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Comparative Analysis of Normal Plaster and Ready-Mix Plaster

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ABSTRACT - This study offers an in-depth comparison between traditional plaster and modern ready-mix plaster, both of which are commonly used in construction. The paper explores various characteristics of these materials, such as their composition, application techniques, properties, and environmental effects. Traditional plaster, typically made from a mixture of cement, sand, and water, has been a fundamental material in construction for centuries. The process of making this plaster traditionally involves combining the ingredients on-site, which can be labour-intensive and sometimes lead to variations in quality. In contrast, ready-mix plaster is delivered to the construction site as a pre-prepared mixture. It often contains additional components like polymers and fibres, which improve its overall performance.

Key Words: traditional plaster, RMC, sulphonated naphthalene formaldehyde, bagasse ash.

1.INTRODUCTION

1.1 Ready-Mix Plaster:

Ready-mix plaster is a pre-prepared product that is ready for immediate use, eliminating the need to manually mix dry ingredients with water on-site. It is typically composed of gypsum or plaster of Paris, combined with water and various additives that enhance its workability, adhesion, and drying time. This type of plaster is commonly used in construction for tasks such as smoothing interior surfaces, repairing cracks, or adding decorative finishes. Its primary benefit lies in the convenience it provides, as it can be directly applied from the container, saving both time and labour.

1.2 Conventional Plaster:

Conventional plaster, often referred to as traditional plaster, is a mixture prepared on-site by combining dry plaster materials—such as gypsum, lime, or cement—with water to create a paste. This paste is then applied to surfaces like walls and ceilings to form a smooth, durable finish. Unlike ready-mix plaster, conventional plaster demands more skill and labour during preparation, as it is essential to achieve the correct ratio of materials and water for proper consistency and adhesion. This type of plaster is used in both interior and exterior applications and can be layered to create the desired thickness or texture.

2. LITERATURE REVIEW

The extensive literature survey has been carried out through various sources. The comprehensive review of literature is presented below

2.1. Hamonangan, G. I. R. S. A. N. G., & Nazmi, H. T. M. (2020)- This research examines a comparison between ready-mix mortar and conventional mortar in terms of cost, quality, and time efficiency for constructing red brick walls with plaster. The findings indicate that after 28 days, the compressive strength of Mortar RM-115 was 215.88 kg/cm², significantly higher and more consistent than that of conventional mortar, which had a compressive strength of 151.76 kg/cm². In some cases, the conventional mortar did not meet the desired standards during application.

The time required to complete the red brick wall construction using Mortar RM-115 was 14 days, whereas the use of conventional mortar took 15 days. Therefore, the use of Mortar RM-115 proved to be one day more efficient and offered cleaner storage compared to conventional mortar. In terms of cost, the total expense for installing red brick walls with Mortar RM-115 in Bintaro Sector 7 amounted to Rp. 36,858,425.99. On the other hand, the cost for the same task with conventional mortar, including plastering, was Rp. 47,188,780.22. Although Mortar RM-115 resulted in a higher installation price by Rp. 10,330,354.23, it still offered a more efficient and reliable solution.

2.2. Delinière, R., Aubert, J. E., Rojat, F., & Gasc-Barbier, M. (2014)

This study focuses on the analysis of five ready-mixed clay plasters sourced from French brickworks, evaluated according to the latest German standards. The primary objective of the research was to assess the flow properties of fresh clay plasters and their behaviour once hardened, including shrinkage, compressive strength, flexural strength, and adhesive strength. The results of the analysis indicated that the granular properties of the samples were largely similar, with the key distinction being the type of clay minerals they contained. Four of the samples were predominantly composed of montmorillonite, chlorite, and illite, while one sample was made almost entirely of kaolinite. Despite this variation in mineral content, the flow properties of the fresh plasters and their hardened characteristics were comparable. Based on these findings, the authors suggest that the current procedures for measuring adhesive strength should be refined and adapted. Additionally, they propose the development of new testing methods to better assess this important characteristic, both in laboratory settings and on construction sites.

2.3. Freire, M. T., do Rosário Veiga, M., Silva, A. S., & de Brito, J. (2019)

This research investigates the physical and mechanical properties of 44 gypsum-based plaster samples from ancient structures, providing a foundation for designing compatible restoration materials. The study analyzed three types of plaster: thin-layer, on-site molded, and pre-molded. The findings revealed a clear relationship between the plaster composition and the application method. Each type of plaster exhibited distinct porosity characteristics, with the on-site molded elements showing the highest water absorption, while thin-layer samples demonstrated the lowest. Additionally, the mechanical properties of the plasters appeared to correlate with their composition: a higher gypsum content was associated with increased compressive strength and greater ultrasound pulse velocity. Based on these results, the study established quantitative guidelines for developing restoration materials that would be compatible with the original plasters.

