



# Earthquake Requirements Save \$12 for Each \$1 Invested

## Introduction

Natural hazards present significant risks to many communities across the United States. Fortunately, there are measures governments, building owners, developers, tenants, and others can take to reduce the impacts of such events. These measures—commonly called mitigation—can improve safety and prevent property loss and disruption of day-to-day life. The National Institute of Building Sciences Multihazard Mitigation Council undertook a multi-year study in 2017 to update and expand upon its 2005 *Mitigation Saves* study on the value of mitigation. In the *Mitigation Saves: 2018 Interim Report*, the project team estimated benefit-cost ratios for four kinds of mitigation and five perils, as shown in Table 1.

	National Benefit-Cost Ratio Per Peril <small>*BCR numbers in this study have been rounded</small>	Exceed common code requirements	Meet common code requirements	Utilities and transportation	Federally funded
	<b>Overall Hazard Benefit-Cost Ratio</b>	<b>4:1</b>	<b>11:1</b>	<b>4:1</b>	<b>6:1</b>
<b>Riverine Flood</b>		5:1	6:1	8:1	7:1
<b>Hurricane Surge</b>		7:1	Not applicable	Not applicable	Too few grants
<b>Wind</b>		5:1	10:1	7:1	5:1
<b>Earthquake</b>		4:1	12:1	3:1	3:1
<b>Wildland-Urban Interface Fire</b>		4:1	Not applicable	Not applicable	3:1

Table 1. Benefit-cost ratio by hazard and mitigation measure.

- **Exceed common code requirements:** Most U.S. communities adopt recent editions of the *International Building Code* (IBC) and *International Residential Code* (IRC). Few adopt the *International Wildland-Urban Interface Code* (IWUIC). These codes set out minimum safety requirements, not maxima. Exceeding certain requirements of the commonly adopted codes and adopting the IWUIC can save \$4 per \$1 invested.
- **Meet common code requirements:** Modern building codes have improved society’s disaster resilience to hurricanes, floods, and earthquakes (among other improvements), and they have developed over time. Compared with a generation ago, code development in these areas saves an estimated \$11 per \$1 invested.
- **Retrofit utilities and transportation infrastructure:** Society relies on roads, highways, railways, electricity, telecommunications, water, wastewater, and other lifelines. Retrofitting these facilities to better resist disasters saves society \$4 per \$1 invested.
- **Federal grants:** The impacts of 23 years of grants made by the Federal Emergency Management Agency (FEMA), Economic Development Administration (EDA), and the Department of Housing and Urban Development (HUD) result in a national benefit of \$6 for every \$1 invested.

## Meeting Common Code Requirements for Earthquake

Over the long term, building codes have gradually increased the required strength and stiffness of new buildings to resist earthquakes, along with numerous improvements to structural details. Building strength and stiffness increases on the order of 50% every 30 years in the higher-risk areas in the western United States. Thus, the average West Coast building built today to comply with I-Codes is about 1.5 times as strong and stiff as it would have been under the *1988 Uniform Building Code*. The greater strength makes the building less likely to collapse or to be red-tagged in a large earthquake. The greater stiffness makes it less likely to suffer damage to many architectural elements such as walls and windows. These aspects of the 2018 I-Codes save \$7 billion in the long term for every year of new buildings built to the code, at a cost of \$600 million, producing a benefit-cost ratio of 12:1. Figure 1 shows the sources of these benefits. Figure 2 shows that benefit-cost ratios are highest in high-seismicity areas. Note that in much of the country, wind design forces exceed those for earthquake, so those areas are shown in gray, along with a small portion of Oklahoma where design forces have been raised to better protect people from seismicity associated with deep well injection of fracking waste fluid.

**Benefit: \$7 billion**

- 43% – Property: \$3
- 29% – Additional living expenses and direct business interruption: \$2
- 14% – Deaths, injuries, and post-traumatic stress disorder: \$1
- 14% – Indirect business interruption: \$1
- 0.3% – Urban search and rescue: \$0.02

Billions 2018 USD

**Cost: \$0.6 billion**

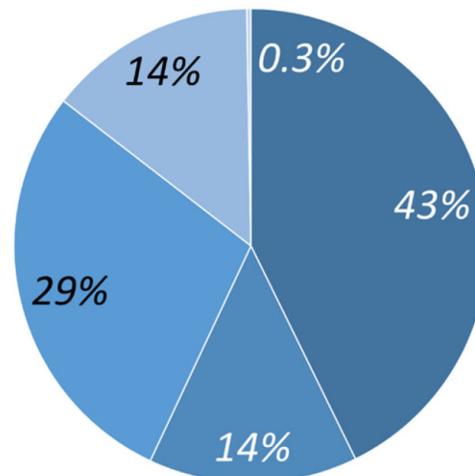


Figure 1. Total costs and benefits of new design to comply with 2018 I-Code requirements for earthquake, relative to 1990.

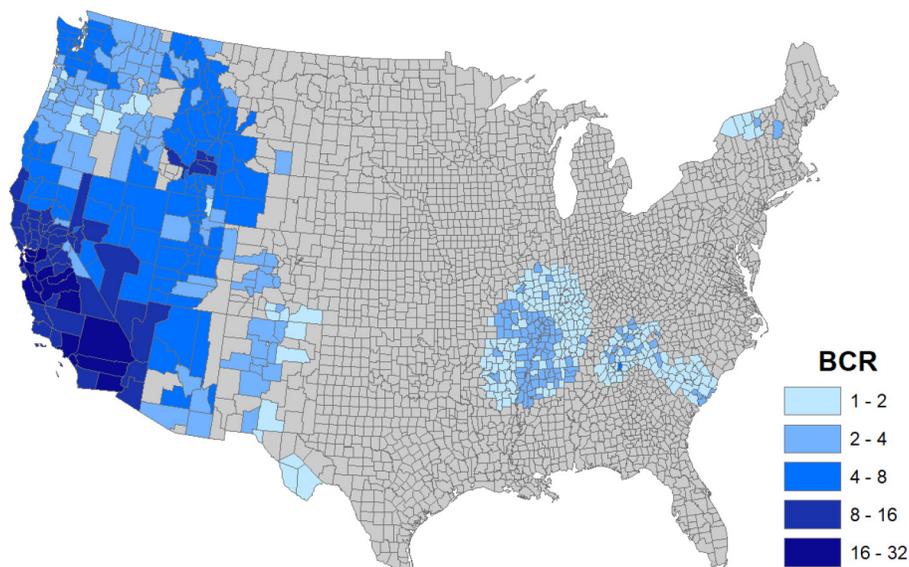


Figure 2. Benefit-cost ratios for seismic code compliance are highest in high-seismicity areas.