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AN NOVEL INVESTIGATION OF COMPRESSIVE BEHAVIOR OF RICE HUSK AND E-WASTE IN A CONCRETE COMPARED TO CONVENTIONAL CONCRETE

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Abstract

Aim: *This study aimed to evaluate the Compressive strength of pavement quality concrete (PQC) reinforced by replacing coarse aggregate with E-waste and Rice Husk Ash with cement in concrete.*

Materials and Methods: *This study used Ordinary Portland Cement that met Indian Standards as the main materials, with 36 samples divided into two groups of 18 each for testing. The Compressive strength was tested by comparing the ratio of coarse aggregate of 90% of weight and 10% of e-waste of size 12-20mm and with OPC grade of cement 95 % and RHA of 5 % (N=18 samples) with Conventional concrete (N=18 samples) through statistical analysis using G-power software with a power of 0.8 and a 95% confidence interval.*

Results: *The compressive strength of proposed concrete Cement with Rice Husk Ash and E-Waste with Coarse Aggregate in Concrete was greater than that of regular concrete, according to a study. Cement With Rice Husk Ash and E-Waste with Coarse Aggregate in Concrete of 32 N/mm2 compared to 25 N/mm2 for normal concrete. A p-value of less than 0.05 (p=0.001) indicates a significant link between the usage of RHA and E-waste improvement in compressive strength.*

Conclusion: *The addition of RHA and E-waste to concrete is an effective way to enhance its strength and toughness properties, making it a durable and long-lasting building material.*

Keywords: *Novel Treatment Of compressive strength, Concrete, Cement, Statistical analysis, Pavement quality concrete (PQC), Rice Husk Ash (RHA), E-Waste, Conventional concrete.*

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1. Introduction

The objective of this project is to utilize the E-Waste (produced from electronic industry) and rice husk ash (produced from rice mills) to avoid the disposal problems which lead to environmental degradation. To determine the physical properties of rice husk ash blended with ordinary Portland cement. To evaluate the compressive strength by partial replacement of Rice Husk Ash with cement and E-waste plastic with coarse aggregate in different trial proportions. This study leads us to assess effective alternative material for coarse aggregate (E-waste) and cement (RHA) in different mix proportions. In this study we are using the waste dumped materials by utilizing the natural and locally available materials. After collection of E-waste from the industries it is reduced to standard coarse aggregate size (12-20) mm by using cutting tools and hammer.

The physical properties and strength assessment carried out for various mix proportions by replacing coarse aggregate with E-waste and Rice Husk Ash with cement in concrete. The main drawback of conventional concrete in terms of Compressive strength is that it can be brittle and prone to cracking under high loads. This can lead to a reduction in its overall strength and durability, as well as an increased likelihood of failure. Additionally, conventional concrete typically has a relatively low compressive strength compared to other building materials, which can limit its use in certain types of construction. To address this issue, this study proposed a Cement with Rice Husk Ash and E-Waste with Coarse Aggregate (CRHA & EWCA) and compared it to conventional concrete. The proposed method was compared to conventional concrete to evaluate the potential improvements in Compressive strength. The aim was to determine the potential improvements in Compressive strength when using Cement with Rice Husk Ash and E-Waste with Coarse Aggregate to conventional concrete.

The objective of this project is to utilize the E-Waste (produced from electronic industry) and rice husk ash (produced from rice mills) to avoid the disposal problems which leads to environmental degradation. **Josephin Alex, J. Dhanalakshmi, B. Ambedkar – (**2016**).**(Experimental study on use of E-waste ...; Experimental investigation on rice hu...) .This study leads us to assess effective alternative material for coarse aggregate (E-waste) and cement (RHA) in different mix proportions. In this study we are using the waste dumped materials by utilizing the natural and locally available materials. Mechanical properties of elastic modulus, splitting tensile strength and flexural tensile strength were found to depend on the independent parameters of concrete compressive strength, PET waste aggregate volume, concrete density and PET waste particles properties. **Azad A. Mohammed (2017) (Modelling the mechanical properties o...)** The strongest one was found to be the compressive strength, and for simplicity the effect of other parameters was omitted in the regression analysis on the test data. Based on a large amount of test data, equations were proposed, and can be used for concrete containing PET waste with a ratio varied from 0.4% to 75% as sand replacement.

An experimental study of replacing conventional coarse aggregate with E-waste plastic for M40 grade concrete using river sand The control mix that is **N.M. Mary TreasaShinu , S. Needhidasan – (2019).(An experimental study of replacing co...)** without E-plastic waste was the 1st type and coarse aggregate replaced with 12%, 17% and 22% of E-waste plastic were the other 3 types respectively. The quantities of concrete ingredients for control mix, 12%, 17% and 22 Pavement quality concrete (PQC) is a type of concrete that is used in the construction of roads and pavements.

