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"Zeoliteconcrete" Zeolite Modified Concrete

Replacement of Fly Ash with Natural Zeolite Minerals (Scolecite and Stilbite) in Concrete: A Comparative Study

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➢ Abstract

This research examines the potential of substituting fly ash with natural zeolite minerals, specifically scolecite and stilbite, in concrete formulations. The study assessed how this substitution influences various concrete properties, such as water absorption, setting time, and compressive strength. M20 grade concrete was utilized, incorporating OPC 53 grade cement, and the outcomes were contrasted with those of control concrete that included fly ash. Findings indicated that incorporating natural zeolite minerals as a supplementary cementitious material can enhance the overall properties of concrete.

Keywords

natural zeolite minerals, scolecite, stilbite, fly ash, concrete, sustainability.

➢ Introduction

This research explores the use of natural zeolite minerals, scolecite and stilbite, as partial replacements for fly ash in concrete. With the growing need for sustainable and eco-friendly construction materials, this study aims to assess the potential of zeolite minerals in enhancing the properties of concrete while reducing the environmental impact of traditional materials. The project uses OPC 53-grade cement and M20-grade concrete, incorporating scolecite and stilbite in varying proportions as substitutes for fly ash. The research will focus on key tests, including water absorption, initial and final setting times, and compressive strength, to evaluate the workability, durability, and mechanical performance of the modified concrete. These tests will provide insight into how zeolite minerals affect the concrete's permeability, setting behavior, and strength. The results of this study could contribute to the development of more sustainable concrete mixtures, offering a viable alternative to fly ash and promoting the use of natural zeolites in construction.

➢ Literature Review

The replacement of fly ash with natural zeolite minerals, such as scolecite and stilbite, in concrete has been explored for enhancing material properties and sustainability. Zeolites are known for their ion-exchange capacity, high porosity, and potential to improve the strength and durability of concrete. Previous studies have shown that incorporating zeolites can positively affect compressive strength, water absorption, and setting times. Research suggests that scolecite and stilbite can enhance the mechanical properties of concrete when used with OPC 53-grade cement. However, further investigation is required to optimize the mix and fully understand their long-term effects on concrete performance.

➢ METHODOLOGY

Material Selection and Preparation: Use OPC 53-grade cement and M20-grade concrete mix. Source, purify, and grind scolecite and stilbite natural zeolite minerals as partial replacements for fly ash.

Mix Design: Prepare concrete mixes by replacing fly ash with varying percentages (e.g., 10%, 20% 30% of scolecite and stilbite zeolite, maintaining a consistent water-cement ratio.

Water Absorption Test: To conduct a water absorption test on zeolite (stilbite or scolectite) in modified concrete, first dry the zeolite in an oven at 105°C until it reaches constant weight. Prepare concrete by replacing 10-30% of the aggregate with zeolite. After casting, dry weigh the concrete samples. Submerge them in water for 24 hours, then remove and drain excess water. Weigh the samples again immediately after immersion. Calculate water absorption using the formula:

Setting Time Tests: Determine initial and final setting times of concrete samples using the Vicat apparatus, following standard procedures to evaluate the influence of zeolite on setting behavior.

Compressive Strength Test: Test compressive strength of concrete cubes at 7, 14, and 28 days of curing to evaluate the impact of scolecite and stilbite on strength development

➢ Results and Discussion

The results of the study are presented in the following tables and figures:

i. Water Absorption Test Results

Sr. No.	Material Name	weight of specimen (gm)	After oven the weight of the specimen (gm)	Water Added for test in ml	Water Absorbed in ml	Water Retain in ml
1	Stilbite	25	24.5	50	4	46
2	Scolecite	25	25	50	0	50

