smaller than 300 microns is increased.

A vital component in the making of concrete is water. In this study, drinkable tap water was used.

IV MIX DESIGN

In this thesis, the mix proportions for concrete of grades M 20, M 30, and M 40 were determined for the various amounts of replacement of natural sand with manufactured sand in increments of ten. This required taking into account the values of each replacement level of manufactured sand's specific gravity and fineness modulus. The mixtures were labelled A, B, C, D, E, F, G, H, I, J, and K for 0% to 100%, respectively, during the process. Concrete blends were created in accordance with IS 10262 - 2019. Tables 3.1 to 3.3 and Figures 3.2 to 3.4 provide the mix proportions for concrete grades M 20, M 30, andM40.

Table 3.1 Ingredients of M 20 grade concrete

Designation	Cement (kg)	F.A (kg)	C.A (kg)	Water (Lit)	A/C ratio	F.A:C.A	F.A:C.A (based on surface index value)
A	372	550.56	1242.48	197.16	4.82	30 : 70	1 : 2.26
B	372	550.56	1253.64	197.16	4.85	30 : 70	1 : 2.28
C	372	550.56	1223.88	197.16	4.77	31 : 69	1 : 2.23
D	372	587.76	1197.84	193.44	4.80	33 : 67	1 : 2.04
E	372	587.76	1197.84	189.72	4.80	33 : 67	1 : 2.04
F	372	591.48	1197.84	189.72	4.81	33 : 67	1 : 2.03
G	372	617.52	1197.84	186.00	4.88	34 : 66	1 : 1.94
H	372	617.52	1197.84	186.00	4.88	34 : 66	1 : 1.94
I	372	613.80	1197.84	182.28	4.87	34 : 66	1 : 1.95
J	372	602.64	1197.84	182.28	4.84	33 : 67	1 : 1.99
K	372	595.20	1223.88	182.28	4.88	33 : 67	1 : 2.00

