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"Rubber ash and sewage sludge as a partial course/ fine aggregate replacement in concrete"

Jagruti Kondvilkar[1], Rutuja Gaikwad[2], Sakshi Barve[3], Shashank Banagar[4], Prof. Shilpa Mahajan[5]

[1, 2, 3, 4, 5] Department of Civil Engineering, Genba Sopanrao Moze College of Engineering, Balewadi, Pune – 411045

ABSTRACT

The global increase in vehicle manufacturing has led to a rise in tire production. However, the disposal of waste tires poses significant environmental challenges, including time-consuming processes and damage to the ecosystem. Landfill space scarcity exacerbates this issue. Meanwhile, traditional construction materials like concrete rely on sand, cement, and stone aggregates, sourced from quarries causing environmental degradation. Hence, this research aims to explore the impact of substituting varying amounts of sand with crumb rubber in concrete mixes. Additionally, the incorporation of different percentages of glass fibres aims to enhance compressive strength. The study focuses on replacing old rubber with a new type and mixing concrete aggregates with glass fibres to produce a product with superior engineering properties.

Keywords: -

INTRODUCTION

The exploration of unconventional components like rubber ash and sewage sludge in concrete presents an intriguing avenue. As we delve into the realm of innovative construction practices, the integration of these materials as partial replacements for coarse and fine aggregates in concrete holds the promise of not just structural strength, but also environmentally conscious construction. Rubber ash, a byproduct of tire recycling, and sewage sludge, derived from wastewater treatment, bring forth a unique synergy where waste materials find new life in the creation of durable and resilient concrete structures. This journey into the utilization of alternative aggregates marks a significant step towards eco-friendly construction practices, challenging conventional norms and paving the way for a more sustainable future.

Rubber Ash

Origin and Composition: Rubber ash is a byproduct derived from the recycling of discarded tires. Through a process of controlled combustion, the rubber components of tires are reduced to fine ash particles. Properties: The chemical and physical properties of rubber ash contribute to its appeal as an aggregate replacement. It possesses unique characteristics such as high elasticity and resilience, providing concrete with flexibility and impact resistance.

Environmental Impact: The utilization of rubber ash in concrete not only diverts a significant amount of waste from landfills but also addresses concerns related to the disposal of used tires, contributing to sustainable waste management practices.

Sewage Sludge

Source and Composition: Sewage sludge is a residual product obtained from wastewater treatment processes. Rich in organic and inorganic compounds, sewage sludge can be effectively treated and utilized in concrete production. Properties: The inclusion of sewage sludge in concrete introduces organic matter that enhances workability and
provides supplementary cementitious properties. Additionally, the fine particles in sewage sludge contribute to improved cohesion in the concrete mix.

Sustainability Aspect: Incorporating sewage sludge into concrete aligns with the principles of circular economy, as it transforms a waste product into a valuable resource for construction.

Materials and Methods

Replacement of Rubber Ash

Rubber ash, a byproduct derived from the incineration of discarded tires, has gained significant attention as a potential alternative material in concrete production. This detailed study delves into the various aspects of rubber ash, ranging from its production process to its impact on the properties and performance of concrete.

Figure1.1: Rubber Ash

Waste Reduction and Circular Economy:

Environmental Impact: The integration of rubber ash and sewage sludge addresses the mounting environmental concerns associated with waste disposal. By repurposing these byproducts into construction materials, we contribute to reducing the burden on landfills and minimizing environmental degradation.

Circular Economy: Utilizing rubber ash and sewage sludge aligns with the principles of a circular economy, where waste materials are transformed into valuable resources, promoting a more sustainable and resource-efficient approach to construction.

Resource Conservation:

Reduced Dependency on Natural Resources: Traditional aggregates, such as sand and gravel, deplete natural resources and contribute to environmental disturbances. The motivation for using rubber ash and sewage sludge lies in their potential to serve as alternative materials, reducing the reliance on finite resources and promoting a more sustainable construction industry.

Energy and Cost Efficiency:

Energy Savings: The production of traditional aggregates involves energy-intensive processes, such as quarrying and transportation. Substituting rubber ash and sewage sludge as replacement materials can potentially lead to energy savings by utilizing readily available waste products, contributing to a more energy-efficient construction process.

