

On the Prevailing Waste Recycling Methods: a Southeast Queensland Study

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Abstract

In Australia, waste generated from construction and building demolition work constitutes about 44% of the total amount each year. Consequently, it has created a serious waste management problem. The State Governments of Victoria and New South Wales have been pushing for the use of recycled materials; they have promulgated specifications for the use of recycled aggregate from construction and related waste. However, in Queensland, similar specifications are not available, which explains the lack of research conducted in this important area. This paper presents an evaluation of the prevailing waste recycling methods used in Queensland. Nine sites have been visited, including two construction sites, three demolition sites, three recycling plants and one landfill in Southeast Queensland. Difficulties encountered by the recycling operators and their associates from these site visits are investigated. One of the major barriers is that the local councils disallow the use of recycled materials in construction activities! To help improve the situations, state and local authorities should implement policies encourage the use of recycled construction waste. This can be done by: (i) developing specification for the use of recycled materials; and (ii) increasing landfill disposal charges for construction and building companies to discourage dumping.

Keywords

Waste management, recycling, construction, Southeast Queensland.

1. Introduction

The promotion of environmental management and the mission of sustainable development have exerted the pressure demanding for the adoption of proper methods to protect the environment across all industries including construction. Construction by nature is not an environmental-friendly activity. The hierarchy of disposal options, which categorizes environmental impacts into six levels, from low to high; namely, reduce, reuse, recycle, compost, incinerate and landfill (Peng *et al.*, 1997). 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 process is essential.

Recycling, being one of the strategies in minimization of waste, offers three benefits (Edwards, 1999): i) reduce the demand upon new resources; ii) cut down on transport and production energy costs; and iii) use waste which would otherwise be lost to landfill sites. Construction and demolition waste including demolished concrete (foundations, slabs, columns, floors, etc), bricks and masonry, wood and other materials such as dry wall, glass, insulation, roofing, wire, pipe, rock and soil (Coventry, 1999) constitute a significant component of the total waste.

To improve the existing practices of waste recycling, this paper focuses on the following objectives:

- i) Investigating the waste problems in construction;
- ii) Examining the importance on waste recycling;
- iii) Exploring the existing waste recycling methods by visiting to construction and demolition sites, landfills and centralized recycling plants; and
- iv) Pinpointing the difficulties encountered from the existing waste recycling methods, the recovery methods for the current waste recycling market are suggested.

2. The Existing Waste Management Situations in Southeast Queensland

Southeast Queensland including Brisbane and Moreton Statistical Divisions, comprises of about 17 local government areas, represents the largest concentration of urban development in Queensland, and contains the majority of the State's population. Southeast Queensland has around 2.63 million residents, which are nearly two-thirds (about 66.3%) of the State's total population in 2004, and about 70% of population growth was recorded in 2005 (Planning Information and Forecasting Unit, 2006). At the regional level, there is a strong link between population and household waste disposal. It appears that Southeast Queensland produces approximately two-thirds of the municipal solid waste that was kept in council landfills (Queensland Government, 2004).

Furthermore, Southeast Queensland has the highest population growth in Queensland, construction industrial growth is also increasing to support the population growth. This means that the number of construction and demolition waste would increase from construction activities. Waste materials from construction and demolition sites are major components of the waste stream in Queensland urban centres. On average, construction and demolition waste comprises of about 25-30% of the total waste. More than 80 percent of construction and demolition waste is landfilled. However, construction and demolition waste can be generated and reused as recycled materials for construction work. Overall, in Queensland, recycling of construction and demolition waste is not well established (Environmental Protection Agency, 2007). Although, landfill and natural resource materials in Queensland are still sufficient for construction activities, waste reduction, reuse and recycling should be employed to keep environmental and natural materials for the future.

The Queensland local governments reported the management of about 1,548,000 tons of secondary resources between 2004 and 2005, including construction and demolition waste, commercial and industrial waste, green and organic waste, and bio-solid waste (Queensland Government, 2004).

The generation of construction and demolition waste is directly connected to building and construction activities. Because of the close connection between the construction industry and the demolition industry, the extent of activities in the construction industry is a clear indication of demolition activities. Demolition waste includes a wide range of materials such as bricks, tiles, concrete, steel, glass, timber, plastic and other products generally used in the building industry. Traditionally, the only type of construction waste recorded at council landfills has been builders' rubble. Waste generated by civil construction such as road works and bulk excavations has been generally not considered as construction waste (Environmental Protection Agency, 2007). As with demolition waste, the type and quantity of waste generated from a construction project depend on site-specific issues such as design, architectural style, method of construction, and building materials.

From Environmental Protection Agency surveys, it has been found that less than 20% of construction and demolition waste generated in Queensland (excluding earthen spoil) is recycled or reused. Overall, the recycling and reusing of construction and demolition waste materials is

sporadic. As would be expected, the major diversion of materials from landfill occurs in Southeast Queensland (Environmental Protection Agency, 2007). There are little organised activities in regional areas where these waste types are not considered as a major issue.

In particular, from the point of view of recycling and reusing of construction and demolition waste, construction and demolition sites in Southeast Queensland will be visited to investigate difficulties in recycling construction and demolition waste.

