



Building Life Cycle Cost Analysis

Life cycle costs of hazard resistant buildings

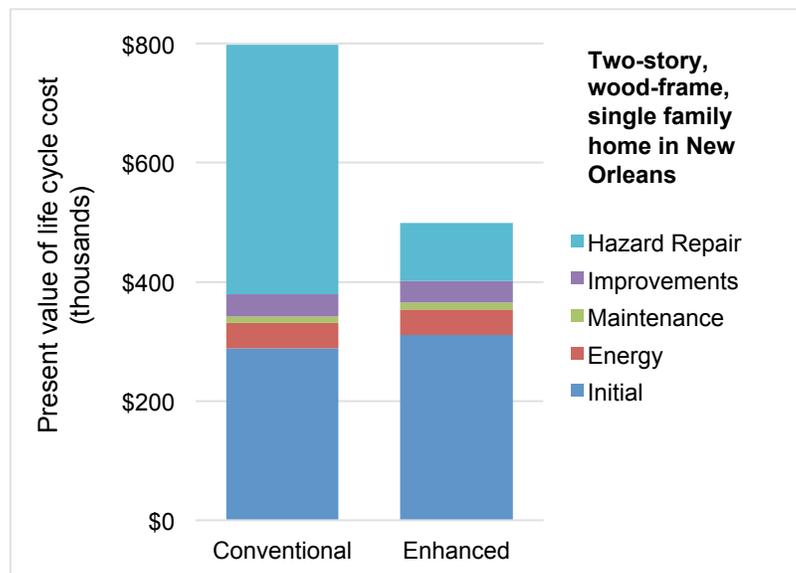
It is important to take a life cycle perspective when evaluating the costs of owning and operating buildings in hazard-prone areas

- Between 1996 and 2014 damages in the US due to hazards (hurricanes, tornadoes, floods, earthquakes, etc.) totaled over \$377 Billion according to a National Weather Service report.
- Investing in mitigation against the impacts of hazards means buildings will likely have lower operating costs due to fewer repairs caused by hazards.
- MIT researchers have developed a building life cycle cost analysis (LCCA) approach that combines initial construction costs along with several types of operational costs, including costs associated with energy consumption and repairs due to damage from hazards. The latter uses FEMA's benefit-cost analysis tool.
- The costs of repairs due to damage from hazards are estimated by combining the probability that a hazard will occur with the expected damage from the hazard over the life cycle of the building.
- The LCCA approach enables calculation of a payback period for more hazard resistant construction by comparing hazard resistant designs with conventional designs.



The costs of repairs due to hazards for conventional buildings in hazard-prone areas can exceed the initial building cost

- Hazard-induced maintenance costs can be significant over the lifetime of a building.
- In one study, CSHub researchers evaluated the 50-year performance of a conventional design and enhanced design for a two-story wood-frame single-family townhouse with 1800 ft² living area and attached two-car garage in the hurricane-prone city of New Orleans.
- Conventional building represents the construction in accordance to the minimum acceptable standard; construction of the enhanced building is based on a higher standard that is intended to mitigate the impacts of hurricanes. For hurricane-prone cities, enhanced building standards involve increasing the nail size in roof panels, increasing the resistance of roof shingles, using windows with higher thickness, and using stronger hurricane clips for roof to wall connections.

