Estimating the Economic Value of FORTIFIED™ Multifamily Construction[1]

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Executive Summary:

The FORTIFIED Multifamily™ Wind program includes a re-roofing and construction standard and verification process that mitigates wind-peril losses for multifamily structures. In this study, we estimate the net value of the FORTIFIED™ Multifamily Wind program by comparing the marginal costs to the marginal benefits. We present the analysis in relation to the owners of buildings because they are the ultimate decision makers. However, we note that value can accrue to owners through increased value to tenants (higher rent) or government (reduced disaster cost).

Estimates of benefits and costs vary across locations based on the expected frequency and severity of hazards, the current building codes in force, and the local cost of labor and materials. We average results of the analysis into three categories: 1) coastal areas inside a windborne debris zone, 2) coastal areas outside of a windborne debris zone, and 3) inland areas.

We find that the FORTIFIED Multifamily™ program is an efficient means of mitigating wind losses. The marginal cost of building to the FORTIFIED standard is between 0.3% and 1.4% of the cost of our example structure. The average cost is 0.56% of the total cost.

We also expect investments in FORTIFIED construction to perform well. The lowest estimated rate of return is 8% and the highest estimated rate of return is 72%.[2]

[1] We thank the IBHS staff, Julie Shiyou-Woodard, and Kenny Wunder for helpful input.

[2] We measure return as the internal rate of return (IRR) on a 20-year project. We provide a detailed description of IRR in the benefit/cost analysis.

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Introduction

The purpose of this study is to estimate the economic costs and benefits of the FORTIFIED Multifamily™ Wind program. Results may be used to encourage private entities and policymakers to build FORTIFIED and incentivize FORTIFIED construction.

The FORTIFIED Multifamily™ program has the potential to improve resilience for much of the U.S. workforce, including many of the nation's most vulnerable families. In 2019, 18.3% of U.S. housing units were in multifamily structures.[3] In addition to the resident families themselves, loss mitigation will provide benefits for apartment owners, surrounding businesses (including their customers and suppliers), employers, and federal, state, and local governments. This analysis, however, is focused on costs and benefits to the owners of multifamily structures.

The FORTIFIED Multifamily program includes hurricane standards in coastal areas and high wind and hail (HWH) standards inland.

Two factors complicate our analysis. First, the perils we address are inherently uncertain in timing, frequency, and severity. Although we know wind damage will occur in the future, we do not know when it will happen, how often, or how much it will cost. Second, we cannot observe the performance of the new mitigation system. We rely on the most advanced simulation analysis available, coupled with actuarial and econometric procedures to estimate the expected efficacy of FORTIFIED Multifamily. In addition, we choose conservative estimates when the analysis requires subjective input or assumptions. The product is our best attempt to set a lower bound on the value of loss mitigation to affected parties.

There are many parties that may be affected by investments in loss mitigation. We estimate the effects on owners and tenants of multifamily housing, as well as to a subset of the government disaster aid programs supported by taxes and the businesses that employ residents of multifamily housing. Indeed, wind perils also affect most forms of commerce, human capital employed by public and private entities, and the value of real estate.[4] Though we acknowledge these additional sources of value, we are not able to measure them with sufficient rigor to include the estimates in this study.

The benefits to owners include reduced insurance premiums and retained losses (e.g., deductibles) and, possibly, greater property insurance availability (i.e., choices among carriers). Owners and operators may also experience reduced disruption of business operations due to a reduction in property damage. Tenants may place value on loss mitigation because it decreases the expected cost of losses to personal property and reduces premiums for renter's insurance,[5] and they may value the peace of mind from knowing that their residence is protected from storms and that they will not be dislocated by severe weather. Each of these factors may increase the

[3] U.S. Census, American Community Survey, available from https://data.census.gov/cedsci/table?q=DP04&tid=ACSDP5Y2019.DP04. Accessed 1/14/2022

[4] See Awondo et al. 2021; Basker and Miranda, 2018; Dumm, Sirmans, and Smersh, 2011; Carson, McCullough, and Pooser, 2013; and Gallagher and Hartley, 2017.

[5] Not all insurance companies offer FORTIFIED discounts on renters' insurance.

rent tenants are willing to pay to live in a FORTIFIED structure. Therefore, we consider benefits provided to tenants to actually accrue to the owners.

We complete the analysis by estimating the cost of building FORTIFIED compared to the cost of meeting local building codes. As a preview of results, we find that the costs of building to the FORTIFIED standard are small, both as a proportion of the cost of building an apartment complex, and in comparison to the expected benefits. The marginal cost of FORTIFIED Multifamily is between 0.3% and 1.4% of the total cost of building our example structure. The expected internal rate of return on such mitigation investments varies between 8% and 72%, depending on the level of FORTIFIED (Roof or Gold) and the location of the building.[6]

Analysis

We estimate the net value of the FORTIFIED™ Multifamily Wind program by comparing the marginal costs to the marginal benefits. We present the analysis in relation to the owners of buildings because they are the ultimate decision makers. However, we note that value can accrue to owners through increased value to tenants (higher rent) or government (reduced disaster cost).

Cost of FORTIFIED

The marginal cost of building to the FORTIFIED standard differs across locations based on the adopted building code. For example, coastal locations in a windborne debris area[7] already require among the most expensive aspects of the FORTIFIED standard (impact-resistant openings). However, in the compliment of hurricane-exposed areas, we must account for the cost of reinforced openings in the marginal cost of FORTIFIED.

We use the Xactimate system to estimate the costs of building standard structures and FORTIFIED structures in three representative locations.[8] The locations represent common building codes in coastal areas with and without windborne debris requirements, and inland areas exposed to tornados, hail, and straight-line winds.

