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EXPERIMENTAL STUDY ON THE SETTING TIME OF THE CONCRETE WITH PARTIAL AND FULL REPLACEMENT OF RIVER SAND BY MANUFACTURED SAND

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ABSTRACT

The aim of this study is to study the effect of manufactured sand and river sand on the setting time of concrete. The investigation proceeds by changing the proportion of fine aggregate from 100% river sand to 100% manufactured sand. In this process six different concrete mixes are adopted by varying the proportions of the fine aggregates used, i.e: 100% river sand, 50% river sand and 50% manufactured sand, 40% river sand and 60% manufactured sand, 30% river sand and 70% manufactured sand, 20% river sand and 80% manufactured sand, 100% manufactured sand. The effect on the setting time of concrete is studied through penetration resistance method as per IS Code:8142-1976.

Keywords: River sand, Manufactured sand, Setting time of concrete, Penetrometer, chemical admixtures

I. INTRODUCTION

Sand is used as a fine aggregate in mortars and concrete. Natural river sand is most preferred choice as a fine aggregate material. River sand is a product of natural weathering rocks over a period of millions of years. It is mined from riverbeds. River sand is becoming scarce commodity now. River sand is far superior for construction purpose than any other sand used in construction. But due to the shortage of the river sand, especially during monsoon season and also transportation is too expensive. In addition it is causing severe harm to the environment. Therefore, the objective of this project is to develop a technology platform for the shift from natural to manufactured aggregates based on hard rock.

The term-manufactured sand is used for aggregate materials having dimensions less than 5.0mm that are processed from crushed rock or gravel and intended for construction use. The term sand refers to relatively small particles and there are some variations of sand about particle size. In modern technology, natural aggregates have proved to be significantly economical in use, for which reason extensive use of manufactured aggregates has been concentrated to regions or projects where the availability of natural aggregates has been limited. Crushed /manufactured sand has rough surface texture, and the particle size distribution curve can be adjusted in the manufacturing of the material. Another advantage in manufactured sand is quarries can be kept in the near vicinity to its place of end use, therefore shortening transport distances, and increased employment opportunities for the locals. In the future it is expected that manufacturing of sand from rock will increase.

II. LITERATURE REVIEW

Amnon Katz et al [1] investigated on the effect of the addition of fines to normal-strength concrete at levels of up to 227 kg/m^3 (383 lb/yd3) was studied in concrete mixtures prepared with constant workability.

Anzar Hamid Mir et al [2] 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 find new alternative materials to replace river sand so that excess river erosion is prevented, and high strength concrete is obtained at lower cost. C. Sudha et al [3] investigated on the effect of Manufactured sand in concrete by replacing the river sand (0%, 25%, 50%, 75% and 100%) and develop a high-performance high strength concrete with target strength of 40MPa.

M. Kannan et al [4], conducted a to study the influence of the manufactured sand have in compressive strength, split tensile strength of concrete and to assess the prospects of using manufactured sand as fully replacement of natural sand. G. Prasanna Kumar et al [5] emphasized on the use of material to be replaced by natural sand which will give new dimension in concrete mix design and if applied on large scale would revolutionize the construction industry by economizing the construction cost and enable us to conserve natural resources.

Kalyana Chakravarthy P.R et al [6] studied the optimization of replacement of manufactured sand by natural sand with super plasticizer admixture. Concrete mixes for M20, M25 and M30 were evaluated for compressive strength. Kiran. M. Mane et al [7] in their work studied the effect of percentage replacement of manufactured sand by natural sand as 0%, 20%, 40%, 60%, 80% and 100% respectively on workability of concrete and the strength characteristics such as compressive strength, shear strength of concrete. K. Suseela et al [8] conducted an experiment towards effective utilization of Manufactured sand for commercial purpose and incorporated effectiveness of Manufactured sand by investigation compressive stress, split tensile stress and durability of concrete with various mix.

