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GEOTECHNICAL INVESTIGATION ON LEPTYNITE ROCK: A CASE STUDY IN ANAKAPALLI, ANDHRA PRADESH, INDIA

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ABSTRACT: In civil engineering, building materials are necessary for the construction of a variety of structures, including residential buildings, dams, and roads. Natural building materials are essential to construction because they provide affordable solutions; this is especially true when they are easily accessible on the job site. The primary focus of this research is on the usage of "LEPTYNITE" rock material for face work, flooring, and concrete aggregate in various construction applications. The large volume quarry in Anakapalli is the source of the Leptynite rock that will be used in this study. Tests for specific gravity, impact, abrasion, and crushing will be among the studies carried out to investigate the leptynite rock's technical properties. Additionally, the research indicates that adding Leptynite rock sand in place of river sand improves concrete's compressive strength. When a replacement ratio of 60% is used, the best results are obtained and the compressive strength is higher than when regular river sand is used. This research highlights the potential of Leptynite rock as a sustainable and cost-effective alternative building material for construction applications.

Keywords: Leptynite rock, Compressive Strength, Anakapalli, and M30 grade concrete.

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1. INTRODUCTION

Natural stone is the most desirable substance in the world. The ever-increasing demand for the stones has resulted in a stratospheric surge in global trade. Rocks are more than just inert materials; they hold essential information about the earth's temperature, ecosystems, and geological events from the past. Analyzing the planet's past and predicting its future requires a solid understanding of geology. The bulk of engineering projects use rock-based building stones. Building stones can be used in engineering projects as unfinished pieces or as blocks, slabs, columns, or sheets after being cut and shaped. Specific gravity, modulus, compressive strength, shear strength, tensile strength, and point load strength are some of the most commonly tested engineering characteristics in laboratories. The features of the Leptynite rock quarried at Anaka Palli are investigated in this study, as shown in Figure 1. A Leptynite is a metamorphic rock close to gneisses (and sometimes considered a type of this rock), light in color, mainly composed of quartz and alkaline feldspars, poor in mica and amphibole, but sometimes with garnet and cordierite. It has a Foliated Gneissose texture

without banding. This study presents a geotechnical investigation of Leptynite rock from quarries near Anakapalli, focusing on its properties and suitability for various construction applications. Several laboratory studies were performed to establish the engineering properties of leptynite rock and its mineralogical composition for optimal utilization in construction applications

Figure 1.Location of Leptynite rock quarried at Anaka Palli, Andhra pradesh

2. REVIEW OF LITERATURE

The literature review includes several studies that look at different aspects of construction materials and their properties. Diederichs and Kaiser (1999) emphasized the importance of tensile strength in preserving the stability of subsurface apertures, despite the difficulty of doing direct tensile strength tests. Sahu (2003) demonstrated the benefits of replacing natural sand with stone waste by improving compressive strength and other mechanical properties. Chitlange (2010) also discovered that using artificial sand increases concrete strength due to enhanced cement bonding. Suppekar and Kumbhar (2012) proved that replacing up to 60% of natural sand with artificial sand can result in concrete of acceptable strength. The 2014 edition of Revista ION focused mostly on the evaluation of aggregates, specifically quartzmonzodiorite, to establish their suitability for building. The Bulletin of Engineering Geology and the Environment undertook a 2019 study to determine the ability to predict the results of the Los Angeles Abrasion test using regularly utilized aggregate tests. This study gave useful information for determining the quality of aggregate. A recent study published in the Journal of Rock Mechanics and Geotechnical Engineering (2019) investigated the relationship between aggregate degradation characteristics and rock strength tests. This study provides important insights for selecting suitable rock aggregates. Manoj Pravarly and Mahesh (2017) investigated the performance characteristics of concrete utilizing varying concentrations of Robosand and fly ash. The investigation finished by identifying the optimal blend proportions. Chetan and Aravindan (2020) investigated the feasibility of using recycled sand instead of fine aggregate and rice husk ash instead of cement in concrete. Few studies conducted on Evaluation and Validation of Recycled

Aggregate Concrete Borigarla, Priyanka, and Padmakar (2020), they investigated the strength analysis and validation of recycled aggregate concrete. The study sought to evaluate the structural qualities of concrete built from recycled aggregates, so contributing to sustainable construction methods. Borigarla, Buddaha, Kiran, and Hait (2022) investigated substituting sand with M-sand and quarry dust in stiff pavements. The study sought to assess the viability of employing alternative materials in pavement construction to reduce environmental effect while improving pavement performance. Padmakar, Borigarla, and Priyanka (2021) examined the compressive strength of geopolymer concrete. The study sought to better understand the mechanical properties of geopolymer concrete, which is noted for its sustainability and durability when compared to standard Portland cement concrete. They looked precisely at how these substitutions influenced the compressive and split tensile strength of the concrete. These studies improve understanding of construction materials and their applications, providing useful insights for improving construction procedures.