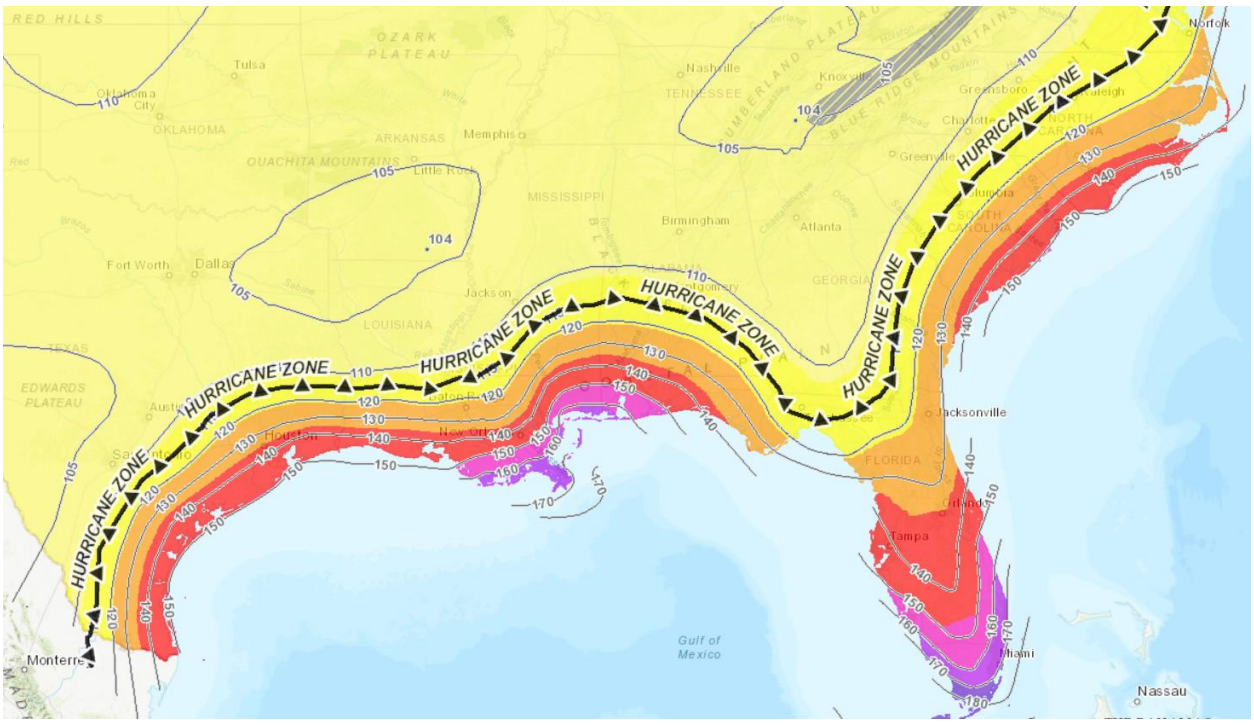
Our example building is two stories, 30,000 square feet, and contains 30 units. The primary cost factor for FORTIFIED HWH construction is the roof because opening protection is not required for the HWH regions. FORTIFIED Hurricane designations also require more expensive exterior openings (doors and windows). The building has 30 front entry doors, 30 back sliding doors, and 90 windows. The marginal cost of FORTIFIED Multifamily differs across locations based on current building codes, and the level of FORTIFIED designation (Roof or Gold).[9] In the case of FORTIFIED Hurricane Roof, the improvements solely focus on the roof system therefore opening protection is not a requirement, whereas for Gold, opening protection is required. While FORTIFIED Roof can be achieved through new construction and retrofitting projects, for the

[6] We provide a detailed description of IRR in the benefit/cost analysis.
[7] We describe the windborne debris area below in Figure 1.
[8] See https://www.xactware.com/en-us/.
[9] The Silver designation lies between Roof and Gold in terms of cost and efficacy.

purposes of this analysis we assume that FORTIFIED Roof is achieved by retrofitting an existing building and FORTIFIED Gold is achieved with new construction.

We present the marginal cost of each FORTIFIED designation in three zones. Figure 1 shows the hazard map for risk category two from ASCE7 (2016), which determines the applicable local code requirements and the FORTIFIED program (HWH or Hurricane).[10] The first zone, Hurricane 1, is the highest hazard zone defined as a windborne debris zone. Windborne debris regions are defined as areas within 1 mile of the coastal mean high water line and the basic design wind speed is 130 mph or greater; or areas where the basic design wind speed is 140 mph or greater. In such areas, we do not include impact resistance openings in the marginal cost of FORTIFIED because they are required by local building codes. In Figure 1, Hurricane 1 is on the coastal side of the 140-mph wind line. The next zone, Hurricane 2, is further inland from Hurricane 1, but still considered a coastal zone exposed to hurricane perils. In Figure 1, this zone is between the 140-mph line and the Hurricane Zone line (bold and marked with triangles). The marginal cost of FORTIFIED Gold is greatest in this zone because local codes, with some limited exceptions, do not require impact resistant openings in the selected jurisdictions. The High Wind and Hail zone includes all areas inland from the Hurricane Zone line.

Figure 1: Map of ASCE7-16 Hazard Zones



Note: Wind speed zones are from ASCE7 (2016) using risk category two. https://asce7hazardtool.online/

[10] Local building codes often – but not always – follow the ASCE7-16 wind zones as described here. However, building codes are set by local jurisdictions, which may overlap the wind zones or choose a different code than prescribed by the wind zone. Therefore, it is important to check local building codes to determine the benefits and costs of building FORTIFIED in a given jurisdiction.

Finally, we include the cost of IBHS FORTIFIED inspections.[11] Qualified inspectors must verify that the buildings' design and construction meet FORTIFIED standards before they can be designated. The cost of the initial inspections for these examples is estimated to be approximately $2,000 for a Roof designation and $5,000 for a Gold designation. The building must also pass inspection every five years to maintain the designations. Quinquennial inspections estimated cost is about $1,500 for Roof designations and $1,800 for Gold designations.

