Designing out Waste

by Dru Meadows
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Xstrata. Photos courtesy NRB, Inc.

With the momentum of various green rating programs and standards, there has been a great deal of discussion regarding minimizing the amount of construction waste sent to the landfills. The impact of construction and demolition debris (C&D) on the environment is staggering. A recent Environmental Protection Agency (EPA) report estimated that more than 135 million tons of debris from construction sites is brought to landfills every year, making it the single largest source in the waste stream. [1]

Most conversations to date have focused on recovery, reuse, recycling or diversion of the waste post-construction, rather than reducing waste on the front end through better management, procurement and construction practices.

Post construction recycling, however, is just one method of reducing the amount of waste that ends up in our landfills. Waste avoidance through lean construction processes and minimization of waste through prefabrication and the use of building information modeling are much more effective techniques. It could also have a much greater impact on reducing the amount of waste sent to landfills.

The Modular Building Institute (MBI) defines modular construction as an off-site construction process performed in a controlled setting yielding 3-D modules transported and assembled at the building site. Due to the factory-controlled process, modular construction by nature is material and resource-efficient.

Example of waste on a construction site that gets sent to landfills. Image courtesy WRAP

A recent white paper by MBI on how modular construction dovetails into the LEED rating system states that one of the great economies of modular construction is the ability to assemble repetitive units in controlled conditions. Another is to minimize material waste associated with conventional construction due to weather intrusion and construction site theft. Whole modular units – largely finished prior to arriving at the construction site – can significantly limit construction waste generated at the site and contribute directly to construction site waste management. [2]

Modular construction capitalizes on the ability to move product in controlled manufacturing conditions and on tight inventory control and project schedules. It is inherently waste-conscious and can have minimum site impact if delivered carefully and strategically with respect to site constraints. In addition, since modular builders work in a factory controlled environment, they can have many construction projects underway simultaneously in one location, so they are better able to re-inventory materials that may have been allocated to one project for use in another. With site-built construction, a general contractor would send any overage to the recycle bin or to the dump.

A report published by the U.K. group, Waste & Resources Action Program (WRAP) supports the fact that off-site manufacturing processes can help the construction industry reduce waste. [3] Up to a 90 percent reduction can be achieved by reducing wastes such as wood pallets, shrink wrap, cardboard, plasterboard, timber, concrete, bricks and cement by increasing the use of off-site manufacture and modular construction.

For example, modular manufacturers have materials delivered to the factory on pallets frequently. However, rather than disposing of the pallets as is common with onsite construction, many manufacturers use companies that remove the pallets and even pay a few pennies to make them available to supplier companies for reuse as is. This direct reuse results in very low embodied energy versus recycling. For modular manufacturers, pallets do not represent part of the waste stream, just a reusable delivery mechanism.

WRAP has developed a resource, "Designing out Waste: A design team guide for buildings," to help owners and contractors. [4] The report names key principles that design teams can use during the design process to reduce waste which include design for off-site fabrication. In addition, it includes design for reuse and deconstruction, another inherent benefit of modular construction.

Not only can off site and prefabrication construction practices significantly reduce waste on a project during the construction process, modular buildings are also more readily designed for deconstruction, thus closing the loop at the end of the life cycle of the buildings. In fact, many companies in the modular industry repurpose and reuse of entire buildings for different applications. The fact that the modular building is assembled in modules means that it can be disassembled at the end of its useful life. One of the most sustainable concepts for the building industry is reuse of an entire, existing building for a new purpose.

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MMC	Est. % reduction	Level of confidence
Volumetric building systems	70 - 90	Reasonable
Timber frame systems	20 - 40	Broad estimate – depends upon the level of pre-fabrication
Concrete panel systems	20 - 30	Broad estimate
Steel frame housing systems	40 - 50	Broad estimate
OSB SIPS	50 - 60	Reasonable – depends on the level of prefabrication
Composite panels	20 - 30	Broad estimate
Pre-cast cladding	40 - 50	Broad estimate
LSF systems	40 - 70	Reasonable – depends on the level of prefabrication
Bathroom/shower & kitchen pods	40 - 50	Broad estimate
Pre-cast flooring	30 - 40	Broad estimate
Thin joint masonry	30 - 40	Broad estimate
Insulating concrete formwork	40 - 50	Broad estimate
Tunnel form construction	50 - 60	Broad estimate

Source: AMA Research/trade estimates

Estimates of the levels of site waste reduced using modular construction. Data courtesy WRAP

Following is a case study of a project that demonstrates the modular construction industry's ability to significantly reduce building

waste.

Xstrata

Xstrata. Photos courtesy NRB, Inc.

Xstrata, by NRB Inc., is a LEED Gold certified 60,000 square foot administration facility for a mine site in Ontario.

Driven by the need for a much shorter project completion schedule and reduced impact from onsite construction activity, Xstrata Nickel chose modular construction to hit its critical completion date and at the same time, significantly reduce the amount of disruptive construction activity at the mine site.

Design strategies included optimal energy efficiencies realized through innovative mechanical/electrical designs and improved thermal protection; the maximum possible use of recycled and regional materials; careful attention to indoor environmental qualities through the use of low-emitting materials and control of contaminants and moisture during and after construction, and the adoption of many water conservation features and strategies.

In addition, the Xstrata project generated only 2.86 lb/square feet of C&D waste material, much less than the industry average of 4.34 lb/ square feet for non-residential construction projects. [5] Also, as part of the LEED certification, NRB applied for an innovation and design credit for "Design for De-constructability" to prove that what went on to the project site methodically in pieces with less disruption, could in fact at the end of its useful life, come out in pieces with less disruption and possibly be reused in whole or in part, elsewhere – rather than face abandonment or destruction.

Most people are familiar with the cost savings and time advantages of modular construction due to the off-site manufacturing process. The modular construction industry also has a significant green advantage in terms of reducing the amount of waste the construction industry produces. The ease with which the modular construction process allows for waste to be reduced in a factory and designed in a way that allows buildings to be reused, strengthens its position as a resource efficient, inherently greener way to build.

Notes:

[1] EPA Report Estimating 2003 Building Related Construction and Demolition Materials Amounts: www.epa.gov/osw/conserve/rrr/imr/cdm/pubs/cd-meas.pdf

[2] MBI White Paper Modular Building and the USGBC's LEED Version 3.0 2009 Building Rating System: http://modular.org/marketing/documents/Modular_09V3LEED.pdf

[3] WRAP Report Current Practices and Future Potential in Modern Methods of Construction: www.wrap.org.uk/downloads/Modern_Methods_of_Construction_-_Summmary.a268f69e.3663.pdf

[4] WRAP Report Designing out Waste: A design team guide for buildings: www.wrap.org.uk/downloads/19279-02_Design_Guide_online_pdf_version.c663251c.7167.pdf

[5] EPA Report Estimating 2003 Building Related Construction and Demolition Materials Amounts: www.epa.gov/osw/conserve/rrr/imr/cdm/pubs/cd-meas.pdf

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