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Treatment of Waste Foundry Sand Using Fungi: An Approach for the Application in Manufacture of Concrete

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Abstract
Metal foundries use large amounts of sand as part of the metal casting process. Foundries successfully recycle and reuse the sand many times in casting process. This study was aimed to present an eco- friendly approach of utilization of fungal treated waste foundry sand in concrete. The ability of producing organic acid and calcium oxalate monohydrate formation by the fungi *R.oryzae* was isolated from waste foundry sand. The optimization study was done for inoculum concentration, days of incubation, substrate concentration and WFS percentage. During optimization studies 6% of fungal inoculum, 3% 0f waste foundry sand and 0.6% of additional nutrient (glucose) gives maximum organic acid production in 7 days of incubation. Study also included leachate analysis obtained from the concrete mixes made with fungal treated WFS and untreated WFS. Results showed the metal concentration of Ba, Cd, Cr, Hg, Mn and Pb were reduced to significant levels as compared with World Health Organization (WHO) standard limits and ground water quality standards (GWQS). The beneficial use of such by-products in construction materials results in reducing the cost of construction materials' ingredients and also helps in reducing disposal problem.

Keywords: Residual binder, casting process, metabolic activity, leaching, optimization.

Introduction

Concrete is one of the most used materials for construction of buildings. It offers a number of advantages such as good mechanical and durability properties, low cost, and high rigidity. Rapidly increasing the demand for concrete due to growth in infrastructure development has resulted in the over exploitation of river sand in the river bed. This led to a range of harmful consequences, including increased river bed depth, water table lowering and the intrusion of salinity into rivers [1]. The boundaries for using river sand increases the price of sand and has severely affected the stability of the construction industry [2]. Foundry sand (FS) is a by-product from the metal alloys casting industry with high silica content. Silica sand is bonded with clay or chemicals, and is used for the material casting process. Foundries produce ferrous and non- ferrous castings and in the process of castings, heat and mechanical abrasion render the sand that can no longer be used in the casting process. After several cycles of metal casting process, sand comes out as waste foundry sand [3]. For each ton of good castings shipped, a typical foundry generates around one ton of WFS. The annual generation of WFS in India is approximately 500,000 tons [4].

Utilization of foundry sector in India currently stands at around average 45 percent. India is 3rd largest casting producer in the world [5]. The Indian casting production rate increased by 22 % while worldwide casting production rate of increase is 13.7%. The market share of Indian foundry industry is approximately 10% of global market [6]. After casting, the waste foundry sand can be considered as solid waste. The disposal and treatment of solid waste is becoming a mushrooming problem due to continuous economic growth and urbanization leads to enormous environmental and climatologically problems. This ensures effective and sustainable management of waste. It reduces/eliminates adverse impact on healthy environment which is directly connected to human life. The primary objective in waste management is to completely prevent the production of waste all together [7]. Second, if waste must be produced, then it is to be recycled. The use of recycled product has been increased worldwide due to conserving resources as well as reduction in fund available for the concrete of construction. The upcoming days make challenges for civil engineers for the utilization of the recycled solid waste and by-products for the basic properties of concrete and its materials. With increased restrictions, industries are constrained to find alternative ways to reuse waste.

Nowadays, the use of microorganisms for recycling of foundry sand is increasing. Three principles are mainly observed on mineralytic effects of fungi (*Aspergillus sp)*, namely acidolysis, complexolysis and redolysis. A series of organic acids are formed by fungal as well as bacterial metabolism resulting in organic acidolysis, complex and chelate formation. A combination of all three mechanisms might be responsible for metal solubilization, often termed "bioleaching" [8, 9]. Fungi interact with natural rock systems, soil and buildings under a broad variety of environmental