[11] The cost of initial and quinquennial inspections will vary with several factors including designation level, location, and building features.

Table *1* presents the marginal cost of constructing the example apartment building described above to each FORTIFIED designation in each zone. With one exception, the additional cost of FORTIFIED Roof hurricane and high wind are similar at around $9,000. The exception is the hurricane Gold designation outside of the windborne debris zone, where the designation requires impact resistant openings, but the building code generally does not. The difference in the cost of FORTIFIED Roof between Hurricane 1 and Hurricane 2 is due to differences in local costs of materials and labor. The requirements are identical. Finally, the hail supplement to the high wind designation increases cost by $10,000 because the local building codes do not require hail-resistant roof coverings. Since the primary resilient deviation from code for the High wind and High wind + Hail (<115) is the roof cover, FORTIFIED Roof and Gold have similar cost increases.

We assume the average cost of building multifamily housing is $100 per square foot. We calculate this estimate using RSMeans Square Foot Costs 2022, a national database of construction costs. The cost estimate includes building materials, labor, equipment, contractor, architectural fees, etc. Although we expect a wide range of costs due to the nature and variability of commercial construction, we use a conservative estimate for this analysis. As the cost of a multifamily building increases due to variable factors such as design, building features, construction materials, and location, the return on investment will also increase.

Our example building is 30,000 square feet. At $100 per foot, the total cost is $3,000,000 for standard construction. Therefore, none of incremental costs of FORTIFIED exceed 1.5% of the total cost of construction. The average marginal cost is 0.56%.

Table 1: Marginal Cost of FORTIFIED Programs by Zone

Zone	FORTIFIED Roof	FORTIFIED Gold
Hurricane 1 (≥140)	$9,000	$12,000
Hurricane 2 (<140)	8,600	43,000
High wind (<115)	8,900	11,900
High wind + Hail (<115)	18,900	21,900

Source: Xactimate pricing software.
Note: The subject building would cost approximately $3,000,000 without FORTIFIED modifications. The cost increases as a percentage of total building costs range from 0.29% to 1.43%. Costs are rounded to the nearest $100. Wind speed zones are from ASCE7 (2016). This table does not include the cost of future quinquennial inspections, which are approximately $1,500 each for Roof designations and $1,800 each for Gold designations. These costs are included in the return calculations in Table 3.

Benefits to Owners

Building or retrofitting to the FORTIFIED Multifamily standard reduces the expected cost of wind losses incurred by the owners of multifamily housing units. The magnitude of this effect depends on several factors related to the location of a dwelling. The first factor is exposure to perils and hazards. For example, a coastal location is more likely to experience hurricane winds than is an inland location. The second factor is the local building code and its enforcement. Building codes differ substantially across locations. If the current building code already requires attributes of the FORTIFIED system, these attributes will not cause a difference between standard and FORTIFIED construction.

Insurance premiums are a function of expected losses, expenses, and risk loading. The risk loading is the amount an insurer charges to bear uncertainty about the ultimate amount of losses. When outcomes are less certain, insurers charge a greater risk load. Following the American Academy of Actuaries (2018) and AIR (2011), we approximate the risk loading as twice the expected loss in hurricane zones and equal to the expected loss inland.[12] Because loss mitigation does not affect the expense load, we do not consider expenses in this calculation.

We use the AIR Worldwide Touchstone catastrophe model to estimate the reduction in losses from building to each FORTIFIED designation. First, we create a hypothetical multifamily structure[13] with the same parameters as the structure used for the cost estimate in the previous section. Then we locate the structure in a sample of coastal and inland cities around the southeastern United States. The results presented in this study are the average results for the locations in each zone.

[12] The risk load represents the standard deviation of expected losses for a portfolio of similar exposures.
[13] See Appendix A: Details of Building Costs, Loss Estimates for details of the hypothetical structure.

The catastrophe model estimates the distribution of expected losses, including expected (average) loss, standard deviation, and several estimates of tail probabilities, for the subject structure. We repeat the modeling process in each location for standard construction, FORTIFIED Roof, and FORTIFIED Gold. We apply the percentage decrease in expected losses to the estimated premium. Table 2 presents the average expected wind losses for existing code and both FORTIFIED designations (Roof and Gold) in each wind speed zone.

Table 2: Average Expected Insurance Premium Reductions from FORTIFIED

FORTIFIED Program	Wind zone	Estimated Wind Premium			Discount	
		Standard	Roof	Gold	Roof	Gold
Hurricane	>140	$15,980	$14,447	$9,431	$1,533	$6,549
Hurricane	≤140	6,511	5,511	4,146	1,000	2,365
High wind	<115	3,571	2,790	2,493	781	1,078
High wind + Hail	<115	3,571	2,667	2,370	904	1,201

Note: We estimate expected losses using the AIR Touchstone catastrophe model. Wind premium does not include losses from other perils or expenses (e.g., commission, tax, labor, etc.). Wind speed zones are from ASCE7 (2016). Details of the analysis appear in Appendix A.

Each of the FORTIFIED designations substantially reduces expected insurance premiums. On average, the Roof designation reduces expected insurance costs by $1,533 (10%) in the windborne debris region, $1,000 (15%) in the remainder of the hurricane zone, and $842[14] (24%) in the high wind zone. The Gold designation reduces average expected insurance costs by $6,549 (41%) in the windborne debris region, $2,365 (36%) in the remaining hurricane area, and $1,139[15] (32%) in the high wind zone.

