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Improvement of Compressive Strength of M30 Grade of Concrete by Novel Hypo Sludge with Addition of Sikacrete and Comparison of Compressive Strength of Conventional Concrete

Kakarla Ajay and Lakshmi Thangasamy*

Department of Civil Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India

***Correspondence to:**
Lakshmi Thangasamy
Department of Civil Engineering,
Saveetha School of Engineering,
Saveetha Institute of Medical and Technical Sciences, Saveetha University,
Chennai, Tamil Nadu, India.
E-mail: lakshmits.sse@saveetha.com

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Abstract

The use of novel hypo sludge as a partial replacement for cement is examined in this research since it is crucial to the development of affordable building materials. To ascertain the ideal novel hypo sludge and sikacrete mix proportions for achieving the specified mechanical characteristics in concrete. Novel hypo sludge is used in concrete in place of cement with the addition of sikacrete as much as 30% when superplasticizers are employed, as well as when they are not utilized. In 28 days, the compressive strength was calculated. Comparatively to conventional concrete, which had a mean compressive strength of 33.50 N/mm^2, novel hypo sludge-added concrete had a mean compressive strength of 36.60 N/mm^2. Conventional concrete was casted with M30 mix design for 18 cubes of size 150 mm x 150 mm x 150 mm. In comparison to conventional concrete, which had a mean compressive strength of 33.50 N/mm^2, concrete that has novel hypo sludge added at a 30% addition had a mean compressive strength of 36.60 N/mm^2. From the statistical analysis the significant value is calculated as p value = 0.000, ($p < 0.05$), two-tailed and is considered as statistically significant in the accuracy rate with comparison of both novel hypo sludge and conventional concrete. Group statistics for a sample group of 30% of hypo sludge concrete mean (33.5050, 36.6000), standard deviation (1.08475, 0.96290) and standard error is (0.25568, 0.22696). The addition of hypo sludge (paper pulp) and sikacrete to cement can greatly enhance the performance of hypo sludge concrete when put through the compressive strength test.

Keywords

Novel hypo sludge, Sikacrete, M30 grade, Conventional concrete, Cement, Solid waste, Compressive strength

Introduction

Concrete has made great strides in the past thanks to ongoing research that aims to provide a product that is both affordable and powerful enough to withstand a variety of loads. There has always been intense competition amongst industries in this expanding world [1]. Concrete is the primary building material that is garnering attention in one such industry, that of construction [2]. One of the most important building materials is concrete, which has strong compressive and flexural qualities as well as durability. It has gained widespread usage due to its relatively low cost and construction from some of the most readily available materials. It may be molded, modified, and is largely fire resistant [3]. It is a manufactured substance that, more than any other material currently on the market satisfies practically any conceivable set of performance standards, which has greatly increased its popularity as a building material [4]. In actuality higher than 10 billion tons of concrete are produced per year or more than 1 m^3 per per-

son. The most crucial factors to take into account while talking about concrete are strength (load bearing capability) and durability (its resistance to deteriorating agents) [5]. Chemical degrading agents, such as sulphates, chlorides, CO_2, acids, etc., or mechanical ones, such as abrasion, impact, temperature, etc., may be the culprits. Concrete must be designed and detailed structurally, the mix must be properly proportioned, the concrete must be properly poured, there must be adequate quality control on site, and the concrete must have the right elements [6]. One such factor is the type of cement. The importance and impact of the type of cement on the strength and longevity of the corresponding concrete are the main topics of this essay. Due to its intrinsic qualities and benefits, concrete has, as noted, grown to be so popular and essential [7]. Concrete application underwent a revolution with the introduction of reinforcing. Nonetheless, in comparison to other building materials like metals and polymers, concrete is generally far more brittle and has a weak tensile strength. Based on data on fracture toughness, steel is at least 100 times more resistant to crack propagation when employed as reinforcement than concrete.

