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Comparing the implementation of concrete recycling in the Australian and Japanese construction industries

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ABSTRACT

Environmental problems have been considered to be serious in the construction industry. Waste management pressures are pressing very hard with alarming industrial warming signals. Among the different types of construction and demolition wastes, concrete is about 81 percent of the volume of construction and demolition waste in Australia. To minimize the concrete waste generated from construction activities, recycling of concrete waste is one of the best methods to improve the environment. However, situations of concrete recycling in different countries vary considerably. Japan is a leading country in recycling concrete waste, with 100 percent recycling of the wastes that are used for new structural applications. This paper investigates the current concrete recycling situations in Australian and Japanese construction industries. A questionnaire survey and structured interviews were conducted. In comparing the current concrete recycling situations between Australia and Japan, it should be noted that major difficulties found from Australian and Japanese construction industries are on different phases of the transition to recycling of construction wastes. Therefore, it is suggested that the Australian construction industry should be: i) developing a unified policy in concrete recycling; ii) providing financial governmental support; iii) developing clear technical specifications or standards on the use of recycled aggregate for structural applications.

1. Introduction

The promotion of environmental management and the mission of sustainable development have exerted pressure on the adoption of proper methods to protect the environment across all industries, including construction. Extensive extraction of natural resources for building construction jeopardizes the principle of sustainability and has received increasing objections from environmentalists. Construction by nature is not necessarily an environmental-friendly activity. The comprehensive building development and redevelopment plans in different countries have aggravated construction problems pertaining to building demolition. To optimize the use of natural resources and particularly concrete demolition waste, there is a need to develop long-term action plans on the use of materials and to coordinate various interests among stakeholders and companies in the construction industry [1]. The hierarchy of disposal options can be categorized into six environmental impact levels, from low to high; namely, reduce, reuse, recycle, compost, incinerate and landfill [2]. Three main waste minimization strategies of reuse, recycle and reduction are collectively called the "3Rs". To reduce construction waste generated on site, coordination among all those involved in the design and construction processes is essential.

Sustainable construction is a set of processes by which a profitable and competitive industry delivers built assets [3,4]: i) to enhance the quality of life and to provide customer satisfaction; ii) to offer flexibility and the potential to help to anticipate and respond to anticipated future, user demands; iii) to provide and support desirable natural and social environments; and iv) to maximize the efficient use of resources. A potential contributor for sustainable performance can include recycling of construction waste.

The best way to deal with material wastes is not to create them in the first place [34,63]. Table 1 summarizes the problems of the current practices and highlights some of the recommended measures for reducing the generation of construction wastes by improved management and operational improvements. Four management measures are highlighted including: i) policy; ii) training; iii) audit; and iv) feedback and two operational measures on design and construction stages are also considered.

Recycling, being one of the strategies in waste minimization, offers three major benefits [5]: i) to reduce the demand upon new resources; ii) to cut down transport and production energy costs; and iii) to use waste which would otherwise be transferred to

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Table 1
Problems and recommended measures for controlling construction waste by previous researchers [14–16,34,50,54,56,57,59–78].

	Management level				Operational level	
	Policy	Training	Audit	Feedback	Design	Construction
Aim	Enhance environmental awareness and company culture	Provide benchmarking measures in understanding the weaknesses		Achieve continuous improvement	Have an early planning for the environmental issues	Ensure all construction wastage had been minimized by all means
Problems	Waste management as a low priority in a project	Insufficient training provided and lack of knowledge on waste minimization technology	Normally no benchmarking tool provided in an organization	No encouragement to provide feedback	Lack of consideration of environmental issues in the design stage	Waste generation is increasing
Measures	Set up environmental policy Demonstrate greater commitment to waste management Implement waste management plan Consider reduction of construction waste and awareness of environmental protection as basic requirements in building management	Provide training programme to all levels of employees	Provide benchmarking measures for understanding the problems of the current measure and provide some improvements Incentive reward scheme	Provide feedback loop from the public and in-house employees Improve building construction technology by research or adoption	Use long-life construction materials, such as steel Consider dimensional coordination construction Minimize variations Flexible design Purchasing quantity of materials just required Consider site selection Provision of adequate information on maintenance Clear specification Use environmental-friendly construction method and modular design, such as prefabrication Avoid buying poor quality materials Coordinate with designer and specification writer to use recyclable materials	Reuse, recycle and reduction Good site planning Separation of construction materials Well-organized site and proper storage facilities Use of secondary materials Avoid complex and labour intensive works Labeling of construction materials Effective logistics Agreements with sub-contractors Avoid overloading limited storage space on site Avoid unnecessary handling Less packaging or reusable packaging Adopt just-in-time ordering Avoid damage while unpacking on site Order appropriate material sizes to minimize cutting, and order appropriate quantities to avoid excess Designate central areas for cutting and storage so reusable pieces can easily be located Review waste management periodically to identify additional waste reduction alternatives Employ competent sub-contractors and skill labourers

landfill sites. Construction and demolition waste including demolished concrete, bricks and masonry, wood, glass, insulation, roofing, wire, pipe, rock and soil [6] constitutes a significant component in the total waste.

Among various types of construction and demolition waste, concrete constitutes the major proportions of the total waste of about 81 percent in Australia [7]. The situation of surrounding concrete recycling is varied in different countries. Japan is a leading country in concrete recycling, in which about 98 percent of concrete waste is recycled [8]. Most demolished concrete structures are reused for road-base materials and backfill materials, some can even be used it for structural applications [9,10]. Although concrete recycling is recommended in the Australian construction industry, it is still not clear on concrete recycling procedures and the lack of experience in conducting these [11]. This limits the concrete recycling rate in Australia to only about 40 percent which is mainly used for low-grade applications [12].

2. Research objectives

This paper aims to achieve the following objectives:

- to study waste generation in the Australian and Japanese construction industries;
- to examine their regulatory requirements on waste minimization and concrete recycling procedures;
- to investigate their current concrete recycling methods;