Experimental study on use of E-waste plastics as coarse aggregate in concrete with manufactured sand.PQC is designed to be more durable and resistant to wear and tear than regular concrete **Santhanam Needhidasan, B. Ramesh, S. Joshua Richard Prab-(2019).**(Experimental study on use of E-waste ...). This study is focused on replacing conventional coarse aggregate ranging from 0 to 12.5% with e-waste plastic for M 20 grade concrete using manufacturing sand. It has been found that the compressive strength of concrete replacing e-waste is high compared.

The application of sugarcane bagasse ash (SCBA) as cement substitution to produce SCBA concrete was reviewed through existing literature. The physical and chemical properties of SCBA concrete were discussed and compared with ordinary Portland cement. **Muhammad Jahanzaib Khalil , Muhammad Aslam , Sajjad Ahmad (2021).**(Experimental study on use of E-waste ...; Utilization of sugarcane bagasse ash ...)It has been concluded through existing literature that up to 20% substitutions of cement with SCBA decreased the number of coulombs representing the improvement in resistance to chloride penetration.

Addition of E-waste as a coarse mixture doesn't affect the workability of concrete. The addition of E-waste grained within the concrete for building construction works affects a significant rate that it saves the world atmosphere from solid waste pollution. Nirmalkumar **Krishnaswami, Sampathkumar Velusamy, Chandrasekaran Palanisamy, Gowthaman Govindarajan, Guhan Elanchezhiyan, Gowtham Ravi(2022)**(Experimental studies on recycled E-wa...) This go-green idea ought to be inspired by research engineers, construction site people and everyone on the relevant personalities of the market today. Aspiring to conserve environments, soils, groundwater aquifers, and surfaces.

Supplementary **cementitious materials** (SCM) have been successfully utilized in concrete buildings, but they have been rarely exploited in concrete pavements. In recent years, due to the growing importance of concrete pavements, researchers have begun studying the performance of various types of SCMs from pavement perspective. The overview herein assesses the existing research associated with utilizing different kinds of silica-rich waste as SCM. **Arunabh Pandey Brind Kumar (2022)** (Pandey and Kumar 2022) For this purpose, five agricultural waste (AW) comprising rice husk ash (RHA), rice straw ash (RSA), corn cob ash (CCA), palm oil fuel ash (POFA), sugarcane bagasse ash (SBA) and three industrial by-products (IB), i.e., fly ash (FA), ground granulated blast furnace slag (GGBFS) and microsilica (MS), were selected. Their effects on various properties of concrete were exhaustively reviewed. This study also furnishes reasons for limited literature on SCMs utilization in concrete pavements. Moreover, this review accentuates the previous studies' gaps, which require further research, such as the need for dedicated standard codes for AW utilization in concrete pavements. The guidance for future research to further enhance the properties of pavement quality concrete is also given.

Incorporation of manufactured e-waste plastic, SG, and CG aggregates increases the workability of concrete owing to their smooth surface texture. However, using unmanufactured e-waste plastic aggregates can decrease the workability of concrete because they (e-waste aggregates) entrap available moisture in created voids, which is required for concrete to flow. **Aamar Danish a, Mohammad Ali Mosaberpanah b, Togay Ozbakkaloglu a, Muhammad Usama Salim c, Kiran Khurshid d e, Muhammed Bayram a, Mugahed Amran f g, Roman Fediuk h i, Diyar N. Qader (2023) (A compendious review on the influence...)** The fresh and dry properties of concrete with e-waste aggregates can be enhanced with admixtures (like fly ash and steel slag), superplasticizer, and biomineralization. However, more data is necessary to estimate the long-term performance potential of e-waste incorporated concrete.

2. Materials and Methods

The experiment was carried out in the Concrete Laboratory of the Civil Engineering Department at Saveetha School of Engineering, using samples obtained from Chettinad cement Concrete from retail stores, RHA in ABG chambers and E-waste in scraps. A total of 36 concrete cube specimens comparing with a ratio of coarse aggregate of 90% of weight and 10% of e-waste of size 12mm - 20mm and with OPC grade of cement 95 % and RHA of 5% (N=18 samples) with Conventional concrete (PQC) were made, with 0.5% volume fraction of Cement with Rice Husk Ash and E-Waste with Coarse Aggregate (CRHA & EWCA). These specimens were allowed to cure for 28 days before being tested for compressive strength to evaluate the impact of steel fibers on PQC Compressive strength. The research study had a sample size of 36, which was divided into two groups of 10 each. The group1 consisted of conventional concrete, while the group 2 used a Cement with Rice Husk Ash and E-Waste with Coarse Aggregate (CRHA & EWCA). The IS: 10262: 2009 concluded that the mix proportion results for M25 grade concrete. The data analysis was conducted using G-power software with a significance level of 0.05 and a power of 0.25. The results are reported with a 95% confidence interval.

