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Evaluation of Compressive Strength of Concrete Using Stone Dust and Superplasticizer

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Abstract

Concrete, which is usually composed of cement, water, and fine and coarse aggregate, is the most dynamic building material for the construction of physical infrastructures because of its strength and durability, which solidifies over time in response to environmental changes. The size and shape of the aggregate have a significant impact on workability, strength, and durability of concrete since various particle sizes produce distinct reactions. To support the manufacturing of sustainable concrete, the research suggested substituting stone dust (SD) for sand. In contrast to the addition of stone dust, the application of superplasticizers improves the workability of concrete. The study aims to examine the compressive strength of M20-grade concrete that has superplasticizer added in addition to stone dust as fine aggregate replacement. The Maximum compressive strength of concrete has been achieved at 40% sand replacement. The findings revealed that the increase in stone dust content results in an increase in compressive strength of concrete using superplasticizer. The use of superplasticizer serves to increase the workability of the concrete and has no discernible effect on the compressive strength up to 50% sand replacement. The 28-days compressive strength achieved maximum value at 50% sand replacement with 2% superplasticizer. When stone dust and superplasticizer are added, the concrete becomes denser; conversely, when the amount of stone dust and superplasticizer is increased, the concrete becomes more slumped. For the construction of sustainable concrete, the SD can be used in place of fine aggregate in conjunction with superplasticizer.

Keywords: *Compressive strength, Concrete, Sand, Stone dust, Superplasticizer*

1. Introduction

1.1 Concrete: Concrete, in general, is a composite material consisting of cement paste, aggregate (such as sand), water, and cement. Chemical admixtures may also be added to it to increase its strength and durability. Concrete consumption shot to the top of the building material demand chart, making it the second most utilized substance in human history, behind water, because of growing urbanization and development activity in many sectors. The production of concrete has consumed 60% of all mass produced by humans to date to fulfill the increasing need for the construction of physical infrastructure(Pöllmann et al., 2022). The manufacture of concrete is heavily dependent on the manufacturing of cement, with an annual need exceeding 4000 million tons in 2020(Sverdrup et al., 2023). It has been believed that GDP and investment are significant factors for cement and concrete production; the greater the GDP potential, the greater the quantity of infrastructure allocated(Subiyanto et al., 2020). Since CO2 emissions from the use of hydrocarbons in cement manufacturing have a detrimental effect on the environment, technological changes in cement production are imperative. The planning and tactics for decarbonization concealed chances for demand-side intervention by relying mostly on supply-side technology, such as carbon capture and storage (CCS). Without using widespread deployment of CCS, as stipulated by the United Nations Sustainable Development Goals (SDGs) in the cement and concrete cycle, cross-cutting solutions incorporating both the supply and demand sides can reach net-zero emissions by 2050(Watari et al., 2022). The replacement of cement with alternative materials, such as geopolymer, which uses waste materials and by-products which will contribute less to global warming by reducing CO2 emission(Khaiyum et al., 2023).

1.2 Aggregate: In addition to being the most widely collected and used mineral raw material by humans, building aggregates are one of the key components enabling the development of physical infrastructure necessary for human civilization, thus they require special attention(Ogunbayo et al., 2018). The strength of the concrete mix is influenced by the kind of cement, the coarse aggregate, and the contact between the aggregate and mortar. However, the strength and elasticity modulus of concrete, particularly the high strength concrete, are greatly influenced by the type of coarse aggregate used in the concrete(Kalra et al., 2018). Since sand lowers the workability and void content of concrete, it is believed to be a necessary inert component in the production process. River sand is extremely scarce in comparison to all other natural resources due to rising demand(Vandhiyan et al., 2020). The excessive dredging of sand from riverbeds and unavailability of land for disposal of stone dust has forced us to search for feasible alternative for sand in concrete production(Srivastava et al., 2020). The manufacture of cement, aggregate, and concrete currently faces several sustainability issues, such as resource overuse and environmental damage. Policies need to be changed, with greater emphasis on restricting the increase in concrete manufacturing or using substitute materials. It is possible to address the shortage of sand and climate problems by utilizing alternative resources and by modifying the design, manufacture, usage, and disposal of concrete.

