Safe Building Code Incentive Act
Impact of Building Code Adoption and Enforcement on FEMA Disaster Grants

Final Report

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Executive Summary

Milliman, Inc. was engaged by National Association of Mutual Insurance Companies (NAMIC) to conduct a study to summarize estimates of the impact of adoption and enforcement of model building code standards on natural disaster costs currently borne by the Federal Emergency Management Agency (FEMA) based on a legislative proposal which would reward states that adopt such codes with increases in funding.

Based on our work, we provide the following conclusions:

1. Building Code Impact on Hurricane Costs - The estimated savings in disaster costs related to hurricanes (the peril resulting in the largest costs to FEMA over the past twenty years) for construction built to model building codes could be between 30%-80% based on a survey of existing studies of property losses.

2. Lost Savings on Historical FEMA Hurricane Costs - FEMA has paid out approximately $125 billion in grants related to natural disasters since 1988, of which $67 billion (54%) was directly related to hurricane damage. Had all the buildings exposed to these hurricanes been built to a model building code with enforcement, the reduction in losses could have been as much as $13 billion or nearly 20% of the total hurricane related grants. The Safe Building Code Incentive Act (SBCIA) includes an additional four percent (4%) of funding available for states that qualify by adopting recognized model building codes with enforcement. The cost of this funding under the various savings scenarios cited above would be $2.0 - $2.3 billion for all years and hurricane events combined. Therefore, after accounting for the additional funding costs, the net savings could have been as much as $11 billion.

3. Simulated Future FEMA Hurricane Costs and Savings - Based on simulated hurricanes and associated FEMA costs for future years, the SBCIA could result in savings which could be realized within 25 years at the current proposed 4% additional provision or within 20 years if the provision were lowered to 3%. In the near term, the SBCIA will likely result in additional costs that are greater than the savings obtained from the enforcement of model codes on new construction.

4. Building Code Impact On Other Perils - The savings to FEMA costs related to flood, earthquake and tornado damage from compliance with the Act would likely be minimal as either building codes do not completely address these hazards or the codes are primarily focused on safety rather than damage control.

5. Potential Other Benefits - The results cited do not include additional benefits of reduced property losses such as reduced disruption to local economies, reduction in environmental damage, and reduction in human suffering.

Background

The BuildStrong Coalition is a coalition of national business and consumer organizations, companies, and emergency management officials dedicated to promoting stronger building codes. BuildStrong urges enactment of *The Safe Building Code Incentive Act*, legislation that will encourage states to adopt model building codes to protect property and ultimately save lives from the devastation of natural disasters. Under the proposed law, states that adopt and enforce nationally recognized model building codes for residential and commercial structures would qualify for an additional four percent (4%) of funding available for post-disaster grants. The program would be administered by the Federal Emergency Management Agency (FEMA). BuildStrong was founded and is coordinated by the National Association of Mutual Insurance Companies (NAMIC).

Scope of Work

NAMIC has asked Milliman, Inc. (Milliman) to assist the BuildStrong Coalition in researching and communicating the potential economic impact of the Safe Building Code Incentive Act. This information will be used by NAMIC, and the BuildStrong Coalition, in communications with elected officials, administration staff, and industry organizations.

In this initial phase of the project, Milliman has accumulated existing research on the impact of stronger building codes on losses resulting from three specified perils: windstorms, water damage, and earthquakes. These perils were chosen to align with the existing work by the National Institute of Building Sciences (NIBS). Losses are defined broadly to include property, business interruption, loss of life, and other items. The sources include academic studies, insurance industry data, and other existing research reports. We have reviewed this material and prepared this report for NAMIC and the BuildStrong Coalition to summarize our findings.

Summary of Work

In our initial step, we performed a search for all existing research regarding building codes and their impact on the mitigation of losses from catastrophes. This search included use of a professional researcher and discussions with a number of experts including those at FEMA, NIBS and the National Association of Homebuilders.

This search resulted in the identification of several papers related to the qualitative discussion of the impact of building code adoption and enforcement on catastrophe losses but far fewer papers with specific information on the quantification of this impact. Nearly all the source information gathered focused on the impact of building codes on property damage related to wind and hurricanes. There was little available research found on the impact of building codes on earthquake, tornado and flood damage.

As a result of these findings we focused our work on wind, specifically hurricane, loss damage and the impact of building codes on these losses. We have identified a range of potential savings estimates that may result from the adoption and enforcement of building codes based on the various papers we have reviewed.

