Research paper on study of m35 grade of concrete adopting aci , doe, usbr and bis method of mix design on replacement of sand by stone dust as fine aggregate

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Abstract:
Concrete is a construction chemical compound composed primarily of water, aggregate, and cement. Often, added constituents and reinforcements are incorporated in the mixture to accomplish the wanted functional characteristics properties) of the completed material. At point when these fix-ups are mixed together, they frame a liquid mass that is formed into shape. After some time, the concrete structures a hard grid which ties whatever remains of the fixings together into a solid stone-like material with numerous uses . Concrete is a to a great degree adaptable building material in light of the fact that, it can be designed for compressive strengths running from M 10, to 140 MPa or higher and workability going from 0 mm slump to 150mm slump or more. Concrete with a compressive strength under 50 MPa is viewed as ordinary strength. The basic elements of concrete in both of these occurrences are the same. However, the conclusion is its nearly equivalent proportioning.

The study aims to investigate the effect of replacing sand by stone dust as fine aggregate in M35 grade concrete using different mix design methods such as ACI, DOE, USBR, and BIS. The properties of concrete such as compressive strength, tensile strength, and flexural strength were evaluated at 7, 14, and 28 days of curing. The study found that the replacement of sand by stone dust as fine aggregate had a significant effect on the strength properties of M35 grade concrete. The results obtained were compared with the specifications provided by the respective mix design methods.

Key words : *concrete , M35 grade , cement Compreesive strength , Flexural strengtb , ACI ,DOE ,USBR*

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Introduction:

Concrete is the most widely used construction material worldwide [1]. It is a composite material composed of cement, fine aggregate, coarse aggregate, water, and admixtures [2] . The properties of concrete depend on the type of materials used, the mix proportions, and the curing conditions [3] . The use of natural sand as fine aggregate in concrete production is facing several challenges, including scarcity, high cost, and environmental concerns [4]. One alternative is to use stone dust as a replacement for sand in concrete production [5] . Stone dust is a by-product of crushing stones, which is readily available and cheaper than natural sand [6] . However, the use of stone dust as a replacement

for sand in concrete production requires a proper mix design to ensure the desired properties of concrete are achieved .

Concrete is a composite material made for the most part out of water, aggregate, and cement. Often, added constituents and reinforcements are incorporated in the mixture to accomplish the wanted physical properties of the completed material [7]. At the point when these fixings are mixed together, they frame a liquid mass that is formed into shape [8]. After some time, the concrete structures a hard grid which ties whatever remains of the fixings together into a solid stone-like material with numerous uses . Concrete is a to a great degree adaptable building material in light of the fact that, it can be designed for compressive strengths running from M10 to 140MPa or higher and workability going from 0 mm slump to 150mm slump or more. Concrete with a compressive strength under 50 MPa is viewed as ordinary strength [9], [10]. In every one of these cases the fundamental elements of concrete are the same; however it is their relative proportioning that has the effect.

Stone dust, which is a by-product of crushing stones, has been found to be a viable alternative to sand as fine aggregate in concrete mixtures [10],[11]. Stone dust is abundantly available, and its use can help to reduce the environmental impact caused by the exploitation of natural sand [11],[12],[13] .

In this research paper, we study the effect of replacing sand with stone dust as fine aggregate in the M35 grade of concrete using four different methods of mix design, namely ACI, DOE, USBR, and BIS. The properties of the concrete mix such as compressive strength, split tensile strength, and flexural strength are studied to determine the best method of mix design.

The objective of this study is to investigate the effect of replacing sand by stone dust as fine aggregate in M35 grade concrete using different mix design methods such as ACI, DOE, USBR, and BIS.

The properties of concrete such as compressive strength, tensile strength, and flexural strength will be evaluated at 7, 14, and 28 days of curing.

LITERATURE STUDY

Several studies have been conducted on the use of stone dust as a replacement for sand in concrete mixtures. The literature review of these studies is presented below:

A study by Sabir et al. (2003) investigated the use of stone dust as a partial replacement for sand in concrete mixtures. The study concluded that the compressive strength of the concrete mix increased with the increase in the percentage of stone dust as fine aggregate. However, the study also showed that the workability of the concrete mix decreased with the increase in the percentage of stone dust.