Martins Pilegis et al [9] studied the influence on concrete workability and strength, when manufactured sand is completely replaced with natural sand in concrete and modelled using artificial neural networks (ANN). Venkata Sairam Kumar N et al [10] used quarry dust for partial replacement of cement in concrete for studying the strength property of concrete. The aim of the experiment is to find the maximum content of quarry dust partial replacement of cement in concrete.

III. NOVELTY OF THE WORK

- The setting time of concrete is different from the setting time of cement. When the river sand is replaced with manufactured sand the effect on the setting time of concrete is being studied.

IV. MATERIAL USED

The materials utilized in the experiment and mix design for M20 grade Concrete is mentioned here. In addition to the traditional materials, chemical admixtures are also used.

Grade 53 of ordinary Portland cement (OPC): In this experimentation work, the 53 grade of OPC is used. The qualities meet the requirements of BIS-12269-2015.

Fine Aggregate: In this work, river sand(RS) is chosen as a fine aggregate. Locally available fine aggregate used in this experimentation is conforming to Zone-II sand after grading examination. Fineness modulus (FM) is recorded as 2.82 in this work.

Manufactured sand (MS): Manufactured sand (M-Sand) is a substitute of river sand for concrete construction. It is produced from hard granite stone by crushing. Due to fast growing construction industry,

demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the world. Due to the depletion of good quality river sand for the use of construction, the use of manufactured sand has been increased. Another reason for use of M-Sand is its availability and transportation cost. Since manufactured sand can be crushed from hard granite rocks, it can be readily available at the construction place, reducing the cost of transportation from far-off river sand bed.

Coarse Aggregate: The fineness modulus (FM) of the coarse aggregate was noted as is recorded as 6.7. It is clearly defined that the aggregate size ranges from 20mm to 4.75mm in size are used in this experimentation.

Chemical Admixtures: The superplasticizer used in the mix is CONPLAST SP430, it is manufactured by Fosroc Limited Company.

Water: Throughout the experiment, potable water was used for both mixings and curing the concrete. Oil and alkaline materials are not present in the water.

Table 1: Mix Design Proportions for M20 grade concrete

w/c	Water (litre/m^3)	Cement (kg/m^3)	C.A (kg/m^3)	F.A (kg/m^3)	Chemical Admixture (kg/m^3)
0.46	148	320	1188.6	771.68	1.6

V. EXPERIMENTATION

The objective of present study is to estimate the setting time of concrete by six varying proportions of river sand and manufactured sand i.e., 100% river sand, 50% river sand and 50% manufactured sand,40% river sand and 60% manufactured sand, 30% river sand and 70% manufactured sand, 20% river sand and 80% manufactured sand and 100% manufactured sand. Table 1 gives the mix proportions of M20 grade concrete used and table 2 shows the obtained slump value for various mixes.

TABLE 2: Slump Values for various mix proportions

Mix type	Slump (mm)
100%RS	80
50%RS+50%MS	70
40%RS+60%MS	60
30%RS+70%MS	50
20%RS+80%MS	40
100%MS	30

VI. SETTING TIME OF CONCRETE

ASTM C125 defines the time of setting as the elapsed time from the addition of mixing water to a cementitious mixture until the mixture reaches a specified degree of rigidity as measured by a specific procedure. The development of rigidity in cementitious mixtures is a gradual and continuous process. For cementitious mixtures development of rigidity is measured as the elapsed time to attain a specified level of resistance to penetration by a probe. Initial setting time duration is required to delay the process of hydration or hardening.

