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THE EFFECT OF 2012-2021 BUILDING CODE REVISIONS ON BREAK-EVEN RENTS OF 3-STORY APARTMENTS

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Abstract:

130 revisions to building codes affecting new multifamily housing developments were approved by the International Code Council between 2012-2021. We determine that 36 of these revisions at least marginally increased the cost of development with enhancement in fire suppression and safety (72%) being the most common stated motivation of revisions over this period. We estimate these revisions increased the national average of upfront construction cost of a 32,790 square 3-story exterior entry apartment by 12.4% holding prices and labor productivity constant at 2024 levels. This translates to an additional $169-to-$279 in monthly break-even rents of a 2-bedroom apartment in new developments taking into account local land, capital, and operational costs across the most populous city in each state.

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I. Introduction

There is a growing lack of safe, suitable, and affordable housing in all American communities. A growing body of evidence has identified zoning, parking minimums and other land-use restrictions as important factors explaining declines in affordability. However, the role of building codes as a land-use restriction that in turn limits what is legally permissible to build and occupy is poorly understood. The purpose of this research is to measure how recent revisions to multifamily building codes impact the break-even rent of new rental housing developments.

The United States Constitution gives power to state and local governments to establish building codes and standards to maintain the health, safety, and welfare within their jurisdictions (Berman, 2019). The first International Building Code (IBC) was established by the non-profit International Code Council (ICC) in 2000 as a standard for residential structures with more than 2 units, and has been subsequently revised every 3 years starting in 2003 (i.e., 2003, 2006, … , 2018, 2021).[2] Although the ICC has no actual legal authority, the IBC serves as a base code adopted within 44 of 50 states regulating what is legally permitted to be constructed and eventually occupied, although often with amendments and considerable lag when new revisions are released according to the ICC (2023). Revisions to building codes pertain to not only structural stability and fire survivability, but also regulate minimum allowable quality of services including energy efficiency, noise, air quality, and economic durability (Muzio et al., 2023).

A 2022 survey of developers conducted by the National Association of Home Builders and the National Multifamily Housing Council suggested that "regulation" increased the cost of multifamily housing by 40.6%, although the specific role of building codes remain unclear (Emrath and Walter, 2022). While the ICC requires proponents of code revisions to provide an estimated impact on construction costs, the ranges are those estimates usually lack both rigor and saliency for the end user (Hamilton, 2025). Several reasons underpin why we do not know more about how adopted IBC revisions impact housing affordability. One of the many challenges in providing meaningful cost estimates is how they potentially impact different densities and typologies of multifamily housing (e.g., garden, midrise, podium, tower, etc.). Home Innovation Research Labs

[2] The International Residential Code (IRC) was also established by the ICC and pertains to structures with 2 or less residential units.

(HIRL) illustrated this variation by estimating the cost of switching from the 2015-to-2018 IBC ranged from $2,500 to $384,724 across 5 reference building types (HIRL, 2018). Even if costs impacts were consistently identified, how they ultimately impacted rents paid by tenants after taking into account land, financing, and other costs to our knowledge has not been previously estimated.

In this study, we provide estimates how the revisions adopted within the 2012-2021 IBC impacted break-even rents of a 32,790 square foot 3-story exterior entry apartment building. These estimates were created after first specifying necessary materials and labor to construct a prototype building based on 2009 IBC standards, which was then entered into R.S. Means Online to recover associated prices of each component in 2024 and labor productivity. We then classified adopted revisions from 2012-2021 to the IBC impacting multifamily, and identified those as impacting the specified building as either cost-neutral or cost-increasing, and the resulting differences in materials and labor required as a result of the change.[3] Break-even rents (BER) incorporating the pre-/post-revisions were then recovered using the two construction costs plus additional information on land and financing costs using the methods and assumptions outlined by Eriksen and Orlando (2024).

