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Performance of Concrete by Dunite Powder as Cement Replacement and Tamarind Kernel Shell Powder as Additive

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ABSTRACT: The quest for sustainable and eco-friendly construction materials has led to the exploration of alternative components in concrete production. This study investigates the performance of concrete incorporating dunite powder as a partial replacement for cement and tamarind kernel shell powder (TKS) as an additive. Dunite, a magnesium-rich rock, is abundant and offers potential as a cementitious material due to its pozzolanic properties. Tamarind kernel shell powder, a by-product of the tamarind processing industry, is rich in polysaccharides and exhibits properties that can enhance concrete performance. In this experimental study, concrete mixes with varying proportions of dunite powder as cement replacement by 20%, 40% & 60% by weight and TKS as an additive by weight of cement with constant 0.5% were prepared and tested. The fresh properties of the concrete, including workability and setting time, were evaluated. Additionally, compressive strength and split tensile strength were assessed at 7 and 28 days.

KEY WORDS: Dunite Powder, Tamarind Kernel Shell Powder, magnesium-rich rock, Compressive Strength and Split Tensile Strength.

I.INTRODUCTION

Concrete, as one of the most widely used construction materials globally, plays a significant role in infrastructure development. However, its production involves the consumption of large quantities of cement, a primary binder with substantial environmental impacts due to the high energy requirements and CO₂ emissions associated with its manufacturing process. Additionally, the disposal of agricultural and industrial by-products poses environmental challenges. In response to these concerns, there has been increasing interest in developing sustainable alternatives for concrete production by incorporating supplementary cementitious materials and eco-friendly additives.

One promising approach involves the utilization of dunite powder as a partial replacement for cement and tamarind kernel shell (TKS) as an additive. Dunite, a naturally occurring magnesium-rich rock, possesses pozzolanic properties that can contribute to the hydration and strength development of concrete when finely ground and incorporated into mixes. Furthermore, tamarind kernel shell, a by-product of the tamarind processing industry, contains polysaccharides and other organic compounds that have been shown to enhance the properties of concrete.

The combination of dunite powder as a cement replacement and TKS as an additive offers the potential to improve the performance, durability, and sustainability of concrete while reducing its environmental footprint. This study aims to investigate the effects of incorporating dunite powder and TKS on the fresh and hardened properties of concrete, including workability, strength, and durability characteristics.

By exploring the performance of concrete mixes containing dunite powder and TKS, this research contributes to the growing body of knowledge on sustainable construction materials and provides insights into the feasibility of utilizing these alternative components in concrete production. The findings of this study have implications for the construction industry, offering potential pathways towards more environmentally friendly and resilient infrastructure development.

II. OBJECTIVES

1. To assess the usage of Dunite powder and Tamarind Kernel Shell Powder in Cement.
2. To determine the compressive and split tensile strength of concrete.

III. MATERIALS

3.1 Cement: Cement is a material used in construction that serves as a binding agent to hold the other building materials together. Fine aggregate fills in the gaps left by the coarse aggregate, which makes up the majority of the material in concrete. Whereas concrete is merely cement mixed with coarse material, mortar is just normal cement mixed with water and fine aggregate.

3.2 Fine Aggregate: Sand particles that naturally form and are taken out of the earth during mining are known as fine aggregates. Any size of crushed stone particles $\frac{1}{4}$ " or smaller can be used. This product's size, or grade, of aggregate is why it is commonly referred to as 1/4' minus. Fine aggregate is defined as material that passes through an IS Sieve with a 4.75 mm aperture. The River Grade II Grading Zone has sand. Medium-sized grains.

3.3 Coarse Aggregate: Coarse aggregate is defined as aggregate that has been preserved over IS Sieve 4.75 mm. The typical maximum size for self-compacting concrete is progressively 10–20 mm, while it has been observed to employ particle sizes of up to 40 mm or higher.

3.4 Dunite Powder: Dunite powder refers to a finely ground form of dunite, which is a type of ultramafic rock primarily composed of the mineral olivine, along with smaller amounts of other minerals such as pyroxene and chromite. Dunite is typically found in mantle-derived igneous rock formations and is characterized by its high magnesium content.

3.5 Tamarind Kernel Shell Powder: TKS powder is obtained by grinding and milling the outer shells or husks of the tamarind seeds into a fine powder. This powder is rich in polysaccharides, fibers, and other organic compounds. Due to its composition, TKS powder possesses several properties that make it suitable for various industrial applications, including its use as an additive in concrete production.

3.6 Water: In the context of concrete mixtures, water refers to one of the essential ingredients used to bind the cement, aggregate (such as sand and gravel or crushed stone), and any supplementary materials together to form a cohesive and workable mixture.

IV. EXPERIMENTAL INVESTIGATIONS

4.1 Compressive Strength Results: To determine the compressive strength of concrete specimens are cast and cured under controlled conditions according to standard procedures. Typically, these specimens are tested in a compression testing machine, where a gradually increasing compressive force is applied until the specimen fails. The maximum compressive load sustained by the specimen, divided by the cross-sectional area, gives the compressive strength of the concrete, usually expressed in units of N/mm^2 or megapascals (MPa).

Table 1: Compressive Strength of Concrete with Constant Percent of Tamarind Kernel Shell Powder and Dunite Powder as Partial Replacement of Cement.

S.No	0.5% of TKS+ % of Dunite Powder	Compressive strength results, (N/mm^2)	
		7 days	28 days
1	0%	33.52	49.16
2	0.5%+20%	45.76	66.14
3	0.5%+40%	48.03	68.72
4	0.5%+60%	45.47	67.01

4.2 Split Tensile Strength Test: A cylindrical specimen is positioned horizontally between two compressive platens of a testing apparatus in a split tensile strength test for concrete. The specimen experiences a diametrically applied

compressive force that causes it to split and fracture along its length. Split tensile stress is the tensile stress that develops perpendicular to the applied force.

Table 2: Split tensile Strength of Concrete with Constant Percent of Tamarind Kernel Shell Powder and Dunite Powder as Partial Replacement of Cement.

S.No	0.5% of TKS+ % of Dunite Powder	Split tensile strength results,(N/mm ²)	
		7 days	28 days
1	0%	3.26	4.81
2	0.5%+20%	4.42	6.49
3	0.5%+40%	4.71	6.83
4	0.5%+60%	4.54	6.58

V. CONCLUSIONS

1. The compressive strength results for 7 and 28 days of normal concrete are 33.52 and 49.16 N/mm².
2. The split tensile strength results for 7 and 28 days of normal concrete are 3.26 and 4.81 N/mm².
3. 0.5% of Tamarind kernel shell powder is maintaining constant and varying different percentages of dunite powder at 40% optimum the compressive strength results for 7 and 28 days is 48.03 and 68.72 N/mm².
4. 0.5% of Tamarind kernel shell powder is maintaining constant and varying different percentages of dunite powder at 40% optimum the split tensile strength results for 7 and 28 days is 4.71 and 6.83 N/mm².

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