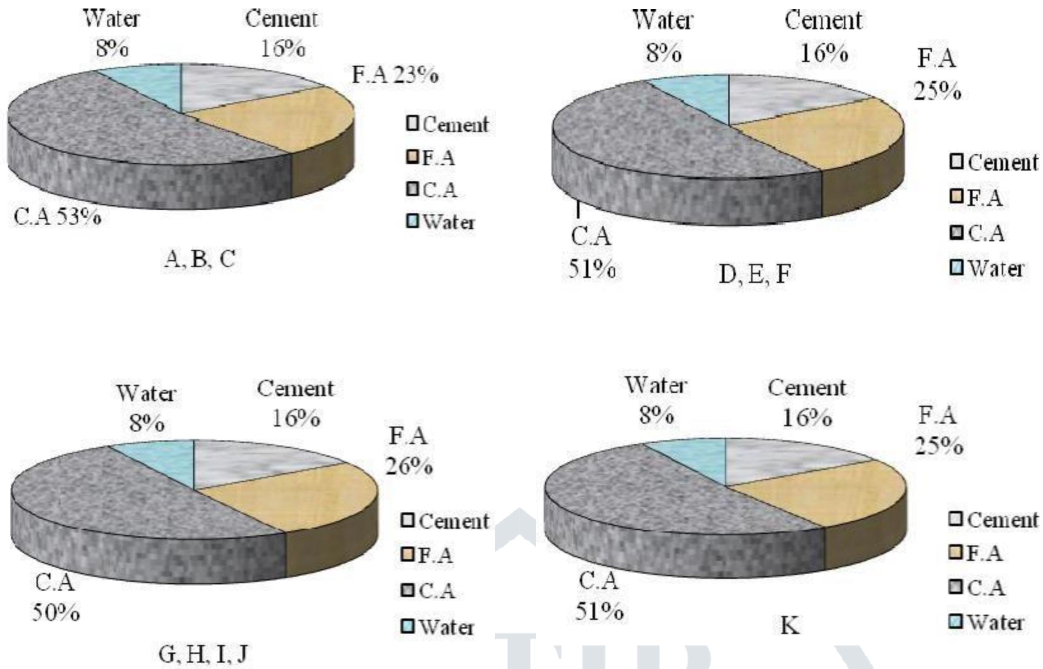


Figure 3.2 Percentages of ingredients for M 20 grade concrete

Table 3.2 Ingredients of M 30 grade concrete

Designation	Cement (kg)	F.A (kg)	C.A (kg)	Water (Lit)	A/C ratio	F.A:C.A	F.A:C.A (based on surface index value)
A	404.35	529.38	1247.81	197.39	4.40	30 : 70	1 : 2.36
B	404.35	526.66	1247.80	196.03	4.39	30 : 70	1 : 2.37
C	404.35	539.17	1220.88	193.13	4.35	31 : 69	1 : 2.26
D	404.35	565.67	1193.76	191.72	4.35	32 : 68	1 : 2.11
E	404.35	566.57	1193.77	191.23	4.35	32 : 68	1 : 2.11
F	404.35	570.31	1193.78	189.74	4.36	32 : 68	1 : 2.09
G	404.35	595.13	1193.78	187.34	4.42	33 : 67	1 : 2.01
H	404.35	593.22	1193.76	186.51	4.42	33 : 67	1 : 2.01
I	404.35	594.11	1193.78	183.87	4.42	33 : 67	1 : 2.01
J	404.35	592.74	1193.78	181.80	4.38	33 : 67	1 : 2.06
K	404.35	578.90	1193.78	178.52	4.42	33 : 67	1 : 2.01

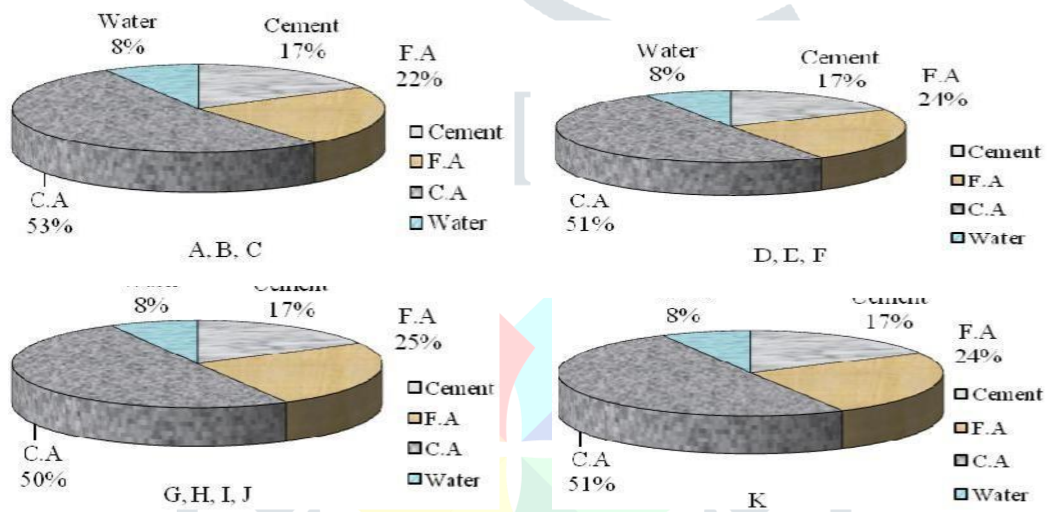


Figure 3.3 Percentages of ingredients for M 30 grade concrete

Table 3.3 Ingredients of M 40 grade concrete

D	Cement (kg)	F.A (kg)	C.A (kg)	Water (Lit)	A/C ratio	F.A:C.A	F.A:C.A (based on surface index value)
A	436.5	399.69	1328.91	192.18	3.55	23 : 77	1 : 3.32
B	436.5	397.63	1328.90	191.15	3.55	23 : 77	1 : 3.34
C	436.5	397.63	1328.90	191.15	3.53	24 : 76	1 : 3.16
D	436.5	437.92	1276.53	187.99	3.52	26 : 74	1 : 2.91
E	436.5	438.61	1276.53	187.22	3.53	26 : 74	1 : 2.91
F	436.5	441.49	1276.51	186.15	3.53	26 : 74	1 : 2.89
G	436.5	460.72	1276.29	184.31	3.57	26 : 74	1 : 2.78
H	436.5	459.63	1276.29	183.64	3.57	26 : 74	1 : 2.78
I	436.5	459.92	1276.29	181.61	3.57	26 : 74	1 : 2.78
J	436.5	458.86	1276.29	181.22	3.54	26 : 74	1 : 2.78
K	436.5	448.16	1276.28	177.46	3.57	26 : 74	1 : 2.78