There were 130 identified significant revisions to IBC from 2012-2021 affecting multifamily housing with 36 of them determined to at least marginally increased the cost of development. We estimate these revisions increased the national average of upfront construction cost of a 32,790 square 3-story exterior entry apartment by 12.4% holding prices and labor productivity constant at 2024 levels over this period. Improvements in fire suppression were the most common intended benefit of revision, and accounted for 72% of dollar-weighted cost increases.

Significant variation in the cost of adopting revised building code standards existed across the most populous cities in each state depending on the share of land acquisition and income capitalization rates. These regional increases translated to an additional $169-to-$279 increase in monthly break-even rents of 2-bedroom units in new developments with the highest (12.30%) percentage increase in Huntsville, AL and the lowest in Honolulu, HI (6.9%). These increases

[3] We purposely exclude costs of complying with revised energy efficiency standards given the difficult to identify future returns due to uncertain energy costs and other potential externalities. Interested readers about these potential returns from adopted energy efficiency standards are encouraged to reader the 2015 report by the Pacific Northwest Energy Labs.

translate to the median renter household in 2024 being required to spend up to an additional 2.9-7.4 percentage points (pp) of their income as a result of the revisions.

II. Background on Building Codes in the United States

United States Constitution gives power to state and local governments to self-govern health, safety, and welfare of their residents rooted in the Tenth Amendment's power clause while adopting regulations to local needs (Strom, 2024; Berman, 2019). This broad power, known as "police power", grant State governments the ability to enact laws and regulations that promote public welfare, including those related to public health, building safety, zoning, and environmental protection (Perdue et al., 2003). Building codes and zoning regulations and ordinances provide guidelines for safe practices in the design and construction stages of the built environment, which ensure safety in use and occupancy stages (Ching & Winkel, 2021).

At the local level, municipalities and counties derive their regulatory authority from state law and the extent of their power depends on whether they operate under Dillon's Rule or Home Rule (Richardson, 2011). Under Dillon's Rule, local governments have only the authority explicitly granted to them by the state legislature, which limits their ability to enact independent regulations. In contrast, under Home Rule, local governments possess broader autonomy to regulate local matters as long as their policies do not conflict with state or federal laws. This distinction significantly impacts how cities and counties enforce building codes, zoning ordinances, and public safety regulations (Russell & Bostrom, 2016; Barron, 2003).

Despite the broad powers of state and local governments, their regulations must still comply with constitutional protections and federal laws. The Supremacy Clause of the United States Constitution establishes that federal law takes precedence over conflicting state or local regulations. As a result, federal statutes such as the Americans with Disabilities Act (ADA), the Clean Air Act, and the Fair Housing Act impose minimum requirements that state and local governments must follow.

In the United States, building codes provide minimum requirements that ensure health and safety for various aspects of building design and construction, including structural, mechanical, electrical,

and plumbing systems, occupancy rules, and energy conservation. These codes are primarily established and enforced by state and local governments, leading to variations across jurisdictions (NIST, 2022). To promote uniformity, the International Code Council (ICC) developed the International Building Code (IBC), which serves as a model code. The ICC was founded in 1994 as a non-profit organization with the intention of creating a single national model code by reconciling disparate regional codes. Building codes in the United States started as a response to urban fires that caused loss of life and property, with Chicago developing one of the country's first building codes after its 1871 fires (Hamilton, 2024).

Many jurisdictions in the United States adopt the IBC either in its entirety or with modifications to align with local requirements (IBC, 2025). Building codes are essential for ensuring public health and safety, as they regulate the standards to prevent potential hazards while governing the design and installation of materials and methods. (IBC, 2025). Building codes in the United States continually evolve with updates every three years with code development committees (CRS, 2023). These updates are driven by advancements in technology, emerging safety concerns, and the need to address environmental challenges. Specifically for residential buildings such as single-family homes, multi-family homes, two-family dwellings, townhouse (low-rise residential buildings with a limit of three stories above grade level), the International Residential Code (IRC) is enforced. Residential building codes have various effects on the housing market and rents, influencing housing prices, rental rates, and the health and economic well-being of residents (HIRL, 2024; Bartram, 2019; Hammitt, Belsky, Levy, & Graham, 1999).