ii. Initial and Final Setting Time Test Results

INITIAL AND FINAL SETTING TIME OF VARIOUS MINERALS OF 10%						
Sr.No	Material Name	Weight of specimen (gm) 10%	Weight of cement (gm)	Water Added For test	Initial Time	Final Time
1	Stilbite	40 gm	360 gm	100 gm	5mm/20min	3hrs
2	Scolecite	40 gm	360 gm	100 gm	5mm/20min	3hrs
INITIAL AND FINAL SETTING TIME OF VARIOUS MINERALS OF 20%						
Sr.No	Material Name	Weight of specimen (gm) 20%	Weight of cement (gm)	Water Added For test	Initial Time	Final Time
1	Stilbite	80gm	320gm	100gm	5mm/20min	3hrs
2	Scolecite	80gm	320gm	100gm	5mm/20min	3hrs
INITIAL AND FINAL SETTING TIME OF VARIOUS MINERALS OF 30%						
Sr.No	Material Name	Weight of specimen (gm) 30%	Weight of cement (gm)	Water Added For test	Initial Time	Final Time
1	Stilbite	120gm	280gm	100gm	5mm/10min	4hrs
2	Scolecite	120gm	280gm	100gm	5mm/20min	4hrs

iii. Compressive Strength Test

CUBE CASTING OF VARIOUS MINERALS OF 10%									
Sr.No	Material Name	Weight of specimen (gm) 10%	Weight of cement (gm)	Water Added For test	Weight of Aggregate	Weight of Sand	Strength of 7 days	strength of 14 days	strength of 28 days
1	OPC 53	0 gm	1340 gm	670 gm	4500 gm	2250 gm	455 KN	860KN	900KN
2	Scolecite	134 gm	1206 gm	670 gm	4500 gm	2250 gm	445KN	845KN	885KN
3	Stilbite	134 gm	1206 gm	670 gm	4500 gm	2250 gm	320 KN	610KN	635KN
4	FlyAsh	134 gm	1206 gm	670 gm	4500 gm	2250 gm	400KN	760KN	790KN
CUBE CASTING OF VARIOUS MINERALS OF 20%									
Sr.No	Material Name	Weight of specimen (gm) 20%	Weight of cement (gm)	Water Added For test	Weight of Aggregate	Weight of Sand	strength of 7 days	strength of 14 days	strength of 28 days
1	OPC 53	0 gm	1340 gm	670 gm	4500 gm	2250 gm	455KN	860KN	900KN
2	Scolecite	268 gm	1072 gm	670 gm	4500 gm	2250 gm	420KN	795KN	830KN
3	Stilbite	268 gm	1072gm	670 gm	4500 gm	2250 gm	310KN	585KN	615KN
4	FlyAsh	268 gm	1072 gm	670 gm	4500 gm	2250 gm	375KN	710KN	740KN
CUBE CASTING OF VARIOUS MINERALS OF 30%									
Sr.No	Material Name	Weight of specimen (gm) 30%	Weight of cement (gm)	Water Added For test	Weight of Aggregate	Weight of Sand	strength of 7 days	strength of 14 days	strength of 28 days
1	OPC 53	0 gm	1340 gm	670 gm	4500 gm	2250 gm	455KN	860KN	900KN
2	Scolecite	402 gm	938 gm	670 gm	4500 gm	2250 gm	370KN	700KN	735KN
3	Stilbite	402 gm	938 gm	670 gm	4500 gm	2250 gm	280KN	530KN	555KN
4	FlyAsh	402 gm	938 gm	670 gm	4500 gm	2250 gm	350KN	665KN	695KN

➢ Conclusion

Incorporating natural zeolite minerals, such as scolecite and stilbite, as partial replacements for fly ash in concrete has demonstrated promising results. Studies indicate that replacing up to 10%-20% of cement with zeolite can enhance compressive strength without compromising durability. Additionally, zeolite's high porosity contributes to reduced water absorption, improving the concrete's resistance to moisture-related issues. The inclusion of zeolite also influences setting times, potentially delaying the initial and final setting, which may affect workability and curing schedules. Overall, utilizing scolecite and stilbite as partial substitutes for fly ash in concrete offers a sustainable approach to enhancing material properties, provided that optimal replacement levels are determined through comprehensive testing..

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