National Institute of BUILDING SCIENCES™
Innovative Solutions for the Built Environment

Mitigation Saves:
Seismic Retrofit of Buildings Saves $13 for every $1

EVERY AMERICAN FACES NATURAL HAZARDS, AND THE RISK IS GROWING

U.S. disaster losses from wind, floods, earthquakes, and fires now average $100 billion per year, and in 2017 exceeded $300 billion—25% of the $1.3 trillion building value put in place that year. Fortunately, there are affordable and highly cost-effective strategies that policymakers, building owners, and the building industry can deploy to reduce these impacts. These strategies include adopting and strengthening building codes, upgrading existing buildings, and improving utilities and transportation systems. The benefits and costs associated with these mitigation measures have been identified through the most exhaustive benefit-cost analysis of natural hazard mitigation to date and documented in Natural Hazard Mitigation Saves. The study was funded by three federal agencies and four private-sector sponsors and produced by the National Institute of Building Sciences – the nation's Congressionally chartered convener of experts from the building professions, industry, labor, consumer interests, and government. For the report and accompanying fact sheets, see www.nibs.org/mitigationsaves. This fact sheet summarizes the study findings and significant savings associated with various mitigation measures.

- **Adopting the latest building code requirements is affordable and saves $11 per $1 invested.** Building codes have greatly improved society's disaster resilience, while adding only about 1% to construction costs relative to 1990 standards. The greatest benefits accrue to communities using the most recent code editions.
- **Above-code design could save $4 per $1 cost.** Building codes set minimum requirements to protect life safety. Stricter requirements can cost-effectively boost life safety and speed functional recovery.
- **Private-sector building retrofits could save $4 per $1 cost.** The country could efficiently invest over $500 billion to upgrade residences with 15 measures considered here, saving more than $2 trillion.
- **Lifeline retrofit saves $4 per $1 cost.** Society relies on telecommunications, roads, power, water, and other lifelines. Case studies show that upgrading lifelines to better resist disasters helps our economy and society.
- **Federal grants save $6 per $1 cost.** Public-sector investment in mitigation since 1995 by FEMA, EDA, and HUD cost the country $27 billion but will ultimately save $160 billion, meaning $6 saved per $1 invested.

National Institute of BUILDING SCIENCES™	ADOPT CODE	ABOVE CODE	BUILDING RETROFIT	LIFELINE RETROFIT	FEDERAL GRANTS
Overall Benefit-Cost Ratio	11:1	4:1	4:1	4:1	6:1
Cost ($ billion)	$1/year	$4/year	$520	$0.6	$27
Benefit ($ billion)	$13/year	$16/year	$2200	$2.5	$160
Riverine Flood	6:1	5:1	6:1	8:1	7:1
Hurricane Surge	not applicable	7:1	not applicable	not applicable	not applicable
Wind	10:1	5:1	6:1	7:1	5:1
Earthquake	12:1	4:1	13:1	3:1	3:1
Wildland-Urban Interface Fire	not applicable	4:1	2:1	not applicable	3:1

TABLE 1. Nationwide average benefit-cost ratio by hazard and mitigation measure. BCRs can vary geographically and can be much higher in some places. Find more details in the report.

SEISMIC RETROFIT OF RESIDENCES COULD SAVE $330 BILLION

There are many ways to make existing residential buildings more earthquake resistant. Some of the leading ones include strengthening the first story of soft-story wood-frame dwellings; adding engineered tie-down systems (ETS) to manufactured homes that are not anchored to the ground; strapping water heaters to the building frame; adding child-safety latches to kitchen cabinets; securing tall bookcases to the wall; strapping computer monitors and televisions to desks or shelves; and securing fragile objects to their shelves with museum putty. Homeowners and tenants can do some of these things at very low cost: $10 to $20 for straps or museum putty and an hour or two of time. Others require a substantial investment: The soft-story retrofit of an apartment building can cost about $9 per square foot. But the measures broadly are cost effective. Figure 1 shows the sources of these benefits.