Cost-Effective Solutions: Integrating waste byproducts into construction materials offers cost-effective alternatives. The motivation lies in exploring economically viable solutions that not only address waste management challenges but also provide construction materials with comparable or enhanced properties.

Environmental Footprint: Carbon Footprint Reduction: Traditional aggregate production contributes to a significant carbon footprint due to extraction, processing, and transportation. The motivation for using rubber ash and sewage sludge stems from their potential to reduce carbon emissions associated with traditional aggregate production, fostering a more environmentally friendly construction industry.

Regulatory Compliance:

Environmental Regulations: Increasingly stringent environmental regulations necessitate a shift towards sustainable construction practices. The motivation for replacing traditional aggregates with rubber ash and sewage sludge is driven by the desire to comply with these regulations, promoting responsible waste management and sustainable building practices.
The motivation for the replacement of rubber ash and sewage sludge in construction is rooted in a holistic approach that seeks to address environmental challenges, conserve resources, and promote innovative, cost-effective, and sustainable practices within the construction industry. As the global community continues to prioritize environmental stewardship, these alternative materials offer a promising pathway towards a more sustainable and resilient built environment.

OBJECTIVE

- To study of this work is to gain a fundamental insight into the drying behaviour of cement-based materials at early-age.
- To investigate the moisture-dependent and the time-dependent properties at early-age of concrete with and without supplementary Cementous materials.
- To Prepare Mixture of Grade M-40 and casting of Cubes as per the methodology
- To Prepare the cubes by replacement of sewage sludge & Rubber Ash with different replacement of percentages
- To Performing Test on Cubes and To optimize the cost

METHODOLOGY

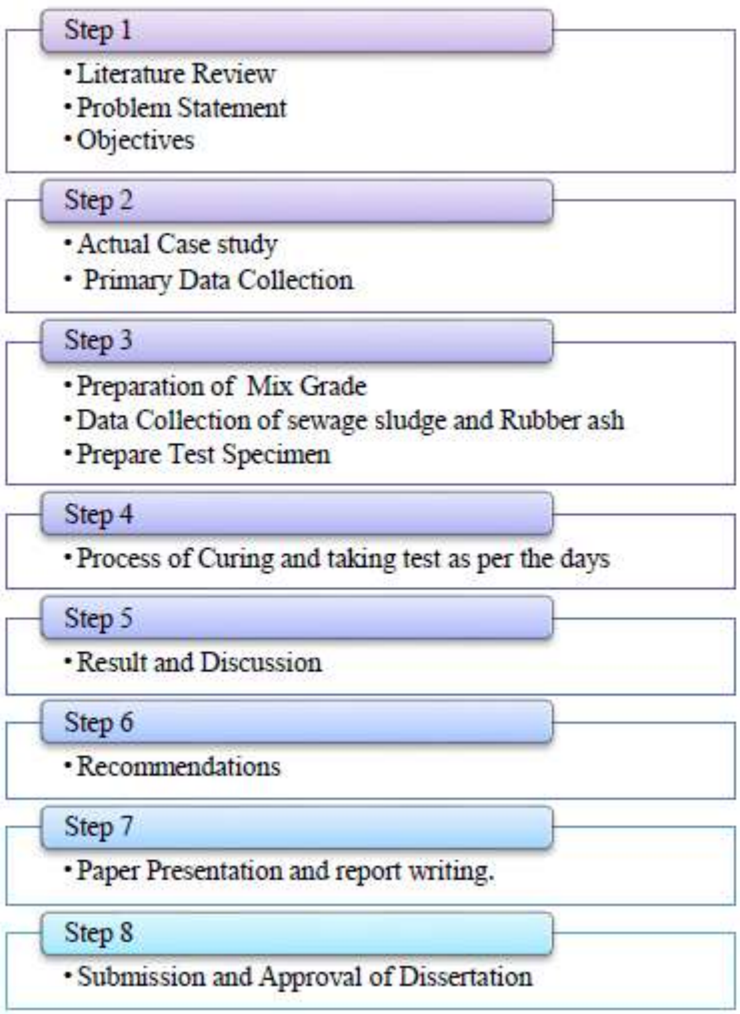


Figure1.2: Research Flow Chart

RESEARCH FRAMWORK MIX DESIGN

1. Mix Design for Grade M 40:
Assumptions for M40:
Characteristics Strength required at 28 days = 40 Mpa
Fly ash grade = Pozzolana 63
Max size of Aggregate = 20 mm
Degree of quality control = Good
Type of exposure = sever.