Final setting time is the time when the paste completely loses its plasticity. It is the time taken for the cement paste or cement concrete to harden sufficiently and attain the shape of the mould in which it is cast. The time of setting of concrete is measured by IS 8142 (1976). A mortar portion is extracted by wet sieving the concrete sample. The elapsed time after initial contact of cement and water required for the mortar to reach a penetration resistance of 3.43 N/sq.mm (35 kg f/sq.cm) is defined as initial setting time and the elapsed time to reach a penetration resistance of 26.97 N/sq.mm (275 kg f/sq.cm) is defined as final setting time. Penetration resistance of concrete surface should not be confused with compressive strength of concrete. A penetration resistance of 26.97 N/sq.mm (275 kg f/sq.cm) (final setting time) approximately corresponds to a compressive strength of 0.674N/sq.mm.

Concrete should set gradually, since concrete users need some time to discharge a fresh load of concrete and work it into the forms before the mixture becomes too stiff. At the same time concrete should not set too slowly as a delay in finishing will increase costs and potential for plastic shrinkage cracking.

VII. SAMPLE PREPARATION

Select a representative sample of concrete of sufficient volume to provide enough mortar to fill the test container to at least a depth of 140mm.Sieve the concrete through 4.75mm IS sieve in order to remove all the mortar from the concrete. Mix the mortar thoroughly and place it in the container in layers. Compact each layer of mortar using tamping rod. The final height of mortar after tamping should be less than 112 mm from the height of the container. This space is required for the collection and removal of bleeding water. Cover the specimen in the container, with a suitable tight fitting, water impermeable blanket for duration of the test. Fig 1 shows samples prepared for penetrometer test.

Fig.1: Cubes after Penetration with Penetrometer

VIII. SETTING TIME OF CONCRETE:

(a) with 100% River Sand

The penetration test results on concrete with 100% river sand are plotted as shown in fig. 2 with time on X- axis and penetration resistance on Y-axis.

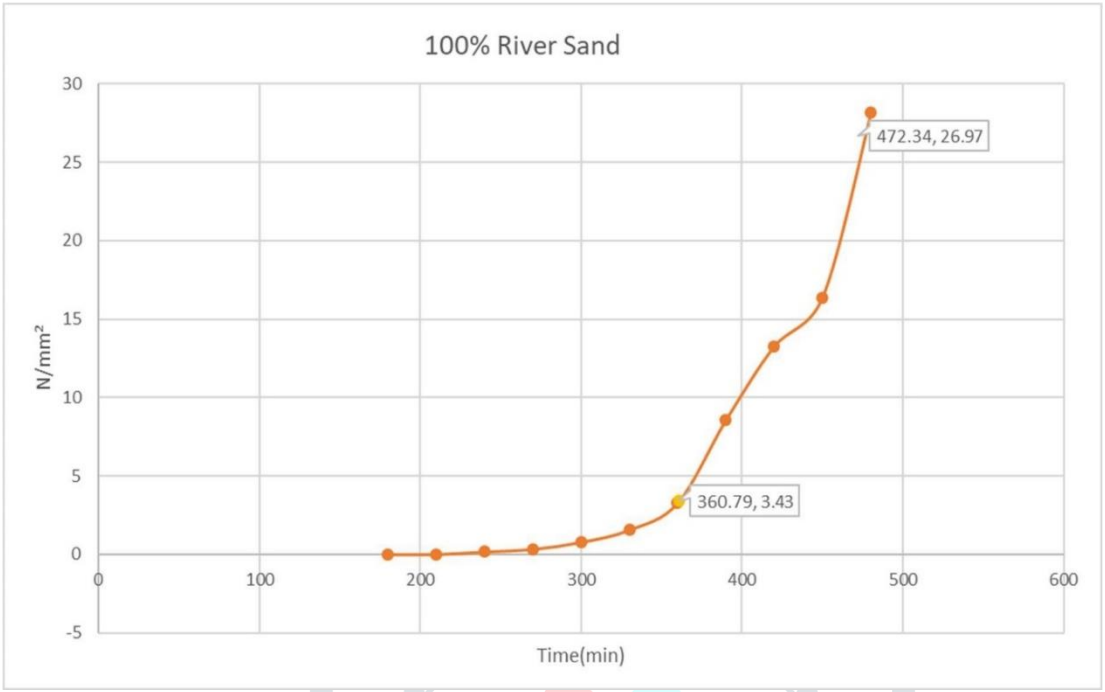

Fig. 2: Standard Penetration Test Result with 100% River Sand

From Fig 2, the initial setting time which corresponds to 3.43 N/mm² is 360.79 minutes and the final setting time which is corresponding to 26.97 N/mm² is 472.34 minutes.