3. Conventional Concrete

The ability of a material to resist breaking when it is compressed is measured by its compression strength, The age of the concrete also affects its Compressive strength. Concrete gains strength over time, and typically reaches about 80% of its final strength after 28 days. The longer the concrete cures, the stronger it will become. The Compressive strength of concrete can be tested by placing a cylindrical or cubic sample of concrete in a Compressive testing machine and applying force to it until it fails. It is common practice to express the Compressive strength of ordinary concrete in terms of pounds per square inch (psi) or megapascals (MPa). The compressive strength of conventional concrete, which is a measurement of how well the concrete can withstand being crushed, is often lower than the flexural strength of conventional concrete.

4. Modified Concrete M25 Grade

Cement With Rice Husk Ash and E-Waste with Coarse Aggregate (CRHA & EWCA). is a type of concrete These E-Waste and RHA Are Incorporated into The Concrete Mixture to Increase Its Overall Durability and Strength. The E-Waste Serve as Reinforcement, And Help Distribute Loads and Strains More Uniformly Throughout The concrete. This can increase the concrete's resistance to cracking and other sorts of damage, as well as its medium load-bearing capacity. Cement With Rice Husk Ash and E-Waste with Coarse Aggregate pavement quality concrete (PQA) also improves the structural performance of the pavement, reduces the risk of cracking and improves the durability of the pavement, which leads to a longer service life. The procedure is performed 18 times with cubical specimens in order to obtain a sample of the concrete mixture that is typical of the whole. After that, the compressive strength Cement with Rice Husk Ash and E-Waste with Coarse Aggregate pavement quality concrete is contrasted with the compressive strength of a control sample of plain concrete that does not contain any RHA, E-waste. ASTM (C109) is the standard test method for determining the compression test done by testing a 2-inch hydraulic cement mortar cube to failure. this standard also outlines the various equipment and procedures required to create, mold and prepare the specimens prior to testing to Cement with Rice Husk Ash E-Waste with Coarse Aggregate pavement quality concrete utilizing, primarily for pavement quality concrete (PQA) is often used in high-traffic areas, such as roads and highways, as well as in industrial and commercial applications where the concrete will be subject to heavy loads and high stress.

5. Statistical Analysis

SPSS version 26 software was used to examine the experiment's findings. To determine the statistical significance between the study and control groups, an independent sample t-test was conducted. Compressive strength, concrete quality, water-to-cement ratio, cement quality, and curing days are all independent factors in the study; there are no dependent variables. This tool was used to compute compressive strength and calculate the mean, constant deviation, and constant error of the mean a test was carried out to compare the means of the two groups. Dependent variable is Compressive strength. Independent variables are conventional concrete and Cement with RHA And E-Waste with CA pavement quality concrete

6. Results

The bar graph in Figure 1 compares the compressive strength of conventional concrete to that of M25 grade concrete. It has been determined that the average compressive strength of ordinary concrete is 25 MPa, whereas that of M25 grade concrete is 28-32 MPa. The X-axis of the graph indicates the two types of concrete, while the Y-axis displays the mean flexural strength with a 95% Confidence Interval, represented by 1 Standard Deviation, for each group. **Table 1.** shows the difference in Compressive strength between conventional concrete is 25 N/mm^2, while Cement with RHA And E-Waste with CA PQC has a Compressive strength of 28-32 N/mm^2 This indicates that the Cement with RHA And E-Waste with CA PQC has a higher Compressive strength than the conventional concrete.

Table. 2. The statistical calculations, including mean, standard deviation, and standard error mean, for both conventional concrete and Cement with RHA Additional E-Waste with CA PQC. The Compressive strength parameter was used in the t-test. The mean Compressive strength of the conventional concrete is 25 N/mm^2 and that of the

Cement with RHA And E-Waste With CA-PQC is 26-28 N/mm^2. Indicating that the With RHA And E-Waste With CA-PQC has a smaller uncertainty around its median than the CC.

Table 3: The comparative significance value is 0.001. The independent sample t-test was used in this analysis with a 95% confidence interval and a significance level of 0.333. The results of the test include the significance level (two-tailed), the mean difference, the standard error difference, and the range of the difference between the lower and higher intervals.