3. PROBLEM STATEMENT

This study aims to conduct a comparative analysis of traditional "normal plaster" and "ready-mix plaster" across various criteria, such as cost, ease of use, time efficiency, finish quality, durability, and environmental impact. By exploring how these materials perform and their suitability for different construction contexts, the study intends to offer valuable insights for industry professionals, assisting them in selecting the most appropriate plaster material based on the specific requirements of their projects.

A. Cost Comparison: This section will compare the upfront and long-term costs of using normal plaster versus ready-mix plaster.

B. Ease of Application: This part will evaluate the practical considerations involved in applying both types of plaster, including labor demands, skill levels, and the complexity of mixing and applying the materials.

C. Time Efficiency: The analysis will assess how quickly each plaster type can be applied and dried, helping to understand their impact on the overall project schedule.

4. PROJECT OBJECTIVES

A. To analyze the performance of plaster materials in terms of strength, durability, and other key properties.

B. To assess the long-term durability and resistance of normal plaster compared to ready-mix plaster, including factors such as:

i. Resistance to cracking, chipping, and damage from moisture.
ii. Effects of environmental conditions like temperature changes, humidity, and exposure to water.

C. To evaluate the environmental impact of both normal and ready-mix plasters, focusing on aspects such as raw material sourcing, manufacturing, transportation, and disposal:

i. Carbon emissions associated with manufacturing and transportation processes.
ii. Sustainability of raw materials, including the sourcing of sand, cement, and additives.
iii. Considerations regarding waste generation and disposal.

5. MATERIALS USED IN THE STUDY

5.1 CONSTITUENTS OF CONCRETE MIX

Concrete is a composite material formed by combining cement, water, fly ash, sand, and quarry dust.

5.1.1 CEMENT

The entire experimental study utilized Ordinary Portland Cement (53 Grade).

5.1.2 WATER

Potable water, free from organic impurities, was used for mixing and curing the concrete in this study.

5.1.3 SAND

Sand is a granular material made up of fine mineral particles. It varies in composition but is generally characterized by its grain size. Sand grains are finer than gravel but coarser than silt. It is classified into fine, medium, and coarse categories based on grain size, ranging from 0.063 mm to 2.0 mm, as defined by ISO 14688**.**

5.1.4 BAGASSE ASH

Bagasse ash is a byproduct of burning sugarcane bagasse, the fibrous residue left after sugar extraction. It is commonly used as a pozzolanic material in concrete due to its silica content. The preparation process for bagasse ash includes several steps to ensure its quality and functionality in construction applications.

Preparation of Bagasse Ash:

i. Collection of the sample
ii. Drying for two days
iii. Grinding the dried waste into powder
iv. Burning the powder
v. Final preparation of the bagasse ash

5.1.4.1 Physical Properties of Bagasse Ash

i. Specific Gravity: 1.91
ii. Moisture Content: 46%
iii. Consistency: 50%
iv. Initial Setting Time (minutes): 195
v. Final Setting Time (minutes): 330

5.1.5 Sulphonated Naphthalene Formaldehyde (SNF)

Sulphonated Naphthalene Formaldehyde (SNF) is a high-performance superplasticizer and water-reducing agent widely used in the construction industry, especially in concrete and cement applications. It is produced by sulphonating naphthalene and formaldehyde, a process that incorporates sulfonate groups into the molecule. These sulfonate groups are responsible for SNF's ability to reduce water content, which enhances the workability and strength of concrete.

5.1.5.1. Properties of Sulphonated Naphthalene Formaldehyde (SNF)

i. **High Water-Reduction Efficiency**: SNF can significantly reduce the amount of water needed in concrete mixtures (up to 25-30%) while maintaining the desired workability.
ii. **Improved Workability**: The use of SNF makes concrete smoother and more fluid, facilitating easier placement and finishing without the need for extra water.
iii. **Enhanced Strength:** By reducing the water content while preserving the cement quantity, SNF contributes to stronger and denser concrete, resulting in better durability.
iv. **Better Durability:** SNF decreases the porosity of concrete, improving its resistance to environmental factors such as chemical corrosion, freeze-thaw damage, and other external stresses.
v. **Compatibility**: SNF is compatible with various types of cement and supplementary materials like fly ash, slag, and silica fume.

