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OPTIMIZATION OF FLEXIBLE PAVEMENT WASTE FOR BUILDING A DEFENSIBLE CONCRETE

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Abstract: This This study investigates the effect of replacing coarse aggregate with flexible pavement waste on the compressive strength and water absorption of concrete. Different percentages of replacement (0%, 25%, 35%, and 45%) were tested to assess the mechanical properties of the concrete at 28 days of curing. The results revealed a notable decrease in compressive strength as the percentage of coarse aggregate replacement increased up to 25%, with the compressive strength at 25% replacement (16.4 N/mm²) significantly lower than that of the control mix (24.73 N/mm²). However, beyond 25% replacement, an improvement in strength was observed, with the 45% replacement yielding a compressive strength of 22.01 N/mm², higher than that at 35% replacement. Additionally, the water absorption percentage of flexible pavement waste (1.02%) was found to be lower than that of conventional coarse aggregate (1.74%), suggesting better moisture resistance and durability. Based on these findings, it can be concluded that a 45% replacement of coarse aggregate with flexible pavement waste offers the optimum balance between strength and sustainability. The observed difference in compressive strength between conventional and flexible pavement waste aggregate concrete at 28 days of curing was 11%, indicating the potential of flexible pavement waste as a viable alternative for sustainable concrete production.

***Keywords* - Coarse Aggregate, Compressive Strength, Flexible Pavement Waste, Water Absorption Percentage, Moisture Resistance**

I. INTRODUCTION

Concrete is a widely used construction material made by mixing cement, water, fine aggregates (such as sand), and coarse aggregates (larger particles like gravel or crushed stone). When mixed, these materials form a paste that binds the aggregates together, resulting in a strong, durable material suitable for a wide range of construction applications. Concrete's versatility, strength, and ease of use have made it essential for building roads, bridges, buildings, and other infrastructure.

Coarse aggregate plays a vital role in concrete by providing volume, reducing the amount of cement needed, and influencing the strength and durability of the mix. Typically consisting of larger particles ranging from 4.75 mm to 75 mm, coarse aggregates help in reducing the overall cost of concrete without compromising its strength. They contribute to the compressive strength of the material, making concrete capable of withstanding heavy loads. The size, shape, and quality of the coarse aggregate significantly affect the concrete’s workability and long-term performance, as well as its resistance to environmental factors like freeze-thaw cycles and chemical attacks. Proper selection and proportioning of coarse aggregates are essential for achieving the desired strength, durability, and performance of concrete in various construction projects.

Flexible pavement is a type of road surface structure designed to distribute traffic loads across a wide area, relying on the deformation of its layers. It consists of multiple layers, including a subgrade, sub-base, base, and surface course, with the topmost layer typically made of asphalt. The flexibility of this pavement allows it to adjust to slight shifts in the subgrade without cracking, making it ideal for areas with fluctuating loads and climatic conditions. Flexible pavements are cost-effective, durable, and relatively easy to repair, which makes them commonly used for highways, streets, and parking lots.

Silica fume is a highly reactive pozzolanic material used in concrete to enhance its strength and durability. When added to concrete, silica fume reacts with calcium hydroxide in the cement to form additional calcium silicate hydrate (C-S-H), improving the concrete's microstructure. This leads to increased compressive strength, reduced permeability, and better resistance to chemical attacks and abrasion. Silica fume also helps to reduce the concrete's water-cement ratio, improving its workability and long-term durability. It is especially beneficial in high-performance concrete, used in applications like bridges, dams, and structures exposed to harsh environments.

II. LITERATURE REVIEW

Akshatha K.B. (2018): -The experimental investigation involves addition of silica fume in various proportion as 5%, 7.5%, 10% and 12% by weight of cement to the concrete. The M45 grade of concrete was prepared on the guidelines in IS 10262-2009 and IS 456- 2000. The targeted slump was selected as 100 and water cement ratio is 0.4. The final mix proportion for control mix of 1:1.68:2.79:0.4 with cement content 410 kg/m³ was selected

Topcu, I.B. and Sengel, S. (2002): -concluded that Recycled aggregate normally has higher water absorption and lower specific gravity.

González, F.B. and Martinez, A.F. (2006): -The density of recycled aggregate used is lower than the density of normal aggregate. Porosity of recycled aggregates is also much higher than those
of natural aggregates

Bhupinderjeet Singh and Ritesh Jain (2018): **-** The percentages of replacement were 10%, 20%, 30% and 40% by weight of fine aggregate in concrete. The maximum compressive strength obtained at 20% replacement of fine aggregate with glass powder. Concrete containing glass powder found to be economical and environment friendly as compared to normal concrete.