Building Code Revisions

The ICC is responsible for developing and updating the codes through a consensus-based process that involves multiple stakeholders, including building officials, industry professionals, engineers, architects, and the public. The revision process follows a three-year cycle, including (i) submission of a proposal to modify codes by a stakeholder, (ii) code development and committee action hearings, (iii) public comment and public committee hearings, (iv) governmental consensus by building and fire code officials, and (v) the final publication of code with the reference of the year it is published such as 2018 IBC, 2021 IBC (Bartlett, 2003).

The revision proposals are reviewed and analyzed by the relevant technical committees, who evaluate each submission to ensure that the proposed changes align with modern construction practices, technological advancements, and public safety requirements (Meacham, 2010). Following submission, the code development and committee action hearings take place, during which ICC committees, composed of experts in various fields, evaluate the proposed changes. These hearings provide an opportunity for technical discussions, debate, and initial voting on proposed modifications. After the committee hearings, the process moves into the public comment phase, where interested parties can review, critique, and submit additional feedback on the proposed changes. The public comment hearings allow for further deliberation, where committee members and governmental representatives assess the feedback and make necessary revisions before the final approval process. The final stage of the process involves the governmental consensus, where building and fire code officials come together to reach a unified decision on the proposed changes.

The intent of the consensus-driven approach is that the International Building Code remains a comprehensive and balanced document that serves the needs of the industry and the public (IBC, 2025; Barnett, 2012). Individuals submitting suggested revisions are asked to provide an brief summary of how the change may affect underlying cost, although these estimates are rarely more than a couple of sentences describing differences in required components or practices but never an actual dollar figure.

Growing Divide/Division Among States in Revision Approvals

The adoption and enforcement of building codes across the United States exhibit significant variation, leading to a growing divide among states. This disparity stems from differences in legislative approaches, local autonomy, and responsiveness to emerging challenges in that particular state (Go, 2016). The variability in building codes across states and localities often results in increased construction costs. For instance, building a house in a state or city that enforces stricter regulations, such as additional safety or fire measures, will likely increase the overall cost of construction (HIRL, 2024). This can lead to higher housing prices as these costs are passed onto homebuyers. Moreover, these differences can create inefficiencies in construction that impact the

speed and schedule of the construction process, contributing to affordable housing and housing shortages (Listokin & Hattis, 2005). On the other hand, less stringent codes can lead to long-term affordability challenges if properties become vulnerable to damage from natural disasters. This, in turn, may result in higher maintenance costs and insurance premiums, which can further strain household budgets.

III. IBC Revisions Impacting Multifamily Housing

In this section a method is developed and impact to estimate the impact of IBC Revisions on Multifamily Housing. The method is composed of the four key steps presented below and further explained in the following subsections: (a) define the total number of code revision to be considered; (b) classify the revisions by potential benefits; (c) classify the revisions per cost-neutral or cost increasing, and (d) breakdown of required changes in materials/labor in order to comply.

This project examines adopted revisions to the International Building Code (IBC) pertaining affecting multifamily housing development and occupancy. The first comprehensive IBC was released in 2000, but this analysis focuses on what ICC classifies as significant revisions in 2012, 2015, 2018, and 2012 with 2009 considered the base year. The decision to focus on this period stems from R.S. Means Online providing historical estimates starting 2007, although could be extended further back at at least 2000 using R.S. Means handbooks. During this period, household rents outpaced income growth in 47 of the 50 most populous U.S. cities between in the last 20 years (Eriksen, 2021).

The ICC releases a publication labeled “Significant Changes to the International Building Code” along with each vintage of revised codes. This publication lists for each adopted revision “Change Type,” “Change Summary,” “2012 Code,” and “Change Significance.” The publication does not always indicate affected typologies of building, so the authors identified 130 revisions directly affected multifamily housing development, not including energy usage, from 2012-2021.