For the previous five years of research, Google Scholar has produced about 137 results. This increases the significance of using this material in concrete. The development of substitute binders is necessary to make the concrete industry sustainable. By doing so, the continued depletion of natural resources and the environmental effects of cement production can be addressed [8]. This study investigates the viability of replacing some of the cement in new concrete with waste paper sludge ash. A large amount of solid waste made from used paper. The paper and board sector faces a serious economic and environmental issue with paper mill solid waste. It is a waste product from de-inking and repulping paper.

Paper waste, often known as "hypo sludge", is a byproduct of the paper and board sector. Paper waste is thought to make up 0.7% of all urban waste created in India [9]. For the paper industry, solid waste is a significant economic and environmental issue. There are both strong and weak fibers in paper sludge. Weak waste fibers are transferred to the disposal site, and the strong fibers are taken to the recycling facility to make recycled paper. Due to this disposal, there is a serious issue with soil, water, and air pollution [10]. Paper trash acts like cement because of silica and magnesium characteristics, which shorten the setting time of cement and help to lessen the disposal issue. Hypo sludge was first developed as artificial pozzolan, a material with the primary cement-making properties of lime, magnesium, and a little quantity of silica [11]. Hypo sludge was studied for its mechanical, physical, and chemical qualities because it is utilized as a substitute in mortar production. By using recycled materials instead of raw materials, you can save money and prevent environmental and ecological harm from quarrying and mining for raw materials to make cement [12]. Worldwide need for affordable concrete is rising; by making this concrete, demand for concrete will decline, as would CO_2 emissions from the cement sector.

Materials and Method

The Civil Engineering Department at the Saveetha School of Engineering in Chennai (Tamil Nadu, India) has taken care of every aspect of the project work. Ramco 53 grade cement was used in this inquiry and experiment. The FA in conventional concrete is made up of river sand and aggregates that have been passed through a 75 mm IS (International standard) sieve. Figure 1 illustrates cement. It complies with IS 383-1970. The coarse particles come from crushed stone.

Aggregates used in concrete must be angular and at least 20 mm in size. When those aggregates can pass through a sieve with a mesh size of 75 mm while still hanging onto the term "coarse aggregate" refers to its 4.75 mm size. Figure 2a and 2b depict hypo sludge and sikacrete, respectively.

The determinations of IS 383-1970 should be followed when communicating the evaluation of coarse aggregates. India produces 420 million tons of industrial waste annually through chemical processes. The mix design was created using the IS: 10262:2009 codebook. And M30 grade concrete was chosen as the mix proportion for this study. Figure 3 shows the concrete cube mold. Two sets of specimens are prepared and prepared for an experimental test. Group 1 specimens were prepared to take the compressive strength test for conventional concrete and group 2 specimens were prepared to take the Compressive strength test for modified concrete. The concrete cube size is 150 mm x 150 mm x 150 mm. Figure 4 shows the curing of the concrete cube. Alternative binders must be developed in the construction industry in order to decrease cement production and paper waste disposal issues.

Figure 1: Cement.

(a) **(b)**

Figure 2: (a) Hypo sludge and **(b)** Sikacrete.

In this study, paper waste (also known as hypo sludge) is used as a partial replacement for cement. It is crucial to create lucrative construction materials from hypo sludge [9]. Concrete was mixed with hypo sludge, a 30% partial cement replacement. Additionally, a chemical additive called sikacrete increases the strength of the features. The slump cone test is seen in figure 5.

Figure 3: Preparing concrete cube mold.

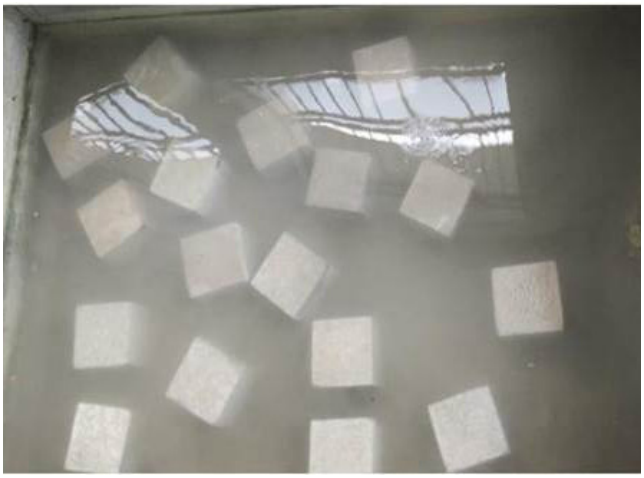

Figure 4: Curing of concrete cubes.