(b) with 50% manufactured sand and 50% river sand

The penetration test results on concrete with 50% manufactured sand and 50% river sand are plotted in fig 3 with time on X- axis and penetration resistance on Y-axis.

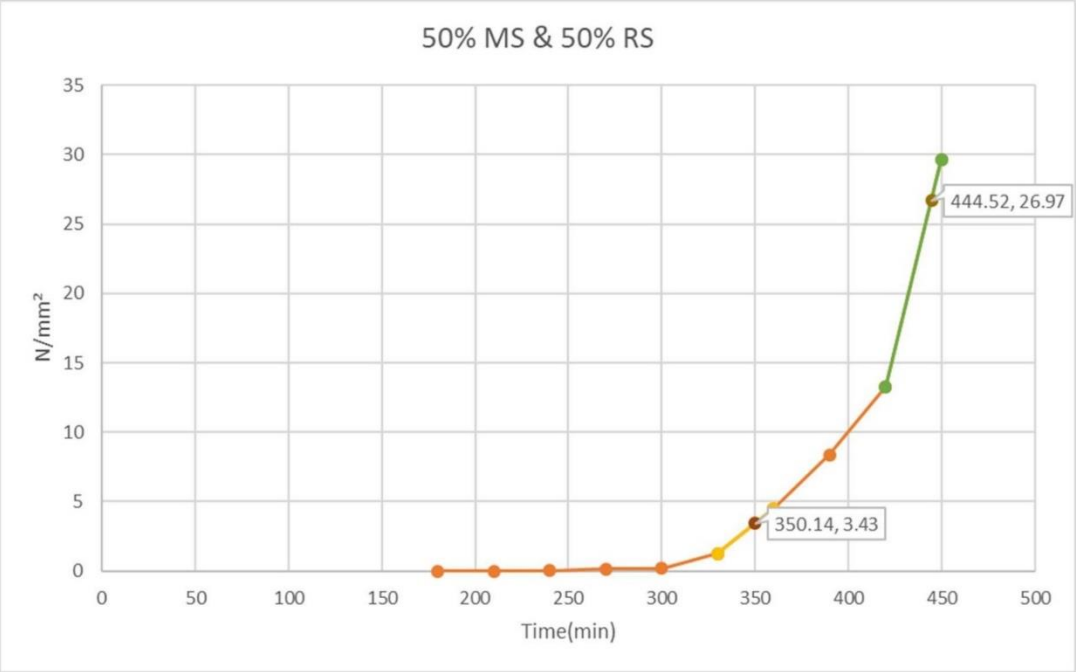

Fig 3: Standard Penetration Test Result with 50% MS and 50% RS

From the above graph the initial setting time which corresponds to 3.43 N/mm² is 350.14 minutes and the final setting time which is corresponding to 26.97 N/mm² is 444.52 minutes.

The initial setting time of concrete with 50% manufactured sand and 50% river sand has decreased by 2.95% compared to concrete with 100% river sand whereas the final setting time has decreased by 5.8%.

(c) with 60% manufactured sand and 40% river sand

Fig. 4 shows the penetration test results on concrete with 60% manufactured sand and 40% river sand with time on X- axis and penetration resistance on Y-axis.