Benefits to Tenants

The residents of a multifamily housing property can benefit from the FORTIFIED designation in at least two ways. First, they may recognize a decrease in the cost of renters insurance and uninsured losses. Second, the reduction in uncertainty surrounding disaster losses may increase the utility of a FORTIFIED residence.

We estimate the benefits to tenants using data collected in survey of multifamily housing residents in states targeted for the FORTIFIED Multifamily program. We conducted the survey in 2021 using the Qualtrics survey panel. We received 1,050 responses of which 1,013 were complete. Summary statistics of the survey data appear in Appendix B: Details of WTP Survey.

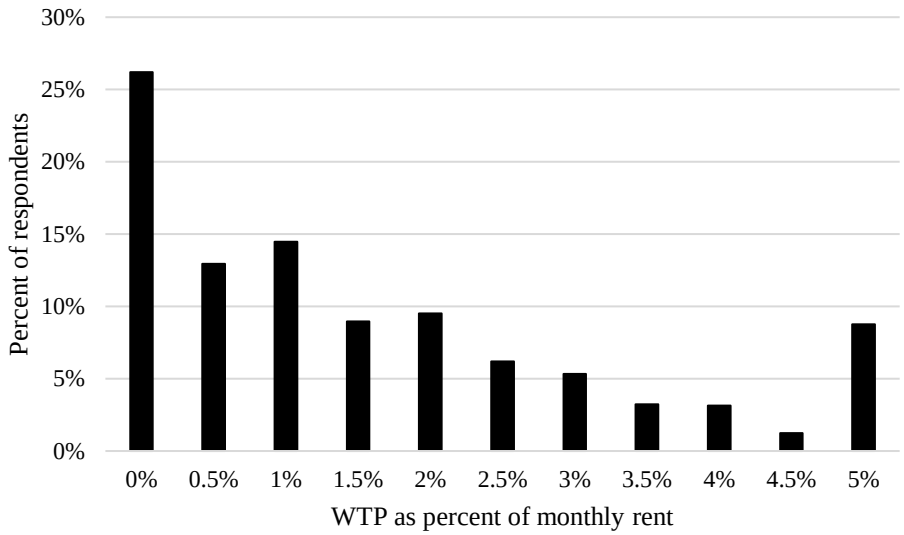
First, we find that 64% of respondents in our sample purchase renters' insurance, indicating that a majority of residents could see decreases in their monthly expenses if they obtain a lowered

[14] This is the average of the FORTIFIED Roof discounts for high wind and high wind + hail ([781+904]÷2=$842).
[15] This is the average of the FORTIFIED Gold discounts for high wind and high wind + hail ([1,078+1,201]÷2=$1,139).

price for renters insurance by living in FORTIFIED Multifamily buildings. Other residents would realize this savings from reduced losses over time.

Next, we elicited survey participants' willingness to pay (WTP) to live in a FORTIFIED Multifamily building. The question was posed as a percentage of current monthly rent. Figure 2 shows the distribution of responses.

Figure 2: Willingness to Pay for FORTIFIED Multifamily



Source: Qualtrics survey of multifamily housing residents

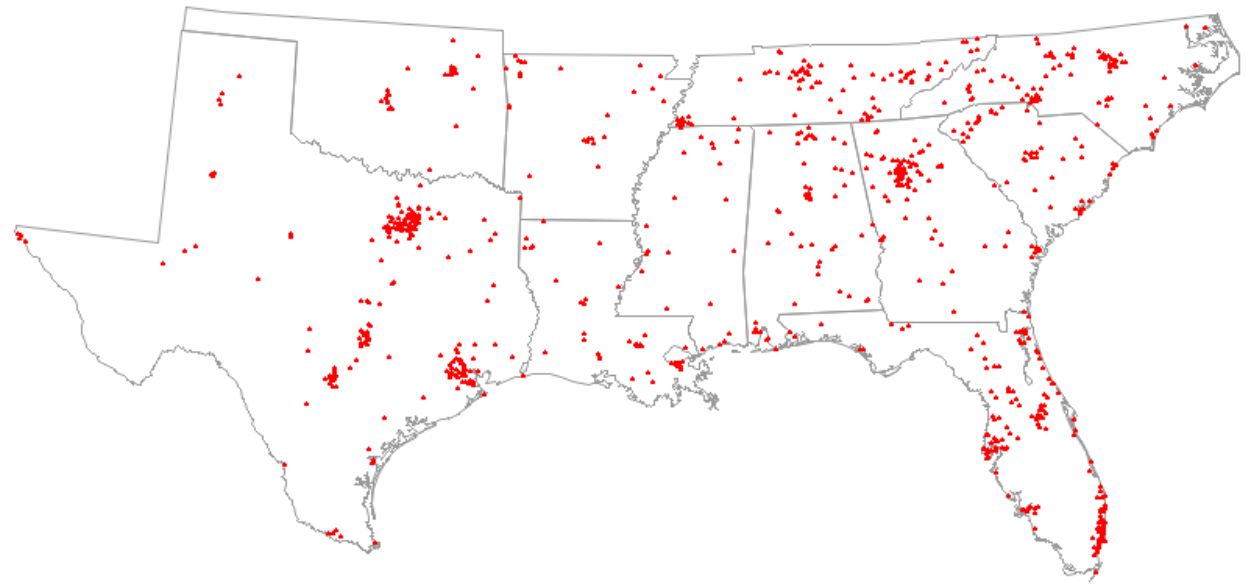
We find that 74% of survey participants are willing to pay additional rent to live in a FORTIFIED Multifamily home. Multiplying monthly rent by the increased percentage that respondents are willing to pay, yields an average of 1.67% or $17.31.[16] However, among those who are willing to pay more than zero, the average acceptable increase is 2.17% or $23.38. The latter result suggests that advertising the benefits of FORTIFIED Multifamily could further increase the economic benefits recognized by owners.