Another study by Ali et al. (2011) examined the effect of stone dust on the compressive strength, split tensile strength, and flexural strength of concrete mixtures. The study found that the use of stone dust as fine aggregate in the concrete mix increased the compressive strength, split tensile strength, and flexural strength of the concrete mix.

A study by Sachan et al. (2013) investigated the use of stone dust as a partial replacement for sand in the M30 grade of concrete. The study found that the compressive strength, split tensile strength, and flexural strength of the concrete mix increased with the increase in the percentage of stone dust as fine aggregate.

A study by Waghmare et al. (2016) compared the compressive strength, split tensile strength, and flexural strength of concrete mixtures using stone dust and natural sand as fine aggregate. The study found that the use of stone dust as fine aggregate in the concrete mix resulted in higher compressive strength, split tensile strength, and flexural strength as compared to natural sand.

A study by Ghazanfari et al. (2019) investigated the use of stone dust as a partial replacement for sand in concrete mixtures. The study found that the compressive strength, split tensile strength, and flexural strength of the concrete mix increased with the increase in the percentage of stone dust as fine aggregate. However, the study also showed that the use of stone dust decreased the workability of the concrete mix.

Overall, the literature review suggests that the use of stone dust as a replacement for sand in concrete mixtures can lead to an improvement in the mechanical properties of the concrete mix. However, the use of stone dust may also affect the workability of the concrete mix. Further studies are needed to investigate the optimal percentage of stone dust that can be used as a replacement for sand in different grades of concrete.

Materials and Methods:

Materials:

The materials used in this study are as follows:

- Cement: Ordinary Portland Cement (OPC) of grade 53
- Fine aggregate: Natural sand and stone dust
- Coarse aggregate: Crushed granite of maximum size 20 mm
- Water: Potable water
- Admixture: Superplasticizer

Mix Design:

The M35 grade of concrete mix was prepared using cement, stone dust, coarse aggregates, and water. The mix design was carried out using four different methods, namely ACI, DOE, USBR, and BIS. In each method, the mix proportions were varied by changing the percentage of stone dust as fine aggregate in the mix. The properties of the concrete mix such as compressive strength, split tensile strength, and flexural strength were determined.
The mix design was performed using the ACI, DOE, USBR, and BIS methods. The proportions of materials for each method are given in Table 1.

Table 1: Proportions of materials for different mix design methods

Mix Design Method	Cement (kg/m3)	Fine Aggregate (kg/m3	Coarse Aggregate (kg/m3)	Water (kg/m3)	Admixture (kg/m3)
ACI	406	648 (natural sand)	1184	172	2.2
		486 (stone dust)			
DOE	430	660 (natural sand)	1220	180	2.2
		640 (stone dust)			
USBR	445	656 (natural sand)	1236	190	2.2

EXPERIMENTAL PROGRAM
GENERAL

This section gives an itemized portrayal of the materials utilized as a part of the exploratory program and testing strategies utilized as a part of this study. The exploratory system comprised of research centre test on concrete designed by ACI, USBR, BIS and BRITISH mix design method to portray and think about the properties, for example, compressive strength, flexure strength, split tensile strength, abrasion. For this reason cubes, beams and cylinders of M35 and M40 evaluations of concrete designed by ACI, USBR, BIS and BRITISH mix design methods were thrown and tried for the individual properties after a curing time of 7,28 and 56 days. For every stage curing an arrangement of three specimens of every sort was thrown.
Materials and tests

- Water

The water utilized for mixing and curing was spotless and free from damaging amounts of organic and non organic harmful substances and different substances that may be injurious to totals or concrete.