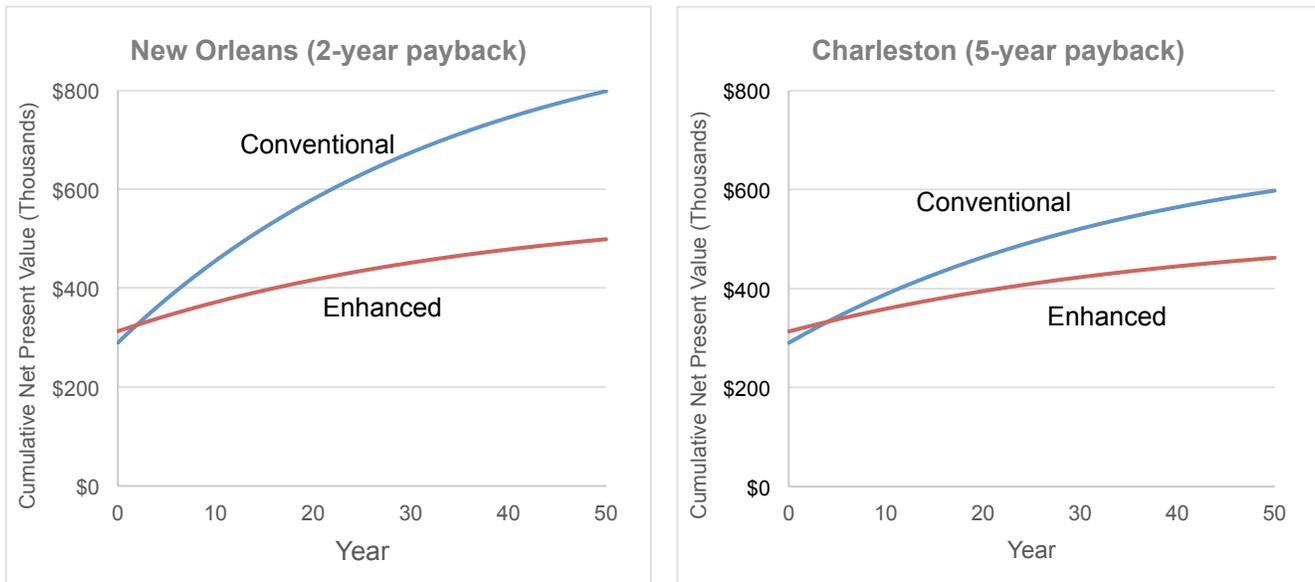


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- In New Orleans, a city that experiences frequent and intense hurricanes, the analysis found that the expected cost of maintenance due to damage from hazards for over a conventional building's lifetime can exceed the initial construction costs. By contrast, the enhanced building has slightly higher initial costs but significantly lower hazard maintenance costs.

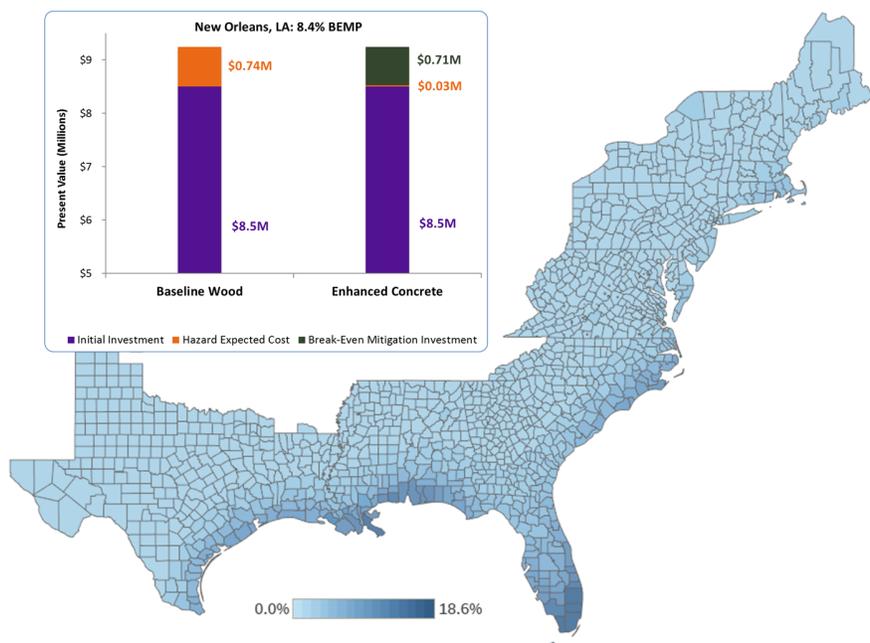
Payback periods for hazard mitigation in residential buildings can be five years or less

- Many building designers and owners make decisions based on payback periods.
- Payback for investments in hazard mitigation in New Orleans was only 2 years.
- A similar analysis for a home in Charleston, SC showed a payback period of 5 years.



The benefits of investing in hazard mitigation depend on building location, type, and mitigation strategies

- The Break Even Mitigation Percent (BEMP), a metric developed by CSHub researchers, offers a way to estimate the amount to invest in hazard mitigation to break even over the lifetime of a building.
- In one case study, using a 4-story midrise apartment building with 32 apartments in two building types (a baseline wood structure and an enhanced concrete structure), researchers created a model based on the FEMA Benefit Cost Analysis V5.2.1 tool to estimate the BEMP for hurricane wind damage across the Gulf Coast and East Coast.
- In areas prone to more natural disasters, more spending on mitigation is justified; the BEMP helps to identify how much extra spending is recommended.



- In New Orleans, LA, for example, the BEMP was found to be 8.4 percent, meaning \$714,000 could be spent on mitigation for an \$8.5M midrise apartment building, and break even over the building life. A lower discount rate would translate into a larger investment.
- The highest BEMPs are in cities in southeastern Florida, where the values are approximately 18%.

Additional information may be found at: <http://cshub.mit.edu/>

Publications

Noshadravan, A., Miller, T.R., Gregory, J. “A life cycle cost analysis of residential buildings including natural hazard risk”, accepted for publication in the Journal of Construction Engineering and Management, 2016.

Related Research Briefs

Miller, T.R., Gregory, J., and Kirchain, R., “[A Break-Even Hazard Mitigation Metric](#),” MIT Concrete Sustainability Hub, July 2016

Miller, T.R., Noshadravan, A., Gregory, J. and Kirchain, R. “[Value of Building Life Cycle Cost Analysis](#),” MIT Concrete Sustainability Hub, May 2015