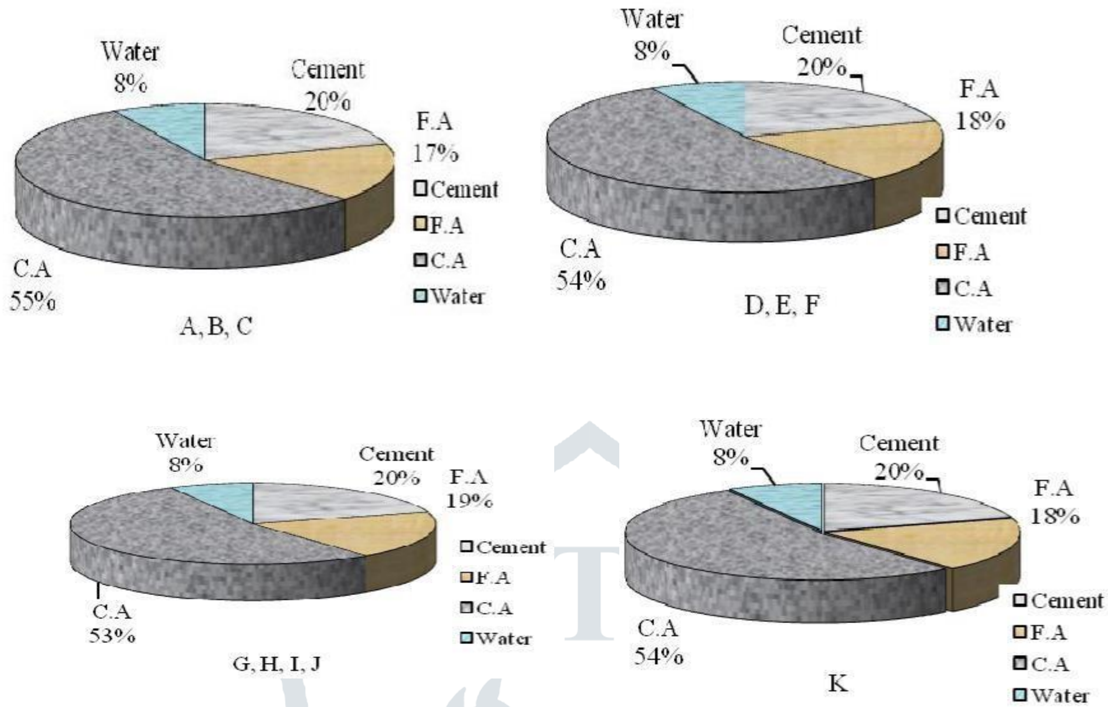


Figure 3.4 Percentages of ingredients of M 40 grade concrete

V FRESH AND HARDENED PROPERTIES OF CONCRETE WITH MANUFACTURED SAND

The material properties, mix design of M20, M30 and M40 grades of concrete were discussed in the previous chapter. In this chapter, the fresh concrete property such as workability and the hardened properties such as compressive strength, splitting tensile strength, and flexural strength of concrete are studied.

5.1 DISCUSSION OF TEST RESULTS

5.1.1 Workability

Figure 5.1 displays the slump values for the M20, M30, and M40 concrete grades with varying percentages of manufactured sand substitution, ranging from 0% to 100%.

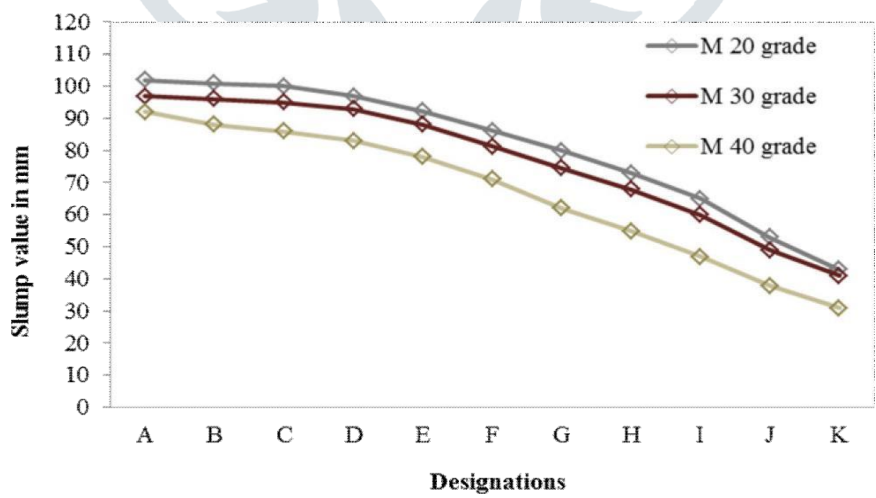
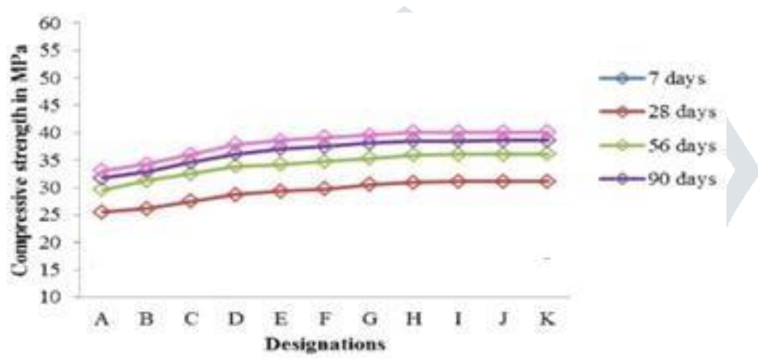


