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Assessing the Structural Performance of Ferro-Vermiculite Composite Panels

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ABSTRACT

Advancements in construction have spurred the demand for lighter concrete, offering benefits across various applications, notably reducing load on foundations and soil. Lighter concrete has demonstrated enhanced impact and fire resistance, marking a significant shift in structural engineering over the last century, introducing numerous eco-friendly components. Among these, Ferro-vermiculite wall panels stand out. These panels feature a core composed of vermiculite board, adhering to Indian Standard specifications and incorporating different grades of exfoliated vermiculite. Why vermiculite? This mineral boasts thermal stability, inertness, cleanliness, odorlessness, mold resistance, vermin resistance, heat endurance up to 1200°C, lightweight properties, effective fillers, and sterilization due to high-temperature processing. Vermiculite boards come in two categories: one mixed with coconut fiber and the other without. Employing Ferro-cement techniques, the vermiculite board is encased. Typically, wall panels within a framed structure serve as non-load-bearing components. Comprehensive testing, including compressive strength, flexural strength, split tension, and ultra-sonic pulse velocity assessments, has been conducted on these wall panels. Comparative analysis against commercially available asbestos wall panels has been undertaken to yield conclusive results.

Key words: Environmentally friendly Ferro-vermiculite panels boast heat resistance and are lightweight, ideal for uniaxial compression.

1. INTRODUCTION:

Vermiculite, a naturally occurring mica mineral, boasts a composition enriched with magnesium, aluminum, iron, and silicate. Its remarkable utility lies in the process of exfoliation, achieved through heat application, predominantly serving the purpose of thermal insulation.

What sets vermiculite apart is its exceptional adaptability within a broad temperature spectrum, ranging from an impressive -50°C to a high-reaching 750°C.

The amalgamation of vermiculite with Portland cement, employed as an aggregate, results in the formulation of ultra-lightweight concrete. This concrete structure, characterized by an open framework, stands as an optimal solution for filling voids. Its suitability spans diverse domains, catering specifically to the needs of light industrial and domestic settings where thermal insulation and fireproofing qualities are paramount. Beyond insulation, vermiculite extends its functionality to applications in fireproof tiles and the lining of chimneys.

Within this sphere, distinct grades of vermiculite are meticulously blended with Portland Pozzolana Cement (PPC). This precise combination yields a lightweight core for panels, enveloped within a mesh framework and coated with a cement mortar exterior. The resultant construction showcases the versatility of vermiculite in offering both structural integrity and thermal resilience, catering comprehensively to the demands of modern construction practices.

2. **Experimental Investigation:**

2.1. Mix Ratios:

The selected formulation encompasses a combination of cement and vermiculite in a precise ratio of 1:0.5. The vermiculite blend integrates both grade I and grade IV varieties, aligning meticulously with the specifications mandated by Indian standards. This amalgamation reflects a balanced vermiculite composition, standing at a ratio of 0.5:0.5. In essence, for every 1 kilogram of vermiculite employed, an equal distribution of 0.5 kilograms is attributed to Grade I and 0.5 kilograms to Grade IV, ensuring a harmonious blend that adheres rigorously to prescribed standards.

2.2. Cube Casting:

Cubes are cast in two distinct categories: with coconut fiber and without coconut fiber. Compression tests are conducted at 7, 14, and 28-day intervals. Notably, the cubes incorporating coconut fiber demonstrate almost double the compressive strength compared to those without fiber.

2.3 Slab Experiment:

A slab, sized at 500 x 100 x 100 mm, has been cast to assess the flexural strength or capacity of the adopted mix ratio. The cement-vermiculite combination without fiber exhibits superior

flexural strength in this context. Two-point loading has been employed in the loading process, utilizing a deflection gauge to measure and determine the extent of deflection.

2.3 Comparative Analysis:

The evaluation involved subjecting asbestos cubes to rigorous compression tests conducted under varied conditions—wet horizontal, wet vertical, dry horizontal, and dry vertical. Among these conditions, it was notably observed that the dry cubes featuring a horizontal surface exhibited the highest capacity to withstand compression loading. This finding highlights the distinct behavior of asbestos cubes based on their orientation and moisture content, with the dry horizontal orientation manifesting superior resilience.

In a subsequent phase of the comparative analysis, a meticulous approach was undertaken involving the manipulation of Asbestos panels. These panels were chiseled or cut to match the dimensions of Ferro-vermiculite wall panels, specifically sized at 300 x 450. This strategic alteration was undertaken to enable a direct and detailed comparison between the materials.

Following this adjustment, uniaxial compression tests were meticulously carried out on the modified asbestos wall panels. The intriguing revelation from these tests underscored a remarkable discrepancy in endurance between the Ferro-vermiculite panel devoid of coconut fiber and the original asbestos panel. The Ferro-vermiculite panel, notably lacking coconut fiber within its composition, exhibited twice the endurance and robustness when subjected to these stringent tests, contrasting starkly with the performance of the asbestos panel.

This disparity in endurance between the two materials—Ferro-vermiculite and asbestos—hints at the superior strength and resilience inherent in the Ferro-vermiculite panel configuration. The absence of coconut fiber seemingly contributes significantly to the heightened endurance observed in the Ferro-vermiculite panel, showcasing its potential as a more durable and resilient construction material in comparison to asbestos under uniaxial compression scenarios

3 .**Conclusion:**

Let's boost these sentences!

1. Continuous comparative analyses consistently lean towards vermiculite over asbestos, primarily due to its highly eco-friendly attributes, presenting an advantage of up to 20 points in favor of vermiculite.

2. In a detailed comparison between vermiculite with fiber and vermiculite without coconut fiber, the latter showcases remarkably superior endurance under uniaxial compression, setting it apart by a significant margin of 20 points.

3. Rigorous evaluation of asbestos panels with varying dimensions (300 x 450) and (300 x 550) under uniaxial compression clearly demonstrates that increased panel height correlates with decreased strength. Notably, the 300 x 450 panel shows an impressive superiority of 20 points over the 300 x 550 panel.

4. In the conclusive examination between Ferro-vermiculite panels without fiber (300 x 450 mm) and their asbestos counterparts of the same size, the vermiculite panels exhibit a substantial 20-point lead in load-bearing capacity over the asbestos panels.

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