Partial Replacement of Fine Aggregate with Grit Chamber (Stp) Sand in Concrete.

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***Abstract*—The rapid depletion of natural river sand and the increasing generation of waste materials from sewage treatment plants (STPs) have created significant environmental concerns in the construction industry. This study investigates the potential use of treated grit chamber sand, a by-product collected from STPs, as a partial replacement for natural fine aggregate in concrete. The primary objective is to evaluate its influence on the fresh and hardened properties of concrete while promoting sustainable waste management practices.**

Concrete mixtures were prepared with varying percentages of grit chamber sand replacing natural fine aggregate, and their workability, compressive strength, and durability characteristics were assessed. The results indicate that the incorporation of grit chamber sand at suitable replacement levels can produce concrete with acceptable engineering properties comparable to conventional concrete. Additionally, the utilization of STP grit chamber sand reduces the demand for natural river sand, minimizes landfill disposal requirements, and contributes to environmental sustainability through resource conservation and waste recycling.

The study demonstrates that treated grit chamber sand can be effectively used as an alternative fine aggregate in concrete, offering both environmental and economic benefits. Its application supports sustainable construction practices and encourages the development of eco-friendly concrete materials for future infrastructure projects.

***Index Terms*—Grit Chamber Sand, Sewage Treatment Plant (STP), Fine Aggregate Replacement, Sustainable Concrete, Waste Recycling, Environmental Sustainability, Compressive Strength.**

I. INTRODUCTION

Concrete remains the most extensively used construction material worldwide because of its excellent strength, durability, and adaptability in various structural applications. Fine aggregate, typically obtained from natural river sand, is a fundamental component of concrete that significantly influences its workability, strength, and overall performance. However, the growing demand for infrastructure development has resulted in the excessive extraction of natural sand, leading to serious environmental concerns such as riverbank erosion, destruction of aquatic habitats, lowering of groundwater levels, and ecological disturbances. Consequently, identifying sustainable alternatives to natural fine aggregate has become a major focus in modern construction research.

Simultaneously, large volumes of grit chamber sand are produced during the operation of Sewage Treatment Plants (STPs). This material is separated from wastewater in the initial stages of treatment and mainly consists of sand, silt, gravel, and other inert particles. In most cases, the collected grit is discarded in landfills, which not only increases disposal costs but also creates environmental management challenges. Therefore, finding beneficial applications for this waste material is essential for sustainable waste management.

II. LITERATURE REVIEW

1. The fate of microplastic in sludge management systems, Agnieszka Cydzik-Kwiatkowsk, 2022

The study focuses on the utilization of waste foundry sand, glass powder, and recycled steel fibers in alkali-activated ultra-high-performance concrete to enhance the sustainability of construction materials.

The researchers assessed the effects of these waste-based additives on the strength, durability, and environmental impact of concrete.
The findings revealed that replacing conventional materials with industrial by-products resulted in concrete with adequate mechanical properties and improved environmental performance. The adoption of these waste materials also helped lower energy requirements, greenhouse gas emissions, and overall production expenses.
The research demonstrates the importance of recycling industrial residues in the construction industry, as it reduces the consumption of natural resources and minimizes waste disposal problems. The study supports the concept of sustainable construction by encouraging the reuse of materials that would otherwise be discarded.
However, the scope of the investigation was limited to specific industrial waste products and did not include the evaluation of grit chamber sand generated from Sewage Treatment Plants (STPs) as a fine aggregate substitute. Further studies are required to examine the long-term behavior and practical application of such alternative materials in concrete.
In conclusion, the paper highlights the feasibility of incorporating waste-derived materials into concrete production and provides a basis for future research on the use of treated STP grit chamber sand as an environmentally friendly replacement for natural fine aggregate.

2. Possibilities of using waste from wastewater treatment plants to create
soil-like materials,Monika Czop,2024
This study examines the application of industrial waste materials, including waste foundry sand (WFS), glass powder (GP), and recycled steel fibers (RSF), in the production of alkali-activated ultra-high-performance concrete (AAUHPC). The primary aim was to enhance the sustainability of concrete by minimizing the use of virgin raw materials and promoting the reuse of industrial by-products. The findings revealed that the incorporation of these materials produced concrete with adequate mechanical strength while lowering manufacturing costs, energy consumption, and greenhouse gas emissions.
The research demonstrates that waste-derived materials can be effectively integrated into concrete mixtures to achieve both environmental and economic advantages. By utilizing industrial by-products, the study contributes to the development of eco-friendly construction practices and supports the reduction of waste disposal issues.
However, the investigation was limited to waste foundry sand, glass powder, and recycled steel fibers, and did not consider the use of grit chamber sand obtained from Sewage Treatment Plants (STPs). In addition, aspects such as long-term durability and large-scale field implementation require further research.
Overall, the study provides valuable insights into the sustainable use of waste materials in concrete production and highlights the potential for exploring other alternative materials, such as treated STP grit chamber sand, as partial replacements for natural fine aggregate.

