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Review Paper on Properties of Concrete using Grind Fish Scale in Different forms Replacing Fine Aggregate and Cement

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Abstract: *This study intends the use waste Fish scale powder as an alternative material for cement and fish scales as an alternative material for fine aggregates in concrete production. Different partial replacements of fish scale powder and fish scales (0%, 2%, 4%, and 6%) and (0%, 5%, 10%, and 15%) by volume of cement and fine aggregate are cast and test such as compressive strength is to be performed on concrete. Experimental research illustrates the enhancement of mechanical features in concrete due to the replacement of fish scale powder and fish scale concrete. A compression test will be carried out to evaluate the strength properties of concrete at the age of the 3rd, 7th, and 28th day*

Keywords: Fish Scale, Fish scale powder, replacement, & concrete

I. INTRODUCTION

As India is a rapidly developing country its infrastructure development plays and vital role in its development thus, the development of roads, buildings, highways, bridges, etc., is the prime need. The material widely used for all these constructions is concrete basically concrete is a blend of cement, coarse aggregate, fine aggregate, water, and various admixtures. One of the major materials in concrete is 'cement.' As we know India is the seventh largest country in the production of cement. As cement emits large amounts of CO^2 and toxic gasses which are perilous for the environment as well as for our health, cement also needs to be used economically at the same time. The most used type of cement in India is the 'ordinary Portland cement'(OPC) generally, three grades of cement are available in the Indian market, viz., 33grade, 43grade, and 53grade, which is generally expensive and yields carbon dioxide emissions during production. Approximately 0.5 – 0.6 tons of carbon dioxide greenhouse gases are produced to make one ton of cement. It results, in the social and environmental issues of sustainability and energy conservation to curb this issue, they are encouraging to partially replace cement with other supplementary cementing materials. Nowadays, various waste materials are being studied and utilized as raw materials in concrete production. Recycled materials have been added to concrete to reduce the amount of post-consumer waste and industrial by-products entering landfills.

The second major material is 'aggregate.' There is a great demand for aggregate in the civil engineering industry for various concrete construction work. This certainly led to a continuous and increasing demand for natural materials used for their production. But nowadays availability of natural aggregates is a very difficult problem. Natural resources are depleting worldwide. Parallel to the need for the utilization of natural resources emerges a growing concern for protecting the environment and a need to preserve natural resources, such as aggregate. So, there is a strong need to use alternative materials in place of natural aggregates.

India has one of the largest fishery industries due to that there is a maximum of 20% to 25% of waste material generated per first from that there is a maximum of 6% to 7% of fish scale generation as a waste product. Dumping fish scales in water causes water erosion, which is harmful to the aqua life and causes water pollution considering problems. With the ever-increasing population of the world, there is tremendous pressure on civil engineers to develop a cost-effective as well as eco-friendly structure so that we can reduce, reuse, and recycle (3r technique) the waste material. So, there is a strong need to use alternative materials in place of natural aggregates and cement. Thus, we will partially replace fish scales in our concrete with fine aggregate and cement.

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II. TEST SPECIMEN

2.1 Cement

Cement is super important in making concrete because it is what holds everything together. It's made from natural materials and sometimes mixed with industrial waste. In the study you mentioned, they used OPC 53 grades Ordinary Portland cement (OPC) that meets the standards set by IS12269-1987. Using the right type of cement is key to ensuring the strength and quality of the concrete.

Ordinary Portland cement (OPC) of 53-grade Birla Cement is used in this experimental work. The weight of each cement bag is 50 kg. The standard consistency of the cement sample is found to be 33.43%. The fineness modulus was obtained at 5 %. The setting time for the given cement sample is found to be:

Initial setting time = 30 min

Final setting time = 605 min

Fig.1. Initial and Final setting time of cement

2.2 Fine Aggregate

Which make up around 70 to 75 percent of the concrete volume, and are sometimes seen as inactive ingredients. But now we know that their physical, chemical, and thermal properties have a big impact on how concrete performs. In this study, they used clean, dry sand as the fine aggregate. They made sure to sieve it through a 4.75 mm sieve to remove any pebbles. This careful process helps maintain the quality of the concrete.

Crushed sand having Specific Gravity 3.0

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Fig.2. Sieve Analysis of fine aggregate

Fig.3. Specific Gravity of fine aggregate

2.3 Coarse Aggregate

Is an essential ingredient in making concrete. They can be in the form of irregular broken stones or naturally occurring gravel. Coarse aggregates are materials that are too large to pass through a 4.75mm sieve. They can have a maximum size of up to 40mm. These larger pieces play a crucial role in providing strength and stability to the concrete mixture.