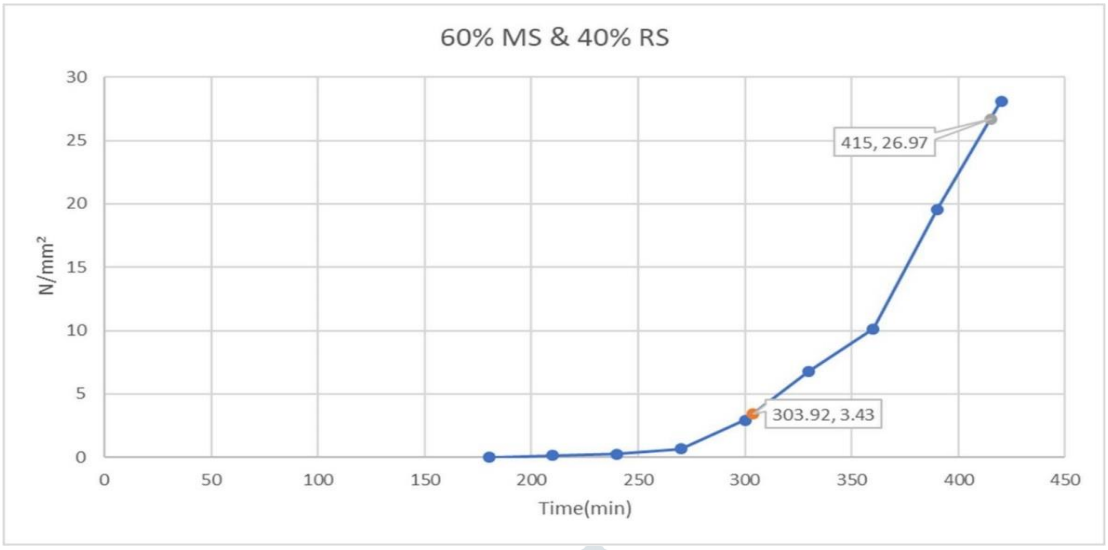

Fig. 4: Standard Penetration Test Result with 60% MS and 40%

From the graph the initial setting time which corresponds to 3.43 N/mm² is 303.92 minutes and the final setting time which is corresponding to 26.97 N/mm² is 415 minutes. The initial setting time of concrete with 60% manufactured sand and 40% river sand has decreased by 15.76% compared to concrete with 100% river sand whereas the final setting time has decreased by 12.13%.

(d) with 70% manufactured sand and 30% river sand

Fig 5 presents the penetration test results on concrete with 70% manufactured sand and 30% river sand when with time on X- axis and penetration resistance on Y-axis.