Anurag Jain & P.Y. Pawade (2015): **-** Studied the characteristics of silica fume concrete and they stated that silica fume is a pozzolanic admixture which is improving the properties of concrete and also enhances the chemical durability of concrete. The silica fume used as a partial replacement of cement in concrete. The replacement used in experimental investigation were 5%, 10%, 15%, 20% and 25% by weight of cement. The physical properties of silica fume concrete are compared with standard concrete. From test result it was observed that there is drop in early compressive strength of silica fume concrete but compressive strength is significantly improved after 56 days. The effect of silica fume in concrete is more noticeable in 28 days curing than 7 days curing. It was found that the performance of concrete is optimum at 15% replacement. Silica fume also increases concrete protection towards steel bars corrosion.

III. MATERIAL & METHODOLOGY

3.1 Materials
1. Cement
2. Fine aggregate
3. Coarse aggregate
4. Flexible Pavement waste as aggregate
5. Water
6.Silica Fume

Fig. No: - 1 Silica Fume

Fig. No: - 2 Coarse Aggregate

Fig. No: - 3 Flexible Pavement Waste

3.2 Methodology Adopted:
1. Selection and procurement of materials.
2. Evaluation of material properties.
3. Mix design calculation and preparation of moulds.
4. Casting and curing of cubes.
5. Conduction of test to determine strength of cubes after 28 days.

For this study cubes of 150 mm size were cast by replacing coarse aggregate by Flexible pavement waste & Compressive strength was observed and compared with those of natural aggregate concrete

3.3 Description of specimen

Table No.: -01 Combination of coarse aggregate with Flexible pavement Waste

S.N.	Normal Coarse Aggregate %	Flexible Pavement Waste %
1	0	0
2	75	25
3	65	35
4	55	45

3.4 Following experiments were selected in this investigation process: -

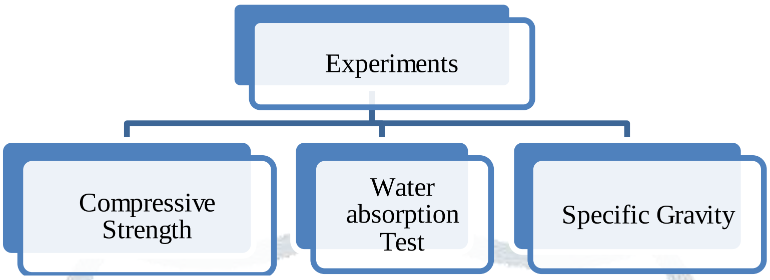

Fig. No.-04 Performed Tests

Table No.: -02 Reference code for compressive Strength Test & Maximum Size of Aggregate

S.N.	Parameter	Reference Code
1	Compressive Strength	IS: 10262 (1982)
2	Size of Coarse aggregate	IS: 383-1970

IV. Result & Discussion

4.1 Compressive strength: - The results suggest a notable decrease in compressive strength as the percentage of coarse aggregate replacement increases up to 25%. The compressive strength at 25% replacement (16.4 N/mm²) is significantly lower than that of the control group (24.73 N/mm²). However, beyond 25% replacement, there is an improvement in strength, with the 45% replacement yielding a compressive strength of 22.01 N/mm², which is higher than the 35% replacement.

Table No.: - 3 Compressive Strength of Cubes

S. No	Percentage of Replacement of coarse Aggregate by Flexibleble pavement waste	Average Compressive Strength (N/mm2) 28 days
1	0%	24.73
2	25%	16.4
3	35%	19.2
4	45%	22.01

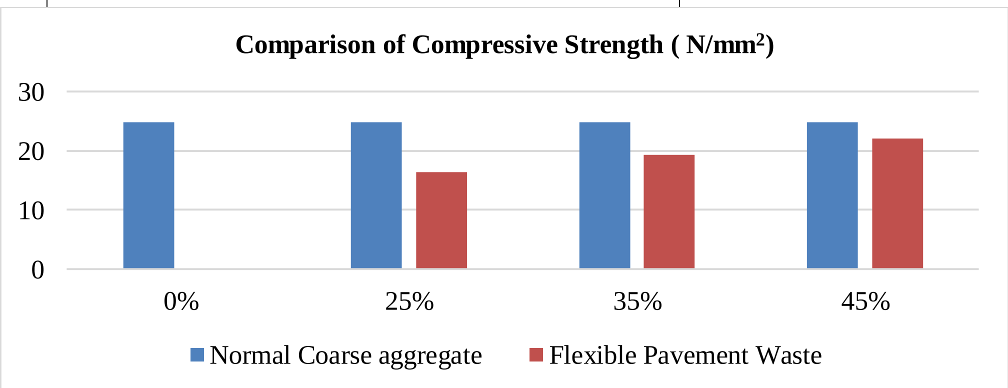

Fig. No.-05 Comparison of Compressive strength

4.2 Specific Gravity: - This difference implies that flexible pavement waste might be used in scenarios where a lower-density material is acceptable or where cost and sustainability factors are prioritized. For instance, it could be used in non-load-bearing structures or in mixtures where reduced weight is important, but it may need to be combined with other materials to compensate for the strength deficit.