Figure 5.1 Slump values of M 20, M 30 and M 40 grade concrete with MS

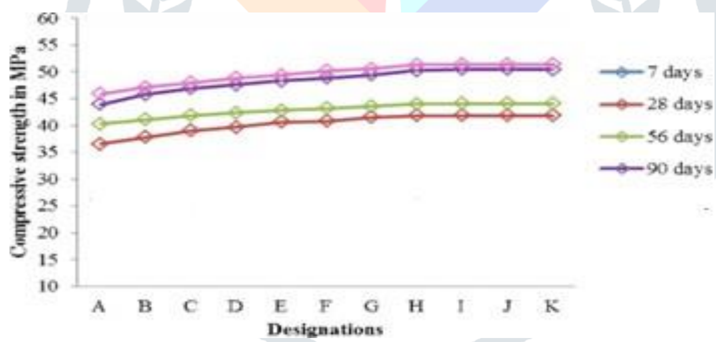
Figure 5.1 shows that for all three grades of concrete, the slump values are decreased while the replacement levels of produced sand are raised. The amount of water needed for the mix is significantly influenced by the form and surface roughness of the manufactured sand. Natural sand has a high degree of workability due to its round form and smooth surface texture, which lowers inter particle friction in the fine aggregate component. The angular shape of manufactured sand and its rough surface texture increase internal mixing friction, which decreases concrete's workability. Due to the high concentration of particles in produced sand, the results show extremely low slump values in 80%, 90%, and 100% of it.

5.1.2 Compressive Strength

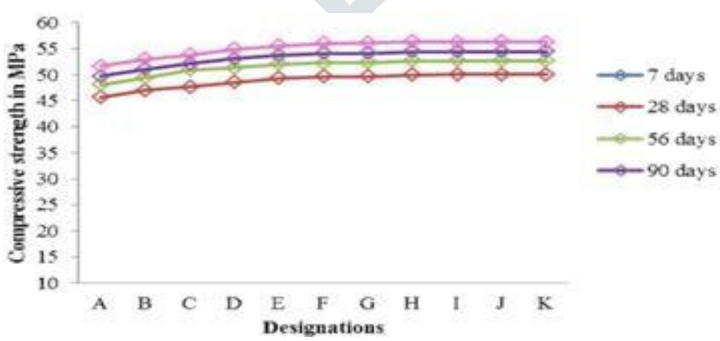
The compressive strength of concrete in the M 20, M 30, and M 40 grades is depicted in Figures 5.2(a), (b), and (c). Figures 5.3 (a), (b), and (c) show the rate of increase in strength for the M 20, M 30, and M 40 grades of concrete. The compressive strength of concrete with MS grades M 20, M 30, and M 40 is compared in Figure 5.4.