Coarse Aggregate consists of 20 mm, having a Specific Gravity of 2.59 and water absorption of 1.55.

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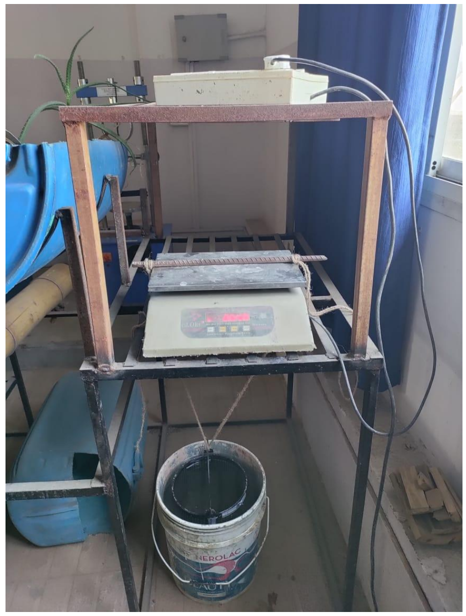

Fig.4. Specific Gravity of coarse aggregate

2.4 Fish Scales

Fish scales, often regarded as waste from fishing and food industries, pose significant environmental and economic challenges. However, they hold potential for various applications such as collagen production, hydroxyapatite extraction, guanine isolation, animal feed, fertilizers, food additives, cosmetics, adsorbents, and biomaterials. Primarily composed of proteins, particularly collagen, and minerals, with hydroxyapatite being a key inorganic constituent, fish scales require complex separation methods involving solubilization through heat, enzymatic treatment, acid/base reactions, or organic solvents. These processes, spanning up to two weeks, demand substantial amounts of washing agents and energy.

A. Crushed Fish Scales:

This is to replace fine aggregate which consists of grind fish scales passing from 2.36mm sieve and retained on 90µm sieve.

B. Fish Scale Powder

Preparation of inorganic powders from fish scales like there are different steps involved, like washing, drying, deproteinization, neutralization, and heat treatment. The high-temperature treatment resulted in the formation of chlorapatite/rhenanite powder with larger particles. However, there was a significant mass loss and particle growth, which might not be ideal for ceramics production. On the other hand, it was shown that the phase composition of the powder can be altered by pretreating it with different inorganic salt solutions. It's fascinating how fish scales can be used to create powders like hydroxyapatite through heat treatment.

This was the supplementary material for cement, which was first collected from Fish Market Ganesh Peth, Pune. Then grinded and sieved from 90 µm sieve.

Fig. Fish Scales

2.5 Water

plays a crucial role in the formation of concrete as it chemically reacts with the cement. This reaction leads to the formation of a gel that helps increase the strength of the concrete. It's important to use clean water for mixing and curing. The water should be free from harmful substances like alkalies, acids, oils, salts, sugar, organic materials, and anything that could be harmful to bricks, stone, concrete, or steel. Generally, portable water is considered suitable for mixing concrete. It's all about ensuring the best quality for that strong and sturdy concrete

III. LITERATURE REVIEW

Recycling of fishery waste as planting base porous Concrete aimed at achieving carbon neutrality. 2023 have studied that the Paris Agreement stands as the global framework in the fight against climate change, with progress being made in reducing greenhouse gas emissions worldwide. However, in Japan, waste disposal remains a significant challenge, with a target reduction to 13 million tons by 2025. Concrete, a widely used material, offers promise in waste reduction, yet its production emits substantial CO2. Moreover, Japan's consumption habits result in significant fishery waste, with only a fraction being recycled. This study explores the potential of using hydroxyapatite derived from fish bones as an alternative to cement in porous concrete. By utilizing Fishbone Powder (FbP) as a binder, CO2 emissions can be reduced by approximately 2.6 kg per 1 m3 of porous concrete, while also improving plant growth conditions. The research examines various physical properties, such as porosity, permeability, and compressive strength, demonstrating FbP's viability as a sustainable binder for porous concrete with minimal environmental impact.

Inorganic Powders Prepared from Fish Scales. 2022 have studied that utilizing a blend of scales from freshwater bream, crucian carp, and pike perch to produce fish scale powder containing both organic and inorganic constituents. The scales underwent washing, drying, and grinding to create the powder, which was then enriched with inorganic components using vibration sieving. Thermal analysis revealed that the enriched powder consisted of approximately 36.5% organic components and 63.5% mineral components. Heat treatment of the powder at temperatures ranging from 800 to 1000°C yielded inorganic powders comprising hydroxyapatite and magnesium whitlockite. These powders exhibited sintered grains with dimensions less than 100 nm at 800°C, less than 200 nm at 900°C, and 100–1000 nm at 1000°C. The study suggests that the fish scale powder enriched with inorganic components and the resulting heat-treated inorganic powders could be utilized in the production of various materials such as ceramics or composites.