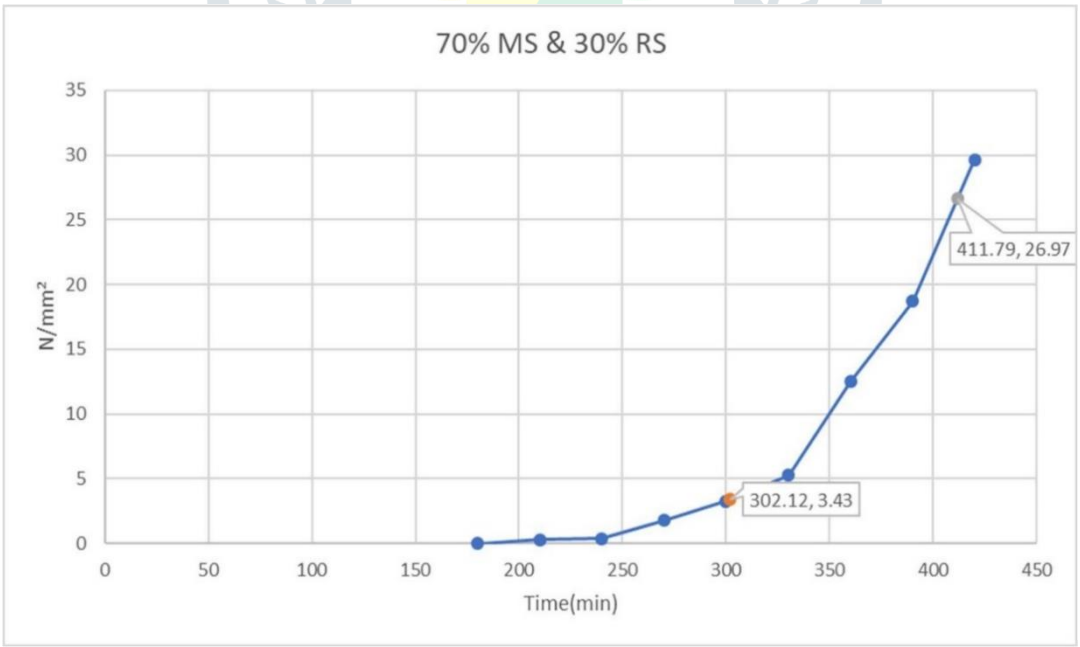

Fig. 5: Standard Penetration Test Result with 70% MS and 30% RS

From the above graph it is seen that the initial setting time which corresponds to 3.43 N/mm² is 302.12 minutes and the final setting time which is corresponding to 26.97 N/mm² is 411.79 minutes.

The initial setting time of concrete with 70% manufactured sand and 30% river sand has decreased by 16.26% compared to concrete with 100% river sand whereas the final setting time has decreased by 12.81%.

(e) with 80% manufactured sand and 20% river sand

The penetration test results on concrete with 80% manufactured sand and 20% river sand are plotted on a graph with time on X- axis and penetration resistance on Y-axis.

From the fig 6, the initial setting time which corresponds to 3.43 N/mm² is 301.34 minutes and the final setting time which is corresponding to 26.97 N/mm² is 408.83 minutes. The initial setting time of concrete with 80% manufactured sand and 20% river sand has decreased by 16.47% compared to concrete with 100% river sand whereas the final setting time has decreased by 13.44