1.3 Use of Alternate Materials in Concrete

Coal bottom ash (CBA), over-burnt brick, crushed glass, plastic, wood chips, shredded rubber, dust, granulated blast furnace slag, construction demolition waste, Recycled Polyethylene Terephthalate (RPET), marble waste, and many more can be utilized for sand replacement for concrete production. Using recycled powder considerably lowers the compressive strength of the concrete; nonetheless, brick rubble is a sustainable solution for the construction of green concrete, which helps Nepal's clean and intelligent cities(Gyawali, 2022). According to the results of the experimental study, the best substitute for achieving the benefits of improved concrete strength, durability, and workability is a suitable amount of CBA(Muthusamy et al., 2020). The partial application (5-15%) of sawdust in replacement of sand produced good quality of concrete in respect to compressive strength and less hazardous to health(Olaiya et al., 2023). By replacing 10% of the volume of the coarse aggregate with coconut shells and 3% of the volume of cement with coconut fiber, lighter concrete (10.9%) may be made(Bharat et al., 2019). 22.5% marble waste and 44.5% scoria saved up to 4.5% of the total cost of concrete with weight reduction up to 5% is the ideal replacement level (Yifru et al., 2020). The results of the experiment showed that when 15% glass powder was added to M20 concrete in place of sand, the concrete's compressive strength increased by 9.4% (Safarizki et al., 2020). When sand was substituted with bauxite instead of natural concrete, the results showed a considerable increase in the concrete's compressive, tensile splitting, and flexural strengths, ranging from 60.3 to 65.5%(Danso et al., 2019). The use of waste ceramics as found aggregate and integrated waterproof (IWP) additive to boost compressive strength, modulus of elasticity, and absorption has led to a significant rise in the production of concrete. Compressive strength and modulus of elasticity increased when IWP was used alone, whereas absorption decreased when conventional sand was substituted with ceramic powder(Mawashee et al., 2023). Although it is currently regarded as a by-product, rock dust can be utilized in cement mortars and the production of concrete in place of cement or certain fine aggregates which facilitates effective waste management(Dobiszewska et al., 2022). Although the target grade concrete's compressive strength requirement has been met, there is a noticeable reduction in the material's compressive strength when stone dust is added in place of some of the sand (Zahir et al., 2023). Building industry trust has been bolstered by the practical and favorable mechanical performance of up to 30% of fly ash and quarry dust added to the high strength concrete (Teja Prathipati et al., 2022). In the process of making concrete, nylon fiber (NF) is utilized as reinforcement and crushed stone dust (CSD) as fine aggregate which indicates that when CSD percentages are raised over a certain level, the concrete's strength begins to decrease. However, as both CSD and NF levels grow, the concrete's fresh density and workability show a downward tendency (Mita et al., 2023). The 90-day compressive strength of geopolymer concrete has been found to decrease when recycled coarse aggregate (RCA) is partially substituted with conventional coarse aggregate. Nevertheless, even at 40% RCA level, the compressive strength was found to be adequate for most structural applications (Naveena et al., 2021).

1.4 Use of Stone Dust and Superplasticizer in Concrete Production

The usage of substitute materials in concrete should be decided by the strength required as well as the feasibility analysis to get the faith of the end users. When dust is used in part instead of fine aggregate in concrete, the mechanical strength of concrete is usually improved, and its workability is often much decreased. However, it is crucial to establish a site-specific relationship between the origin of the concrete ingredients and the qualities of the concrete. Previous research has shown that depending on the source, stone dust has different chemical characteristics. It has been shown that the mechanical properties of concrete tend to decrease when the percentage of stone dust increases, yet the workability of the material decreases as the percentage of water absorbed increases (Silva et al., 2023). The pore structure of concrete is greatly enhanced, and the structure of mortar and concrete are further compacted by the water-reducing chemical known as superplasticizer, which increases the compressive strength of concrete (Xun et al., 2020). The water-reducing effect of the superplasticizer and the associated proportionate change in concrete strength are taken into consideration for assessing the efficacy and compatibility of superplasticizers with cement (Dvorkin et al., 2023). However, in Nepal's concrete sector, superplasticizer usage and sand substitution have gotten less attention. To evaluate the combined effects of adding an admixture and partially substituting stone dust for sand, one must evaluate the compressive strength of the concrete, and a detailed analysis of the material's properties is required to get the concrete to the appropriate strength. The current study aims to improve understanding of how strength is assessed in various ratios of fine aggregate (sand) to crushed stone dust by adding superplasticizer to cement concrete. To fulfill the demands of globalization, Nepal, a developing nation, is presently launching a significant drive to expand infrastructure, including roads, airports, hydropower, industries, and enormous structures. River sand has become rare and expensive due to concrete works depleting the riverbed; instead, stone dust might be utilized. Since stone dust takes less water in combination to produce concrete, superplasticizers have been proposed for use in concrete. By enabling the sustainable use of natural resources and protecting the environment from the disposal of stone dust, this research will help to enhance the knowledge on the strength performance of concrete utilizing various ratios of sand to stone dust.