3. State-of-the-art review of geotechnical challenges and opportunities in
recycling and reusing sewage sludge as landfill cover material, A review
Mohammad Jamalimoghadam,2025
This paper examines the feasibility of incorporating waste foundry sand, glass powder, and recycled steel fibers into alkali-activated ultra-high-performance concrete. The objective of the research was to develop a more sustainable concrete mixture by replacing conventional materials with industrial waste products. The experimental investigation showed that the modified concrete achieved adequate strength and durability while lowering energy requirements, production expenses, and environmental impacts.
The study emphasizes the importance of recycling industrial by-products in construction materials. The use of these waste resources not only decreases the dependence on natural raw materials but also helps address waste disposal challenges. The results indicate that sustainable concrete can be produced without significantly compromising its engineering performance.
Despite these positive outcomes, the research focuses only on selected industrial wastes and does not consider the use of grit chamber sand obtained from Sewage Treatment Plants (STPs). Furthermore, additional research is needed to assess long-term performance and large-scale implementation of such

sustainable concrete mixtures.

Overall, the paper provides valuable evidence supporting the use of waste materials in concrete production and encourages further investigation into alternative materials such as treated STP grit chamber sand as a replacement for natural fine aggregate.

state-of-the-art review of geotechnical challenges and opportunities in

recycling and reusing sewage sludge as landfill cover material: A review

Mohammad Jamalimoghadam

4. Mix design optimization of alkali-activated ultra-high-performance concrete incorporating sustainable waste materials using response surface methodology, may Erfan Askaripour Sarmast,Kayvan Ajir, 2026

Growing environmental concerns and the depletion of natural resources have encouraged researchers to explore alternative materials for concrete production. The use of waste materials in concrete helps reduce pollution while conserving natural aggregates.

Previous studies have shown that waste foundry sand, glass powder, and recycled steel fibers can be successfully incorporated into concrete. These materials have been reported to improve strength and durability when used in appropriate proportions. Waste foundry sand, due to its similarity to natural sand, has been identified as a suitable replacement for fine aggregate.

Research has also demonstrated that processed glass powder contributes to concrete performance through pozzolanic activity, while recycled steel fibers enhance crack resistance and tensile strength.

Recent studies have focused on municipal waste materials from Sewage Treatment Plants (STPs). Among these, grit chamber sand has gained attention as a potential substitute for natural fine aggregate. Its utilization can reduce landfill disposal and decrease the demand for river sand.

The reviewed literature indicates that treated waste materials can be effectively used in concrete without significantly affecting its performance. However, limited research is available on the application of STP grit chamber sand. Therefore, further investigation is needed to evaluate its suitability as a sustainable fine aggregate replacement in concrete.

III. METHODOLOGY

1. Collection of Grit Chamber (STP) Sand

The grit chamber sand was collected from a nearby Sewage Treatment Plant (STP) collection and handling of the material.

2. Washing of Sand

The collected grit chamber sand contained organic matter, clay particles, dust, and unwanted impurities.

3. Oven Drying at 110°C for 24 Hours

After washing, the sand was dried in a laboratory oven at a temperature of 110°C for 24 hours

4. Collection and Testing of Coarse Aggregate

Coarse aggregate required for concrete preparation was collected from a standard construction material supplier

5. Tests Conducted on Sand

Both natural sand and treated grit chamber sand were subjected to various laboratory tests to evaluate their suitability as fine aggregate in concrete.

6. M30 Concrete Mix Design

Concrete of grade M30 was designed according to standard mix design procedures.