7. Discussion

In this work, the compressive strength of traditional concrete and the proposed Cement With RHA And E-Waste With CA-PQC is compared and contrasted. According to the findings, incorporating E-Waste and RHA into concrete can improve both the material's compressive strength and its resistance to plastic deformation. The matrix of the concrete is made more robust by the addition of the E-Waste and RHA. The compressive strength of standard concrete is 25 N/mm^2, whereas the compressive strength of RHA And E-Waste With CA-PQC is 28-32 N/mm^2. According to the findings of the study, the addition of E-Waste and RHA at a volume fraction of 0.5% strengthens the compressive strength of PQC by 10%, resulting in enhanced resistance to cracking and deformation under large loads. The increased Compressive strength of Cement With RHA And E-Waste With CA-PQC makes it a suitable choice for pavement construction as it can withstand heavy loads and high traffic volumes commonly found on roadways and highways.

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8. Conclusion

The use of Cement with RHA And E-Waste With CA-PQC results in a significant increase in Compressive strength compared to conventional concrete. This makes it a more suitable option for pavement construction, as it can better withstand the heavy loads and high traffic volumes typically seen on roadways and highways. The compressive strength of novel PQC reinforced with Cement with RHA And E-Waste with CA is considerably greater than that of normal concrete. The compressive strength of PQC Cement with RHA And E-Waste with CA is 32 N/mm^2, compared to 25 N/mm^2 for normal concrete.

9. Declaration

Conflicts of Interest

No conflict of interest in this manuscript

Authors Contributions

Author name was involved in data collection, data analysis and manuscript writing. Author guide name was involved in conceptualization, data validation, and critical review of manuscripts.

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3. Saveetha School of Engineering

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Tables and Figures

Table 1: Compressive Strength Result of M25 Grade Concrete for the Conventional Concrete

SI.No.	Test Size	Compressive Strength (N/mm^2)	
		Conventional concrete	**Modified Concrete**
1	Test1	27.73	28.57
2	Test2	27.87	29.60
3	Test3	27.91	31.50
4	Test4	27.56	29.00
5	Test5	28.04	29.87
6	Test6	27.24	29.54
7	Test7	28.18	31.20
8	Test8	26.93	31.95
9	Test9	28.31	29.54
10	Test10	26.62	32.20
11	Test1	28.44	29.78
12	Test2	26.31	28.98
13	Test3	28.58	30.30
14	Test4	26.00	30.10
15	Test5	28.71	31.53
16	Test6	25.69	30.48
17	Test7	28.84	31.25
18	Test8	25.38	28.20

Table. 2. The statistical calculations, including mean, standard deviation, and standard error mean, for both conventional concrete and M25 grade concrete. The Compression strength parameter was used in the t-test. The mean Compression strength of the conventional concrete is 32 MPa and that of the Modified concrete M25 is 25 MPa. The standard deviation of the conventional concrete is 0.917and that of the M25 grade concrete is 1.074. The standard error mean of the conventional concrete is 0.21 and that of the M25 grade concrete is 0.25.

Group		N	Median	Standard Deviation	Standard Error Median
Compressive Strength	M25 grade concrete	18	32.5	0.917	0.21
	Conventional Concrete	18	26.3	1.014	0.25

Table 3: Independent-samples-t-test from the spss software statistical analysis and the comparative statistical report of the conventional and modified concrete. The significance p-value greater than 0.05 i.e., p=0.384. There is no significant difference.

Group		Levene's Test for Equality of Variances		t-test for Equality of Medians						
		F	Sig.	t	df	Sig. (2-tailed)	Median Difference	Std. Error Difference	95% Confidence Interval (Lower)	95% Confidence Interval (Upper)
Compressive Strength	Equal variances assumed	0.779	0.384	-8.341	34	0.001	-2.778	0.333	-0.345	-2.101
	Equal variances not assumed			-8.341	33	0.001	-2.778	0.333	-0.345	-2.101

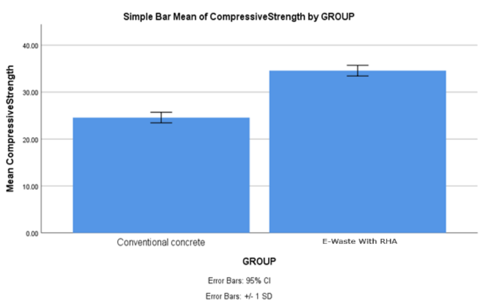

Fig. 1. A bar graph that illustrates the comparison of the Compressive strength between conventional concrete and reinforced Cement with RHA AND E-Waste with CA PQC. The conventional concrete has a mean Compressive strength of 25 MPa while the E-Waste with CA PQC has a mean Compressive strength of 32 MPa. The X-axis shows the two types of concrete while the Y-axis displays the mean Compressive strength with a 95% Confidence Interval (CI) represented by ±1 Standard Deviation (SD) for the two groups.