3. FIELD VISIT & EXPERIMENTAL WORK

The quarry, namely Ravi Teja Projects Pvt Ltd (17°44’22.9’N and 83°01’14.5E) in Anakapalli district were considered for the study. Fresh rock samples were collected for relevant study. Leptynite is a leucocratic rock, with feldspar and quartz. Biotite may be present up to 10%. It was obtained from a quarry at Anakapalli. It showed in Equigranular texture Garnet was present as porphyroblasts.

EXPERIMENTAL WORK AND RESULTS

The specific gravity, hardness, toughness, and abrasion tests are critical for determining the suitability of rocks for building. The specific gravity test offers information about the density and porosity of rocks, which is critical for assessing their load-bearing capacity. Hardness testing measures a rock's resistance to abrasion and wear, demonstrating its durability. Toughness testing reveals how effectively a rock can absorb energy and deform without fracturing, which is critical for determining its ability to bear dynamic loads. The abrasion test assesses a rock's resistance to wear and deformation under repeated impacts, which is critical for determining its appropriateness as aggregate in concrete and road building. These tests are vital to guarantee that the rocks used in construction fulfill the requisite standards of strength, durability, and performance.The key elements of the experimental investigation were:

- Obtaining bulk samples from quarry sites with diverse geological characteristics.
- Core extraction from bulk samples to ensure accuracy and integrity.
- Creating and refining cores to fulfill IS code 2386-1963(Part-IV) specifications.
- Examines and quantifies geotechnical parameters through laboratory tests.
- Determined compressive strength of concrete cubes with rock sand as a partial replacement.

STUDY OF PHYSICAL AND STRENGTH CHARACTERISTICS

The average specific gravity of the Leptynite rock is 2.95.According to IS 2386-1963 (1963) specific gravity of rocks for construction purpose should be in the range of 2.5 to 3.Hencethe sample rock is strong to bear the load and thus suitable for road construction. As per IS code 2386-1963 (part IV) this

rock sample is suitable for water bound macadam and bituminous macadam for flexible pavements and also as a wearing course for rigid pavements as its crushing value is not more than 40%. The average impact value of this rock sample is 25%.As per IS code 2386 - 1963 (part IV) this sample aggregate is satisfactory for road surfacing as its impact value lies between 20 - 30% and it is also suitable for bituminous bound macadam base course as its impact value is not more than 30%. The abrasion value of this rock sample is 44.8%. As per IS code 2386 - 1963 (part IV) the sample aggregate is suitable for WBM base course with bituminous surfacing and bituminous bound macadam pavements constructions as its maximum permissible abrasion value is not more than 50%. In partial replacement of river sand with rocks and the compressive strength of concrete fluctuates with increase in the percentage of rock sand and attains its linear increase in strength at 60% onwards and satisfies the requirements of M30 grade.

Table 1 show that the laboratory test results reveal that Leptynite rock exhibits a specific gravity of 2.95, indicating a dense and low-porosity nature suitable for load-bearing applications. Its crushing strength, measured at 39.3%, suggests a good ability to withstand crushing forces, essential for durability in construction. The rock's moderate toughness, with an impact strength of 25%, implies it can resist moderate impact loads without fracturing, making it suitable for applications where impact resistance is important, such as road construction. Additionally, the Los Angeles Abrasion test result of 44.8% indicates a moderate resistance to abrasion, a crucial factor for its durability under traffic or mechanical stresses. Overall, these findings suggest that Leptynite rock possesses favorable properties for construction, but further evaluation is recommended for specific applications.

Table 1 physical properties of Leptynite rock

Property	Type of test	Value
Specific gravity	Laboratory test (IS 2386-1963 part 4)	2.95
Hardness	Crushing strength test	39.3%
Toughness	Impact test	25%
Abrasion	Los angeles abrasion test	44.8%

4. PRINCIPAL RESULTS AND DISCUSSION

River sand is frequently used as fine aggregate in the global concrete industry. However, its high cost, primarily due to transportation costs derived from natural resources, has resulted in environmental issues and concerns. The large-scale decline of river sand supplies has made its availability less predictable. To address these concerns, alternative or replacement products for river sand in concrete manufacturing are being investigated. In this study, the researchers concentrated on M30 grade concrete and explored the usage of Robo sand as a substitute for river sand. Robo sand is artificial sand made from crushed stones that is regarded a feasible substitute to river sand. The researchers investigated the impact of various Robo sand replacement amounts (0%, 20%, 40%, 60%, 80%, and 100%) on the compressive strength of M30 grade concrete. The compressive strength of the concrete was measured at 7, 14, and 21 days to evaluate the performance of the concrete mixtures over time. The purpose of this experimental investigation was to evaluate the appropriate

replacement level of river sand with Robo sand for achieving sufficient compressive strength in M30 grade concrete.