Figure 5: Slump cone test.

According to the analysis of the mix percentage for M30 grade, 50 ml should be added for each cube while mixing concrete. It aims to create lightweight, inexpensive concrete using byproducts of the paper industry. As a substitute for conventional concrete, the use of hypo sludge in concrete formulations as supplementary cementitious materials has been tested [2]. To determine the strength of the concrete, a compressive strength test was conducted after the cube specimen was constructed [13]. The purpose of these experiments was to assess the mechanical characteristics, such as compressive strength at 28 days. Hypo sludge-made concrete's strength is contrasted with conventional concrete. The compressive strength test was conducted using an all-purpose testing machine.

Statistical analysis

With the use of the Statistical Package for the Social Sciences version 26 program, the experiment's outcomes were examined. The study's independent variables, such as concrete quality, curing days, water to cement ratio, and compressive strength, do not have any dependent counterparts. This tool was used to calculate the compressive strength, mean, constant deviation, and constant error of the mean. The incident's significance was $p = 0.000$ ($p < 0.05$). Mean (33.5050, 36.6000), standard deviation (1.08475, 0.96290), and standard error for the sample group with 30% hypo sludge M30 grade concrete (0.25568, 0.22696). Figure 6 displays the analysis of the mean compressive strength of conventional concrete and modified concrete using a bar chart. The concrete with 30% novel hypo sludge added is stronger when compared to the other two forms of concrete in terms of strength. +/- 1 standard deviation is the typical detection precision.

Results

The results demonstrate that the inclusion of novel hypo sludge enhanced the compressive strengths of traditional M30 grade concrete. In comparison to conventional concrete's 33.5050 N/mm^2 compressive strength, 30% hypo sludge concrete with 50 ml of sikacrete added has a mean compressive

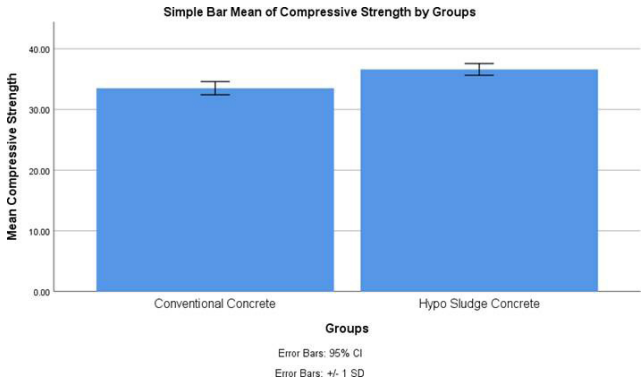

Figure 6: A bar chart is used to analyze the mean compressive strength of standard and modified concrete. On the X-axis, the groups of conventional concrete and hypo sludge concrete is visible. The Y-axis shows the average compressive strength in N/mm^2. The concrete with 30% novel hypo sludge added is stronger than regular concrete. +/- 1 standard deviation is the mean detection accuracy.

strength of 36.6000 N/mm^2. When compared to regular M30 grade concrete, the compressive strength of hypo sludge concrete is 9.25% higher. This ratio will drop when polypropylene concrete content rises above 20%; however, sikacrete boosts concrete's yield strength by as much as 30%, partially substituting for the hypo sludge in the cement [14]. The statistical difference in this investigation is represented by the value p = 0.000 ($p < 0.05$). Table 1 provides information about the compressive strength of standard M30 grade concrete. The compressive strength of grade M30 new concrete with hypo-sludge addition is shown in table 2.