2. Methodology

2.1 Study Zone

This study has been conducted by collecting materials from the Kotre Quarry sites crusher plants. The processed coarse aggregate, fine aggregate, and stone dust have been taken from different crusher plants assuming that the processing of the material is stable. Due to fast urbanization and rapid infrastructure development, the demand of construction material is increasing and the Seti-Gandaki River is the most feasible river in the Pokhara valley in terms of construction material extraction. If the development increases in this trend, the shortage of natural aggregates may become critical which may lead towards the shortage of fine aggregates. For sustainability and environmental protection due to waste produced during aggregate production it is essential to use stone dust for construction. So, it is important to justify the use of alternate material (stone dust) for the replacement of fine aggregate (sand) to fulfill all requirements of concrete the use of superplasticizer can also be accessed.

2.2 Data Collection

Primary Data: The coarse aggregate, fine aggregate processed from Kotre Crusher Plant, and stone dust produced during the aggregate processing were collected for the investigation.

Table 1: Aggregate source

Material	Material Sources
Fine aggregate coarse aggregate, and stone dust	Kotre Crusher Plant

Secondary Data: The secondary data were consulted from the norms and specifications of the Department of Roads, Government of Nepal, IS standards, published research articles, reports, and other design guidelines.

2.3 Material for Concrete Preparation

(a) Aggregate (Coarse and Fine)

The well-graded aggregate was used for the preparation of concrete to ensure a uniform-concrete mix. The following physical properties of the aggregate has been tested which has been presented in Table 2 and Table 3.

Table 2: Test and test methods for physical properties for coarse and fine aggregate

Name of Test	Test Methods
Sieve analysis	IS:2386 Part IV
Water absorption	IS:2386 Part IV
Specific gravity	IS:2386 Part IV
Bulking of sand	IS:2386 Part I

Table 3: Test and test methods for mechanical properties for coarse aggregate

Name of Test	Test Methods
Los Angeles Abrasion Test (LAA)	IS:2386 Part IV
Aggregate Impact Test (AIV)	IS:2386 Part IV
Aggregate Crushing Value Test (ACV)	IS:2386 Part IV

(b) Cement

For the preparation of the mixture, Argakhachi 43 grade Ordinary Portland Cement (OPC) was used. The cement has been tested and checked as per Indian Standards (IS), and Nepal Standard (NS) (NS, 2019).The initial setting time, and final setting time test were conducted according to IS as shown in Table 4.

Table 4: Cement test

Name of Test	Test Methods
Initial setting time	IS: 4031 Part V
Maximum final setting time	IS: 4031 Part V

2.4 Study Design

The appropriate numbers of samples were prepared to test the various strength characteristics of M20 concrete using stone dust and admixture. In the laboratory, a sieve was used to separate the stone dust from the other particles which were not produced in the quarry mining. Fine aggregates (sand) were replaced with stone dust for concrete production. The mix design was developed based on the properties of ingredients used in the concrete at designed water-cement ratio that was prepared in accordance with Indian standards (IS) for concrete. The samples were made by replacing the fine aggregates in the concrete with stone dust at 40 % replacement. Workability, unit weight, and compressive strength tests were performed on the sample after it had been produced. A total of 48 samples were produced, three for the 7-day cube test and three for the 28-day cube test. Tables 5 and 6 indicate the sample preparation and planned properties of ingredients and concrete.

Table 5: Sample preparation for M20 concrete.

(%) Sand Replacement	Number of Samples without Superplasticizers	Number of Samples with Superplasticizers
0	6	6
30	6	6
40	6	6
50	6	6

Table 6: Planned properties of ingredients and M20 concrete.

S.N.	Particulars	Properties
1	Design Compressive Strength of Concrete mix (MPa)	20
2	Targeted Compressive Strength of Concrete (MPa)	26.60
3	Type of coarse aggregate	Crushed
4	Type and grade of cement	43 Grade OPC
5	Type of fine aggregate	Crushed
6	Degree of Workability (slump) mm	100
7	Degree of Quality Control	Good
8	Type of Exposure	Moderate

For preparation of concrete mix, coarse aggregate (Passing through 20mm IS sieve), sand falling into gradation zone II, OPC-43 grade cement and tap water were used. The superplasticizer was used in concrete mix design/casting. General properties of materials and laboratory working environment are given in Table 7.

Table 7: Mix design M20 concrete.