Table No.: - 4 Specific Gravity of Coarse agg. & Flexible Pavement Waste

S. No	Material	Specific Gravity
1	Coarse aggregate	2.67
2	Flexible Pavement Waste	1

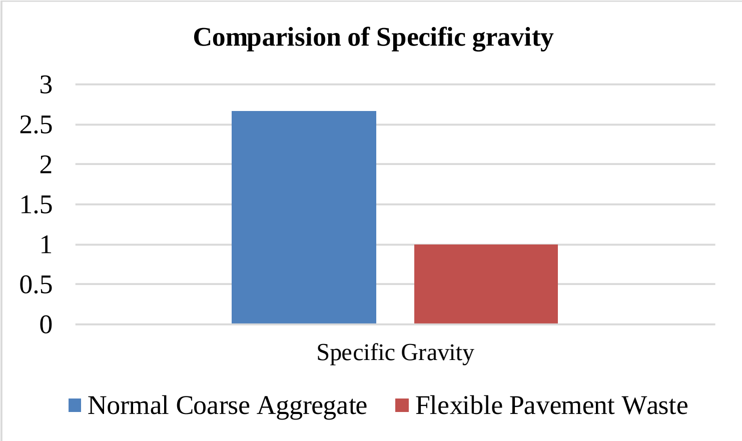

Fig. No.-06 Comparison of specific Gravity

4.3 Water absorption %: - The water absorption percentage of flexible pavement waste is 1.02%, which is lower than that of coarse aggregate. This means that the flexible pavement waste has a lower porosity and is less likely to absorb water. While this could indicate better durability in terms of moisture resistance.

Table No.: - 5 Water Absorption % of Coarse agg. & Flexible Pavement Waste

S. No	Material	W.A.%
1	Coarse aggregate	1.74
2	Flexible Pavement Waste	1.02

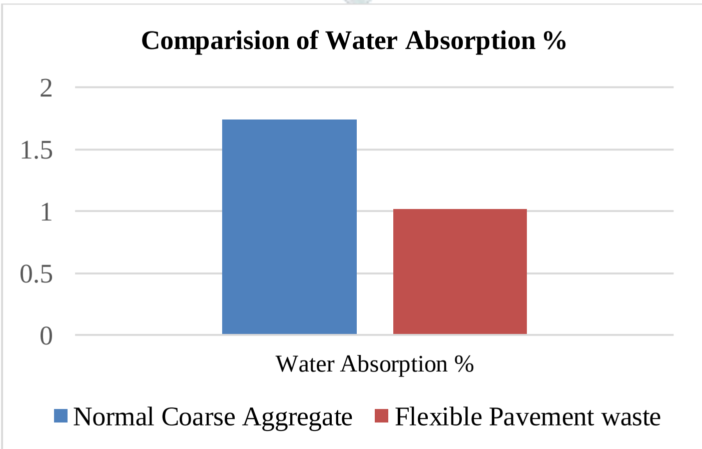

Fig. No.-07 Comparison of Water Absorption %

Table 6: - Difference of average Compressive strength of 25%, 35% & 50% flexible pavement waste concrete compared to conventional concrete.

S. No	Replacement %	% Difference of average Compressive strength 28 days
1	25%	33.69
2	35%	22.37
3	45%	11

V. Conclusion

1. The test values of compressive strength of cubes of demolished concrete aggregate for 28 days are obtained, and the values are compared with the conventional concrete.
2. From the above investigation, it can be hence concluded that the optimum replacement for this mix for high strength concrete is found to be 45%, thereby reducing the consumption of M-sand and contributing to sustainable concrete.
3. As we observed that the difference in compressive strength of conventional and Flexible pavement waste aggregate concrete at a 28 days curing is 11%.
4. flexible pavement waste has a lower porosity and is less likely to absorb water.
5. flexible pavement waste might be used in scenarios where a lower-density material is acceptable or where cost and sustainability factors are prioritized.

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