Missed Opportunities in Structural Sustainability

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Many structural engineers view the sustainable building movement as affording them little opportunity. Additionally, the predominant metric for measuring sustainable buildings, the LEED (Leadership in Energy and Environmental Design) rating system, offers few points for specifically structural solutions. To date, engineers following the LEED scorecard can recommend fly ash in concrete, recycled materials in steel, and sustainably harvested FSC wood. Beyond that, however, most engineers agree in principle with the comments of a LEED consultant in a recent meeting the authors attended: "As structural engineers, you guys can't do much for sustainability." This article argues otherwise, looking at the growing link between the reuse of buildings and sustainability and the role structural engineers can play in this type of design.

In 1987, the Bruntland Commission issued a report to the United Nations that included what has become the most widely accepted definition of sustainability as: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs"[1]. Since that time, most discussion about sustainability has included three aspects: environmental, economic, and social sustainability [2]. The common approach to sustainability from structural engineers (where there has been any approach at all) has focused almost exclusively on the environmental elements, in particular specifying reusable or renewable materials. There is a great need for broader thinking about sustainability from the structural engineering community. As engineers, we can significantly expand our impact on environmental sustainability, as well as contribute to economic and social sustainability, with only minor shifts in our thinking and practice. To do this, we must first understand the concept of embodied energy as well as become more willing to work with existing buildings.

Embodied Energy and Existing Buildings

When a building is constructed, significant amounts of energy are consumed in extracting, processing, and assembling raw materials into the finished product. Studies suggest that a building's embodied energy ranges anywhere from 15 to 20 percent of its total life cycle energy use [2]. This reality lends credence to Carl Elefante's adage: "the greenest building is one that is already built"[3]. If a structure is demolished at or before the end of a building's 50-year service life, all of its embodied energy is wasted. This energy waste is in addition to the physical waste created, as well as the energy required in transporting the physical waste to a landfill. Another increasingly selected option exists for the design team, namely adaptively reusing the building.

Recent projects serves as an example of how reusing buildings makes sustainable sense. The authors completed an adaptive reuse of a 1950s, 2-story concrete warehouse (*Figure 1, see page 34*). The building is not on the national or local historic registers and the owner could easily have chosen to demolish it and erected a new, similar sized building in its place.

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Instead, it was decided to retrofit and reuse the building, though not necessarily for sustainable reasons. Using an online calculator, the embodied energy in the 50,000 SF building is 56,500,000 million BTUs [4]. In addition, the energy required to demolish the building would be 775,000 MBTUs, a small percentage of the embodied energy. Finally, by not demolishing the building, an equivalent amount of energy saved by not having to construct a new building, another 56,500,000 MBTU. While any number of comparisons could be made for this quantity of energy, the total energy represented in the sum *embodied energy+demolition+new construction* is roughly equivalent to 1,000,000 gallons of gasoline. Ironically, a new energy efficient building would take longer than 50 years for its own efficiencies to equal, and thereby pay back, this same amount of energy.

The numbers related to a building's embodied energy present a compelling case for expanding our impact on environmental sustainability beyond specifying materials. The concept of embodied energy does not require a cognitive leap of faith. The challenge for engineers is what Patrice Frey quotes as: "shifting the presumption on stewardship of built heritage to favor reuse" rather than demolition [2]. Many engineers, whether through training or experience, do not like working with existing buildings. This is even more the case in California, where "seismic concerns" regularly trump desires to keep otherwise well-performing buildings. If we want to have an impact on sustainability, we must change this prevailing belief within our profession and be more vocal about our efforts in our industry.

Opportunities for Structural Sustainability

The opportunity presented to engineers at the intersection of reusing buildings and sustainability is significant. The Brookings Institute estimates that, by 2030, the United States will replace 82 billion square feet of its current building stock [6]. Our willingness to work with, rather than preemptively condemn many of these buildings, will go a long way toward contributing to sustainability. Architects, developers, and building owners look to engineers to provide honest recommendations regarding the potential of existing structures. Firms that become experts in working with, rather than avoiding, existing buildings will gain a competitive edge as market conditions and sustainable concerns increasingly favor building reuse.

One might look at the idea of reusing buildings and embodied energy and think that we are merely expanding our impact on environmental sustainability alone. While on the surface this is true, reusing existing buildings also promotes the economic and social aspects of sustainability. According to a report by the Brookings Institute, the decision to reinvest rather than tear down or abandon a building "presents convincing

Figure 1: Reuse versus demo: embodied energy calculations.

evidence that 'preservation pays' when viewed in economic terms." This payment comes in the form of driving economic growth, job creation, friendliness to small businesses, and promoting high wage jobs. All of these are forms of sustainable economic development when viewed long term. Additionally, reusing existing buildings adds to social sustainability by protecting social diversity and maintaining our sense of place in our increasingly globalized world. Patrice Frey expands greatly on how existing buildings promote social and economic sustainability, and the reader would be well served to read her paper [2].

Conclusions

In closing, we return to the question of how LEED recognizes the contributions of the structural engineer to sustainability. At present, LEED primarily credits environmental sustainability in the form of material specification; recycled content in concrete and steel, and sustainably harvested wood. In its current form, LEED awards the same number of credits for reusing 75% of the building's walls, floors, and roof as it does for specifying bike racks and showers for 5% of a building's occupants. At present, it does not address the idea of embodied energy directly and does not take into account the cultural heritage associated with preserving buildings. LEED 2009, which launched in March of this year, gives much greater credit than its predecessor to metrics such as *Community Connectivity* and *Alternative Transportation*, both of which favor existing buildings. In addition, there is now an *Alternative Compliance Path* that specifically recognizes an existing building's embodied energy. Lastly, a *Sustainable Preservation Coalition* has been formed to incorporate preservation, social, and cultural values into LEED, though probably not until its next release in 2011 [5].

Admittedly, the choice to reuse existing buildings does not rest solely in the hands of structural engineers though our opinion often becomes the deal-breaker. We must partner with owners, architects, and developers in order to maintain our built heritage. Engineers have a more extensive role to play than merely specifying sustainable materials. If understood and promoted properly, the intersection of sustainability and reusing buildings affords structural engineers a great opportunity for professional development, marketing, and occasion to contribute to a greener future.▪

References

[1] Brundtland, Gro Harlem and World Commission on Environment and Development. [1987]. *Report of the World Commission on Environment and Development: "Our Common Future."*

[2] Frey, Patrice. [2007]. *Making the Case: Historic Preservation as Sustainable Development.* (www.preservationnation.org/issues/sustainability/additional-resources/DiscussionDraft_10_15.pdf, accessed 1/16/09)

[3] Elefante, Carl. [2007]. *The Greenest Building Is…One That Is Already Built.* Forum Journal. Vol 21, No 4.

[4] www.TheGreenestBuilding.org

[5] Campagna, Barbara. [2009]. *How Changes to LEED™ Will Benefit Existing and Historic Buildings.* (www.aia.org/hrc_a_200812_campagna, accessed 1/16/09)

[6] Nelson, A.C. (2004) *Toward a New Metropolis: The Opportunity to Rebuild America.* Brookings Institute. (http://www.brookings.edu/reports/2004/12metropolitanpolicy_nelson.aspx)

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