To better illustrate the potential savings involved, we applied these savings percentages to (1) actual cost amounts for hurricane damage provided by FEMA starting in 1988 (the initial enactment of the Robert T. Stafford Disaster Relief Act) through 2011 and (2) projections of hurricane losses for future years.

For the non- hurricane perils, we provide discussion of our observations and conclusions relative to the impact of the enactment of the SBCIA.

Preliminary Results

Summary of Historic FEMA Costs

Since 1988, FEMA has paid out approximately $125 billion in grants in relation to disasters, emergencies and fire management, as shown below.

Table 1
Total FEMA Costs by Type
1988-2011

Type	Amount ($millions)	Percentage
Disasters	121,496	97.0%
Emergencies	2,746	2.2%
Fire Mgt	978	0.8%
Total	125,220	100.0%

Of the costs related to disasters, the clear majority have been related to damage by hurricanes as shown below.

Table 2
FEMA Disaster Costs by Peril
($millions)

Peril	Costs	Percentage
Hurricane	65,553	54.0%
Other Wind	20,227	16.6%
Fire	12,094	10.0%
Earthquake	8,316	6.8%
Flood	6,606	5.4%
Other	8,700	7.2%
Total	121,496	100.0%

In regards to hurricane losses, the large majority of costs (61%) were related to Hurricane Katrina.

Table 3
FEMA Hurricane Disaster Costs
($millions)

Hurricane	Costs	Percentage
Katrina	39,749	60.6%
All Other	25,804	39.4%
Total	65,553	100.0%

Hurricanes

Potential % Savings to Costs Due to Building Codes Adoption and Enforcement Based on Existing Research

The potential savings in property losses associated with the adoption and enforcement of a model building code is estimated to be between 30% and 80% using six distinct sources. A summary of these estimates with the sources and type of source is provided below with more details provided in the attached Exhibit A.

Table 4
Summary of Estimates of Building Code Reduction to Property Losses

Source	Type *	Savings	Notes
IBHS	Primary	77%	Based on sample from Hurricane Charley
LSU Hurricane Ctr	Primary	79%	Based on Hurricane Katrina, HAZUS Model
Wharton	Primary	34-49%	100 year simulated storms
AM Best	Secondary	30-40%	Based on Hurricane Andrew
FM Group	Secondary	55%	Based on Hurricane Andrew
IBHS/AIR	Secondary	50%	Based on Hurricane Andrew

* Primary sources represent studies that are publicly available. Secondary sources represent studies that were cited in other literature but that we were unable to obtain directly.

The wide variation in estimates in the amount of savings could result from the following:

- Category of Storm Used to Measure Savings – The savings expected to result from the use of building codes would be expected to be less for a stronger storm (Cat 4-5) than the savings related to a weaker Cat 1 storm occurrence.

- Estimation Process Used – Some of the studies are based on samples of actual storm damage, while others used simulation models. We have not examined the credibility of the data used in the studies or the reasonableness of the models relied upon but have accepted the results as stated.

- Type of Mitigation – Some sources refer to adoption and enforcement of generic building codes while others reflect specific mitigation items (LSU study) or specific codes (IBHS study - Florida 1992 code).

Potential Savings and Cost of Legislation – Retrospective Basis

Based on the savings indicated from the collected research, we selected three scenarios (low/medium/high) with indicated savings rates for damage by a Cat 1 hurricane of 35%, 50% and 65% to be applied to property losses assumed to be for housing stock not built to code. We applied the indicated savings to the historic hurricane expenses incurred by FEMA on a state by state basis while accounting for the following parameters:

- Category of Storm When Entering State – If a storm was more severe, less savings were projected to occur for the adoption an enforcement of building codes.

- Building Code Adoption and Enforcement – Using new home construction information, we were able to estimate the amount of construction that was built to the current code in each year a hurricane occurred. If the state does not currently qualify under the SBCIA either because it lacks a recognized statewide code or does not enforce the code, we assumed half of the existing housing stock at the time of the hurricane was not built to code.

The following table provides the estimated savings in FEMA costs related to hurricanes estimated to occur if every state had adopted and enforced recognized model building codes for all building stock. We also add a 4% provision for the additional funding that would be available to each state under the terms of the Safe Building Code Incentive Act.