S.N.	Particulars	Properties
1	Nominal maximum size of aggregate	20 mm
2	Cement type	43 Grade OPC
3	Coarse Aggregate	Confirming Table 2 of IS 383
4	Fine Aggregate	Confirming to zone II, Table 4 IS 383
5	Water - Cement ratio	0.50

Mix design ratio = 1:1.804:3.085 (Cement: Fine Aggregate: Coarse Aggregate: Water)

3. Results and Discussions

The physical properties and mechanical properties of the samples of fine aggregate, stone dust, cement, and coarse aggregate were tested to justify its suitability for concrete production. The properties have been accessed based on Indian Standards and DoR guidelines (DoR, 2016; IS, 1991, 1997a, 1997b). The experimental results have been presented in the following sections:

3.1. Test Result of Aggregate

Gradation analysis of the coarse and fine aggregate

The particle size distribution of the coarse aggregate, fine aggregate (sand), and stone dust was performed in the registered laboratory based on IS 383 – 1970. The results have been presented in Table

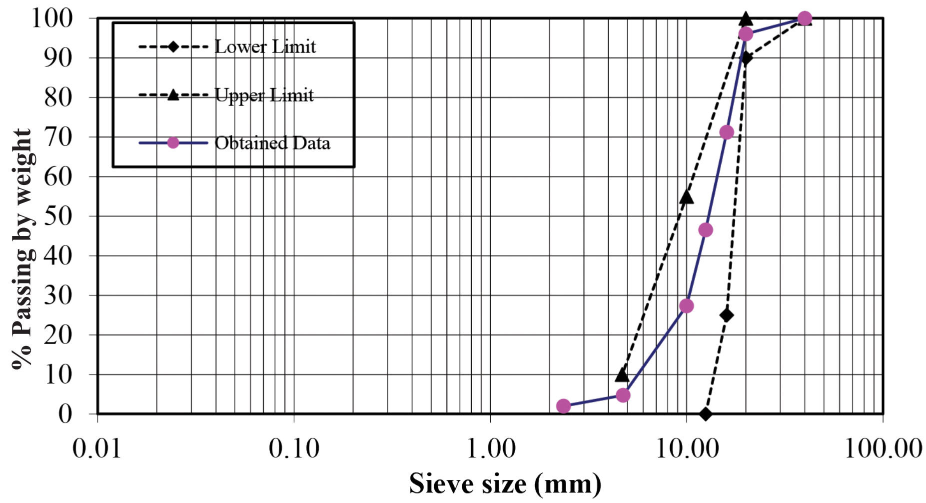
8, Table 9, and Figure 1 (a, b, and c). The result and its comparison with the IS-383-1970 standards, the fine aggregate has fulfilled the criteria of Zone II/DoR norms and stone dust has not fulfilled the criteria of Zone II/DoR norms. The gradation of coarse aggregate has also been tested in laboratory and complies grading limit as per IS383-1970.

Table 8: Gradation of coarse aggregate

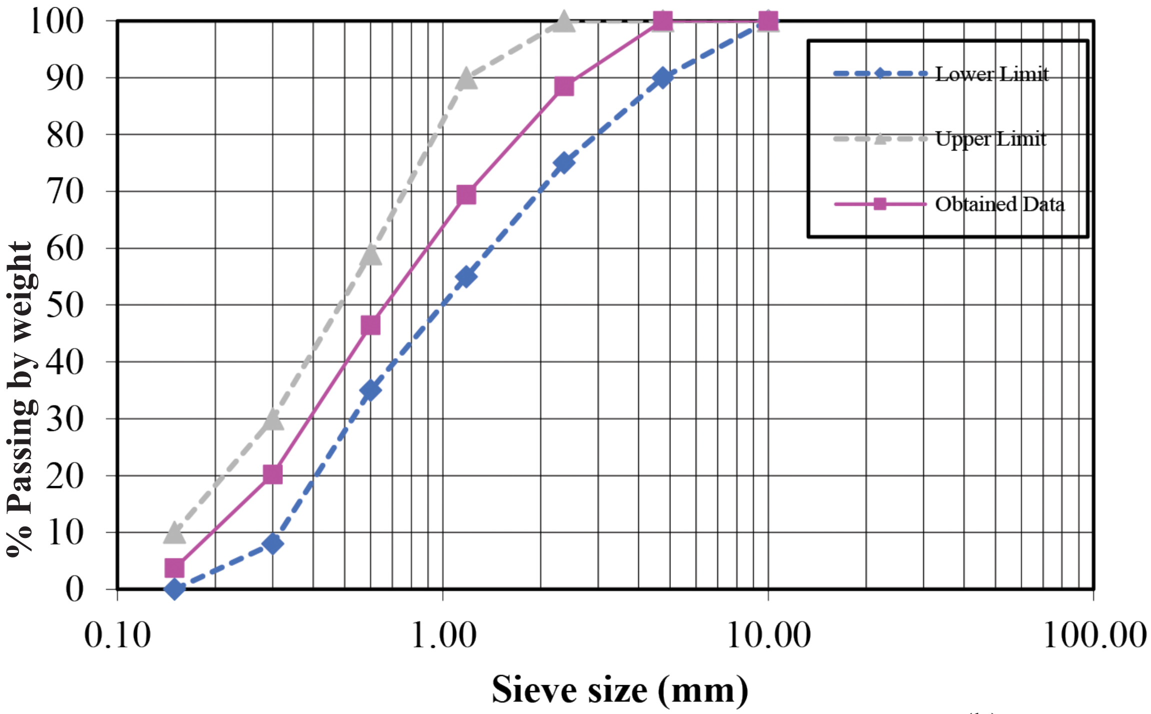
Particle size (mm)	**% Passing**	**Specification Limit (Zone II)/DoR**	
		Lower	**Upper**
40	100.0	100	100
20	96.0	90	100
16	71.2	-	-
12.5	46.5	-	-
10	27.3	25	35
4.75	4.7	0	10
2.36	2.0	-	-
Pan	0.0	-	-
FM	**4.52**		