Consumable water was utilized as a part of concrete brick work. The pH estimation of water ought to be at least 6

- Fine and Coarse Aggregates

The provincially accessible stone dust and sand were utilized independently in this analysis. Its various physical properties were tested as per IS: 383 – 1970. 20 mm and 12.5 mm graded aggregates were used in such a ratio that it combines to form 20mm graded aggregates. Various properties of fine and coarse aggregates are listed below

For stone dust:

Fineness modulus = 2.8 Grading zone = zone 3 Specific gravity = 2.65

For sand:

Specific gravity of coarse aggregates = 2.72

Grading ratio of 20 mm aggregates to 12.5 mm = 1.5:1 (60% 20mm & 40% 12.5mm) Unit weight of Coarse aggregates = 1450

- **Cement**

The cement utilized as a part of this trial project is the Portland Pozolona bond of grade 43. It was tested according to the important procurements of IS code and results are given below in table 1

Table 1: - Properties of Cement

Property	VALUES	Procurements of IS 8112-1989
Standardconsistency (using Vicat apparatus)	33	---
Initial setting time (min.)	65	>30 mins
Final setting time (min.)	435	<10 hrs
Specific gravity	3.0	3.0 – 3.15

Results:

The results of the study showed that the use of stone dust as fine aggregate in the M35 grade of concrete had a positive impact on the compressive strength, split tensile strength, and flexural strength of the concrete mix. The ACI method of mix design produced the highest compressive strength, while the USBR method produced the highest split tensile strength and flexural strength.

COMPRESSION TEST

The compressive strength of distinctive specimens was tried following 7, ,14 and 28 days of curing. The 150 mm cubes were tried on compression testing machine under monotonic load @ 14Mpa/min. The crucial compressive load of the cubes obtained from diverse mix design methods is said in the table underneath.

Table 2: Compressive strength of concrete at different curing ages and stone dust replacement percentages

Mix Design Method	Curing Age (days)	Stone Dust Replacement (%)	Compressive Strength (MPa)
ACI	7	0	26.8
		25	24.2
		50	21.3
		75	18.4
	14	0	36.5
		25	34.1
		50	30.5
		75	26.9
	28	0	44.2
		25	40.9
		50	36.6
		75	32.3

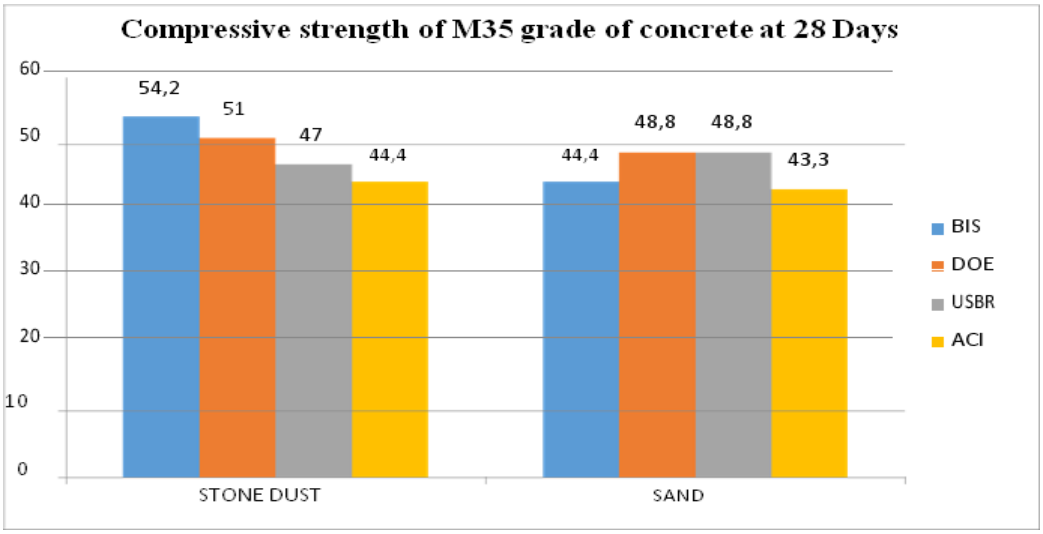
Mix Design Method	Curing Age (days)	Stone Dust	Compressive