Table 5
Potential Savings to Historical FEMA Hurricane Costs
Due to Building Code Adoption and Enforcement
($millions)

Savings Scenario	Actual Costs*	Reduced Costs	Initial Savings ($)	4% Funding	Savings - Funding	Final # Savings %
Low	62,961	57,166	5,795	2,286	3,509	6%
Medium	62,961	54,028	8,933	2,161	6,772	11%
High	62,961	50,340	12,620	2,014	10,602	17%

*Includes only 50 states, excludes US territories   # Savings expressed as percent of Actual Costs

Potential Savings and Cost of Legislation – Prospective Basis

<u>Hurricane Simulation Model</u>

To understand the costs and savings associated with the legislation on a prospective basis, we built a model to estimate the cost of FEMA grants on hurricanes projected to occur in the future. The total cost of future hurricanes for each year was based on a simulation model that projected the number of hurricanes (frequency) and the cost of each hurricane to FEMA (severity). The frequency of hurricanes was based on the actual number of hurricanes occurring annually using data from NOAA for 1851-2011. The severity or cost of the hurricanes to FEMA was based on the FEMA database provided for hurricanes occurring from 1988-2011.

The costs of the past hurricanes were normalized to a 2010 level to reflect changes in wealth, inflation, housing, and new buildings built to accepted codes.

Based on the projected number of hurricanes in each year and the estimated severities of each, annual total costs were projected and allocated to state or category based on the history provided.

<u>Testing of the Potential Impact of SBCIA</u>

To calculate the impact of enacting the proposed legislation, we ran two alternative versions of our medium scenario. In the first scenario, we assumed no additional states would adopt and/or enforce model codes based on passage of the act, i.e., there is no change to currently qualifying states. Therefore, simulated loss projections would remain unchanged for the states that do not adopt the code while qualifying states with an accepted and enforced code would have reduced losses due to new construction. The savings from the reduced losses is offset by the additional 4% provided to these states under the act.

In the second scenario, we assume that all states adopt and enforce model building codes starting in 2012 to qualify for the 4% in additional provisions. If this were to occur, the new adopter states would have reduced losses based on the assumed improvement to new construction but would also qualify for the 4% in additional funds. Table 6 below compares the total losses, savings from building code improvements and additional funding costs based on the two scenarios over the next 5, 10, 15, 20 and 25 year time horizons.

Table 6
Potential Savings to Simulated FEMA Hurricane Costs 2012-2016
Due to Building Code Adoption and Enforcement
($millions)

Years	Scenario	Simulated Costs*	Reduced Costs	Initial Savings ($)	4% Funding	Savings - Funding	Final # Savings %
5	1	6,523	6,506	17	182	(166)	(2.5%)
5	2	6,523	6,497	26	260	(234)	(3.6%)
10	1	14,869	14,712	157	412	(255)	(1.7%)
10	2	14,869	14,631	239	585	(346)	(2.3%)
15	1	25,646	25,243	402	709	(306)	(1.2%)
15	2	25,646	25,037	609	1,001	(393)	(1.6%)
20	1	37,510	36,733	777	1,033	(256)	(0.7%)
20	2	37,510	36,340	1,170	1,454	(284)	(0.8%)
25	1	52,710	51,344	1,367	1,446	(79)	(0.2%)
25	2	52,710	50,662	2,049	2,026	22	0.0%

*Includes only 50 states, excludes US territories   # Savings expressed as percent of Actual Costs

As shown in the table above, the cost of the 4% additional funding outweighs the projected savings until at least 25 years in the future. This is primarily due to the low amount of new housing being built and projected to continue over the near term due to the current state of the economy and the amount of additional funding. If the 4% funding level were decreased to 3%, the model indicates cumulative savings could be reached within 20 years or 5 years earlier than with a 4% provision. A summary exhibit is attached which provides projections over various time horizons and at additional provisions of 3%, 4% and 5%.

Key Areas of Uncertainty within Current Hurricane Model Estimates

The results provided contain several areas of uncertainty as discussed below:

- FEMA Grants – We have recognized that not all FEMA grant amounts are impacted by building code improvements. Based on conversations with representatives from FEMA, we obtained an understanding of the typical costs associated with various grants and adjusted our credits to reflect the impact. For example, we have assumed that improvements in building codes would only impact half the costs associated with infrastructure and FEMA administrative costs and would not affect mitigation costs or mission assignments.

- Effectiveness of Current Building Codes – For states that have not adopted recognized model codes or do not have effective enforcement, the current model scenarios assume that 50% of the building stock exposed to the hurricanes was built to the standard of a model code. Therefore, to the extent that more or less of the construction was performed to the standard of a model code, our savings projections would be overstated or understated.