Procedure of Mix Design

Step 1:

Target mean strength, fck = fck + t x S
Where, t = a statistical value depending on expected proportion of low result t = 1.65 &
S = Standard deviation from Table 3.6
For M40 grade concrete & good quality control, S = 5
Target mean strength = 40 + (1.65 x 5) = 48.25 Mpa

Step 2:

To decide water /cement ratio, this will give 48.25 Mpa
Select water /cement ratio (w/c) = 0.4; this is lesser than 0.45 prescribed in
I.S 456-2000[20] for sever condition for reinforced concrete (Table 3.7).

Step 3:

Selection of water content: from Table 3.9
For 20 mm size of aggregate use maximum water content 186 lit.
For 100 mm slump = 186 + (6/100) ×186 = 197

Step 4:

Calculation of cement content:
Cement content: 197/0.4 = 492.5 kg/m^3
492.5 kg/m^3 > 320 kg/m^3 … OK

Step 5:

Volume of C.A. and F.A.:
Table 3.10, Volume of C.A. corresponding to 20 mm size of aggregate and F.A. zoneII for W/C ratio = 0.4 Therefore, Volume of C.A. = 0.56 and Volume of F.A. = 0.44.

Step 6:

Mix calculation:
i. Volume of concrete = 1 m^3
ii. Volume of fly ash = (Mass of fly ash/ Specific gravity of fly ash) × (1/1000)
= (492.5 /2.3) × (1/1000) = 0.2141 m^3
iii. Volume of water = (water/ Specific gravity of water) × (1/1000)
= (197/ 1) × (1/1000) = 0.197 m^3

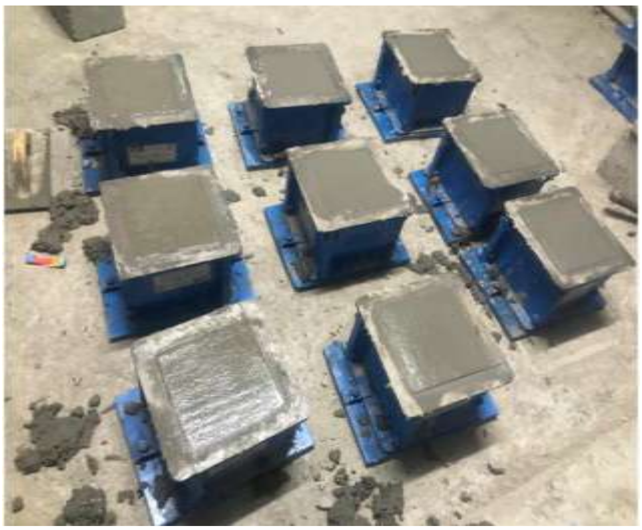
iv. Volume of all aggregate = i- (ii + iii)
= 1- (0.2141+0.197)
= 0.5889 m^3
v. Mass of C.A. = iv × volume of C.A. × Specific gravity of C.A. × 1000
= 903.60 kg.

vi. Mass of F.A. = iv × volume of F.A. × Specific gravity of F.A. × 1000
= 709.89 kg.
[Note: 1. Replace cement by fly ash by 100%
2. Replace water by alkaline solution such as sodium silicate and sodium hydroxide by 100%.]

Table No.1.1: Mix proportion of Concrete for M40

Rubber Ash	NaOH	Na2SiO3	F.A.	C.A.
1	0.114	0.285	1.44	1.827

CASTING CUBE



TESTING OF SPECIMEN:

Testing of hardened concrete plays an important role in controlling and confirming the quality of raw materials, which help to achieve higher efficiency of material used and greater assurance of performance of concrete.

In the present study test conducted on harden concrete were carried out by using Compressive Testing Machine (CTM) of capacity 2000 kN and Universal Testing Machine (UTM) of capacity 200 KN as per IS 516:1959

Table shows the 7-day compressive strength test result for M40 concrete. Ponding" had the highest average compressive strength, followed by "wet-covering" and the cube with least average compressive strength was "sprinkling."