The apartment building in our cost example includes 30 units. Increasing the rent for each unit by $17 to $23 could yield $6,120 to $7,920 per year in additional rent revenue. However, these estimates are not uniform across states. Moreover, the elicitation survey was not incentivized, mandating a conservative approach when applying these findings. It is also noteworthy that our survey sample is not concentrated along the coast, except for the participants in Florida. Figure 3 presents the locations of survey respondents' ZIP Codes. No more than four responses came from any one ZIP Code.

[16] This is the percentage increase renters are willing to pay times their rent. The average rent in the sample is $1,038.

We apply a censored regression methodology to estimate the average WTP in each state, while controlling for demographics that affect WTP in our model.[17] As expected, we find lower WTP in landlocked states than in coastal states. The average WTP in Arkansas, Oklahoma, and Tennessee ($6.88) is about half of the average for states with coastal exposure ($13.13).

Figure 3: Locations of survey respondents



Source: Qualtrics survey of multifamily housing residents

Although we find significant differences between coastal and land-locked states, the responses do not differ by distance to the coast. Therefore, we start with $6 per unit in the high wind zone and $12 per unit in the hurricane zones. Next, we divide each estimate by two as an ad-hoc adjustment recognizing the fundamental uncertainty associated with WTP surveys.

The annual WTP value for our subject building with 30 units is $2,160 (12×30×$6=$2,160) in the hurricane zones and $1,080 (12×30×$3=$1,080) in the high wind zone.

Benefit / Cost Analysis

Our final step is to estimate the relationship between costs and benefits of the FORTIFIED Multifamily program. The first numbered line in **Error! Reference source not found.** is insurance savings from FORTIFIED construction. The second line is the potential increase in rent residents are willing to pay to live in FORTIFIED housing. Line 3 is the sum of lines 1 and 2. Line 4 is the total cost.

The payback ratio is the initial cost (line 4) divided by the annual benefit (line 3). It represents the period of time required to recoup an investment in a FORTIFIED Multifamily residential

[17] See Appendix B for details about the survey and this analysis.

building. The payback ratio does not consider the potential interest earned on an investment. The return is the internal rate of return (IRR), which measures the rate of return from owning a FORTIFIED apartment building for 30 years.[18] IRR is a common financial measure used to compare the value of projects, defined as the annualized effective compounded return rate. It is calculated by solving the following equation for r.

$$0 = \sum_{n=0}^{N} \frac{CF_n}{(1+r)^n}$$

Where CF_n is the expected cash flow in period n.

Building a FORTIFIED Gold structure in the windborne debris zone provides the fastest breakeven period at less than 17 months and the highest IRR at 72%. The smallest return accrues to FORTIFIED Gold High Wind and Hail designations. For these, the payback period is 9.6 years and the IRR is 8.1%.

Table 3: Benefit Cost Analysis Results

FORTIFIED program	Hurricane		Hurricane		High Wind		High Wind+Hail	
Mitigation level	Roof	Gold	Roof	Gold	Roof	Gold	Roof	Gold
Wind zone	>140	>140	115-140	115-140	<115	<115	<115	<115
(1) Insurance savings	1,533	6,549	1,000	2,365	781	1,078	904	1,201
(2) Increased demand	2,160	2,160	2,160	2,160	1,080	1,080	1,080	1,080
(3) Annual benefit	3,693	8,709	3,160	4,525	1,861	2,158	1,984	2,281
(4) Initial cost	9,000	12,000	8,600	43,000	8,900	11,900	18,900	21,900
Payback period	2.44	1.38	2.72	9.50	4.78	5.52	9.53	9.60
Return (IRR)	39%	72%	35%	9%	18%	16%	8.3%	8.1%

Note: These data represent average costs and benefits for each FORTIFIED program in each wind speed region. The internal rate of return (IRR) calculation is based on a 30-year useful life of the mitigation features. Wind speed zones are from ASCE7 (2016). The return calculation includes the cost of evaluations every five years that are not included in the initial cost row. The cost of these inspections varies, but we assume an average of $1,500 every five years for Roof designations and $1,800 for Gold designations.

Summary and Conclusions

The FORTIFIED Multifamily™ Wind program provides building standards that reduce damage to multifamily housing from wind-related perils including hurricanes, tornadoes, straight line winds, and hail. This study evaluates the economic value of the FORTIFIED program for owners of multifamily residential buildings.

[18] FEMA, 2009 indicates the expected useful life of roof retrofit project is 30 years.

We use Xactimate software to estimate costs of the FORTIFIED programs compared to costs of building to the current building code in three representative cities, one in each wind zone.[19] The example building we use is a common 30,000 square foot, two story apartment building with 30 units.[20]

Our results indicate that building to the FORTIFIED Multifamily Wind standards provides impressive return on investment in each category and location considered. The annual estimated return ranges from 8% for the high wind and hail designations to 72% for the Hurricane Gold designation in the windborne debris zone (wind speed >140 mph).

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[19] The cities are Mobile, Alabama (>140), Jackson, Mississippi (115-140), and Oklahoma City, Oklahoma (<115).
[20] Appendix A provides further detail about the example building.