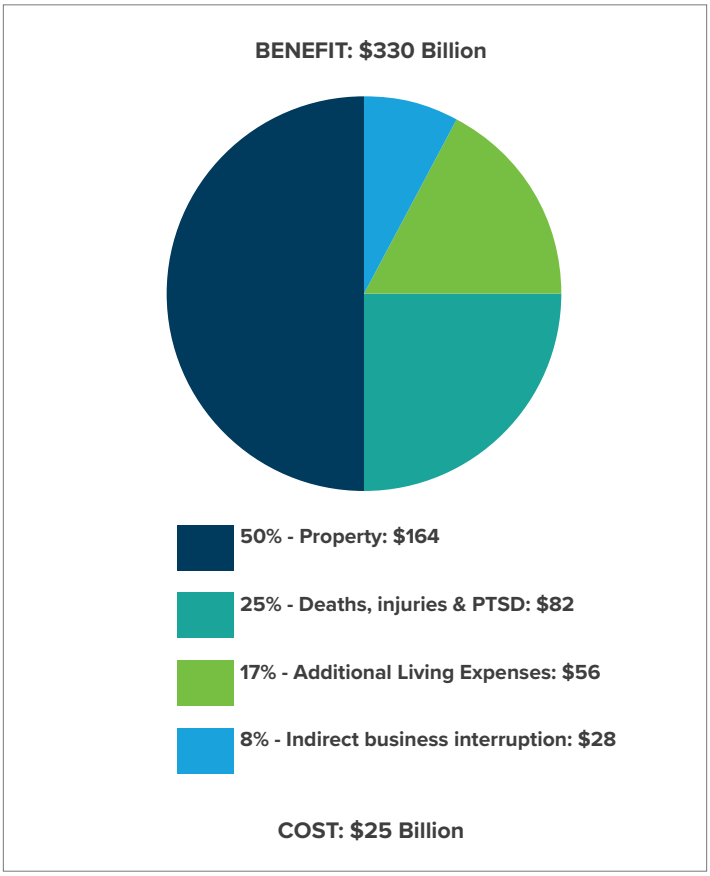

FIGURE 1. Total costs and benefits of private-sector earthquake

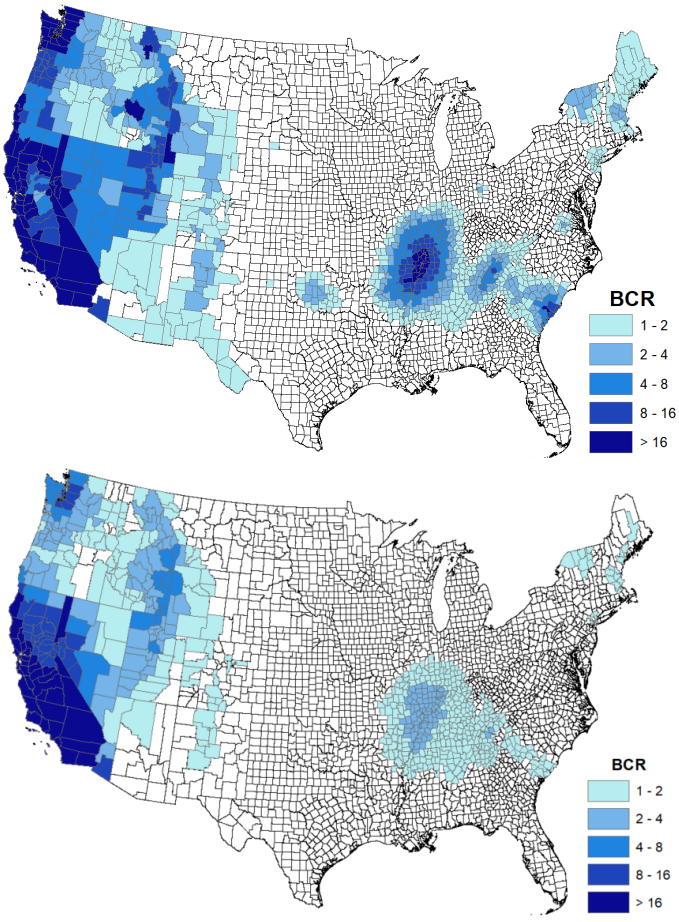

FIGURE 2. Benefit-cost ratios of seismic retrofit of two leading measures: (above) soft-story retrofit, and (below) strap water heaters.

The BCRs for the seven earthquake retrofit measures varied widely, but averaged between 2:1 and 24:1. Soft-story retrofit had a BCR of 12:1. Engineered tie-down systems had an overall average BCR of 3:1. Strapping water heaters had an overall average BCR of 24:1, because of how effective the measure is in reducing post-earthquake fires. Kitchen cabinet latches produced a BCR of 8:1. Strapping bookcases to the wall saves $13 per $1 invested. Strapping monitors and televisions saves $2 per $1 of cost. And securing fragile objects with museum putty had a benefit-cost ratio of 3:1. BCRs also varied geographically. Each measure had its highest BCR in the places with the greatest seismicity, that is, in places where earthquakes are biggest, most frequent, or both. They all were cost effective in some places, but in many cases exceeded 16:1 in some counties. Figure 2 shows how much location matters to the BCR for the two most cost-effective measures: soft-story retrofit and strapping water heaters to the building frame.