

STEM

Clear as Mud: Analyzing Soil Composition for Use as a Building Material in Kenya

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Understanding the composition and material properties of mixtures of red and black soils is essential for indigenous people to understand while building various structures. Our work specifically deals with the Nandi community in western Kenya. During the construction of traditional Nandi kitchens, soil is mixed in specific ratios and used to fill stick frameworks to form the walls. The purpose of this research is to determine a ratio of black and red soil that is optimal for construction based on experimental results and chemical composition.

Three separate tests—compression, absorption, and weathering—were completed with 8-cubic-centimeter mud cube samples created with varying soil compositions. For the compression test, a 100 Series Modular Tensile Test Machine, a machine that tests the durability of a material, was used to determine the Young's modulus and load at failure. For the absorption test, mud cubes were submerged in deionized water and qualitatively compared by looking at level of disintegration. Lastly, for the weathering test, cubes

were placed outdoors in West Lafayette, Indiana, to experience multiple freezing and thawing cycles to determine the mass lost due to the effects of erosion.

A combination of these three tests worked to provide our insight. Compression informed the height to which a structure could be built depending on material strength. Weathering provided insight into material durability, especially in exposure to freezing and thawing cycles, rainstorms, or the drying heat of direct sunlight. Absorption complemented weathering, as it examines how much precipitation the structure should be able to withstand. The three tests enabled us to determine that a 2:3 red-to-black soil ratio was optimal with respect to its suitability as a building material, which is the composition currently used by the Nandi community and throughout the developing world as a whole. Therefore, our results show that combining different types of mud can result in stronger structures, leading to buildings with less upkeep.

Research advisor Brandon E. Boor writes: "The EPICS Global Air Quality Trekkers team is building a Nandi kitchen at Purdue to evaluate how natural ventilation designs can help mitigate indoor air pollution in Kenya. The Mud team explored how soil composition influences the structural integrity and durability of traditional Nandi earthen building materials used in kitchen construction."