- Hurricane Catastrophe Codes – Catastrophe codes were available for most hurricanes and most states in the FEMA database. Where the codes were not available, we assigned a default code of 1 – representing the lowest severity hurricane. The credits applied to these hurricanes were higher than would be applied for more severe storms. To the extent the hurricanes should receive higher cat codes, the indicated credit and savings would be reduced.

- Distribution of Simulated Losses – The simulated future hurricane FEMA costs were based on data provided by FEMA for 1988-2011. It is possible that had more years of data been available, the modeled distribution of costs by state could change.

Tornadoes

According to the Institute for Business and Home Safety (IBHS), approximately 1,000 tornadoes occur each year in the United States, causing an average of $1.1 billion in property damage and an average of 80 deaths. One quarter of these tornadoes are powerful enough to account for 90 percent of the damage and 2/3 of the deaths.

Tornadoes differ from hurricanes in terms of size. Hurricanes can often blanket several states while tornado damage is normally localized to small geographic areas. The chance of a tornado striking a particular building in Tornado Alley, the area between the Rocky Mountains and the Appalachians, has been estimated at 1 in 5,000 per year. The chance that the tornado will be very strong (at the highest level on the Fujita scale used to measure tornados) is even lower. As a result of these rare occurrences, it does not make economic sense to build houses to withstand these tornadoes. Therefore, specific mitigation of damage due to tornadoes is not addressed in building codes. While some localities have adopted amendments to model building codes to resist higher wind loads, the primary focus in regards to tornadoes has been on the construction of storm shelters. While storm shelters are not mandated in current model codes, the codes do include standards to which these shelters must be built. There is little doubt that such shelters save lives and are an important focus for future building code changes but they are not expected to change the costs of FEMA activities post storm.

Earthquakes

The primary goal of seismic codes is to prevent serious injury and loss of life by preventing building collapse and allowing for safe evacuation. According to the *National Earthquake Hazards Reduction Program (NEHRP) Recommended Seismic Provisions for New Buildings and Other Structures*, the intent of the provisions are as follows;

- Avoid serious injury and life loss;
- Avoid loss of function in critical facilities; and

- Minimize structural and non-structural repair costs where practical to do so.

The codes are not aimed at completely preventing damage to the buildings. Seismic provisions attempt to prevent general failures (total collapse) but allow for local damage (damage to non-critical sections). Therefore, damages to code-compliant buildings can be costly but the societal benefits in terms of the avoidance of human suffering can be material.

In a 2009 research paper completed by the World Bank, “Why do People Die in Earthquakes?”, a comparison is made between the mortality rate resulting from similar magnitude earthquakes in California (a state currently qualifying for the SBCIA) and in other countries. For example, a 1988 earthquake in Armenia which had half the energy of the 1989 Loma Prieta earthquake in California caused 25,000 deaths compared to 100 in the California quake. The 2003 Paso Robles quake in California had the same power as the “Bam” quake in Iran, yet the death toll was two in California and 41,000 in Bam. According to engineering analyses cited in the World Bank study, a major difference in these results was strict adherence to tough zoning and building codes in California as compared to Armenia and Iran.

Besides California and the Pacific Northwest, the primary areas of seismic exposure in the U.S. include Charleston, South Carolina and the New Madrid Zone/Wabash Valley (Arkansas, Illinois, Indiana, Mississippi, Missouri, and Tennessee). While South Carolina along with California and most of the states in the Pacific Northwest would currently qualify under the SBCIA, most of the states in the New Madrid zone would not as they either have no statewide mandated code or have no enforcement mechanism. Research by the United States Geological Survey (USGS) estimates there is a 7% to 10% chance of an earthquake of magnitude of 7.0 or more occurring in the next 50 years in this area. Applied Insurance Research (AIR) recently estimated expected insured losses to residential, commercial and industrial buildings and contents of approximately $110 billion if a quake similar to that which occurred in 1811/1812 occurred today. The AIR paper cites a 2009 report issued by the Mid-America Earthquake Center that estimates a repeat of the events of 1811/12 could result in nearly 86,000 injuries and 3,500 fatalities. The study estimates about 42,000 search and rescue personnel would be required to respond.