Effects of partial replacement of sand with Sawdust and fish scales on the properties of Concrete blocks. 2022 this study explores the potential utilization of sawdust and fish scales as alternative aggregates in replacing sand during the production of masonry blocks. Both materials are considered organic waste products from industrial processes. The methodology involved analysing the physical properties and compressive strength of samples produced by replacing sand with varying percentages of sawdust and crushed fish scales (5%, 10%, 15%, and 20%). Prior to mixing, both materials underwent pre-treatment, including washing, sun drying for 24 hours, and grinding in the case of fish scales, to remove impurities and moisture. They were then blended with lime for compatibility with the cement matrix at a 5%

proportion. Compressive strength tests were conducted on the masonry blocks at intervals of 7, 14, 21, and 28 days. The optimum replacement level was determined to be 5%, with a compressive strength of 15.7N/mm2 at the age of 28 days. The research concludes that incorporating up to 5% fine aggregates replacement with sawdust blend is viable for masonry block production. Ultimately, this study aims to contribute to the construction industry's pursuit of low-cost housing through the use of economically feasible and environmentally friendly materials.

Preliminary investigation properties of novel sustainable composite: Fish scales reinforced cement concrete. 2022 this study investigated the impact of fish scales reinforcement on both fresh and hardened properties of concrete. Twenty-four cubes and twenty-four cylinders were casted using a design mix ratio of 1:2.3:4.3, with a water-cement ratio of 0.57. Specimens were prepared with fish scales reinforcement levels of 0%, 1%, 1.5%, and 2% by weight of cement. Fresh-state assessment involved observing workability via slump tests, revealing a decrease in slump value with increasing fish scales due to heightened water demand. Notably, the addition of 2% fish scales resulted in a 36.40% reduction in concrete mix workability. Compressive and tensile strengths were evaluated using a Universal Testing Machine (UTM) after curing for 7 and 28 days. Out of 48 specimens, 24 were tested for compressive strength, while the remaining 24 were tested for tensile strength.

On the regeneration of fish scales: structure and mechanical Behavior. 2020 this study delves into the structural and mechanical properties of fish scales, which act as natural armor protecting against physical injury. While previous research has focused mainly on the structure and behavior of ontogenetic scales, little attention has been given to the structure-property relationships of regenerated scales. Common carp (Cyprinus carpio) were studied in an aquatic laboratory environment at different temperatures. Both ontogenetic and regenerated scales were analyzed for their microstructure and mechanical properties under hydrated conditions. The results revealed that the regenerated scales exhibited significantly lower strength, strain to fracture, and toughness compared to ontogenetic scales from the same fish, irrespective of water temperature. Scales regenerated at a higher temperature demonstrated superior mechanical properties. Regenerated scales displayed a highly mineralized outer layer but lacked distinct features found in ontogenetic scales, suggesting that during regeneration, a mineralized layer forms first, prioritizing protective qualities before other structural elements develop.

Application of polypropylene non-woven with Fish scale in reinforced concrete. 2019 this study investigates the use of polypropylene (PP) nonwoven layers for reinforcing cement composite, focusing on its flexural performance. Two bonding techniques, needle-punching and calendaring, were employed to produce nonwoven layers for reinforcing cement sheets. The study examined various parameters related to these layers' effects on cement reinforcement. Additionally, the study explored the application of short fibers (PP and acrylic) in cement/nonwoven composites. Results indicate that cement composites with thinner nonwoven layers exhibit higher load-bearing capacity due to better cement paste penetration. Furthermore, cement matrices reinforced by nonwoven layers demonstrate superior flexural performance and strain-hardening behavior compared to those reinforced by short fibers.

Performance of compressed lightweight concrete Manufactured using A blend of sawdust, fish Scales and sand aggregates. 2019 this study assesses the performance of masonry blocks with partial replacement of sand by a blend of sawdust and crushed fish scales. Both materials are industrial by-products considered organic waste. Blocks were produced with varying ratios of sawdust and fish scales (5%, 10%, 15%, and 20% by weight), pre-treated to remove impurities and moisture. Lime was added for compatibility with the cement matrix. Compressive strength tests were conducted at intervals of 7, 14, 21, and 28 days, with the blended blocks achieving a compressive strength of 5.7N/mm2, meeting standards for lightweight blocks. Replacement of up to 5% fine aggregates with sawdust blend proved feasible, aiming to support the construction industry in providing affordable housing for low-income earners.

