

A Review of Shell Waste Utilization in Eco-Friendly Construction Materials

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ABSTRACT

The increasing demand for sustainable construction materials has intensified research on the utilization of waste resources. Shell waste generated from food industries and households, including eggshells, oyster shells, clam shells, and mussel shells, poses significant disposal and environmental challenges. Due to their high calcium carbonate content, shell wastes exhibit promising potential for use in eco-friendly construction materials. This review paper presents a comprehensive overview of shell waste utilization in construction materials, focusing on their sources, processing methods, applications, mechanical performance, and environmental benefits. The study highlights shell-based materials as viable alternatives to conventional construction materials, contributing to sustainable development and circular economy practices.

Keywords: Shell waste, Eco-friendly construction materials, Sustainable construction, Eggshells, Waste utilization

1.INTRODUCTION

The construction industry is one of the largest consumers of natural resources and energy. Conventional materials such as cement, sand, and aggregates significantly contribute to environmental degradation and greenhouse gas emissions. As sustainability becomes a key concern, researchers are exploring alternative materials derived from waste resources. Shell waste from seafood processing industries, restaurants, and households is generated in large quantities and is often disposed of in landfills, causing environmental pollution. Shells are rich in calcium carbonate, which makes them suitable for use in construction materials. This review focuses on the utilization of shell waste in eco-friendly construction materials and evaluates its potential benefits and challenges.

2. TYPES OF SHELL WASTE USED IN CONSTRUCTION

2.1 Eggshell Waste

Eggshells consist of approximately 90–95% calcium carbonate. When processed into fine powder, they can be used as a partial replacement for cement or lime in construction materials.

2.2 Marine Shell Waste

Oyster shells, clam shells, and mussel shells are commonly obtained from seafood industries. These shells exhibit good strength and durability and can be crushed and used as fine or coarse aggregates.

2.3 Snail Shell Waste

Snail shells are used mainly as filler material due to their lightweight nature and calcium-rich composition.

3. PROCESSING METHODS OF SHELL WASTE

Shell waste generally requires processing before use in construction:

- Washing to remove organic impurities
 - Drying under sunlight or in an oven
 - Crushing and grinding into powder
 - Sieving to achieve desired particle size
- Some studies also employ calcination to enhance reactivity.

4. APPLICATIONS OF SHELL WASTE IN CONSTRUCTION MATERIALS

4.1 Shell-Based Bricks

Shell powder is used as a partial replacement of cement or sand in brick manufacturing, improving sustainability and reducing natural resource consumption.

4.2 Concrete and Mortar

Shell waste is incorporated as fine aggregate replacement or filler material, enhancing workability and reducing cement usage.

4.3 Blocks, Tiles, and Pavements

Shell aggregates contribute to lightweight properties and improved thermal insulation.

5. MECHANICAL AND PHYSICAL PROPERTIES

Based on literature:

- Compressive strength remains comparable to conventional materials at low replacement levels (5–15%)
- Water absorption values generally meet IS code limits
- Shell-based materials exhibit adequate durability for non-structural and low-rise structural applications

6. ENVIRONMENTAL AND ECONOMIC BENEFITS

- Reduction in landfill waste
- Conservation of natural resources
- Lower carbon footprint
- Cost-effective production
- Promotion of circular economy

7. CHALLENGES AND LIMITATIONS

- Variability in shell composition
- Need for proper cleaning and processing
- Limited standardization and design guidelines
- Lack of large-scale field applications

8. CONCLUSIONS

The reviewed studies indicate that shell waste can be effectively utilized in eco-friendly construction materials without compromising performance. Shell-based materials offer environmental, economic, and technical benefits, making them suitable alternatives to conventional construction materials. With further research and standardization, shell waste can play a significant role in sustainable construction practices.

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