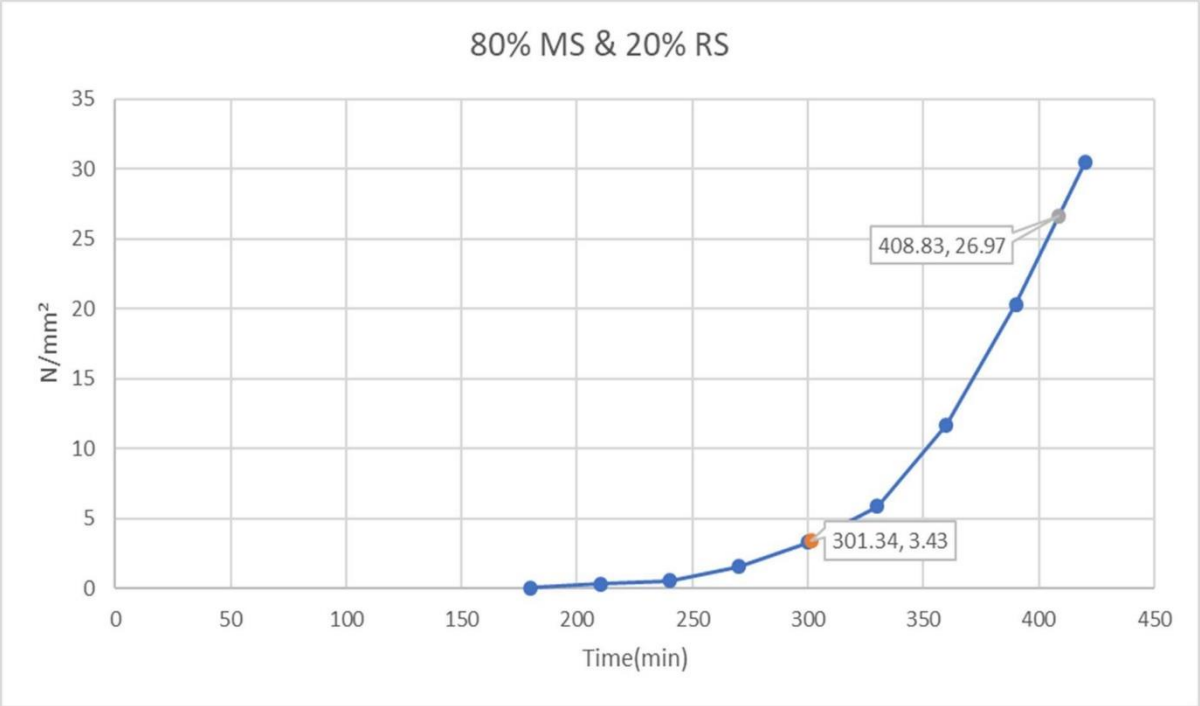

Fig. 6: Standard Penetration Test Result with 80% MS and 20% RS

(f) with 100% manufactured sand

Fig 7 shows the penetration test results on concrete with 100% manufactured sand when plotted on a graph with time on X- axis and penetration resistance on Y-axis.

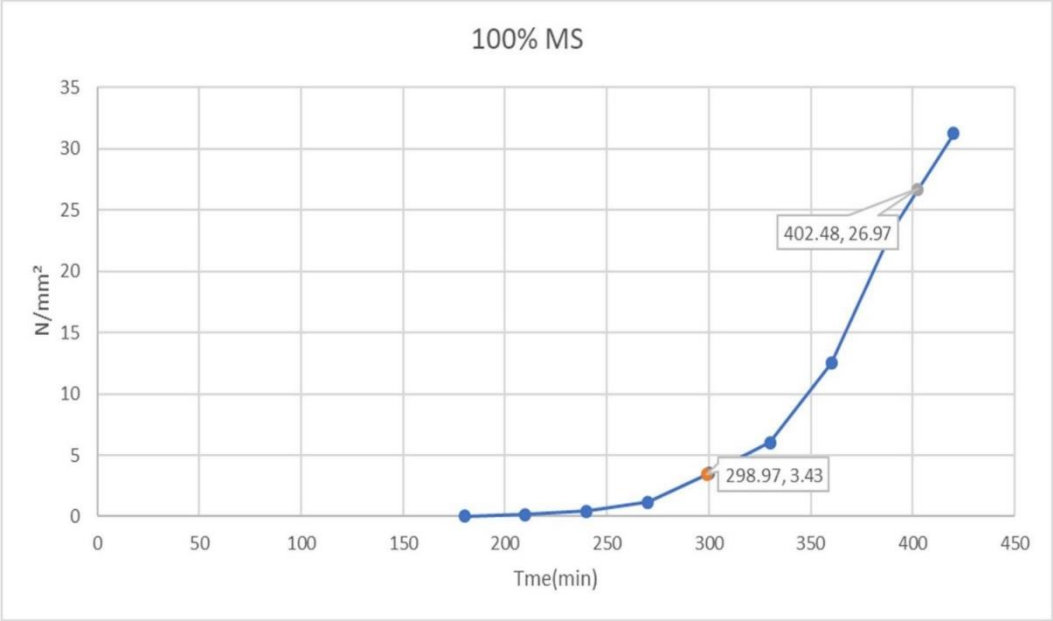

Fig. 7: Standard Penetration Test Result with 100% MS

From the above graph it is observed that the initial setting time which corresponds to 3.43 N/mm² is 298.97 minutes and the final setting time which is corresponding to 26.97 N/mm² is 402.48 minutes.

The initial setting time of concrete with 100% manufactured sand has decreased by 17.13% compared to concrete with 100% river sand whereas the final setting time has decreased by 14.79%.

IX. Variation in Setting Time

The results from the penetration test conducted on concrete with varying percentages of river sand and manufactured sand are tabulated in the Table 3.