Using a p-value of 0.05 and an error of 95%, table 3 summarizes the findings of Levene's test for equality of variances for two different groups: conventional concrete and concrete that has hypo sludge and sikacrete used in partial cement replacement. The group statistics analysis is shown in table 4.

Table 1: Compressive strength result of M30 grade conventional concrete.

Mix type conventional concrete	Compressive strength (N/mm^2)
S1	31.69
S2	33.73
S3	33.87
S4	33.96
S5	34.98
S6	34.09
S7	32.98
S8	31.87
S9	32.67
S10	34.44
S11	32.84
S12	32.09
S13	35.47
S14	32.22
S15	33.96
S16	34.18
S17	34.27
S18	33.78

Table 2: Compressive strength result of M30 grade hypo sludge concrete.

Mix type conventional concrete	Compressive strength (N/mm^2)
S1	36.00
S2	36.89
S3	38.04
S4	37.42
S5	36.44
S6	36.09
S7	36.62
S8	35.38
S9	36.40
S10	36.76
S11	36.18
S12	38.58
S13	35.38
S14	37.69
S15	34.84
S16	36.49
S17	36.18
S18	37.42

Discussion

This study will help the current researchers gain more knowledge, sharpen their analytical skills, and advance their understanding of the impact of new engineering materials on people, the environment, and their chosen fields so that they can compete on a global scale [15]. Finally, future academics can use this study as a guide to expand their own research on the topic of their choice. To demonstrate everyone that even with such garbage we can create something beneficial [16].

This project's goal is to evaluate and examine the potential uses of cement-replacing hypo sludge waste from the paper industry solid waste to create inexpensive, highly effective concrete that is simple to utilize in the field [17]. This is an additional attempt to reduce cement output, which raises greenhouse gas emissions [18]. The researchers will compile all the needed data, analyze the factors that affect concrete's strength, carry out numerous experiments to measure con-

Table 3: Independent samples t-test results for 30% of hypo sludge concrete: This study shows the statistical significance difference observed for compressive strength in an independent sample t-test p = 0.000 as it is less than p = 0.05. SPSS version 26 was used to define the table.

		Levene's test for equality of variances		T-test for equality of means						
		F	Sig.	t	df	Sig.(2-tailed)	Mean difference	Std. error difference	95% CI of the difference	
									Lower	Upper
Flexural strength	Equal variance assumed	0.817	0.372	-9.053	34	0.000	-3.09500	0.34188	-3.7897	-2.400
	Equal variance not assumed			-9.053	33.528	0.000	-3.09500	0.34188	-3.7901	-2.399

Table 4: Group statistics for a sample group of 30% of hypo sludge concrete. Mean (33.5050, 36.6000), standard deviation (1.08475, 0.96290), and standard error mean (0.25568, 0.22696).

	Groups	N	Mean	Std. deviation	Std. error mean
Compressive strength	Conventional concrete	18	33.5050	1.08475	0.25568
	Modified concrete	18	36.6000	0.96290	0.22696

crete's strength, and compare the costs and strengths concrete that is typical and partially replaced [19].

The limitations of the study are the use of sikacrete, a brand of concrete admixture that is claimed to reduce the carbon footprint of concrete production by lowering the amount of cement needed. While this may be a promising approach to mitigating the environmental impact of concrete, the actual efficacy of sikacrete in reducing greenhouse gas emissions may depend on various factors, such as the production process and the source of the raw materials used to make the admixture [20].

In the future, adjusting the ratio of sikacrete and the grade of concrete may be used as a strategy to ensure consistent quality and performance. While this approach may be useful in addressing the limitations of using sikacrete, it is important to note that changing the proportion of materials and the grade of concrete can have significant effects on the properties and characteristics of the final product [21].

Conclusion

The novel hypo sludge concrete was partially replaced for cement to improve the compressive strength of the concrete. Concrete has average compressive hypo sludge strength of 36.60 N/mm^2. Concrete's typical conventional compressive strength is 33.50 N/mm^2. As compared with ordinary concrete, the compressive strength of reinforced concrete improves by 9.25%.

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None.

Conflict of Interest

None.

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