(a) **M 20 grade concrete**

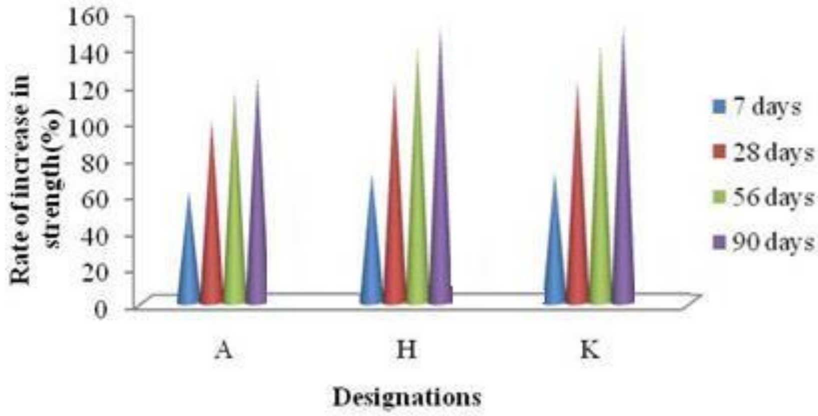


(b) **M 30 grade concrete**

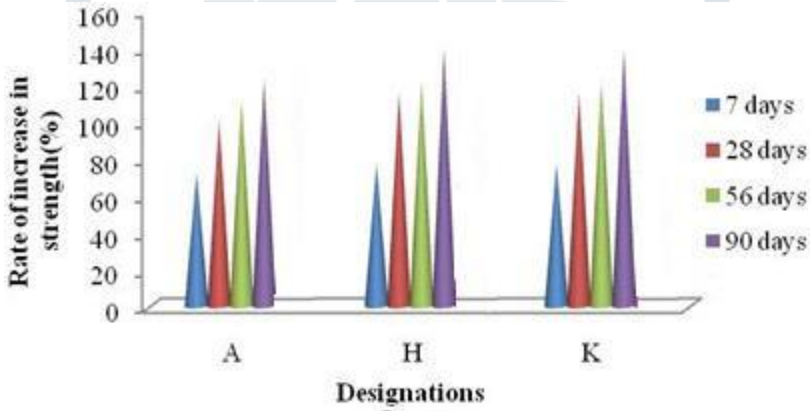


(c) **M 40 grade concrete**

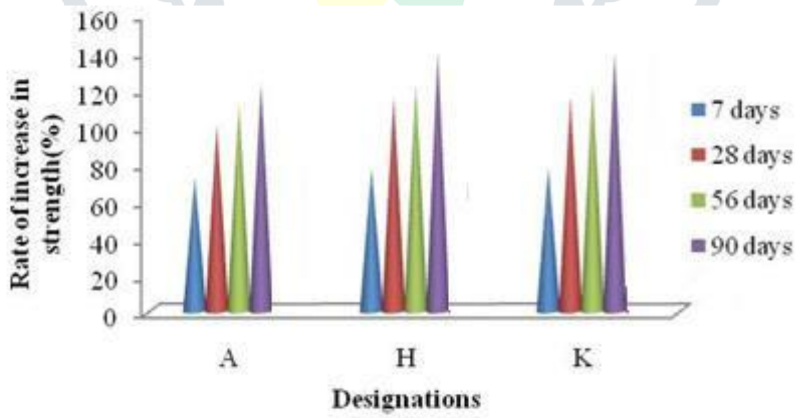
Figure 5.2 Compressive strength of M 20, M 30 and M 40 grade concrete with MS



(a) **M 20 grade concrete**



(b) **M 30 grade concrete**



(c) **M 40 grade concrete**

Figure 5.3 Compressive strength achievements of M 20, M 30 and M 40 grade concrete with MS

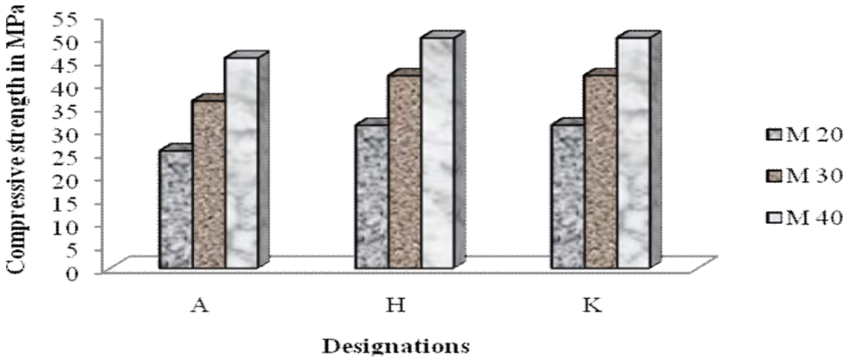
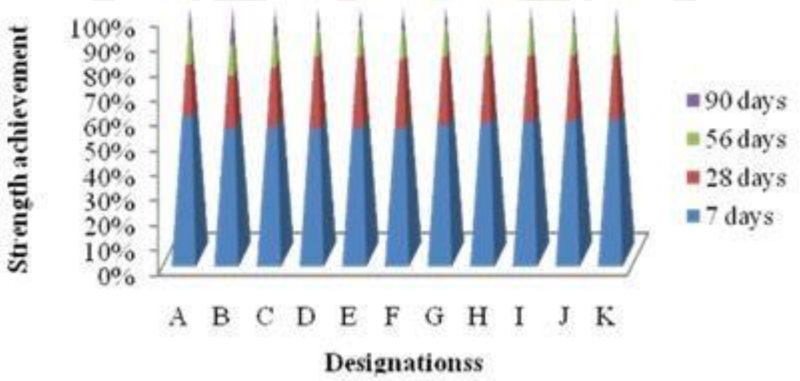


Figure 5.4Comparison between the compressive strength of M 20, M 30 and M 40 grade concrete with MS

