Waste Management at the Construction Site

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Abstract

This paper discusses an issue of growing importance in the construction industry. The construction of a single family home in the United States typically produces between two and four tons of debris, the majority of which is discarded in landfills, despite the fact that 80 percent of this has recycling potential. Debris from demolition also has significant recycling potential. Construction and demolition (C&D) debris combined comprises 24 percent of municipal solid waste, which is leading to increased costs and regulation. Some municipalities now ban C&D waste from landfills. Some progress is being made in diverting such waste from landfills, but substantial barriers still exist to a widespread adoption of environmentally sound waste management practices at construction sites.

Keywords: recycling; waste generation audit; C&D debris

Introduction

The construction of a single family home in the United States typically produces between two and four tons of debris (Jones, 1993; Donnelly, 1995). Home construction activities generate a large amount of waste that is becoming increasingly expensive to discard. The strain caused by increasing waste disposal costs for builders is seen in the rise in average tipping fees across the country: from $4.90 per ton in 1976 to $34.00 per ton in 2002 (Yost, 1995; Chartwell Information, 2003). In a study of home construction firms, 65% of survey respondents indicated that the costs for disposing of construction debris negatively affect the economic health of their companies (Austin, 1991). In addition, from the perspective of home buyers, these costs also have negative impacts on the affordability of homes. Aside from the costs of disposal, questions related to the squandering of resources and declining availability of landfill space require that this situation be addressed systematically, in both new construction and rehabilitation.

Current "State of the Art"

The U.S. Environmental Protection Agency has estimated that construction and demolition (C&D) debris accounts for 24% of all municipal solid waste (Jones, 1993). Beyond the issue of volume, the toxic nature of some of these materials, such as adhesives and solvents, is leading to increased regulation of C&D waste disposal, with some county and municipal authorities banning C&D waste from landfills and developing separate dump sites for such materials (Piasecki, Ray and Golden, 1990; Yost, 1995). In addition, researchers who have examined this issue have concluded that regulation of C&D waste will increase (Cosper, Hallenbeck and Brenniman, 1993).

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A difficult aspect of the C&D waste issue is that with some notable exceptions, a coordinated effort to assist the construction industry in developing viable alternatives to landfill disposal of C&D debris is lacking. For the most part, federal, state, and local governments are not taking an active role in reducing landfill disposal or in stopping the illegal dumping of the material by encouraging its recycling and conversion to other materials.

A better understanding of the composition of C&D waste can be gained by examining how it is classified and characterized. C&D waste can be classified according to its three sources: new construction, renovation or remodeling, and razing or demolition. While the types of wastes generated from these three areas are similar, the amounts each produces are different. C&D waste can be further classified into materials that could be recycled, hazardous waste, and stable landfill materials. But this classification scheme is not as straightforward as it seems. Gypsum board, for example, is both recyclable and potentially hazardous. The reason for the potential hazard arises because of hydrogen sulfide that is produced as the material decomposes under anaerobic conditions (Burger, 1993). This led British Columbia to ban gypsum wallboard waste from municipal landfills (Musick, 1992).

A complicating factor in analyzing this issue has to do with waste characterization. In some areas of the country, C&D waste is characterized by weight, in others by volume. In both characterization schemes, however, wood, gypsum board and corrugated cardboard account for 70 to 80% of total C&D waste generated. Each of these materials has significant recycling potential.

The issues of reducing and recycling C&D waste are important for their effects on both the environment and housing affordability. Environmental aspects are clear: landfill space is becoming more and more limited; faulty landfills pollute air, earth, and water; and illegal dumping of C&D waste is increasing. Regarding housing affordability, the National Association of Home Builders has demonstrated that builders pay twice for construction materials that could be recycled but end up in landfills: payment is made when the materials are purchased and fees are assessed when the materials are dumped (Yost, 1995). These costs are then passed on to homebuyers in the form of increased house prices.

An empirical examination of this issue was undertaken at Cornell University with the following objectives: (1) to observe the weight and volume of debris produced during the house construction process; (2) to investigate alternatives to landfill discard for each item in the waste stream, and (3) to develop an educational program for home builders based on findings from the project. The methodology followed included an on-site waste audit of a 1,894 square feet single family home under construction in Upstate New York. This audit consisted of weighing, measuring and cataloging every item of debris produced; investigating options available for reducing and/or recycling each item; and comparing results of this waste audit with others conducted elsewhere. For a complete review of the project and its findings, see Laquatra and Pierce (2004).

The Cornell waste audit revealed that packaging and materials debris for the house under study included 1,788 pounds of gypsum board scraps and over 1,400 pounds of wood scraps. The total weight of all waste materials, 4,642 pounds (2.3 tons), is consistent with other reported studies.

Results of this audit showed that gypsum, wood and cardboard waste made up almost 75% of total debris by weight. That figure was compared with seven other waste audits that have been conducted around the country and was found to be consistent.

While 80 percent of the waste stream at a residential construction site may be recycled (Yost and Lund, 1996), various obstacles prevent that potential from being realized. This is the case with waste gypsum board, also known as drywall or wallboard. This popular and inexpensive material is commonly applied to wall studs and ceiling joists. After it is applied, the finishing process that involves filling joints and nail or screw heads results in surfaces that are easily painted or covered with various products. But in the process of cutting drywall to fit around windows, doors, and other openings, about one pound of waste for every square foot of house area is produced. This can average to about one ton of drywall waste per house.

There are legitimate reasons why builders and contractors end up with so much scrap. Walls and ceilings are easier to tape and spackle and less likely to develop cracks if they are covered with large pieces of gypsum from which openings are cut. Small pieces require much more time and labor for finishing, and the joints between them are susceptible to cracking over time.

