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Characterizing the generation and management of a new construction waste in China: glass curtain wall

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Abstract

Massive construction and demolition waste is generated in China's rapid development. Within this kind of waste, glass material produced form the widely applied curtain wall system contributes a lot. Currently, the majority of waste glass curtain wall is simply disposed in landfills or dumping, which not only significantly threats the scarcity of land resources, but also raises risks for surrounding environment and human health. However, there is relatively little work in China which focuses on the management of glass curtain wall waste produced from demolition and reconstruction sites. Therefore, this study systematically reviews current application and further development of glass curtain wall system in Shenzhen city (a mega city of China), and then analyzes the compositions and characteristics of the generation of waste glass curtain wall. The results show that the total gross surface area of buildings that use glass curtain wall system has approximately reached to 3 million m^2 in the region (Nanshan district in Shenzhen). It also indicates that there is around 2 kg of waste which could be produced from the construction of glass curtain wall per m^2 and will generate more than 6000 tons of glass curtain wall waste, including the whole life cycle from manufactory and construction. In additional, several recommendations to sound management of the waste glass curtain wall are proposed based on the further review of the management strategies and process methods employed in developed counties. Overall, the findings in this study could be helpful to contribute valuable knowledge and methods to the environmental management and waste recycling in China.

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Keywords: Glass curtain wall; Construction waste Management; waste recycling; environmental management

1. Introduction

The gross domestic product (GDP) of China has reached 57 trillion yuan by 2013, within which the number contributed by construction industry is 16 trillion yuan [1]. As one of the national pillar industries, construction industry develops rapidly along with the further urbanization. To be specific, due to glass curtain wall have advantages of lightness (12% of traditional masonry and 10% of concrete), high transparency property and beautiful appearance, it

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has got a quick development and wide application since it emerged in China in 1980s, and becomes one of the best choice for the outer shield structure in high-rise and super high-rise buildings [2].

Recently in China, however, only less than 10% of construction and demolition (C&D) waste was recycled while the majority of waste remain to be simply landfilled or just to be dumped, glass curtain wall waste [3]. At present, the technology of glass curtain wall has been widely used. It is imperative for us to recognize that the material life is as short as 10 to 20 years which is obviously shorter than other construction material and many glass-wall buildings are facing the situation of being demolished [4]. The newly built buildings adopted glass curtain wall with large scale in 1990s need a large number of replacement which generate enormous GCWW and cause resource waste and environment issues.

Owing to the significance of C&D waste, including GCWW, the investigation has long been attractive to researchers as well as practitioners. Tam et al.(2009) found that rapid urbanization has not only contributed to an increasing use of non-renewable resources, but has also led to the generation of significant amount of construction and demolition (C&D) waste and its associated environmental concerns [5]. At the same time, this rapid growth has resulted in enormous pressure on the ecosystem due to a large amount of energy required.

And glass curtain wall industry is one of the resource-intensive industries. Energy use is a major source of GHG emission, causing environmental problems, which is a serious question given that extreme weather conditions are spreading rapidly across China [6]. Continually rising energy consumption and highly-positioned energy intensity have not only sounded the alarm for Chinese energy security, but also increased the pressure on whether or not China should bear more responsibility in cutting emissions in the post Kyoto-protocol era [7]. Hence, cutting energy consumption has become a matter of urgency in China

When considering GCWW management measures for saving energy and resource, it is necessary to understand the amount, composition, and flows of the generated waste as precisely as possible within a given geographic area [8].Previously, foreign studies have been undertaken to investigate the suitability of glass curtain wall materials. M.Samuel introduces a new direct technique for recycling aluminium scrap with low energy consumption and cost without intervening metallurgical processes and experimental results show that the direct technique for recycling aluminium provides high productivity and about 80% green density [9]. These studies investigated the properties of the waste glass aggregate and tried to find the optimum percentage of waste glass that can be used as aggregate without any effect on the properties of the produced concrete [10,11].

Although these prior literatures enhance our knowledge, they mainly focused on the composition, weight, generation rate and management measures of C&D waste separately, with few focusing on GCWW holistically. Besides, in many cities of China, including Shenzhen, there is lack of regular statistics on the quantities of demolition waste, which presents a major barrier to the development of effective management measures [12].Moreover, there is a pressing need to understand the composition, quantities and weight of GCWW .It is therefore imperative to identify the a new GCWW management measures to replace the traditional mode which is featured with high resources wasting.

The analysis is based on empirical investigations of GCWW in Shenzhen city of south China and the aim of this research is to propose recommendations for improving the performance of GCWW management. The remainder of this paper is organized in four stages, the first of which is to provide methodologies for investigating GCWW and the second stage is conducting waste sorting and weighing at two site in Shenzhen (a construction project and a demolition project) and doing interview about the recycling potential of GCWW, while the third and fourth stages respectively analysed the data and provide results and discussions.

2. Method and data collection

When investigating GCWW, its normally approach is classifying GCWW into different categories. A review indicates that there are four measures are adopted when charactering the waste generation rates, namely (a) percentage of material purchased, (b) percentage of material required by the design, (c) kg/m2 of GFA, or (d) m3/m2 of GFA [13]. This study adopted the measures to calculate the material loss rate in construction period by (a) (b) and waste generation rate by (c), while using two common methodologies for investigating GCWW: (i) using ‘hard’ measures such as on-site sorting and weighing and or truck load records, and (ii) using ‘soft’ measures such as