From the table 3 we can conclude that the setting time of concrete is reduced by increasing proportion of manufactured sand. Fig. 8 shows the variation in setting time of concrete for different proportions of river sand and manufactured sand.

TABLE 3: Variation in Setting Time

Mix Type	Initial Setting Time (min)	Final Setting Time (min)
100%RS	360.79	472.34
50%RS+50%MS	350.14	444.52
40%RS+60%MS	303.92	415
30%RS+70%MS	302.12	411.79
20%RS+80%MS	301.34	408.83
100%MS	298.97	402.48

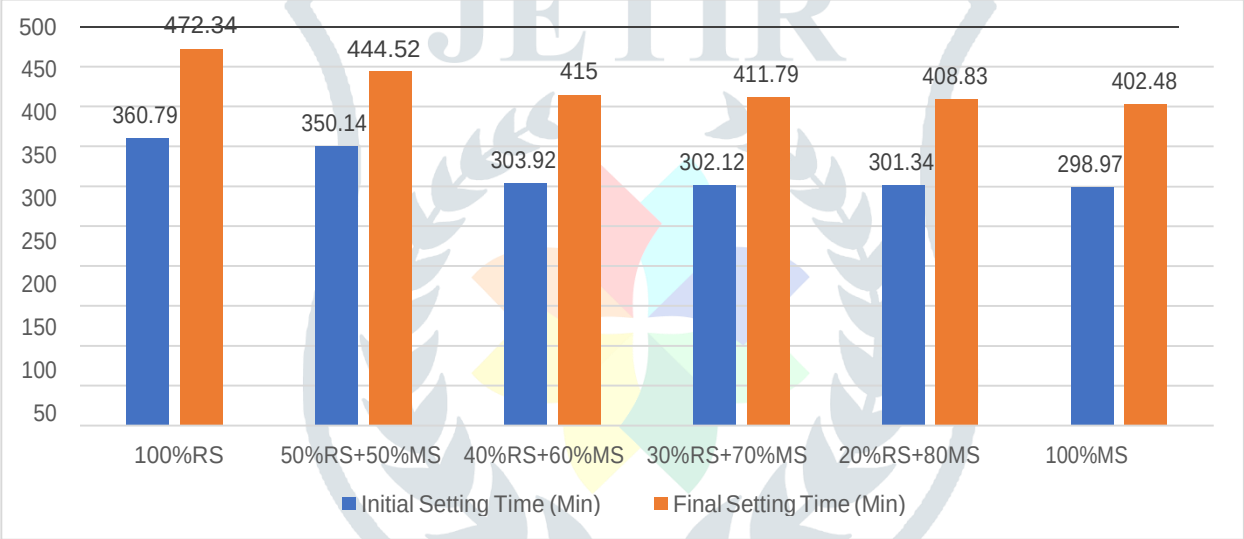

Fig. 8: Variation in setting time of concrete

X. CONCLUSIONS:

1. The slump for the concrete is decreasing with increasing percentages of the manufactured sand. This is due to the more fines present in the manufactured sand causing more water absorption.
2. The initial setting time of concrete with 50% river sand and 50% manufactured sand has decreased by 2.95% compared to concrete with 100% river sand whereas the final setting time has decreased by 5.8%.
3. The initial setting time of concrete with 40% river sand and 60% manufactured sand has decreased by 15.76% compared to concrete with 100% river sand whereas the final setting time has decreased by 12.13%.
4. The initial setting time of concrete with 30% river sand and 70% manufactured sand has decreased by 16.26% compared to concrete with 100% river sand whereas the final setting time has decreased by 12.81%.

5. The initial setting time of concrete with 20% river sand and 80% manufactured sand has decreased by 16.47% compared to concrete with 100% river sand whereas the final setting time has decreased by 13.44%.
6. The initial setting time of concrete with 100% manufactured sand has decreased by 17.13% compared to concrete with 100% river sand whereas the final setting time has decreased by 14.79%.

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