Gallagher, J. and D. Hartley (2017). Household finance after a natural disaster: The case of Hurricane Katrina. *American Economic Journal: Economic Policy*, 9(3), 199–228

Appendix A: Details of Building Costs, Loss Estimates, and Premium Reductions

Building details

Throughout our calculations and estimates we use a hypothetical apartment building with the following specifications:

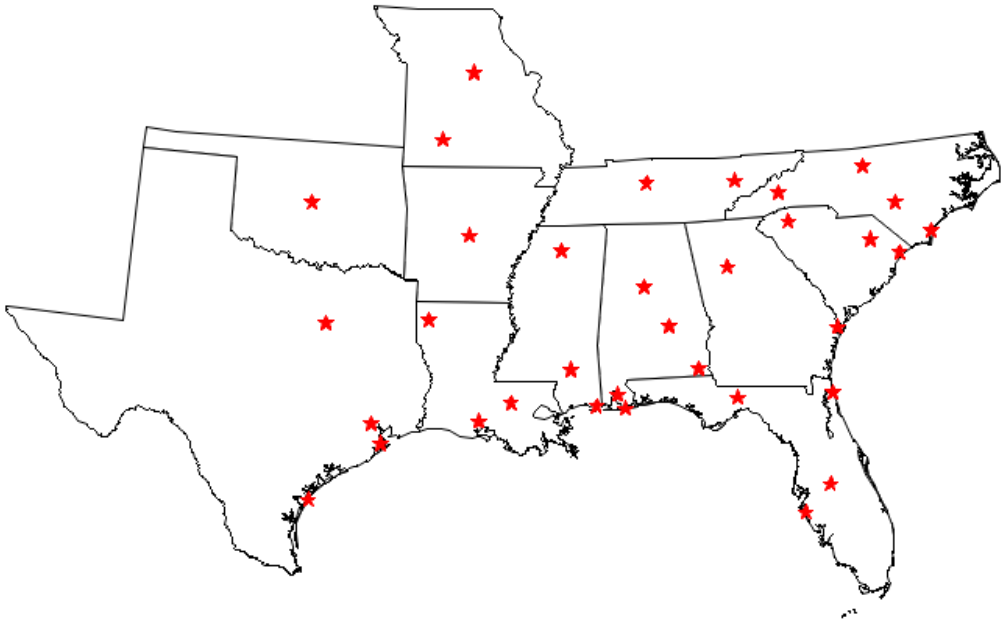
Size: 30,000 square feet
Stories: 2
Number of units: 30
Year built: 2020
Total insured value: $3,375,000
    Building replacement cost: $3,000,000
    Contents: $150,000
    Time element coverage: $225,000
Construction type: Masonry veneer
Roof geometry: Gable ends (unbraced)
Each unit has a standard front entry door, a sliding-glass rear door, and three windows.

RSMeans Square Foot Costs 2022, a national database of construction costs, is the source of our $100 per square foot cost estimate. The cost estimate includes building materials, labor, equipment, contractor, architectural fees, etc. Although we expect a wide range of costs due to the nature and variability of commercial construction, we use a conservative estimate for this analysis. As the cost of a multifamily building increases due to variable factors such as design, building features, construction materials, and location, the return on investment (IRR) will also increase.

Effects of FORTIFIED on expected losses

We use the AIR Worldwide Touchstone™ catastrophe model to estimate expected wind losses to the hypothetical building in 34 locations, using three construction types in each location. The locations are mapped in Figure A.1 and listed in Table A.1. The first construction type meets the local building code (standard), the second is the applicable FORTIFIED Roof designation for the location (hurricane or high wind), and the third is the applicable FORTIFIED Gold designation for the location. In the high wind (inland) locations, we also estimate expected losses for the FORTIFIED Roof and Gold designations with the hail supplement. For each location, we identified an existing multifamily housing structure and used that building's address to ensure that local codes permit multifamily housing. Table A.1 shows the expected annual losses for each type of construction in each location.

Figure A.1: Locations of Example Buildings



In practice, translating the model results to changes in insurance premiums involves many insurer-specific variables and judgement. Because we are not making this estimate for an insurer to use, but rather as an estimate of market outcomes, we follow the approach used in American Academy of Actuaries (2018) and AIR Worldwide (2010). For hurricane losses, these studies assume a risk load equal to one standard deviation of the pooled expected loss from a large book of exposures. The standard deviation appears to converge on twice the average, which is consistent with observed property insurance rate filings.[21]

Less research has been published regarding such analysis of inland severe convective storm (SCS) losses. We observe in property insurance rate filings that the risk load for SCS premiums is approximately half that of coastal hurricane premiums. We also verify this outcome with simulation analysis.[22] Both results suggest that the expected loss is an appropriate risk load for SCS insurance in the area considered by this study.

The baseline expected insurance premiums for wind exposures are three times the expected loss in the hurricane zones and twice the expected loss in the inland zone.

[21] In our small sample, the standard deviation of the pooled loss is approximately 2.4 times the average loss.
[22] In the simulation analysis, we assume a Poisson frequency distribution and a lognormal severity distribution with parameters calibrated to the observed expected loss and standard deviation. Next, we simulate outcomes with a pool of 500 example buildings. The standard deviation of the pooled loss is slightly larger than the expected loss.