Table1.1: Test Results of 7 Days on Cube Test

Type Of Curing	% Rubber Ash	Compressive Strength (Mpa)
SPRINKLING	10%	21.5
	20%	20.1
	30%	28.4
	40%	27.5
PONDING	10%	27.3
	20%	26.5
	30%	30.36
	40%	28.3
WET COVERING	10%	21.1
	20%	24.5
	30%	29.3
	40%	21.4
OPEN AIR CURING	10%	20.4

Table1.2: Test Results of 14 Days on Cube Test

TYPE OF CURING	% Rubber Ash	COMPRESSIVE STRENGTH(MPa)
SPRINKLING	10%	35.7
	20%	33.5
	30%	41.16
	40%	32.8
PONDING	10%	38.5
	20%	39.4
	30%	41.5
	40%	38.6
WET COVERING	10%	37.0
	20%	37.5
	30%	40.9
	40%	37.4
OPEN AIR CURING	10%	35.8

	20%	34.6
	30%	39.5
	40%	35.6
	20%	25.5
	30%	24.8
	40%	26.4

Table1.3: Test Results of 28 Days on Cube Test

TYPE OF CURING	% Rubber Ash	COMPRESSIVE STRENGTH(MPa)
SPRINKLING	10%	39.5
	20%	39.8
	30%	38.8
	40%	38.6
PONDING	10%	40.1
	20%	41.3
	30%	42.3
	40%	41.7
WET COVERING	10%	40
	20%	39.7
	30%	38.7
	40%	40.3
OPEN AIR CURING	10%	38.8
	20%	38.6
	30%	40.06
	40%	39.8

Table1.4: Test Results of 7 Days on Cube Test using Sludge

Type Of Curing	% Sludge	Compressive Strength (Mpa)
SPRINKLING	10%	37.3
	20%	35.7
	30%	21.8
	40%	15.1
Ponding	10%	38.7
	20%	36.6
	30%	23.8
	40%	16.5
WET COVERING	10%	38.7
	20%	34.5
	30%	22.3
	40%	15.8
OPEN AIR CURING	10%	35.7
	20%	33.7
	30%	21.8
	40%	13.8

Table1.5: Test Results of 14 Days on Cube Test using Sludge

Type Of Curing	% Sludge	Compressive Strength (Mpa)
SPRINKLING	10%	35.9
	20%	37.7
	30%	22.03
	40%	20.3
Ponding	10%	39.5
	20%	38.4
	30%	25
	40%	21.4
WET COVERING	10%	38.4
	20%	36.9
	30%	23.7
	40%	20
OPEN AIR CURING	10%	37
	20%	34.2
	30%	21.4
	40%	19.7

Table1.6: Test Results of 28 Days on Cube Test using Sludge

Type Of Curing	% Sludge	Compressive Strength (Mpa)
SPRINKLING	10%	39.5
	20%	37.9
	30%	27.3
	40%	20.6
PONDING	10%	40.1
	20%	38.8
	30%	25.4
	40%	21.6
WET COVERING	10%	38.4
	20%	36.1
	30%	22.7
	40%	19.5
OPEN AIR CURING	10%	37.6
	20%	34.1
	30%	21.2
	40%	19.8

CONCLUSION

· We're looking at the viability of employing both single blended mix and combined blended mix to expand the range of applications for these materials

· We'll see whether that's possible in this study.

· Experimental studies study the effects of Rubber Ash and Sewage Sludge partial substitution on the fresh and hardened characteristics of concrete mixtures.

· A conclusion may be drawn from the results of this study's experiments.
· Rubber Ash and Sewage Sludge were added in percentage increment of 10%, 20%, 30%, and 40%.
· The compressive strength was analyzed for 3, 7, 14, 28 days for both replacements and curing methods. · It is found that 30% replacement of Rubber Ash with Ponding curing gives strong compressive strength and 10% replacement of Sewage Sludge with Ponding curing gives strong compressive strength.
· It can be concluded that at the right percentage replacement of either Rubber Ash or Sewage Sludge with Ponding curing method as compared to sprinkling, wet covering & open-air curing methods, there was an increase in the compressive strength of the concrete.
· This shows that Rubber Ash and Sewage Sludge have the potential to be used as partial replacements with right curing method in concrete production.
· It can be concluded that for Ponding and Wet covering methods this decrease in compressive strength of concrete can be controlled.

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