Value of building life-cycle cost analysis

PROBLEM

At $337 billion in 2013, residential construction has comprised around one-third of all U.S. construction dollars in recent years. The cost of alternate designs and materials influences decisions throughout the process of designing buildings. It is important to factor in all of the initial and future costs to make valid comparisons; life-cycle cost analysis (LCCA) models combine those costs into present values. Researchers have developed separate sets of methods over the past few decades to estimate the initial construction and regular maintenance cost of buildings, to predict a building's energy consumption and associated costs, and to anticipate the hazard-induced maintenance cost (HIMC). Several authors have combined initial construction cost, regular maintenance, and energy costs to form a partial LCCA. There are ASTM standard practices and guides for computing life-cycle cost once each component is estimated. As of yet, there are no comprehensive methods that comprise a complete LCCA that includes HIMC.

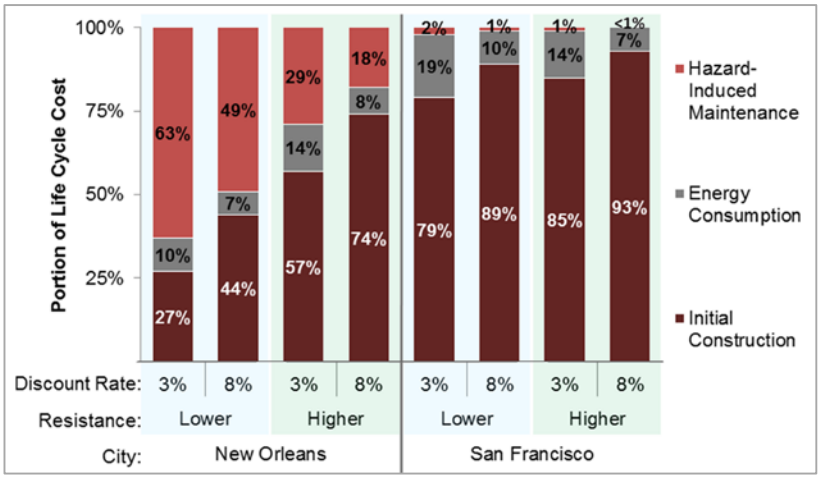

Fig. 1: Comparison of the portion of life-cycle costs attributed to initial construction, energy consumption, and hazard-induced maintenance (HIMC) between lower- and higher-resistance wood-frame single-family homes using 3% and 8% discount rates in in New Orleans and San Francisco over 50-yr period.

APPROACH

In this research, we demonstrate an LCCA approach including initial construction, energy consumption, and HIMC. Regular maintenance was not included but is expected to be relatively small. Initial construction is estimated with the RSMeans Residential Cost data, and energy consumption is estimated with BEopt (Building Energy Optimization) software from the National Renewable Energy Laboratory (NREL). Two alternate designs of a two-story wood-frame home, lower-resistance at the minimal building code acceptable standard and higher-resistance at an enhanced standard, are compared for resistance to hurricanes in New Orleans and earthquakes in San Francisco over a 50-year period. The HIMC is estimated using a probabilistic model that factors in the frequency of the natural hazard at a given intensity and the home's resistance to that hazard at a given intensity.

FINDINGS

Figure 1 compares the initial construction, energy consumption, and HIMC in New Orleans and San Francisco. In all cases, the initial construction cost was several times greater than the cost of energy consumption. Since energy consumption and HIMC are future costs, they are sensitive to the discount rate. Varying the discount rate from 3% to 8%, the contribution of the HIMC is larger for New Orleans due to frequent intense hurricanes (63% to 49% for lower-resistance, 29% to 18% for higher-resistance) and smaller for San Francisco due to infrequent earthquakes (2% or less of all scenarios). Therefore, in this example, even when varying the discount rate, the higher-resistance home would be cost-effective to pursue in New Orleans but not necessarily in San Francisco.

IMPACT

By incorporating initial and future costs, including those due to hazards, into LCCAs, building designers can select materials and designs that are expected to incur the lowest cost across the life of a building.

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