Table A.1 Results of Loss Estimate Analysis

FORTIFIED Program	City	State	Wind Speed Zone	Expected Loss Existing Code	Expected Loss FORTIFIED Roof	Expected Loss FORTIFIED Gold
Hurricane	Gulf Shores	AL	>140	$10,624	$9,690	$6,065
Hurricane	Daphne	AL	>140	3,023	2,710	1,931
Hurricane	Sarasota	FL	>140	2,656	2,309	1,716
Hurricane	Pascagoula	MS	>140	8,220	7,450	4,794
Hurricane	Wilmington	NC	>140	4,358	3,930	1,941
Hurricane	Myrtle Beach	SC	>140	1,963	1,835	1,440
Hurricane	Port Aransas	TX	>140	8,169	7,408	4,944
Hurricane	Hitchcock	TX	>140	3,600	3,192	2,319
Hurricane	Dothan	AL	115 - 140	1,638	1,201	976
Hurricane	Winter Haven	FL	115 - 140	1,774	1,595	1,261
Hurricane	Jacksonville	FL	115 - 140	2,483	2,265	1,377
Hurricane	Savannah	GA	115 - 140	1,526	1,350	892
Hurricane	Abbeville	LA	115 - 140	3,191	2,826	1,766
Hurricane	Baton Rouge	LA	115 - 140	1,948	1,660	1,359
Hurricane	Hattiesburg	MS	115 - 140	2,717	2,125	1,854
Hurricane	Fayetteville	NC	115 - 140	1,784	1,496	1,193
Hurricane	Florence	SC	115 - 140	1,705	1,448	1,140
Hurricane	Houston	TX	115 - 140	2,936	2,405	2,002
High wind	Montgomery	AL	<115	1,537	1,034	885
High wind	Bessemer	AL	<115	1,425	1,031	887
High wind	Little Rock	AR	<115	2,297	1,792	1,664
High wind	Tallahassee	FL	<115	1,536	1,224	1,192
High wind	Atlanta	GA	<115	1,309	1,073	839
High wind	Bossier City	LA	<115	2,412	2,042	1,745
High wind	Springfield	MO	<115	2,629	2,028	1,871
High wind	Columbia	MO	<115	1,432	1,081	1,019
High wind	Oxford	MS	<115	1,797	1,358	1,226
High wind	Greensboro	NC	<115	1,052	812	637
High wind	Asheville	NC	<115	858	709	582
High wind	Oklahoma City	OK	<115	4,037	3,216	3,020
High wind	Greenville	SC	<115	1,195	1,002	799
High wind	Knoxville	TN	<115	921	629	554
High wind	Brentwood	TN	<115	1,675	1,275	1,151
High wind	Waxahachie	TX	<115	2,453	2,015	1,875

Notes: AIR model results for example building. The FORTIFIED Hail supplement reduces expected losses by an additional 3.5% of the expected loss under existing code. Wind speed zone from ASCE 7-16.

Table A.2 shows the average expected loss for each FORTIFIED program in each wind speed zone. Table A.3 presents the expected wind insurance premiums and corresponding insurance discounts.

Table A.2 Expected Losses by Construction Type and Location

FORTIFIED Program	Wind Speed Zone	Expected Loss Existing Code	Expected Loss FORTIFIED Roof	Expected Loss FORTIFIED Gold
Hurricane	>140	$5,327	$4,816	$3,144
Hurricane	115 - 140	2,170	1,837	1,382
High wind	<115	1,785	1,395	1,247
High wind + hail	<115	1,785	1,333	1,185

Note: Wind speed zone from ASCE 7-16.

Table A.3: Expected Insurance Premiums by Construction Type and Location

FORTIFIED Program	Wind Speed Zone	Premium Existing Code	Premium FORTIFIED Roof	Premium FORTIFIED Gold	Premium Discount FORTIFIED Roof	Premium Discount FORTIFIED Gold
Hurricane	>140	$15,980	$14,447	$9,431	$1,533	$6,549
Hurricane	115 - 140	6,511	5,511	4,146	1,000	2,365
High wind	<115	3,571	2,790	2,493	781	1,078
High wind + hail	<115	3,571	2,667	2,370	904	1,201

Note: Wind speed zone from ASCE 7-16.

Appendix B: Details of WTP Survey

We used a survey to estimate the marginal willingness to pay (WTP) for a FORTIFIED apartment. The survey questions and solicitation letter appear at the end of this appendix. We conducted the survey in 2021 using the Qualtrics survey panel. We received 1,050 responses of which 1,013 were complete. Summary statistics of the survey data appear in Table B.1.

Table B.1:Survey Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
WTP Fortified	1,013	17.31	25.42	0	230
Monthly Rent	1,013	1,038	716	100	5000
Income	1,013	67,038	56,734	5,000	275,000
Age	1,013	42.24	15.33	18	92
Female	1,013	.621	.485	0	1
Number of dependents	1,013	.72	1.039	0	9
Bedrooms	1,013	2.38	1.35	1	10
Value of contents	1,013	11,524	20,616	0	100,000
Rental insurance	1,013	.64	.48	0	1

We use a hurdle model to estimate WTP from the survey responses. The hurdle model accommodates nonlinearities in the results by estimating separately the probability that a person will choose to rent a FORTIFIED apartment and the amount they will pay for a FORTIFIED apartment. Regression results appear in Table B.2.

Table B.2: Regression Results

Variable	Estimate	T-statistic
Income	0.231**	(4.74)
Income^2	-0.000583**	(-3.01)
Age	-0.0915	(-1.31)
Female	-5.610**	(-2.79)
Dependents	5.872**	(2.68)
Bedrooms	1.625*	(2.05)
Contents value	0.204**	(4.23)
Wind loss experience	7.979**	(3.50)
Rental insurance	2.667	(1.28)
Coastal state	1.314	(0.49)
Constant	-5.488	(-1.05)
var(WTP)	812.6**	(18.66)
Observations	1,013	

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

With the statistically significant independent variables set at the sample means, the predicted marginal WTP is $6.88 inland and $13.13 for the coastal states.

Survey Questionnaire
Project title: Resilience of Multifamily housing to Windstorm Disaster

Section A: Eligibility

1. Do you currently live in multifamily rental housing (e.g. apartment, townhouse)?

- ❍ Yes
- ❍ No - exit survey

2. Are you at least 18 years of age?

- ❍ Yes
- ❍ No - exit survey

Section B: Demographics

3. Please select your year of birth.

1921 - 2003

4. Please specify your Gender.

- ❍ Male
- ❍ Female
- ❍ Other / Prefer not to answer.

5. Which of the following best describes your race or ethnicity?

- ❍ African American/Black
- ❍ American Indian/Alaska Native
- ❍ Asian
- ❍ Native Hawaiian/Other Pacific Islander
- ❍ White/Caucasian
- ❍ 2+ Races
- ❍ Other _____
- ❍ Prefer not to answer.