Table 9: Gradation of sand and stone dust

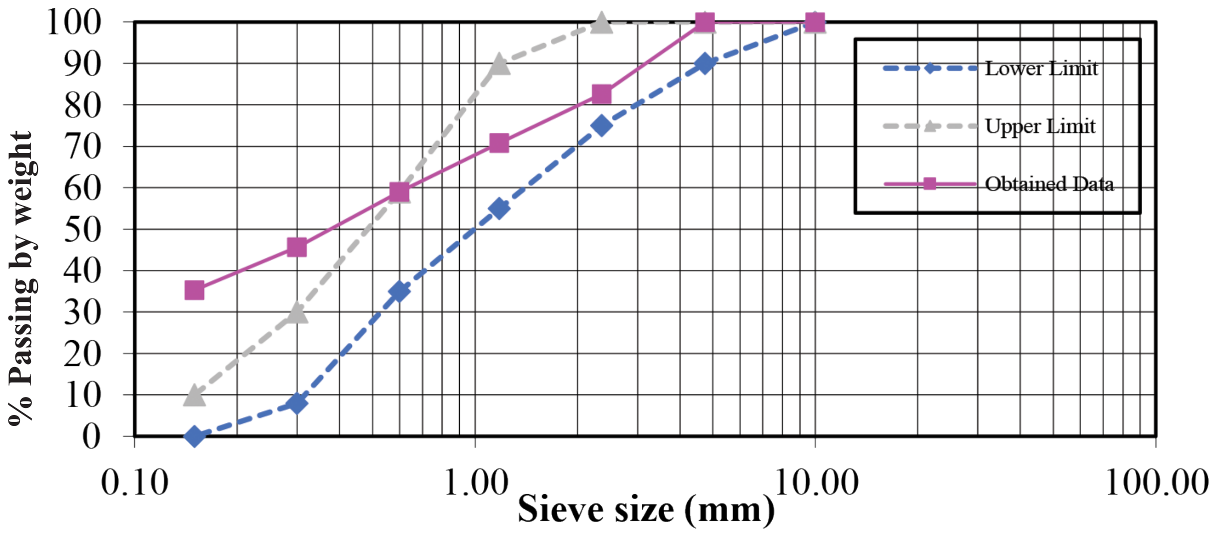
Particle Size (mm)	**% Passing**		**Specification Limit (Zone II)/DoR**	
	Sand	**Stone dust**	**Lower**	**Upper**
10	100.00	100.00	100	100
4.75	100.00	100.00	90	100
2.36	88.49	82.65	75	100
1.18	69.44	70.79	55	90
0.60	46.42	58.97	35	59
0.30	20.20	45.61	8	30
0.15	3.71	35.29	0	10
Pan	0.00	0.00	0	0
FM	**3.71**	**3.06**		



(a)



(b)



(c)

Figure 1: Gradation analysis for (a) Coarse aggregate (b) Fine aggregate (c) Stone dust

Physical and mechanical properties of aggregate

The type of aggregate and its physical properties have great influence on the strength characteristics of concrete. Specific gravity, water absorption coefficient, flakiness index, elongation index, impact strength, crushing strength, and Los Angles Abrasion value test have been conducted as per IS standard and the result were compared as per IS/DoR guidelines. The results have been presented in Table 10.