3. Site Visits

To evaluate the prevailing construction and demolition waste recycling methods used in Queensland. Nine sites have been visited, including two construction sites, three demolition sites, three recycling plants and one landfill in Southeast Queensland. The details of the sites can be seen in Table 1.

4. The Existing Problems of Recycling Materials

From the interview discussions with representatives from each site, major barriers encountered on using recycled materials in construction activities in Queensland are:

- i) Landfill fee charges for dumping waste in Queensland are low compared with fee charges in other States, which do not encourage the industry to recycle waste;
- ii) Recycling material transportation cost is quite expensive compared with that of natural aggregate;
- iii) Recycled aggregate properties are very weak for concrete construction applications;
- iv) There are no specifications for recycled materials for concrete construction work; and
- v) Lack of experience in using recycling materials and construction methods.

5. Benefits of Recycling Material

The benefits of using recycling materials are beneficial to the environment. Three major benefits are summarized: i) economic aspects; ii) lower environmental impacts; and iii) resource saving.

5.1 Economics Aspects

Using demolished concrete as aggregate is an effective and economically viable option to recycle waste materials. This provides waste minimization benefits by avoiding the use of landfill space and reducing resource consumption (Tech Data Sheet, 1998).

5.2 Reducing Environmental Impacts

Waste recycling can greatly reduce environmental damages caused by incorrect disposals, extend the useful life of landfill and preserve precious finite natural resources (Carneiro *et al.*, 2000). The advantage of recycling demolition concrete is that substance can be reused which would otherwise be classed as waste.

5.3 Saving Resources

Recycling of concrete demolition waste can provide opportunities to save resources, energy, time, and money. Furthermore, recycling and managing concrete demolition waste will save land and create better opportunities for handling other kinds of waste (Tam, 2005).

Table 1a: Summary on Information Collected from site visits in Southeast Queensland

	Landfill 1	Construction site 1	Construction site 2	Demolition site 1	Demolition site 2	Demolition site 3	Recycling plant 1	Recycling plant 2	Recycling plant 3
Site details	Started operation seven years ago with 5 workers in this site and will be finished in the next 7 years. Concrete recycling was started 1 year ago.	The two buildings provide 300-unit accommodation at construction site. Three years construction project. Started on 11 September 2006. Estimated to have 400 workers each day on site when construction work is fully run, currently the earthwork is running. Every day, the site can produce 3 10m-skips which cost around \$900 of dumping fee.	This project was started in February 2006 and expected to be finished in the mid of July 2007. 20 workers are working on this site at this moment, currently construction is completed up to level three.	A three-story resident building with seventy-five units of demolition and recycling sites was started about six weeks ago. There are three workers working on site.	A two-story building demolition site. Four days contract for demolishing and material moving. Three workers are working on site.	Started operation on 2 nd May 2006 and expected to be finished at the end of November 2006. 20 workers are working on site.	Started operation since 1970 and operating for concrete recycling around 14-15 years ago with 18 workers on site.	Started operation 10 years ago with 35 workers on site.	The Plant started operating around 3 years ago. There are 3 main staff for sieving, crushing, and sorting.

Table 1b: Summary on Information Collected from site visits in Southeast Queensland

	Landfill 1	Construction site 1	Construction site 2	Demolition site 1	Demolition site 2	Demolition site 3	Recycling plant 1	Recycling plant 2	Recycling plant 3
Received waste	<p>Waste from industrial companies is received for landfilling.</p> <p>Concrete waste is dumped and stocked for around 3 months, then crushed by subcontractors and sold out as RA in about 3-month time.</p> <p>About 6-7% of the total received waste is clean concrete waste.</p> <p>Green waste is used on site for landfilling.</p> <p>Tire waste is crushed and sent out unless used on site.</p> <p>Receive around 500,000 tons of waste per year.</p>	Demolition waste is sent by demolition companies.	Construction waste are separated as metal, concrete and brick, then sorted before being sent to recycling plants and landfills.	Building demolition waste consists of concrete, steel, glass, tree, and other toilet and bathroom materials.	Building demolition waste consists of timber, concrete, brick, steel, glass, and other furniture which will first be pulled down and, separated before being resold to, landfills or recycling plants.	<p>Waste from three power station building demolition consists of concrete, brick, structural steel, rebar, and glass.</p> <p>The building was demolished from its concrete roof, brick wall concrete beam, and then structural steel by an excavation machine.</p>	<p>Building waste materials include soil, concrete, brick, and tire.</p> <p>About 500 – 600 trucks dump the C&D waste and around 700 trucks to carry recycled material out on a busy day.</p>	<p>Building waste materials include soil, concrete, brick, asphalt.</p> <p>About 600 trucks a day to dump the C&D waste, 300 trucks to dump the construction and demolition waste, and 300 trucks to carry recycled material out.</p>	222 – 224 trucks a day dump the C&D waste.