7. Cube Casting

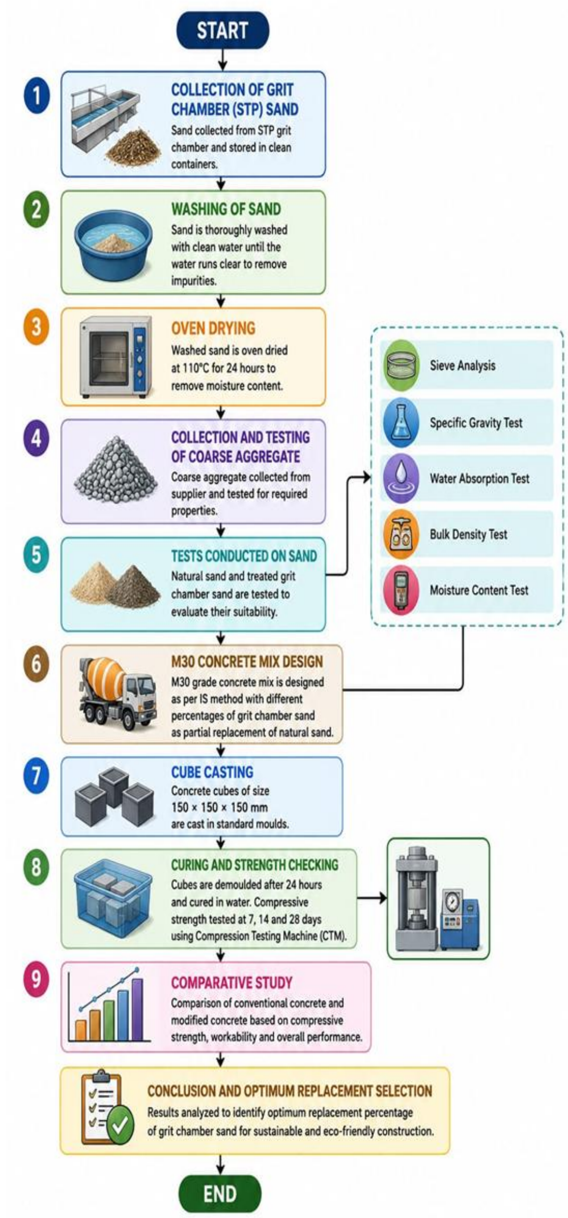
Concrete cubes of standard size 150×150×150 mm150×150×150 mm were cast for compressive strength testing.

8. Checking of Strength

After demoulding, the concrete cubes were cured in water for specified curing periods such as 7 days, 14 days, and 28 days.

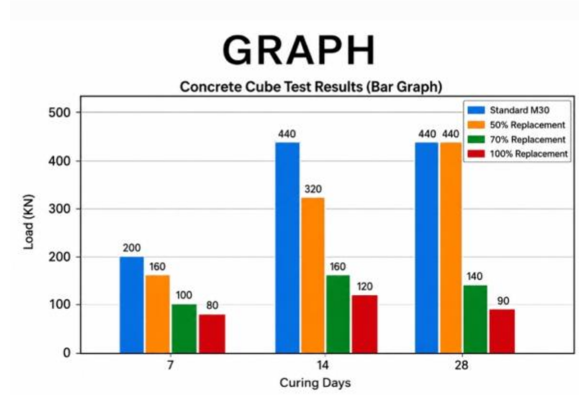
9. Comparative Study

A comparative study was carried out between conventional concrete and concrete prepared using partial replacement of fine aggregate with grit chamber sand



IV. RESULT AND DISCUSSION

Sr. no	Type of mix design	7 days	14 days	28 days
1.	Standard M30	203.24KN	429.26 KN	527.60 KN
2.	50% Replacement	153.67 KN	315.02 KN	411.74 KN
3.	70% replacement	99.99 KN	153.17 KN	109.90 KN
4.	100% replacement	76.51 KN	118.17 KN	67.71 KN



V. DISCUSSION

From the experimental results, it can be concluded that compressive strength decreases as the percentage of STP grit chamber sand increases. The control mix produced the highest strength, while 100% replacement resulted in the lowest performance. Among all replacement levels, the 50% replacement mix showed comparatively better results and acceptable strength development.

Therefore, partial replacement of fine aggregate with STP grit chamber sand can be adopted up to a limited percentage, especially around 50%, for sustainable concrete production. The use of grit chamber sand helps in reducing natural sand consumption and promotes waste utilization from sewage treatment plants. However, higher replacement percentages adversely affect the mechanical properties of concrete and are not recommended for structural applications requiring high strength.

VI. CONCLUSION

STP sand can be used as a partial replacement of fine aggregate up to 50% in M30 concrete.50% replacement gives acceptable strength while reducing the use of natural river sand. Higher replacement levels (70% and 100%) are not recommended for structural concrete due to major reduction in strength.

Environmental Sustainability
Minimize landfill disposal of sand
Reduces land and water pollution
Decreases greenhouse gas emission
Conserving natural resources like river bed
Convert waste sand in concrete

Making it a sustainable alternative material for Partition walls, Footpaths and walkways, Kerb stones Paver blocks Drain covers, Plain cement concrete (PCC)

VII. OUTCOME OF PARTICAL REPLACEMENT OF GRIT CHAMBER SAND

Use of STP sand helps in: Waste utilization Environmental sustainability Reduction in dependence on natural sand resources Recommended Optimum Replacement 50% STP sand replacement is the optimum percentage based on compressive strength results.

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