Table 10: Physical and machinal properties of aggregate

Properties	Test result		
	Sand	**Stone dust**	**Coarse Aggregate**
Specific gravity	2.674	2.712	2.714
Water absorption coefficient (%)	-	-	0.614
Flakiness Index (%)	-	-	21.33
Elongation Index (%)	-	-	11.45
Impact Strength (%)	-	-	22.20
Crushing Strength (%)	-	-	25.01
Los Angles abrasion value (%)	-	-	27.80

The specific gravity of all aggregate has been listed within the standard range as per IS – 2386 (Part III) – 1963, and specification proposed by the Department of Roads (DoR). The coarse aggregate has satisfied the flakiness and elongation index value as per given norms. The impact strength and crushing strength values for coarse aggregate are within the limits of the IS: 2386 (Part IV) – 1963 code, and suitable for use in building and road projects. In accordance with IS: 2386 (Part IV) – 1963 code, and specification proposed by the Department of Roads (DoR), the abrasion values of coarse aggregate samples are within acceptable limits, and hence all samples are suitable for use in construction activity.

3.2 Test of Cement and Superplasticizer

Cement, referred to as the binding material largely used in concrete production for any kind of physical infrastructure. The properties of the cement can be modified as per the project’s need. There are various brands of cement that are being manufactured and imported to use in infrastructure construction in Nepal. The Arghakhachi 43 Grade OPC cement was used for concrete production during my research. The following general tests were conducted, compared with Nepal Standards (N.S.), and the result has been presented in Table 11. “Markplast HSP-100” superplasticizer was used for the preparation of the test samples for the study.

Table 11: Properties of cement

Properties	Test Result	N.S. Norms
Initial setting time (Minutes)	186	45 Minimum
Maximum final setting time (Minutes)	380	600 Maximum

The initial setting time of cement was found to be much higher than that specified by N.S. specification but complies with the specification while the final setting time of the cement was found to be within the safe limit specified by N.S specifications.

3.3 Properties of Fresh Concrete

Concrete is one of the versatile materials for the construction of physical infrastructure. For this research M20 concrete was selected and the composition of the materials has been estimated based on the trial mix design. The evaluation of the properties of fresh concrete has been done at various proportions of sand and stone dust using a 2% superplasticizer. The workability, density, and compressive strength at varying proportions of sand and stone dust with and without superplasticizer has been evaluated. The experimental result of the test has been presented in the following Table 12, Table 13, Table 14, Figure 2, Figure 3, and Figure 4.

Workability:

Table 12: Workability of fresh concrete at different proportions

Mix Proportion (% Replacement)	Slump Value without Using Superplasticizer (mm)	Slump Value Using Superplasticizer (mm)
0	30	96
30	56	105
40	77	127
50	93	135

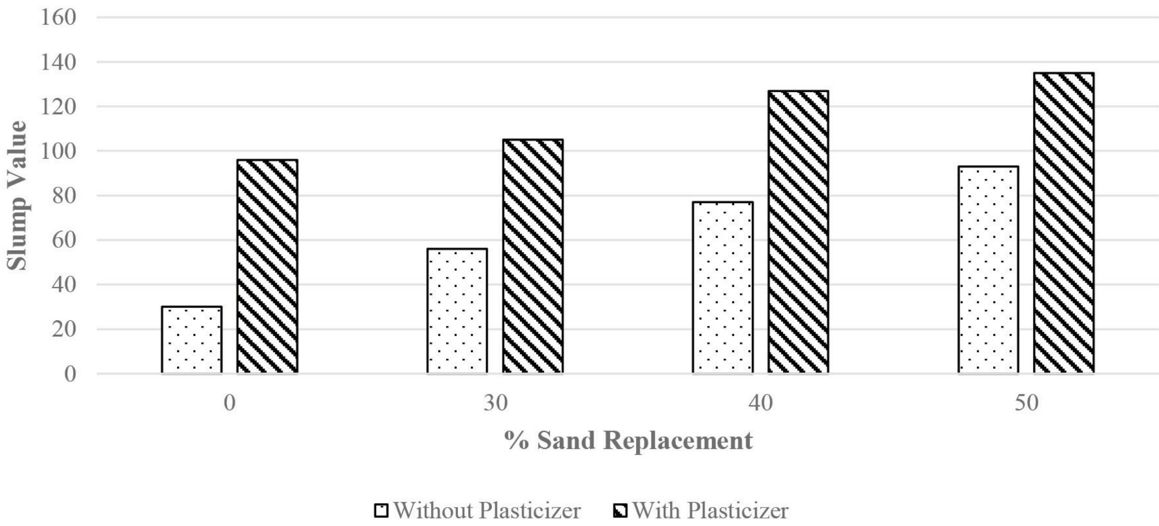


Figure 2: Slump value M20 Concrete at different proportions at different proportions

The previous study has shown that the use of stone dust above 20% can decrease the slump of normal strength concrete and high strength concrete (Turuallo et al., 2020). The mono crushed sand could replace the mono river sand in making concrete, with notable improvements in workability by 22% increment (Ahmad Khan et al., 2023).

