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REVIEW PAPER ON CONCRETE USING LATERITE SAND BY REPLACING NATURAL SAND

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ABSTRACT

Concrete is the most widely used construction material across the world because of its strength, durability, and versatility. However, the growing demand for natural river sand as fine aggregate has resulted in severe environmental degradation, resource depletion, and unsustainable mining practices. To address these issues, laterite sand—a locally available, eco-friendly, and cost-effective material—has been investigated as a partial or complete replacement for natural sand in concrete production. This review examines the properties, performance, and applicability of laterite sand in concrete, emphasizing its influence on workability, strength, durability, and environmental sustainability.

Keywords: Workability, Strength, Durability, Environmental Degradation, Sustainability.

1. INTRODUCTION

Concrete is a composite material composed of cement, fine aggregate, coarse aggregate, and water. Among these constituents, fine aggregate plays a crucial role in influencing the workability, strength, and overall performance of concrete. The excessive extraction of river sand has led to environmental concerns such as riverbank erosion, depletion of groundwater, and ecological imbalance.

To mitigate these impacts, researchers have explored various alternative fine aggregates, including manufactured sand, quarry dust, and laterite sand. Laterite, a soil rich in iron and aluminum oxides, is widely found in tropical and subtropical regions and is formed through intense weathering processes. Utilizing laterite sand as a substitute for natural sand not only lowers construction costs but also promotes environmental sustainability. This review assesses the suitability of laterite sand in concrete, focusing on its mechanical, durability, and environmental aspects for sustainable construction practices.

2. LITERATURE REVIEW

A number of studies have evaluated the impact of using laterite sand and other alternative fine aggregates in concrete:

- **Shukla (2000):** Reported that replacing river sand with stone dust decreases workability but increases compressive and tensile strength up to 40% replacement.
- **Osunade (2002):** Found that increasing laterite content reduces workability and mix cohesion. Laterized concrete with 10–40% granite fines performed well in large foundations and flat slabs.
- **Salau (2003):** Observed similar shrinkage-time patterns for both normal and laterized concretes. Laterite addition did not significantly affect compressive strength or durability.
- **Udoeyo et al. (2006):** Found that increasing laterite content improved workability and compaction, attributed to the coarser texture of laterite particles.
- **Safiuddin (2007):** Demonstrated that substituting quarry waste up to 20% improved workability but reduced compressive strength; however, silica fume addition enhanced strength.
- **Olusola (2014):** Reported that laterized concrete exposed to sulfate solutions initially gained strength but showed reduced performance after prolonged exposure.
- **Ilangovan (2008):** Found that quarry dust can replace fine aggregate, yielding up to 10% higher strength but lower workability compared to conventional concrete.
- **Zhou (2008):** Concluded that combining stone dust and manufactured sand enhances both workability and compressive strength in high-strength concrete.
- **Shahul (2009):** Showed that green concrete with quarry dust and marble sludge exhibited higher strength and durability than control concrete.
- **Alawode et al. (2011):** Reported reduced workability with increased laterite content, affecting compressive strength due to higher water absorption.

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- **Ukpata et al. (2012):** Found that a 25% laterite and 75% quarry dust mix achieved the highest compressive strength at 0.5 water–cement ratio.
- **Norul (2013):** Observed that water curing improved strength performance of laterized concrete up to 30% coarse aggregate replacement.
- **Benny (2014):** Found no major change in fine aggregate grading pattern up to 20% laterite replacement.
- **Siddique (2015):** Demonstrated that foundry sand substitution improved long-term durability of concrete.
- **Awoyera et al. (2016, 2018):** Reported lower workability in laterized concrete with ceramic aggregates and higher porosity compared to normal concrete.
- **Vardhan et al. (2019):** Found optimum replacement of marble waste at 40%, improving strength and minimizing shrinkage.
- **Steyn et al. (2020):** Reported reduced workability with plastic, rubber, and glass additions but improved durability properties with glass.
- **Yaragal et al. (2022):** Found that processed lateritic fine aggregates can replace up to 100% of river sand with minimal strength variation (±3%).
- **Arulmoly et al. (2024):** Suggested that a 25% blend of manufactured and offshore sand can completely substitute river sand with satisfactory performance.

3. CONCLUSION

Laterite sand offers a sustainable and locally available alternative to natural river sand in concrete, particularly in tropical regions where it is abundant. Research indicates that partial replacement of sand (20–40%) with laterite achieves acceptable workability, strength, and durability while lowering construction costs and environmental impacts. Nonetheless, variations in laterite composition and reduced workability remain challenges. These can be mitigated through proper material characterization, mix optimization, and the use of chemical admixtures. Further experimental research and large-scale field applications are essential to standardize mix design procedures and promote the structural use of laterized concrete in sustainable construction.

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