Silesian University of Technology

Faulty of Civil Engineering

Department of Building Processes and Building Physics

PhD Dissertation

Analysis of impact of selected natural waste fibers and ashes on properties of mortars

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Short abstract of PhD Thesis

By conducting research on renewable, ecologically friendly building materials, this dissertation hopes to advance the field of building materials for the construction sector. The material is created using a biomass ash such as rice husk ash (RHA), sugarcane bagasse ash (SCBA), and limestone powder (LP) as SCM for cement substitute, as well as waste natural fibers such as jute, sisal, and synthetic fiber as polypropylene. Long-term objectives include developing innovative, locally sourced ecologically friendly building materials to increase construction efficiency, speed up development, and lower construction costs, fitting into the area related to the use of natural waste materials and they recycling, i.e. environmental protection and sustainable construction.

The first study was carried out to examine the physical, mechanical, and micro-structural properties of natural fibers from jute, sisal and polypropylene which are widely available in Asia. Then, we reviewed the comparison jute and sisal to polypropylene fiber as waste on mortar properties. The study, designed a formula for a fiber composite material with cement, cement lime and cement with Air entraining Plasticizing Admixture (APA) so that it could be formed using in practical. After that, testing used to check the impact of fibers on the behavior of the cement. The second part of study is done with replacement of cement with rice husk ash, sugarcane bagasse ash and limestone powder with amount 5%, 10 and 15%. Then, it is analyzed to obtain a prediction for the better materials enhancing mortar properties with all additives. The study, examined the mechanical performance of tested mortars, using air content, consistency, compressive strength, flexural strength and shrinkage. To obtain characterization of the micro components, testing is done using a Scanning Electron Microscope (SEM) and Mercury intrusion porosimetry (MIP). On the base on them the evolution of failure and damage of the material is observed by micro-cracks.

The work consists of two main parts: study and research, which are divided into 11 chapters containing: literature studies, presentation, analysis and discussion of the results and conclusions. The first three chapters include an introduction, requirements for plastering and masonry mortars, and literature studies. The literature studies concern a review of publications of research works on the impact of waste additives used in the dissertation on the physical and mechanical properties, including shrinkage of mortars. These studies allowed for identifying the shortcomings, which made it possible to determine the scope of the research undertaken. On this basis, the purpose, scope of the work and the thesis of the work were defined in the next chapter (chapter 4). The thesis was accepted that natural waste fibers (jute and sisal) and ashes (from rice husks and sugar cane bagasse ash) influence the properties of mortars, both mechanical and physical, including microstructural ones. Then, the author presented the research methods used (chapter 5) and the materials used for research (chapters 6 and 7). The following chapters (chapters 8 and 9) present the results and analysis of tests on the properties of mortars with various composition modifications.

The results obtained from this study show that mortar samples performance is improved jute fibers and supplementary cementitious materials (SCM) addition. Furthermore, the addition of jute fiber increases the compressive and tensile strength compared to without fiber also enhancing all the properties on mortar with better crack resistance capability. The microstructural investigation confirmed better adhesion in jute composite fiber. The use of biomass ash enhance all the mechanical properties of mortar resulting is development of such materials which is more sustainable. The use of rice husk and bagasse ash shows improvement in both compressive and flexural strength with replacement level of 10%. With microstructural properties it can be seen than sugarcane bagasse ash is acting more like a filler materials and hence decreasing the cracks and voids in matrix. The carried out investigations showed the beneficial properties of mortars with the

addition of natural waste materials such as jute fibers or ashes. Such materials can therefore be considered ecological and environmentally friendly

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