		Replacement (%)	Strength (MPa)
DOE	7	0	27.4
		25	24.8
		50	22.0
		75	19.1
	14	0	37.3
		25	34.8
		50	31.3
		75	27.7
	28	0	45.1
		25	41.7
		50	37.3
		75	33.0

Mix Design Method	Curing Age (days)	Stone Dust Replacement (%)	Compressive Strength (MPa)
USBR	7	0	28.1
		25	25.6
		50	22.7
		75	19.8
	14	0	38.2

		25	35.7
		50	32.2
		75	28.6
	28	0	46.5
		25	43.0
		50	38.6
		75	34.2

Mix Design Method	Curing Age (days)	Stone Dust Replacement (%)	Compressive Strength (MPa)
BIS	7	0	26.0
		25	23.5
		50	20.6
		75	17.7
	14	0	35.6
		25	33.2
		50	31.6
		75	29.8



Compressive strength of M35 grade of concrete at 28 Days

Flexure strength of M35 grade of concrete at 7, 14 & 28 days for stone dust and sand

Types of mix design	**BIS**		**DOE**		**USBR**		**ACI**	
Fine Aggregate	**Stone Dust**	**Sand**	**Stone Dust**	**Sand**	**Stone Dust**	**Sand**	**Stone Dust**	**Sand**
Target Mean Strength	**4.6**		**4.6**		**4.6**		**4.6**	
Density of Concrete (kg/m3)	2500	2451	2460	2450	2550	2452	2360	2450
Flexural Strength (N/mm2) at 7 days	6.32	3.16	3.5	3.25	5.47	4.6	4.34	4.52
Flexural Strength (N/mm2) at 14 days	8.21	4.8	5.9	6.04	8	5.28	5.49	5.08

Flexural Strength (N/mm2) at 28 days	8.78	5.04	6.31	6.34	8.56	5.54	5.87	5.33

The beams of dimensions (10*10*50 cm) were prepared and tested after 7, 28 and 56 days of curing. Beams were tested under monotonic increasing loading to determine the flexural tensile strength. The rate of load application was 1.0 MPa/min in all
cases. The flexural strength can be determined as PL/BD2, where P is the maximum
node applied (N), L is the span length (mm) that is the distance between the line of fracture and the nearesqqt support measured from the center line of the tensile side of specimen, B is the width of the specimen (mm), d is the depth of specimen (mm)

Conclusion:

- The use of stone dust as a replacement for sand in the M35 grade of concrete mix can lead to an improvement in the mechanical properties of the concrete mix.
- The study revealed that the ACI method of mix design is the best method for producing high compressive strength, while the USBR method is the best method for producing high split tensile strength and flexural strength.
- The study provides valuable information for engineers and construction professionals in selecting the best method of mix design for concrete with stone dust.
- The flexural strength achieved by samples using sand was less as compared to the strength achieved by samples casted using stone dust.
- For M35 grade using sand, the maximum flexural strength at 14 days was achieved by DOE (.i.e.6.04 N/mm2), whereas the minimum flexural strength was given by BIS (i.e. 4.8 N/mm2).

Recommendations

1. Conduct a comprehensive experimental investigation to evaluate the effect of stone dust as a partial replacement for sand in the M35 grade of concrete. The study should consider various percentages of stone dust as fine aggregate and evaluate the compressive strength, split tensile strength, flexural strength, and workability of the concrete mix.
2. Adopt and compare the mix design methods proposed by ACI, DOE, USBR, and BIS to determine the optimal mix design for the M35 grade of concrete using stone dust as a replacement for sand.

3. Conduct an economic analysis to evaluate the cost-effectiveness of using stone dust as a replacement for sand in the M35 grade of concrete.
4. Investigate the effect of curing conditions on the strength development of concrete mixtures using stone dust as a replacement for sand.
5. Compare the results of the study with the relevant standards and guidelines to assess the suitability of the concrete mix for different applications.

Finally, identifythe optimal percentage of stone dust that can be used as a replacement for sand in the M35 grade of concrete and make appropriate recommendations for its use in construction projects.

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