Effect of Fish Scales on Workability of Concrete for Rigid Pavements. 2019 have examined that fish processing generates a significant amount of waste, with approximately 65% of total fish weight being discarded after filleting. In India alone, about 7.34 lakhs of tonnes of fish scales are produced annually, remaining largely unused. This study aims to explore the potential utilization of labeo rohitha fish scales as pieces or short fibers in concrete as an additive. Various percentages of fish scales were incorporated, and the workability of the resulting concrete fish scale composite was evaluated. The study yields several promising conclusions regarding the feasibility and benefits of incorporating fish scales into concrete.

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Fish Scales as a Bio composite of Collagen and Calcium Salts. 2013 have studied that the utilization of collagen extracted from fish scales for various biomedical applications, including cosmetic, pharmaceutical, and implant uses. While collagen for biomedical purposes is traditionally sourced from animal tissues, such as bovine or porcine skin, or Achilles tendons from bovine or equine origins, this study focuses on extracting type I collagen from the scales of freshwater and marine fishes, specifically Esox lucius. The process involves demineralizing the fish scales using EDTA and then dissolving them in acetic acid to isolate collagen. This marks the first instance of using Esox lucius scales as a collagen source. The extracted collagen shows promise as a safe and viable material for biomedical applications, capable of being processed into various forms such as sheets, sponges, foams, injectable solutions, and dispersions.

On the mechanics of fish scale structure. 2010 the study explores the structural similarities between biological and manmade structures, focusing on fish scales' properties and functions. Fish scales, comprising small rigid plates, vary in shape, size, and properties to serve specific functions such as structural support and protection. A two-dimensional micromechanical model is introduced to correlate the flexural response of scaled skin with its underlying structure, including geometric and material aspects. The model predicts trends in the structure's response, highlighting the flexibility to tailor scale design, arrangement, and properties to achieve diverse responses. Notably, fish scale structure exhibits an inherent strain-stiffening response influenced by structural features, ensuring both structural support and protection for the animal.

IV. PROBLEM IDENTIFICATION

Based on the literature provided, the identified problem revolves around sustainable waste management and reducing carbon emissions in various industries, particularly in construction. Here's a summarized problem statement.

The construction industry, particularly in Japan, faces challenges in waste disposal and carbon emissions reduction targets. Although the Paris Agreement aims to mitigate global greenhouse gas emissions, Japan struggles with waste management, including fishery waste. Concrete production, a significant contributor to CO_2 emissions, offers potential in waste reduction. However, conventional concrete production methods exacerbate environmental issues. Studies explore innovative approaches such as using fishery waste, specifically fish scales and bones, as alternative materials in concrete production. Challenges include optimizing material properties, such as strength and workability, while minimizing environmental impact and promoting sustainability. The goal is to develop eco-friendly construction materials and techniques to support carbon neutrality initiatives and address waste management challenges in the construction industry.

V. OBJECTIVE

1. To investigate alternative materials for partially substituting cement and fine aggregate (sand).
2. To explore different forms of fish scale for replacement of conventional material.

VI. PROJECT DISCUSSSION

Based on the research studies provided, it's evident that there's significant potential for utilizing fishery waste, specifically fish scales and bones, in various construction materials and composites. This not only addresses waste management issues but also contributes to sustainability efforts in the construction industry. The proposed project of recycling fishery waste as a planting base porous concrete aligns well with the global push for carbon neutrality and reducing greenhouse gas emissions. By utilizing hydroxyapatite derived from fish bones as an alternative binder in porous concrete, CO_2 emissions can be reduced while improving plant growth conditions. Additionally, incorporating fish scales into concrete composites offers benefits such as enhanced mechanical properties and potential biomedical applications due to the collagen content. Overall, these innovative approaches hold promise for achieving environmental sustainability in construction practices.

VII. CONCLUSION

1. The research highlights a multifaceted approach towards sustainability.
2. Fishery waste is utilized in various construction materials and biomedical applications.
3. Examples include porous concrete, reinforced cement, and biomedical collagen extraction.

4. These studies demonstrate innovative methods to reduce waste and lower carbon emissions.
5. The findings promote environmental stewardship by repurposing fishery waste into valuable resources.
6. Overall, this research contributes to global efforts toward achieving carbon neutrality and advancing sustainable development goals.

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