The major disadvantage to the generation of large amounts of drywall waste is related to environmental concerns. Landfill space is becoming more expensive and less available; and the presence of drywall waste in landfills can, under certain conditions, result in the production of hydrogen sulfide gas, which can pose serious human health and safety hazards. In fact, some landfills already refuse to accept drywall waste. These factors underscore the importance of identifying alternative methods for dealing with this material.

Recycling of waste drywall seems like a logical alternative. In fact, some firms now process gypsum board waste into new wallboard. But drywall manufacturing firms that have investigated this possibility have concluded that while it is technically feasible, the low cost of raw gypsum makes it economically unsound. Another alternative that has been examined is incineration, but air pollution concerns associated with that approach make it undesirable. A study of ocean dumping of gypsum board was conducted by the Canadian government (Burger, 1993). The conclusion from this study was that because the materials in gypsum board are naturally present in the ocean environment, this method of disposal would be environmentally benign. However, public perceptions of ocean disposal of solid waste materials limit the usefulness of this option.

One favorable alternative for drywall waste is to use it as a soil amendment. One study found that applying pulverized drywall waste to soil on a plot in Upstate New York had a beneficial and non-detrimental effect on the soil and a positive impact on corn production. Gypsum has a composition of 79% calcium sulfate and 21% water; this calcium and sulfur available from the pulverized drywall enriches the soil without the addition of heavy metals to the environment (Burger, 1993).

A recommendation from this project was that a similar study should be conducted on a range of soil types to develop a data base on effects of gypsum waste on different soils. Another recommendation was that pulverized gypsum waste could be applied to roadside soils in

Northern climates because of benefits for those soils that have been affected by salt used during winter seasons. The Gypsum Association has recommended procedures for disposing gypsum on-site as a soil amendment, where allowed by state and local regulations (Gypsum Association, 2002).

Some concerns about implementing programs that use drywall waste as soil amendments have to do with different drywall types. Fire resistant drywall, for example, has fiberglass in its composition; asphalt-based wax emulsions are used in moisture resistant drywall. These are not regarded as favorable soil additives. These concerns could be addressed by limiting drywall as a soil amendment to regular drywall, but effective limitations would require strict controls.

The State of California has organized waste drywall pickup and processing. Forty-four pickup and/or processing sites are currently in place throughout the state (California Integrated Waste Management Board, 2001). Because it is free of contaminants, drywall waste from new construction sites is most commonly processed. Equipment in place ranges from large grinding plants to mobile chippers. Gypsum is then sold as pellets or powder for agricultural and other uses.

More research is needed on the issue of drywall waste. Growing public awareness of this issue may lead to the development of additional options for re-use or recycling. In the meantime, research could be encouraged to investigate feasible methods that can be used at construction sites to reduce the amount of waste drywall that is being generated.

Wood waste is another significant component of debris from construction sites. Viable options to landfilling include recycling for use in composite wood products, mulching on site, and collection for other uses (Laquatra and Pierce, 2004). The amount of wood waste from new construction alone is substantial. Laquatra and Pierce (2004) found that jack stud cut-offs[2] produced from new homes constructed over a five year period in the U.S. is equivalent to 232.9 million linear feet of scrap. This would span almost 44,110 miles – enough to go around the Earth at the equator one and three-quarter times.

Other components of construction debris include cardboard from packaging materials, roofing shingles, asphalt impregnated felt, pressure treated wood, containers, ferrous-based and other metals, masonry and ceramic materials, plastic, and paper. Many of these materials can also be diverted from a landfill.

Future Research Directions

Although tipping fees for landfilling construction debris are increasing, the total cost for debris disposal on a per-house basis can still be rolled into house price and ultimately paid for by the buyer. But serious enough effects occur in the aggregate to warrant policy interventions. These

[2] Jack studs are used in wood frame structures to provide bearing (a resting seat) for the headers (lintels) that are placed over each door and window opening. Jack studs are shorter than regular length wall studs and are fastened to the inside edge of each opening in a house. Jack studs are typically 80-1/2 inches long and are typically cut from regular height wall studs, which are92 5/8 inches long. This results in about 12 inches of waste per jack stud produced.

do not have to have negative effects on the construction industry. In fact, the King County (Washington) Solid Waste Division has demonstrated that economic incentive and recognition programs can reduce construction debris by 52,000 tons over a three-year period (Goodrich, 2000). This was accomplished by developing a certification program for builders known as Construction Works. The program encourages waste reduction, the use of recycled products, and the implementation of a Reusable Building Materials Exchange. The experience of Collier County, Florida, may underscore the importance of municipal attention to this issue. On October 1, 2002, tipping fees for construction and demolition debris increased 56 percent (Zoldan, 2002).

Some builders are appealing to the green building market niche by participating in the Leadership in Energy and Environmental Design (LEED) rating system of the U.S. Green Building Council (U.S. Green Building Council, 2002). This rating system is a national standard for green buildings – those that perform well from perspectives of materials and resources, indoor environmental quality, and innovation in design. Points are awarded to buildings in each of these categories, and a building is rated as certified, silver, gold, or platinum. Points are awarded in the area of construction waste management depending on how much material is diverted from a landfill.

The building industry itself should take a leadership role in waste reduction at residential construction sites. As part of Green Building programs, this aspect of environmentally sensitive construction can be used as a marketing advantage. Individual builders can improve their profitability and stay ahead of the regulatory curve. Environmental benefits, through reduced logging needs and landfilling of construction waste, will also be realized.

To achieve widespread adoption of activities that divert construction site waste materials from landfills, the issue must be seen as critical to both the construction industry and the general public. Research on community-based programs that link builders with local collection and recycling groups could form the basis for large scale demonstration efforts. The viability of such programs could then be established through further research on economic and environmental benefits that encourage builders to adopt sound waste management practices as a routine part of the construction process.

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