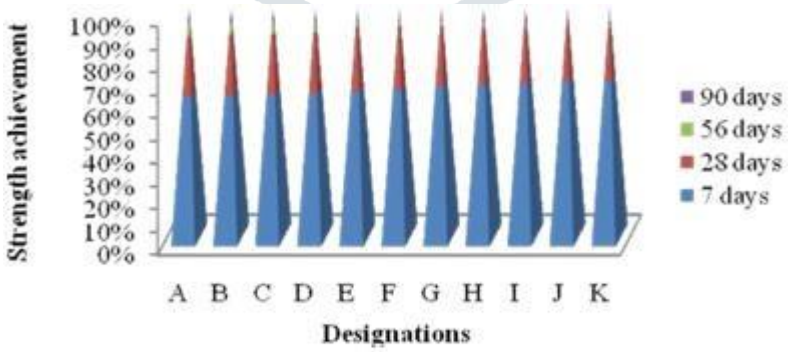
Figures 5.2(a), (b), and (c) show that for all three grades of concrete, the compressive strengths rise as the percentage of produced sand increases. This is because the produced sand's angular granules and rough surface allow the aggregate and wet cement paste to better bond. Due to the higher cement content and lower w/c ratio of the M 30 and M 40 grades of concrete compared to the M 20 grade, the rate of rise of strength at 7 days is higher for these grades. The proportions H and K show no discernible change, according to Figure 5.4. It claims that despite the strength increasing for 100% manufactured sand, there is no appreciable improvement in the strength attainment beyond 70% manufactured sand because of the high concentration of small particles in manufactured sand at 80, 90, and 100%.

5.1.3 Splitting Tensile Strength

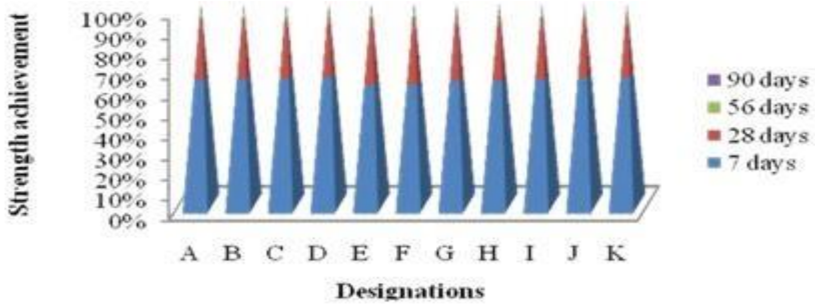
The tensile strength achievements of M 20, M 30 and M 40 grades of concrete are depicted in Figures 4.5(a) , (b) and (c).



(a) **M 20 grade concrete**



(b) **M 30 grade concrete**



(c) M 40 grade concrete

Figure 5.5 Tensile strength achievements of M 20, M 30 and M 40 grade concrete with MS

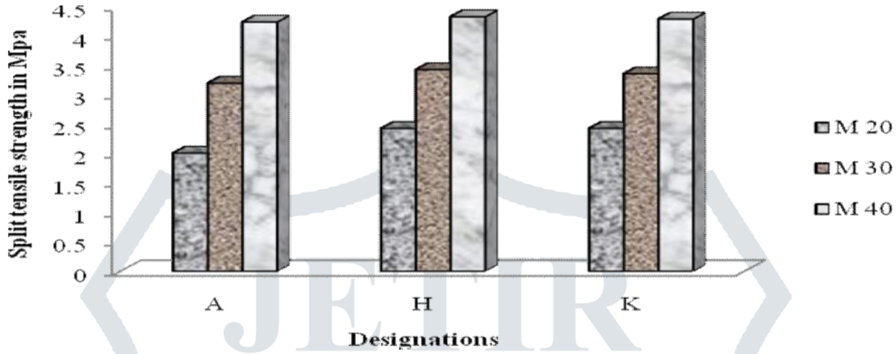


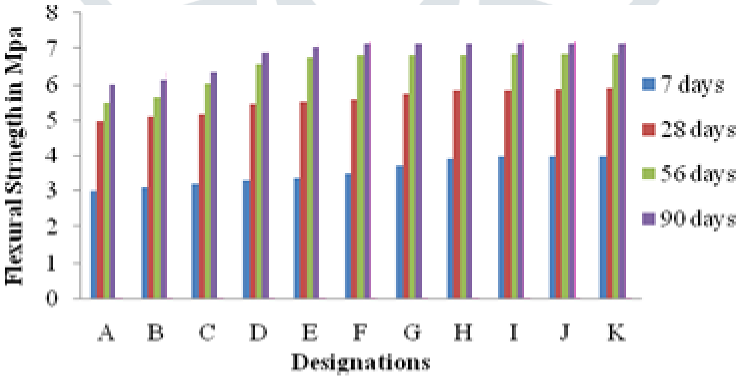
Figure 5.6 Comparison between the splitting tensile strength of M 20, M 30 and M 40 grade concrete with MS

The tensile strength results for M 20, M 30, and M 40 classes of concrete with varying quantities of manufactured sand from 0 to 100% at varied curing times are shown in Figures 5.5(a), (b), and (c). From the figures, it can be shown that increasing the amount of produced sand up to 70% increases the concrete's ability to attain splitting tensile strength. Due to the high cement concentration and lower water content, the strength accomplishment is higher early on and is also found to be higher for M 40 grade concrete when compared to M 20 and M 30 grades of concrete.