Table 12 indicates that the increasing % replacement of sand resulted in an increasing slump value for with and without the use of superplasticizer. According to IS: 456 – 2000, the slump value of concrete with varying mix proportions of fine aggregates and stone dust should be within the range of (25–75 mm), which satisfied the specification with low value. Figure 3 illustrates that at 50% replacement has a higher degree of workability than other percentages of replacement, which means minimal effort is required for placement and compaction of sand and stone dust. In general, SD contains more angular particles with rougher surface texture and flatter faces than normal sand that causes the decrement of slump value, but the use of superplasticizer increases the slump value. Moreover, due to the presence of more voids and moisture content in 0% replacement than in other percentages of replacement, which increases the workability of fresh concrete. The % increase in SD resulted in the decrease in slump value producing less workable concrete since it requires higher water content, but superplasticizer requires less water content. It has clearly been noted that by replacing sand and use of superplasticizer the slump value increases in all proportions.

Density:

The density of concrete measures its unit weight and solidity that is used to evaluate strength. The results of the density of concrete and its standard deviation (SD) at different proportions have been presented in Table 13 and Figure 3.

Table 13: Density of fresh concrete at different proportions

% Replacement	Mean Density of M20 Concrete without Plasticizer (Kg/m3)				Mean Density of M20 Concrete with Plasticizer (Kg/m3)			
	7 Days	SD	28 Days	SD	7 Days	SD	28 Days	SD
0	2536.88	18.25	2542.02	9.98	2563.48	31.67	2564.82	11.94
30	2526.62	2.32	2579.06	28.67	2530.16	14.32	2584.30	20.14
40	2514.96	8.89	2524.96	23.01	2556.93	68.02	2573.94	10.62
50	2504.40	35.67	2557.73	13.49	2523.75	45.98	2568.72	49.34

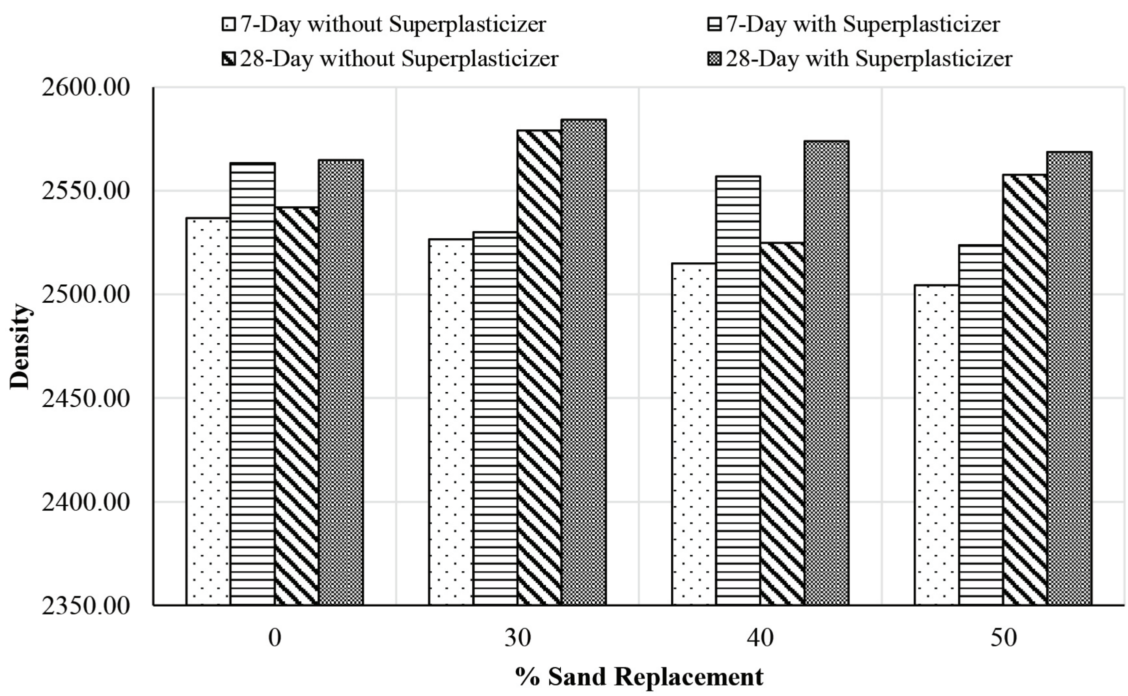


Figure 3: Density of M20 Concrete at different proportions

Figure 3 evidently shows that the 28-days density at 30% replacement using superplasticizer for M20 concrete is higher than the other percentage replacement. Fine aggregate, stone dust, and coarse aggregates have different specific gravity and water absorption values, but at 30% replacement at M20, fine aggregate, stone dust, and coarse aggregates have specific gravity and lower water absorption than the corresponding percent of replacement, which increases the density of the concrete. Also, the density at 0% replacement without superplasticizer for M20 has the maximum value than the other percentage replacement because of higher specific gravity and lower water absorption of sand, stone dust, and coarse aggregates.