Table 1c: Summary on Information Collected from site visits in Southeast Queensland

	Landfill 1	Construction site 1	Construction site 2	Demolition site 1	Demolition site 2	Demolition site 3	Recycling plant 1	Recycling plant 2	Recycling plant 3
Supply of waste	Intake from industrial companies with the fees of about \$13 per ton for general waste, and \$5 per ton for clean concrete waste dumping.	No waste sorting and no recycling in this site, just dumping.	<p>About 80% of waste materials from this project are recycled and reused, about 90% are sent to landfills.</p> <p>Steel and timber are sent to recycling plants and resold.</p> <p>Concrete waste is sent to company's contractors for crushing</p> <p>They buy crushed concrete from their contractors.</p>	<p>About 100% of waste is recycled.</p> <p>Concrete is demolished and crushed to become RA for recycling settlement or groundwork in this site.</p> <p>Steel is separated from concrete and then sold back to market.</p> <p>Other materials are sent to recycling companies to separate such as trees and toilet and bathroom materials.</p>	Demolished concrete, steel, and inside furniture are sent to recycling plants.	Recycled materials will be re-developed in the power station as stated in the contract to form the foundation of constructed tennis courts.	<p>Intake from private companies with charging fees of \$4 – \$8 per ton for dumping depend on steel quantity in concrete.</p> <p>Gold Coast City Council supply waste around 200–300 tons per year.</p> <p>From demolition building sites around the Gold Coast area.</p>	<p>Intake from private companies with charging fees of \$5 per ton for dumping.</p> <p>From demolition building sites around Brisbane and surrounding areas.</p>	From building site around gold coast area.

6. Recommendations to using recycled materials

Although there are many construction projects using recycled aggregate concrete, those are only limited to non-structural concrete applications (Cheung, 2003, Hassan *et al.*, 2000, Poon *et al.*, 2003, Reusser, 1994). Recycled aggregate concrete cannot achieve the designed requirements as normal concrete. The properties of recycled aggregate concrete at high porosity, less density and high absorption tend to be worse in strength and resistance to freezing and thawing than concrete created from ordinary aggregate. Therefore, the following recommendations are proposed to encourage the adoption of recycling aggregate:

- i) The price of recycled aggregate should be as competitive as natural aggregate to encourage the use of recycled aggregate in replacing rocks in concrete;
- ii) Recycled aggregate recommendations and specifications should be provided to promote its use. Detailed requirements should also be provided; including recycled aggregate percentage adoption, application areas, requirement of aggregate properties and strength design. Recycled aggregate should be encouraged and promoted as secondary materials in structural constructions;
- iii) Since the variety of supply sources will cause variation in quality, stricter quality control of recycled aggregate is required. An authorized party should be responsible for controlling the quality before adopting these materials (Tam, 2005);
- iv) Other than setting up recycling plants and quality specifications or standards, an information network should be used to link them. An information network needs to be built up to disseminate the experience in using recycled aggregate (Kawano, 1995);
- v) Methods are adopted to classify different types of recycled aggregate around the world such as density, water absorption, percentage of fine values, content of organic materials and others. A standard classification system should be provided;
- vi) The limited applications of recycled aggregate are attributable to their poor quality. To solve the problems of recycled aggregate concrete, some techniques need to be developed to improve recycled aggregate quality such as to minimize the cement portions adhering to recycled aggregate or separate aggregate from cement paste as much as possible to attain the quality comparable to original aggregate (Tomosawa and Noguchi, 2000);
- vii) The introduction of financial mechanisms to encourage the diversion of waste from landfills. A levy reflecting the environmental and social costs of landfilling could be placed on waste disposed to landfills. The proceeds from this levy could be spent to improve construction and demolition waste management and waste minimization initiatives (Environmental Protection Agency, 2007); and
- viii) Encouraging all landfill operators to introduce differential charging to encourage the source separation of construction and demolition waste (Environmental Protection Agency, 2007).

7. Conclusion

The existing waste management situations in Southeast Queensland have been studied with the emphasis on construction and demolition waste. The management of construction and demolition waste has been investigated by visiting and interviewing representatives from two construction sites, three demolition sites, three recycling plants, and one landfill in Southeast Queensland. The existing problems of recycling materials in this region have been identified from the interview discussions. The major barriers encountered on the use of recycled materials in construction activities are; i) low landfill charge for waste dumping; ii) expensive recycled aggregate transportation costs; iii) weak recycled aggregate properties; and iv) lack of specification and experience in using recycling materials.

The benefits of using recycled materials have also been investigated. Three major benefits are; i) economic aspects; ii) lower environmental impacts; and iii) resource saving. The following recommendations are suggested; i) price of recycled aggregate should be as competitive as natural aggregate to encourage the use of recycled aggregate; ii) recommendations and

specifications for recycled aggregate should be provided in promoting its use; iii) stricter quality control of recycled aggregate from various sources is required by an authorized party responsibility; iv) an information network needs to be built up to disseminate the experience sharing in the use of recycled aggregate; v) a standard classification system should be provided; vi) some techniques need to be developed for improving the quality recycled aggregate; vii) a levy reflecting the environmental and social costs of landfilling could be placed on waste disposed to landfill for improving construction and demolition waste management and waste minimization initiatives; and viii) encourage all landfill operators to introduce differential charging to encourage the source separation of construction and demolition waste.

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