6. CASTING PROCEDURE OF PLASTER

6.1. Mix Design:

• Grade Designation = MM5
• Ratio 1:4
• Type of Cement = OPC-43
• Max Nominal Size of Aggregate = 2.36mm
• Density of Cement = 1440 Kg/m3
• Density of Sand = 1650 Kg/m3 (may vary from 1550 to 1650 Kg/m3)

a) Target Strength
F'ck = 5 to 7.5 N/mm2 (as per IS 2250-1981 table,
Where F'ck = Compressive Strength after 28 days.

b) Dry Volume of Plaster
• Total weight of Plaster Volume = 0.0706 X 0.0706 X 0.0706 = 0.00035 m3
• Volume for 6 cube = 0.00035 X 6 = 0.0021 m3
• Dry Volume of Plaster = 0.0021 + 33% of 0.0021 = 0.0027 m3

c) Weight Calculation of Cement Sand
• Volume of Cement = 0.00054 m3
• Volume of Sand = 4 X 0.00054 = 0.00216 m3
• Weight of Cement = 0.00054 X 1440 = 0.777 Kg
• Weight of Sand = 0.00216 X 1650 = 3.564 Kg
• Total Weight of dry ingredients = 4.341 kg

d) Water Quantity
• To Determine the water quantity, need to take 20% of Dry Ingredients
• 20% of 4341 = 0.868 lit

6.2. Sieve Analysis of Material:

The sieving process involves passing a material through a mesh or other device with an opening size of less than the material's particle size. The particles will either pass through to the other side, be caught in the mesh, or be deflected according to the shape of the opening.

6.3. Weighing and Batching Process:

The materials are weighed accurately based on the specific mix design or recipe, which varies depending on the desired properties of the plaster (e.g., strength, workability).
The process of weighing materials for plaster is crucial to ensure the correct proportions and consistency of the mix. The right ratio of ingredients (e.g., cement, sand, lime, and additives) is essential for the desired properties of the plaster, such as workability, strength, durability, and finish quality. Accurate weighing helps maintain uniformity in the plaster and minimizes the risk of defects like cracking, poor adhesion, or uneven texture.

6.4. Mixing Process and Casting of Material:

This mix, composed of cement, sand, and water, is commonly used due to its durability and flexibility. The cement-to-sand ratio typically ranges from 1:3 to 1:6 based on project requirements. This mix is stronger than lime mortar, making it suitable for long-lasting, modern construction applications.

6.5. Curing of Cube

Curing involves managing moisture, temperature, and time to ensure that plaster hardens correctly and reaches its desired strength. Effective curing is essential to achieve a durable and crack-resistant finish. Without proper curing, plaster may suffer from cracks, shrinkage, or loss of strength, resulting in substandard outcomes.
In this study, a total of 52 test cubes were cast, including both Traditional and Ready- Mix Plaster samples. These cubes were prepared for various testing needs, including compressive strength tests conducted at intervals of 7, 14, and 28 days. Additional tests included drying shrinkage and water absorption assessments.

7. RESULT

7.1 CEMENT

To verify quality, strength, and durability, both cement and sand materials undergo essential tests. Cement tests commonly performed include fineness, consistency, setting time, compressive strength, and soundness, which help ensure the material meets construction standards.

TABLE .1 TESTING RESULT OF CEMENT

Sr. No.	Particular	Test Result	Requirement of IS CODE
1	Fineness	7%	IS 4031(part-2) -1999 10%
2	Consistency %	30%	IS 4031(part-4) - 1988 26-33%
3	Setting Time (min) a) Initial setting Time b) Final setting Time	35 min 360 min	IS 4031(part-5) -1988 30 (Min) 600 (Max)

7.2. SAND

Key tests for sand include evaluating silt content, particle size distribution, bulking, and moisture levels. These assessments help confirm that both sand and cement meet quality requirements, supporting the overall strength and longevity of the construction.

TABLE 2 TESTING RESULT OF SAND

Sr. No.	Particular	Test Result	Requirement of IS CODE
1	Moisture Content	8.45%	IS 2386
2	Sieve Analysis (FM)	2.6	IS 2386 (Part 1) 2.2-2.6 fine sand 2.6-2.9 medium sand >2.9 coarse sand
3	Specific Gravity	2.57	IS 2386 (Part-3) 2.65-2.67
4	Bulking of Sand	8%	IS 2386 (Part 3)

7.3 COMPRESSIVE STRENGTH TEST

The compressive strength test was Carried as per IS:2250, Test specimens of 70.6mm x 70.6mm x70.6 mm Cube were Casted and the compressive strength test was Carried for 7, 14 & 28 days of Curing.

