Innovative Infrastructure Solutions (2024) 9:217
https://doi.org/10.1007/s41062-024-01529-y

TECHNICAL PAPER

Valorization of waste foundry sand by squeezing with sustainable cardanol-starch modified binder for engineered stone

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Received: 29 January 2024 / Accepted: 4 May 2024 / Published online: 21 May 2024

Abstract
Starch is a bio-polymer, renewable and biodegradable material being used as a binder in the field of construction possessing better mechanical properties. However, the bio-degradation property of starch would reduce the life structure of the product. In this context, the present research explores three binder systems viz., modified cassava starch (S), cardanol novolac resin (CH) and the binder SCH obtained by blending varied percentages of modified cassava starch (S) with cardanol novolac resin (CH) to improve the properties of starch binder and to evaluate the effect of degradation and moisture resistance in the developed engineered stone. Engineered stone was made using waste foundry sand (WFS) as a filler and S/CH of three systems as a binder material. The performance of the developed stone was analyzed through physio-mechanical, thermal, microstructural, UV irradiation and anti-microbial studies. The percentage of the binder varied from 7.5 to 15wt%. The resulting WFS-SCH composite at 15% of binder showed better properties of compressive strength of 20.99 MPa, bending strength of 7.26 MPa and moisture resistance of 122 ° (water contact angle) than compared to the WFS-S composite. Based on the analysis, a blended matrix of S and CH with different cross-linkers reduced the aqueous degradation and moisture absorption of the bio-based engineered stone. The potential application, limitations and recommendations of the developed cassava-based engineered stone were discussed. The outcome of the research paves an avenue to overcome the deficient characteristics of starch and provides an effective method for the utilization of solid waste material over natural resources.

Keywords Cassava starch · Cross-linker · Cardanol-hexamine · Waste foundry sand · Hydrophobic · Anti-microbial

Introduction

Natural stones such as limestone, sandstone and ornamental stones are the most important building materials in the areas of covering walls, paving floors etc. Limestones are formed near marine areas containing dissolved calcium, sandstones are developed by cementing the augmented grains formed by sedimentation and ornamental stones are made by exploiting the natural source (quartzite). In recent advancements in minimizing the usage of natural resources and exploitation, artificial stones have been introduced. Artificial stones are developed by high-quality aggregates bonded together either resin or cement-based binder and often more expensive [1]. Waste utilization has emerged to warrant the alternative source with an eco-friendly and sustainable environment. Significant studies have also been made in replacing conventional aggregates with waste materials such as marble residue [2], granite dust [3], FRP waste [4], etc. Discarded sand from foundries is one of the most generated wastes being produced about three million tons annually in India [5]. Waste foundry sand (WFS) has been used as a filler material in making mortars and concretes which possess better mechanical properties [6–8]. In the case of a binder system, often polymeric resins are used particularly epoxy (Diglycidyl ether of bisphenol A) and hardeners. Epoxy

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