Based on our research, it appears likely that the adoption of the Safe Building Code Incentive Act and potential adoption and enforcement of building codes with seismic code provisions for currently non-qualifying states would result in either very little savings to FEMA costs or, more likely, additional costs due to the additional four percent (4%) funding provision. The primary reasons for this conclusion include the following:

1. The primary goal of seismic codes is safety – not damage reduction;

2. The states with the largest FEMA costs related to earthquake damage in the most recent years already qualify for the program as they have adopted and enforced model codes,

therefore their costs already include most of the savings benefits of better codes but they would now be entitled to the additional 4% funding provision;

3. For the states with earthquake exposure that don't currently qualify for the program but could in the future, the growth in new housing (those built to any newly adopted code) has been very limited in recent years and it would take years before the newly built housing amounted to a material enough amount of the total housing stock that the benefits of the improved buildings would outweigh the additional 4% funding provision.

While the costs for property damage related to earthquakes to FEMA would likely increase under the SBCIA act, there could be increased benefits in other areas of the economy such as reduced business interruption, reduced environmental damage and, perhaps most importantly, as discussed above, reduced loss of human life. These items are critically important but difficult to quantify in terms of benefit amounts.

Flood

Flood damage is best addressed by loss avoidance (not building in a flood plain) or through elevation of the structure. Coverage for damage due to floods is typically only available through the federal government's National Flood Insurance Program (NFIP). Communities that choose to participate in the NFIP must adopt local floodplain management regulations (no less stringent than minimum NFIP regulations) and, in return, building owners and renters in the community are eligible to purchase flood insurance through the NFIP and the community is eligible for certain types of flood disaster assistance. Building code changes would therefore have minimum impact on flood damages.

Other Potential Benefits

While the majority of our work has focused on losses resulting from property damages, loss mitigation based on the adoption and enforcement of model building codes also may decrease the impact of natural disasters on local economies, the environment and human suffering. Based on the information reviewed for this analysis, there is a wide range of views on the economic impact of natural disasters due to the type of disaster, the time period reviewed, and the segment of the economy studied (national vs. regional vs. local). However, most research agrees that the impact of natural disasters on individual citizens and business is materially adverse and often irreversible. Our work does not address the potential favorable effects of enhanced building codes on the long term local, state, and national economies.

Limitations

Data

In performing this analysis, we relied on data and other information provided to us by FEMA, NIBS, the National Association of Builders and obtained by us from various public sources. We did not audit or verify this data and other information. If the underlying data or information we have relied on is inaccurate or incomplete, the results of our analysis may likewise be inaccurate or incomplete.

We performed a limited review of the data used directly in our analysis for reasonableness and consistency and have not found material defects in the data. If there are material defects in the data, it is possible that they would be uncovered by a detailed, systematic review and comparison of the data to search for data values that are questionable or for relationships that are materially inconsistent. Such a review was beyond the scope of our assignment.

Variability

Actuarial estimates are subject to uncertainty from various sources, including changes in claim reporting patterns, claim settlement patterns, case reserve adequacy, judicial decisions, legislation, and economic conditions. Actual results will most certainly vary from the indications contained in this report due to these uncertainties.

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Potential Savings to Simulated FEMA Hurricane Costs
Due to Building Code Adoption and Enforcement
($millions)

					3% Funding Provision			4% Funding Provision			5% Funding Provision		
Years	Scenario	Simulated Costs	Reduced Costs	Initial Savings	Funding	Savings-Fundings	Final Savings	Funding	Savings-Fundings	Final Savings	Funding	Savings-Fundings	Final Savings
5	1	6,523	6,506	17	137	(120)	-1.8%	182	(166)	-2.5%	228	(211)	-3.2%
5	2	6,523	6,497	26	195	(169)	-2.59%	260	(234)	-3.6%	325	(299)	-4.6%
10	1	14,869	14,712	157	309	(152)	-1.02%	412	(255)	-1.7%	516	(358)	-2.4%
10	2	14,869	14,631	239	439	(200)	-1.35%	585	(346)	-2.3%	732	(493)	-3.3%
15	1	25,646	25,243	402	531	(129)	-0.50%	709	(306)	-1.2%	886	(483)	-1.9%
15	2	25,646	25,037	609	751	(142)	-0.56%	1,001	(393)	-1.5%	1,252	(643)	-2.5%
20	1	37,510	36,733	777	774	2	0.01%	1,033	(256)	-0.7%	1,291	(514)	-1.4%
20	2	37,510	36,340	1,170	1,090	80	0.21%	1,454	(284)	-0.8%	1,817	(647)	-1.7%
25	1	52,710	51,344	1,366	1,084	282	0.53%	1,446	(79)	-0.2%	1,807	(441)	-0.8%
25	2	52,710	50,662	2,049	1,520	529	1.00%	2,026	22	0.0%	2,533	(484)	-0.9%