TABLE 3. COMPRESSIVE STRENGTH TEST RESULT

No.	Mortar	Ratio	Sample	Compressive Strength (N/mm²)		
				7D	14D	28D
1	Traditional Plaster	1:4	1	4.55	6.65	6.93
			2	4.9	6.3	6.97
			3	6.44	6.79	7.32
2	Ready Mix Plaster	1:4	1	5.81	7.68	7.92
			2	5.41	7.52	7.88
			3	6.01	7.2	8.41

7.4. WATER ABSORPTION TEST

The compressive strength test adhered to IS:2250 standards. Test cubes with dimensions of 70.6 mm x 70.6 mm x 70.6 mm were cast and tested after curing periods of 7, 14, and 28 days. After casting, the cubes were submerged in water for 30 and 90 days for curing. Their wet weight (WW) was recorded before drying them in an oven at 110°C until they reached a stable mass, which was then recorded as the dry weight (DW).

TABLE 4 WATER ABSORPTION TEST RESULT

No.	Mortar	Ratio	Sample	Ww of Sample (Kg)	Wd of Sample (Kg)	Water Absorption (%) – 30 Days
1	Traditional Plaster	1:4	1	0.746	0.692	7.80
			2	0.726	0.674	7.71
			3	0.725	0.660	9.84
2	Ready Mix Plaster	1:4	1	0.727	0.686	5.97
			2	0.825	0.786	4.96
			3	0.756	0.725	4.27

7.5. DRYING SHRINKAGE TEST

The drying shrinkage test was conducted according to IS:4031 (Part 10)-1988 and ASTM C 157/C 157-08. Rectangular specimens of 25 mm x 25 mm x 250 mm were prepared, and shrinkage measurements were taken at 7 and 35 days.

TABLE 5 DRYING SHRINKAGE TEST RESULT

Mortar Mix	Lx (%) 3 days	Lx (%) 7 days	Lx (%) 35 days
Traditional plaster	0	-0.0568	-0.0374
Ready mix plaster	0	0.0230	0.0179

7.6 TESTING OF MORTAR CUBE (WITH ADMIXTURE)

7.6.1. BAGASSE ASH

Bagasse, a dry, fibrous material left after extracting juice from sugarcane stalks, is estimated to produce around 250 million tons of waste annually, with India contributing approximately 40 million tons. Rich in silica and alumina, bagasse ash enhances the strength and durability of plaster when used as an additive.

TABLE 6 BAGASSE ASH RESULT

Characterises	5% replaced bagasse cement	15% replaced bagasse cement	25% replaced bagasse cement
Specific gravity of cement	3.13	2.97	2.83
Fineness of cement	7%	7%	6.5%
Normal consistency	30%	40%	44%
Initial setting time (min)	35	50	70
Final setting time (min)	280	295	335

7.6.2. SULPHONATED NAPHTHALENE FORMALDEHYDE

Sulphonated naphthalene formaldehyde (SNF) is an effective additive that enhances the flow and workability of plaster, especially in projects requiring high strength and durability. It works by lowering the water's surface tension, allowing cement particles to disperse and bond more effectively. When used alongside bagasse ash, SNF can offer significant cost benefits over ready-mix plaster in construction.

TABLE.7 COMPRESSIVE STRENGTH OF MORTAR

Characterises	5% replaced bagasse cement	15% replaced bagasse cement	25% replaced bagasse cement
Specific gravity of cement	3.13	2.97	2.83
Fineness of cement	7%	7%	6.5%
Normal consistency	30%	40%	44%
Initial setting time (min)	35	50	70
Final setting time (min)	280	295	335

8. CONCLUSIONS

i. Bagasse ash, a byproduct of sugarcane processing, is an affordable alternative to traditional plaster materials. It is often low-cost or even regarded as waste, making it an economical option that still improves plaster strength and durability while reducing material costs.

ii. As a strong water-reducing agent, SNF increases plaster workability and fluidity without compromising strength. By minimizing water requirements, it shortens setting time and lowers labor costs. Additionally, SNF allows for a reduction in cement content due to its plasticizing effects, further decreasing expenses.

iii. Using bagasse ash and SNF creates a more cost-effective plaster solution, with the potential to lower construction costs by 30–45%. These materials also promote sustainable practices by recycling agricultural waste (bagasse ash) and reducing cement use. Quality control, however, remains crucial, as variations in bagasse ash quality may influence the final plaster properties.

9. PHOTOGRAPHS OF THE STUDY

FIGURE: 1 SIEVE ANALYSIS

FIGURE: 2 CASTING OF MATERIAL


FIGURE: 3 CTM TEST OF CUBES


FIGURE:4 DRYING SHRINKAGE TEST APPARATUS


FIGURE:4SULPHONATED NAPHTHALENE FORMALDEHYDE

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