



Use of ceramic waste materials as aggregate and pozzolan binder in adobes: mineralogical, hydrologic and strength resistance investigations

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Although Brazil has the world's eighth largest economy, with abundant resources and developed infrastructures, the standard of housing varies widely. Since the mass urban migration in the mid-19th century, the poorest people have lived in *favelas*, urban slums that surround every city. Many dwellings consist in little more than a few boards pounded together, the rich living just a stone's throw away, sometimes separated by little more than a highway. Such a gap is even strongly observed in the Northeast of the country. In this tropical climate area, the red clay ceramic industry, which achieve low technologic development, is the dominant industrial activity, generating large amounts of waste. This study focuses on the development of low-cost building technology using red clay waste for rebuilding viable constructions. In order to address this issue, the combination of ceramic waste with lime in adobe building techniques is used, focusing on the mechanical strength and water resistance efficiencies.

There are many aspects that make the adobe construction technique the most appropriate solution. First, there is a low-cost for both the primary materials, as it uses local soil, and the building process, as earth is manually cast on the building site and sun-dried. Secondly, it is technique that is easily transferred, which is not only appropriate for cost-efficient constructions, but also for less educated inhabitants, who are taught to build their own houses. However, the use of unfired earth under climatic conditions with hard tropical rains might drastically reduce the durability of the constructions. Waste from the ceramic industries, is abundant (it is estimated to be between 10 to 15% of the production). Because there is no value attached due to the lack of recy-

cling technology studies, such waste is often provided free of charge by the factories. When ground, it can be used with lime (CL) to provide a pozzolanic binder, known to improve the strength resistance and reduce the porosity of the brick.

The hydrologic behaviour within a clay-based wall is critically controlled by the pore structure and the stability of the matrix. It is expected that a given earth mix can be optimised for use in damp climates (resisting absorption and promoting dissipation of water) through the adjustment of the granular and filler additions. Firstly, the development of the pozzolanic reaction between ground fired bricks and lime has been studied within earth blocks by both mineralogical observations (XRD, ATD-ATG) and strength measurements. The optimum pozzolanic reaction was characterised by the appropriate percentage of earth to binding material ratio and the fineness of the waste powder. The binder was a 1:1 mixture of lime and ground red brick waste, and the earth to binder ratio varied from 5 to 20%. Secondly, adobes were cast with and without 10% of crushed red brick waste related to the mass of earth. The effect of the particle size distribution was addressed by means of mercury porosimetry, absorption/desorption tests as well as through strength measurements. It is observed that red clay brick waste can be used as pozzolan as well as aggregate, providing an alternative and appropriate solution for tropical climates low cost constructions.