COMPRESSIVE STRENGTH RESULTS

Table 2 shows the compressive strength data for M30 grade concrete with varied Robo sand replacement levels after 7, 14, and 28 days show varying trends. At 0% replacement, compressive strength gradually improves from 20 N/mm² at 7 days to 27 N/mm² at 14 days, and 28.8 N/mm² at 28 days. At 20% replacement, compressive strength rises from 24.3 N/mm² at 7 days to 28.08 N/mm² at 14 days and 29.15 N/mm² at 28 days. At 40% replacement, compressive strength first drops to 19.02 N/mm² at 7 days, but subsequently rises to 23.3 N/mm² at 14 days and 29.9 N/mm² at 28 days. At 60% replacement, compressive strength steadily increases, from 24.9 N/mm² at 7 days to 28.13 N/mm² at 14 days and 32.04 N/mm² at 28 days. These findings indicate that lower replacement levels of Robo sand (up to 20%) result in better compressive strength development over time, whereas higher replacement levels may initially slow strength gain but achieve significant strength at later ages, emphasizing the importance of optimal replacement levels for achieving desired concrete strength characteristics. The figure 2 shows the comparative results of compressive strength.

Table 2 results of Compressive strength in N/mm^2 at 7, 14 and 28 days.

% Replacement of Robo sand	Compressive strength in N/mm^2 (7 days)	Compressive strength in N/mm^2 (7 days)	Compressive strength in N/mm^2 (7 days)
0	20	27	28.8
20	24.3	28.08	29.15
40	19.02	23.3	29.9
60	24.9	28.13	32.04

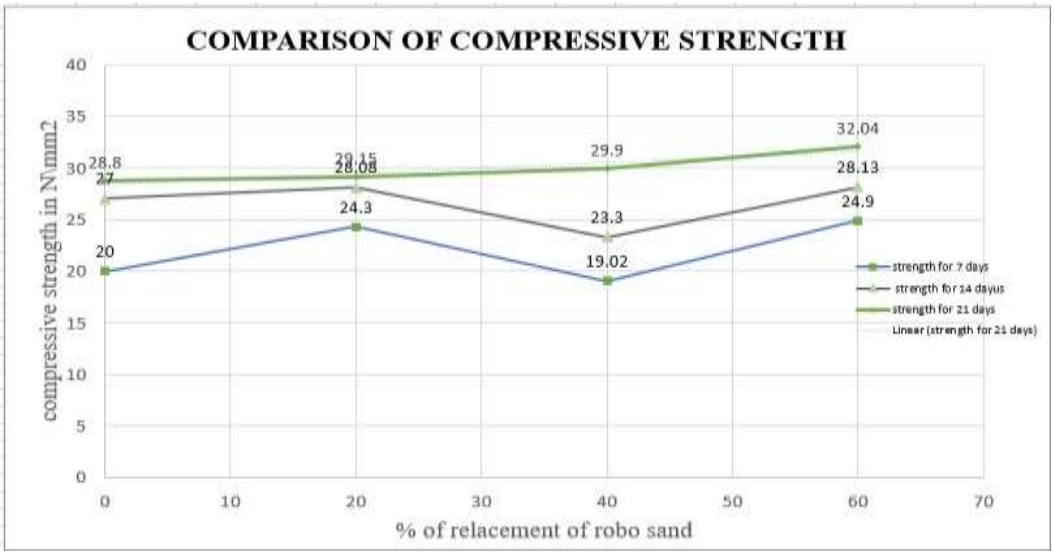

Figure 2. Comparison of compressive strength of M30 grade concrete at 7, 14, 21 days

5. CONCLUSION

The research findings show that Leptynite rock has the potential to be a sustainable and cost-effective alternative building material for a variety of construction applications. The specific gravity of 2.95 indicates that it is suitable for load-bearing in construction. The rock's intermediate hardness, with a crushing strength of 39.3%, implies that it may withstand crushing forces. Furthermore, its moderate toughness, with impact strength of 25%, suggests it can withstand mild impact loads. It is appropriate for applications with critical impact resistance, such as road construction. The Los Angeles Abrasion test score of 44.8% shows moderate abrasion resistance, required for durability in traffic or under mechanical pressures. Furthermore, replacing river sand with Robo sand in concrete manufacturing has produced excellent results.

The study discovered that replacing 60% of natural sand with Robo sand resulted in the highest compressive strength for M30 grade concrete, exceeding the strength achieved with conventional river sand. The compressive strength data at 7, 14, and 28 days showed an increasing trend with greater replacement levels, stressing the need for suitable replacement ratios in achieving desirable concrete strength properties. Overall, our studies highlight the viability of Leptynite rock and Robo sand as construction industry alternatives, with both economic and environmental advantages.

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