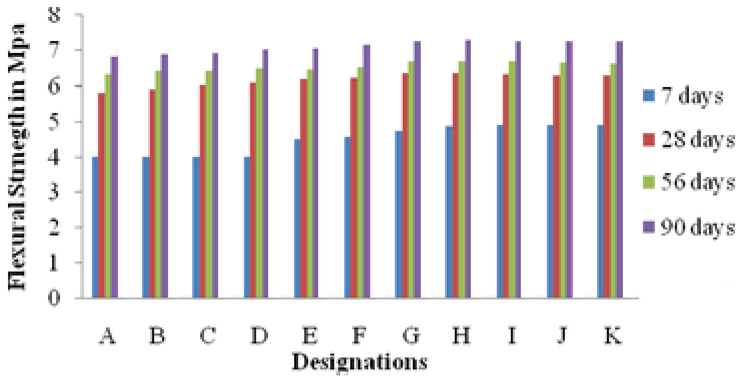
The comparison of the splitting tensile strengths of concrete classes M 20, M 30, and M 40 with the proportions of A, H, and K is shown in Figure 4.6. It can be seen from the Figure that the proportions H and K have not changed significantly. It shows that there is no increase in strength above 70% manufactured sand due to the existence of a significant number of particles in the remaining manufactured sand percentages.

5.3.4 Flexural Strength

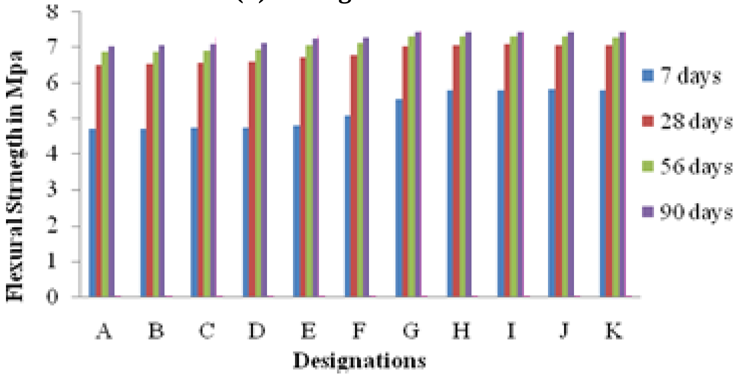
The flexural strength of M 20, M 30 and M 40 grades of concrete are shown in Figures 5.7(a), (b) and (c).



(a) M 20 grade concrete



(b) M 30 grade concrete



(c) M 40 grade concrete

Figure 5.7 Flexural strength of M 20, M 30 and M 40 grade concrete with MS

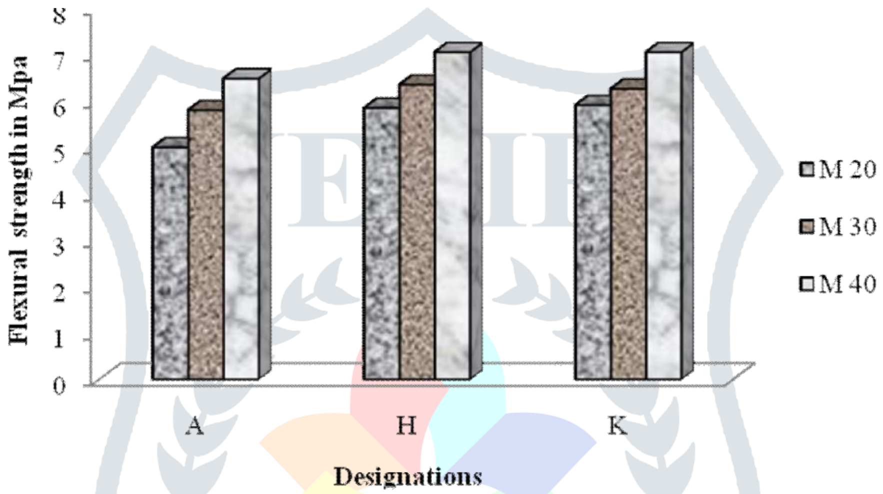


Figure 5.8 Comparison between the flexural strength of M 20, M 30 and M 40 grade concrete with MS

The flexural strengths of M 20, M 30, and M 40 grades of concrete with varying quantities of manufactured sand from 0 to 100% over the various curing times are shown in Figures 5.7(a), (b), and (c). It can be seen from the figures that adding up to 70% more artificial sand increases the flexural strengths. When compared to the typical concrete's 28-day strength in M-20 grade concrete, the flexural strength accomplishments are 80%, 137%, and 144% at 7 days, 56 days, and 90 days, respectively. The strength achievements for concrete classes M 30 and M 40 grow initially and then decline with time.

The flexural strengths of the A, H, and K proportions of three concrete grade levels are shown in Figure 5.8. It is obvious from the Figure that there is no increase in flexural strength above 70% of synthetic sand. This is due to the manufactured sand having a significant number of fine particles in it above 70%.