Compressive strength

The compressive strength of cube and cylinder samples are tested as per standards and the obtained results of sampled sources has been presented below. The experimental results of the M20 grade of the concrete cube its standard deviation (SD) with different sources of aggregate is given and other individual results has been presented in Table 14, and Figure 4.

Table 14: Compressive strength of fresh M20 concrete at different proportions

% Replacement	Mean Compressive strength of Concrete without Superplasticizer (MPa)				Mean Compressive Strength of Concrete with Superplasticizer (MPa)			
	7 Days	SD	28 Days	SD	7 Days	SD	28 Days	SD
0	18.13	1.56	26.63	0.26	18.35	0.79	26.38	0.33
30	18.43	0.72	26.28	0.65	19.94	2.06	26.45	0.70
40	17.37	0.70	27.51	1.46	19.11	0.59	26.33	0.68
50	17.80	0.96	26.50	0.59	18.96	1.02	28.14	0.64

Figure 6: Compressive strength of M25 concrete at different proportions

Table 14 and Figure 4 evidently show that the mean compressive strength and its standard deviation of M20 grade concrete at 28 days for different proportions of sand and stone dust were figured out and most of the mix proportions samples satisfied the specifications of M20 grade concrete at 95% confidence interval. The maximum strength was observed at 40% replacement without superplasticizer having the value of 27.51 MPa that goes decreasing in other proportions while at 50% replacement superplasticizer having the maximum value of 28.14 MPa that goes decreasing in other proportions. It indicates that using stone dust and superplasticizer compressive strength has no significant impact on

28-days. But, the 7-days compressive strength with superplasticizer has improved at 30% replacement. Hence the higher compressive strength is due to good bondage and fewer voids in the concrete matrix. The preceding outcome additionally demonstrated that a 7.5% partial replacement of stone dust results in a 14.42% improvement in compressive strength after 28 days(Ahmad Khan et al., 2023). According to the earlier research, the natural sand with a 30% replacement component performed satisfactorily in terms of compressive strength(Oliveira Andrade et al., 2018). The prior study on the use of pure polycarboxylate polymer resulted in a 34.3% reduction in the water demand for the concrete mixture, but the compressive strength increased more significantly by 106% and 100% at 7 and 28 days, respectively. This can be compared to our research, which found that replacing sand with stone dust may influence the compressive strength of concrete. The results of the study can be used in the manufacturing of concrete in any situation where a lower water-to-cement ratio is required.

4. Conclusions

The study was focused on evaluation of the effect of replacement for natural fine aggregates by stone dust and use of superplasticizer on its compressive strength for M20-grade design mixed concrete. The results of the study have been presented in the following sections.

a. The density of fully hardened concrete (28-days) was maximum at 30% sand replacement with and without using superplasticizer. It has been determined that the specific gravity of measured stone dust is lower than that of the corresponding sand because of its lower water absorption than that of the corresponding sand and superplasticizer requires less water.

b. The 28-days slump value of the concrete increase with increase in % sand replacement. The slump value using superplasticizer is higher than without superplasticizer as superplasticizer enhances water requirements.

c. The compressive strength of fully hardened concrete (28-days) has the greatest value at 50% replacement of fine aggregate (sand) by stone dust using superplasticizer which indicates that increase in superplasticizer enhances the compressive strength of concrete. At the meantime, the compressive strength of concrete at 40% sand replacement without using superplasticizer has maximum value.

5. Recommendations

The research has been done on M20-grade design mix concrete only at fixed W/C ratio. It is recommended that the similar study should be conducted for other mix design concrete grades at varying W/C ratio so that the general equation can be derived for varying proportion of stone dust and W/C ratio with and without using superplasticizer.

Conflicts of Interest

The authors have declared that no competing interests exist. The data used for this research are commonly and predominantly used data in our area of research and country. There is no conflict of interest between the authors and other stakeholders because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by any authorities rather it was funded by the personal efforts of the authors.

Data Availability Statement

The data that support the findings of this study are available to the main author, upon reasonable request.

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