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ADVANCE UPCYCLING OF BY-PRODUCTS IN BINDER AND BINDER-BASED MATERIALS

ELSEVIER

Edited by
MEHMET SERKAN KIRGIZ

Advance Upcycling of By-products in Binder and Binder-based Materials

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Introduction

Upcycling can be described as transforming a by-product into a useful material which will be used in mainstream. In other words, it is also known as creative reuse, which is the process of transforming byproducts, remnants, and wastes into novel materials or products with a greater quality.

For constructional purposes, the meaning of the term upcycling is restricted to the bonding materials used with stone, steel, sand, brick, building blocks, and so on. The principal content of the book includes binders, byproducts, testing, and conclusions at the same time. Upcycling is used in many applications – art, music, industry, clothes, foods, design processes, and so on. The built environment is an indicator for overcoming climate change and transforming CO_2 emission in manufacturing to a net-zero emission in near future. The promotion of management of upcycling for sustainable purposes should use the pressure in demand for the adoption of proper methods to make cement more durable. Since construction by nature is not an ecofriendly activity and even if construction provides life for human generation, construction generates demolition waste whenever any development environment activity takes place, for example, building roads, bridges, flyover, subway, and remodeling. It includes mostly inert and nonbiodegradable materials such as concrete, plaster, metal, wood, plastics, and so on. Apart from industrial byproducts, some of this waste comes to the municipal stream. These wastes are heavy, having a grand unit volume weight, are often massive, and have considerable storage space either on the road/agricultural land or in common waste. Considering all information mentioned above, this book presents efficient upcycling examples for wheat straw ash; fuel ash, both class C and class F; oil shale ash; household waste; calcined clay; ground granulated blast furnace slag; natural rubber latex; recycled asphalt pavement aggregate; recycled concrete aggregate; silica fume; limestone; brick kiln dust; and crumb waste rubber tire in either cement-based systems or bitumen-based systems.

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Preface

Construction materials—concrete, geopolymer material, cement, and mortar—are the most manufactured structural materials. Sometimes, they substitute one another, and sometimes, they contest with one another so that similar structure types and functions could be built by any of the materials. However, scientists often focus more on advanced upcycling processes, in which by-products are made in various industrial manufacturing.

Today's building construction is totally different because the point the construction technology has reached involves the constructions printed with three-dimension printers using either cement paste or cement mortar, water and sand and binder. It is clearly true that manufacturers give guarantee regarding binder quality in a manner similar to that of other construction materials—tiles, brick, steel, wood, and so on. Nevertheless, the topic of advanced upcycling of byproducts in binder and binder-based materials is not limited to cement since there appear a number of novel binders everyday, such as geopolymer binder systems. The disparity in the methods of upcycling making is, therefore, unique, and the significance of the control of the quality of materials work on the site is apparent. Furthermore, since the trade of a materialist has not yet become the education and the convention of a number of other building trades, a scientist supervision is essential on the site. These facts must be considered in mind by the researcher and scientist as careful and intricate design could be easily vitiated if the properties of the actual materials differ from those assumed in the design calculation.

From the above points mentioned, it must not be inferred that making good upcycling of by-products is difficult. Good upcycling is often related to a substance of suitable constituents, mixing, hardening into a formwork, and homogeneous mass. Unfortunately the constituents of a bad upcycling process are also related to the same functions. Therefore the difference is obtained in terms of know-how and cost of labor.

What, then, is the advanced upcycling of by-products? There are two overall criteria: The method has to be satisfactory in its hardened state as well as its fresh state while being moved from the mixer and put in the formwork. The rules in the fresh state of upcycled materials are that there should be consistency in the mix and that it should be compacted by the means desired without excessive effort and also that the mix should be cohesive enough for the method of putting used not to make segregation with a consequent lack of homogeneity of the finished material.

Because the book will be used in so many countries, I thought it is best to use SI units of measurement. All the data, figures, and tables are therefore conveniently presented for readers, progressive or traditionalist, in all countries.

In a book of this size, it is not possible to cover the whole field of upcycling of by-products. The editor and author choose what they take into account as the most important or most interesting or simply what they know most about, but the emphasis is on an integrated view of the properties of materials containing by-products and on the underlying scientific reasons.

Mehmet Serkan Kırgız

Contents

Properties of concrete containing coal bottom ash as hydraulic binder substitution

12

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The use of coal bottom ash (CBA) as a partial cement substitute on the effect of concrete workability is studied.

12.1 Introduction

Concrete is a flexible substance that is produced using natural resources with cement as a binding agent. The use of natural resources rises every year owing to urban and rural growth. Cement manufacturing requires the use of large amounts of raw materials, energy, and heat. World Business Council for Sustainable Development International Energy Agency Technology Roadmap: Low-Carbon Technology for the Indian Cement Industry (2013) projected in 2050 the demand for cement in the range of 780−1361 million tons. Argiz et al. (2018) observed that when 1 ton of Portland cement is manufactured, it releases approximately 0.8 tons of carbon dioxide. The calcination process and combustion for energy generation during cement production are the processes with the greatest effect to the environment (Durastanti & Morretti, 2020). Alternative sustainable materials are needed to enhance the performance of concrete to minimize the use of natural resources (Jayakumar et al., 2021). Utilizing the freely available locally generated waste to replace the harvesting of natural resources for cement production would also contribute to preservation of natural nonrenewable resources and reduce degradation of the environment and wildlife.

At the same time the expanding population with their growing needs and flourishing industries causes an increase in energy demand in many parts of the world. Coal became one of the materials to generate energy in thermal power production

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