Geotechnical and environmental evaluation of tunnel muck as a sustainable road filling material

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Large volumes of tunnel muck in Sri Lanka are commonly discarded, despite potential reuse in transport infrastructure. This study evaluates the geotechnical performance and environmental suitability of tunnel muck from the Habarana-Anuradhapura Tunnel Project to determine its viability as a sustainable road-filling (sub-base/subgrade) material. Homogenized muck was processed to 10 mm nominal maximum size and tested following ASTM/BS EN standards. A focused test suite was selected to quantify key functions: Proctor compaction, Aggregate Impact Value (AIV), Flakiness Index (FI), and California Bearing Ratio (CBR). The material exhibited an optimum moisture content of 5.3% and a maximum dry density of 2.34 gcm^{-3}, consistent with typical sub-base aggregates. AIV = 29.4% indicates moderate resistance to impact fragmentation, while FI = 65% reflects a flaky gradation more appropriate for light- to medium-duty pavement layers or for blending/crushing prior to heavier-duty applications. Bearing capacity was adequate, with CBR = 35% (unsoaked) and 21% (soaked), supporting use in road sub-base and subgrade under normal traffic. A screening life-cycle comparison suggests that in-situ reuse of tunnel muck could reduce greenhouse-gas emissions by up to ~40% relative to quarry-derived aggregates, primarily by avoiding extraction and reducing transport. Overall, the results demonstrate that tunnel muck can be repurposed as an environmentally friendly road sub-base/subgrade material, advancing circular-economy practices in Sri Lanka while diverting waste and lowering emissions. The findings provide a practical evidence base for agencies to adopt specification-compliant reuse pathways with appropriate processing.

Keywords: *California Bearing Ratio, Circular economy, Lifecycle assessment, Road-subbase, Tunnel muck*