Utilization of Chemical Sludge from Paint Manufacturing Effluent Treatment for Sustainable Brick Production

[1] Rajkumar Lakhotia and [2] Prathamesh Ankush More [3] Shivani Krantikumar Wadke
[1] M. Tech Environmental Engineering Dr. Babasaheb Ambedkar Technological University, Lonere
[2] M. Tech Environmental Engineering Dr. Babasaheb Ambedkar Technological University, Lonere
[3] M.Sc. Organic Chemistry D.G. Tatkare Mahavidyalaya, Mangaon, Raigad

Abstract— **This study explores the innovative reuse of chemical sludge generated from effluent treatment processes in paint manufacturing industries for sustainable brick production. The chemical sludge, typically considered hazardous waste, was characterized for its physical and chemical properties and incorporated into clay-based brick formulations. Laboratory tests assessed the mechanical strength, water absorption, and thermal conductivity of the resulting bricks. The findings revealed that up to a certain percentage of sludge incorporation improved brick durability while reducing environmental impact. This approach not only diverts industrial waste from landfills but also promotes circular economy principles in construction materials. The research demonstrates a viable pathway for transforming industrial by-products into value-added products, contributing to sustainable development and waste minimization.**

Index Terms— **Chemical sludge, Paint industry effluent, Sustainable construction, Waste valorization, Brick manufacturing, Circular economy, Industrial waste reuse, Effluent treatment, Eco-friendly building materials, Sludge-based bricks**

I. INTRODUCTION

In the paint manufacturing industry, the chemical sludge generated from the primary treatment of effluent poses a significant environmental disposal challenge. Typically characterized by low calorific value (<2500 kcal/kg), this sludge is not viable for incineration or co-processing, leading to its disposal via landfilling. However, landfilling not only incurs high costs but also contributes to long-term environmental degradation and loss of land resources. This study explores the potential of utilizing such sludge as a raw material in brick manufacturing by blending it with industrial by-products like fly ash and cement. The goal is to develop a value-added, sustainable building material, thereby reducing the environmental footprint of sludge disposal.

II. LITERATURE REVIEW

Industrial waste utilization in construction materials has been a growing area of research. Fly ash, a by-product of coal combustion, has been widely used in brick manufacturing due to its pozzolanic properties and availability (Safiuddin et al., 2010). Several studies (Singh et al., 2014; Raut et al., 2011) have investigated the incorporation of various industrial wastes such as sewage sludge, red mud, and marble dust into bricks. Chemical sludge from ETPs, however, presents more complex challenges due to its variable composition, heavy metal content, and low binding characteristics. Studies by Reddy et al. (2018) demonstrated that when blended with cementitious materials, such sludge can contribute to usable bricks meeting strength and durability criteria for non-load-bearing applications. Despite this, literature on the use of sludge from paint industry effluents is minimal, and this study aims to fill that gap.

III. EXPERIMENTAL PART

This study involved the development of bricks using various combinations of chemical sludge, fly ash, and cement. The sludge was sourced from the primary treatment section of the ETP in a paint manufacturing facility located in Mahad, Raigad. The following steps were taken:

3.1 Sample Collection & Preparation**:** Dewatered sludge was collected and air-dried to remove excess moisture. Fly ash and OPC 43-grade cement were used as additive binders.

3.2 Mixing Ratios: Four sets of brick compositions were prepared, each with varying proportions of sludge, fly ash, and cement.
3.3 Molding and Curing: Bricks were molded using standard molds (5.5 cm x 10 cm x 20 cm), demolded after 24 hours, and cured for 28 days under moist conditions.

IV. RESULT AND DISCUSSION

Table No.1 Composition Details

Sr.No	SET 1	SET 2	SET 3	SET 4
Fly Ash	60%	60%	50%	30%
Cement	20%	10%	30%	20%
Sludge	20%	30%	20%	50%
Sr.No	SET 1	SET 2	SET 3	SET 4
	gm	Gm	Gm	Gm
Fly Ash	660	660	550	330
Cement	220	110	330	220
Sludge	220	330	220	550
Total	1100	1100	1100	1100

Key Observations:
A) Set 3, containing 550 gm fly ash, 330 gm cement, and 220 gm chemical sludge, exhibited the best performance with a compressive strength of 5.5 N/mm² and acceptable water absorption (10.1%).
B) This composition meets the IS 1077:1992 standard for second-class bricks (minimum strength ≥5 N/mm²).
C) Efflorescence test results showed only slight white salt deposits, indicating acceptable quality.
D) Other sets were either too weak or showed high water absorption, making them unsuitable.

Fig.No.1 Mixing

Fig.No.2 Mold Readiness

Fig.No.3 Mixture filling

Fig.No.3 Drying

V. CONCLUSION

This study successfully demonstrates the feasibility of utilizing low-calorific-value chemical sludge from paint industry ETPs in the production of sustainable construction bricks. By optimizing the mix design with fly ash and cement, a brick of acceptable quality and strength (Set 3) was developed. These bricks fulfill the criteria for second-class bricks and can be used in non-load-bearing applications, such as compound walls, pavements, and partition walls. The proposed approach not only reduces sludge disposal volumes but also promotes circular economy practices in the paint manufacturing sector.

REFERENCE

[1] Safiuddin, M., et al. (2010). *Utilization of fly ash in construction materials*. Journal of Materials in Civil Engineering, 22(3), 242–252.
[2] Singh, M., Siddique, R., & Rajor, A. (2014). *Strength and durability of concrete incorporating ETP sludge*. Construction and Building Materials, 61, 216–224.
[3] Raut, S.P., et al. (2011). *Development of sustainable construction material using industrial waste*. Construction and Building Materials, 25(1), 371–377.
[4] Reddy, M., Kumar, R., & Prasad, D. (2018). *Manufacturing bricks from sewage sludge and fly ash*. International Journal of Environmental Science and Technology, 15, 2153–2162.
[5] Bureau of Indian Standards. (1992). *IS 1077: Common Burnt Clay Building Bricks - Specification*, New Delhi.