VI CONCLUSIONS

Following a study of the qualities of fresh and hardened concrete with manufactured sand changing from 0% to 100% as ten increments, the following results are made.

- For 100% replacement of manufactured sand, the slump value is reduced by around 60%, however when manufactured sand is blended with natural sand, the slump value is reduced by about 23 to 38% as compared to the natural sand.
- Strength gains are raised to a level that replaces 70% manufactured sand. Due to the high amount of fine particles in it, there is no improvement in the strength attainment beyond that percentage.
- Due to the high cement concentration and low water content, the strength achievements are higher early on for better grade concrete.
- When compared to natural sand, the compressive strength, splitting tensile strength, and flexural strength of the concrete containing 70% manufactured sand are enhanced by roughly 20%, 15%, and 20%, respectively.
- The relationship between compressive strength and splitting tensile strength, flexural strength, and elastic modulus are stronger than those specified by IS standards.

So it was determined that even if 100% produced sand has higher strength capabilities, mixing 70% manufactured sand with 30% natural sand produces superior outcomes.

REFERENCES

[1] Cortes, D.D, Kim, H.K., Palomino, A.M. and Santamarina, J.C “Rheological and Mechanical properties of mortars prepared with natural and manufactured sand”, Cement and Concrete Research, Vol. 38, pp. 1142-1147, 2008.

[2] Crouch, L.K. and Jason Philips “Lean, Green and Mean Concrete”, 2009 World of Coal Ash Conference (WOCA), pp. 1-17, 2009.

[3] David Manning “Exploitation and Use of Quarry Fines”, Miro - final report, Report No. 087/MIST2/DACM/01, MIST project reference:MA/2/4/003, 19th March, pp. 1-60, 2004.

[4] Experimental study on tensile strength development of concrete with manufactured sand, Shunbo Zhao, Xinxin Ding, Mingshuang Zhao, Changyong Li and Songwei Pei, Construction and Building Materials, Volume 138, May 2017, pages 47-253

[5] Ghataora, G.S., Freer-Hewish, R.J. and Kennedy, J. “Utilisation of quarry fines”, Department of Civil Engineering, The University of Birmingham, 2004.

[6] Hayla Miceli, Mateus G. Rossi, Reiner Neumann and Luís Marcelo Tavares, “Contaminant removal from manufactured fine aggregates by dry rare-earth magnetic separation”, Minerals Engineering, Volume 113, November 2017, pages 15-22.

[7] Hailong Wang and Qingbin Li “Prediction of elastic modulus andPoisson’s ratio for unsaturated concrete”, International Journal of Solids and Structures, Vol. 44, pp. 1370-1379, 2007.

[8] Keiichi Imamoto and Masanao Arai “Specific surface area of aggregate and its relation to concrete drying shrinkage”, Materials and Structures,Vol. 41, pp. 323-333, 2008.

[9] Ilangovan, R. “Studies on Strength and behaviour of concrete by using quarry dust as fine aggregate”, Proceedings of All India Seminar on Materials and Machines for Construction, New Age International, pp. 99-102, 2000.

[10] M.Adams Joe, A.Maria Rajesh, P.Brightson and M.Prem Anand, “Experimental Investigation on the Effect of M-Sand in High Performance Concrete” , American Journal of Engineering Research, Volume 2, Issue 12, 2013, pages 46-51.

[11] Prasanna S, Anandh K S and Kiruthiga K (2017); “Study on High Performance Concrete with Replacement of Fine Aggregate by Manufactured Sand”, International Journal of Civil Engineering and Technology, 2017, Vol. 08, Issue No. 08, pp. 1502–1514.

[12] P Daisy Angelin and P Ravi Kishore “Durability Studies on Concrete with Manufacturing Sand As A Partial Replacement of Fine Aggregate In HCL Solution”, , International Journal of Engineering Research and Development, Volume 11, Issue 12, December 2015, pages 44- 50.

[13] Sachin Kumar, Roshan S K, M-sand an alternative to river sand in construction technology, International Journal of Scientific and Engineering Research, April 2018 Vol.4.

[14] Vasumathi, A.M. “A study on the strength of the concrete by partial replacement of cement with fly ash and sand with quarry dust”, Proceedings of National Seminar on Futuristics in Concrete and Construction Engineering,(NSFCCE), S.R.M Engineering College, Chennai, pp. 8-14, 2003.

[15] Yajurved Reddy M, Swetha D.V and Dhani S.K (2015); “Study on properties of concrete with manufactured sand as replacement to natural sand”. International Journal of Civil Engineering and Technology (IJCIET), August 2015, Vol.06, Issue No. 08, pp. 29-42.