6. Please state your current ZIP Code:

Zip Code

7. What is your current marital status?

- ❍ Single, never married
- ❍ Married
- ❍ Widowed
- ❍ Divorced
- ❍ Separated
- ❍ Prefer not to answer.

8. Including yourself, how many total persons are living in your household?

- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5
- ❍ 6
- ❍ 7
- ❍ 8+
- ❍ Prefer not to answer.

9. How many dependents under the age of 18 years are in your household?

- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5
- ❍ 6
- ❍ 7
- ❍ 8+
- ❍ Prefer not to answer.

10. Which of the following best describes your current employment situation?

- ❍ Full-time employee (40+ hours/week)
- ❍ Part-time employee (0-39 hours/week)
- ❍ Unemployed
- ❍ Self-employed
- ❍ Retired
- ❍ Full-time student
- ❍ Prefer not to answer.

11. Please indicate total yearly income for all adults living in your household.

- ❍ $0-9,999
- ❍ $10,000-19,999
- ❍ $20,000-29,999
- ❍ $30,000-39,999
- ❍ $40,000-49,999
- ❍ $50,000-59,999
- ❍ $60,000-69,999
- ❍ $70,000-79,999
- ❍ $80,000-89,999
- ❍ $90,000-99,999
- ❍ $100,000-119,999
- ❍ $120,000-139,999
- ❍ $140,000-159,999
- ❍ $160,000-179,999
- ❍ $180,000-199,999
- ❍ $200,000-250,000
- ❍ >$250,000

12. What is the highest degree or level of schooling you have completed?

- ❍ 8th grade or lower
- ❍ Some high school, no diploma
- ❍ High school graduate, diploma or the equivalent
- ❍ Some college credit, no degree
- ❍ Trade/vocational/technical training
- ❍ Associate's degree
- ❍ Bachelor's degree
- ❍ Master's degree (e.g. MA, MS, MBA, MFA, MPA, MPH)
- ❍ Professional degree (e.g. JD, MD, DMD, DDS, DVM)
- ❍ Doctoral degree (e.g. PhD, EdD)
- ❍ Prefer not to answer.

Section C: Housing characteristics

13. How many stories are in the building where you live?

- ❍ One-story
- ❍ Two-story
- ❍ Three-story
- ❍ Four-story
- ❍ Five-story
- ❍ More than five stories

14. How many bedrooms are in your unit?

- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5
- ❍ 6 +

15. How much do you pay in rent each month?
    a. $_____
16. Do you currently have renter's insurance?
    a. Yes
    b. No
    c. I don't know

Section D: Damage/loss experiences

17. Have you experienced wind-related damages (housing structure and content) in the past?

- ❍ Yes
- ❍ No

18. What level of damage do you expect your building to sustain if hit by a category 3 hurricane or tornado (wind speed 111-129 mph)?

- ❍ No damage
- ❍ Partial damage to Roof
- ❍ Partial damage to Roof, windows, and doors
- ❍ Major damage to Roof
- ❍ Major damage to Roof, windows, and doors
- ❍ Completely destroy

19. Have you ever experienced an extended (more than 12 hours) power outage in your home?
    Yes

    No

20. The owner of your building could install a backup generator to provide electricity during a power outage, but the residents of your building would have to pay for the generator with increased rent. How much additional rent, if any, would you be willing to pay for an onsite backup power generator?

a. 0 % increase in rent
b. 0.5 % increase in rent
c. 1 % increase in rent
d. 1.5 % increase in rent
e. 2 % increase in rent
f. 2.5 % increase in rent
g. 3 % increase in rent
h. 3.5 % increase in rent
i. 4 % increase in rent
j. 4.5 % increase in rent
k. 5 % increase in rent

The Fortified multifamily building standard is an engineering design that protects residential buildings from hurricane and tornado damage with winds up to 130 miles per hour. This significantly reduces the chances of a building being damaged by wind. However, the rent for a Fortified multifamily building will be higher than the current amount you pay in the Non-Fortified building.

1. What is the maximum increase in your current monthly rent you are willing to pay to live in a Fortified multifamily building? [can we have Qualtrics calculate the amounts from question 15?]

❍ 0 % increase in rent
❍ 0.5 % increase in rent
❍ 1 % increase in rent
❍ 1.5 % increase in rent
❍ 2 % increase in rent
❍ 2.5 % increase in rent
❍ 3 % increase in rent
❍ 3.5 % increase in rent
❍ 4 % increase in rent
❍ 4.5 % increase in rent
❍ 5 % increase in rent

Survey Recruitment Letter:

HELP DEVELOP IMPROVED DISASTER RISK MANAGEMENT PRACTICES

The Alabama Center for Insurance Information and Research (ACIIR) at The University of Alabama is conducting a research study willingness to pay for windstorm-resilient multifamily housing. Results from the study could help lawmakers decide how to promote windstorm resistant multifamily building codes. Because adopting stronger building codes could affect the cost of rent and renters' insurance, it is important that we hear from individuals who could be impacted. In order to participate in this research, you must be:

- 18 years or older
- A renter of a multifamily home (apartment complex)
- A current resident of TX, LA, MS, AL, FL, GA, OK, AR, TN, SC, or NC

If you decide to participate in this research, please access the online survey here. The survey will take approximately 10-15 minutes to complete.

All answers you provide will be protected to the highest possible standards of privacy and confidentiality. Participation in this research is voluntary. You may refuse to participate in the survey. If you choose to participate, you may quit and exit the survey at any time without giving any reason.

At any time, you may ask to have all the information that you provide returned to you, removed from the research records, or destroyed.

For more information on the ACIIR, this research, or your participation, please contact:

Dr. Sebastain Awondo
[Contact information]

Dr. Lawrence Powell
[Contact information]