Figure 1 illustrates these adopted significant revisions by vintage and whether they were also determined to increase costs of development. This determination whether they adopted revisions increased development was reached based upon authors consultation with a cost estimation expert with 35 years of industry experience and advisory board of multifamily housing developers. The most significant revisions affecting multifamily housing were adopted in 2012 with 40, with 9 determined to be cost increasing. The fewest were adopted in 2021 although 11 of the 23 were determined to be cost increasing. 29 revisions were adopted in 2015, but had the fewest determined to determined to be cost increasing with 2. The most cost increasing revisions were 2018 with 14 out of the 38 revisions.

The adopted revisions determined to increase development cost of multifamily housing have been classified by 7 intended categories of benefits. Those categories are: (1) structural safety - the set of conditions related to the ability of building systems to withstand expected loads and stresses without risk of collapse or harm to users; (2) safety in evacuation - the set of conditions that ensure occupants can safely and efficiently evacuate a building during emergencies, minimizing risks to life and injuries; (3) fire suppression - the set of conditions related to fire prevention and the protection of users in case of fire outbreak; (4) hazard protection - the set of conditions related to the protection of users in case of natural or mane-made hazards; (5) safety in use - the set of conditions related to the safety of users during the normal operation of the building system; (6) well-being - the set of conditions related to the states of the building system suitable for the life, health, and activities of its users; and (7) aesthetics - the set of conditions related to the perceptual enjoyment of the building system by its users. We determined an 8th category of intended benefits associated with energy usage and the environment outside the scope of this study.

Figure 2 illustrates a comparison of these adopted revisions. The chart of the left illustrates classified benefit to all 130 significant revisions with the chart of the left pertaining towards only those determined to be cost increasing. Fire protection or suppression was determined to have the most associated revisions 53 revisions and represent 21 of the 46 determined to be cost increasing. Revisions associated with structural safety were the next highest intended benefit with 28 total and 7 determined to be cost increasing. Evacuation safety during emergencies, safety in use during normal operations, and that pertaining to well-being each have 5 adopted revisions determined to be cost increasing.

IV. Estimated Cost Impact for 3-story Multifamily Building

The relevant cost impacts of adopted revisions is not possible to determine without first defining the specific parameters and components of the affected building. The adopted building design for is based on a provided schematic plan for an actual 3-story building with exterior entry provided to the authors. This building consisted of 32,790 square feet and composed of one-, two-, and three-bedroom units and typically classified as a garden-style apartment and the most economical to construct. It is approximately 43 feet tall with a sloped roof and did not have a basement. Based on expert review this building also determined met basic requirements to satisfy the 2009 IBC, including wet pipe sprinkler systems to suppress fires. Last, it was assumed the structure was not located within high-risk flood, wind, and seismic hazard zones. Figure 3 illustrates the layout of the building by floor and Table 1 lists further parameters of the building.

The specific components of the above specified building were entered into RS Means Online to determine associated costs and estimated labor hours to install based on 2024 prices and productivity levels. The 49 specific components of the above specified are listed in the appendix. Those labor hours were assumed to be of non-union employees paid what R.S. Means determined to be local wages for each trade.

The top panel of Figure 4 illustrates the estimated baseline cost to construct this prototype multifamily building on a per square foot basis in the most populous state in each state according to the 2024 US Census. In addition to structure costs directly recovered for RS Means, these estimated costs also include general contractor overhead fees of 10%, and an additional 25% for design, engineering, legal, insurance, and construction interest typically classified as "soft" costs of development. Last, these cost are inclusive of surface parking assuming 1 space per units as minimally required by municipalities in all but the densest urban cores.

The national average cost of the prototype building per 2009 IBC vintage standards in 2024 dollars and labor productivity is estimated to be $5,379,979, or $164.07 per square foot. This ranges from a low of $137.39 per square foot in Little Rock, AR to a high of $209.54 per square foot in New York, NY.

Increase in Construction Cost Due to Significant Revisions

22 of the 36 cost increasing revisions affecting multifamily housing were determined to affect the 3-story structure. Most notably absent were avoided high-cost revisions given the absence of interior hallways and exterior balconies as these revisions. The top panel of Figure 5 illustrates a break-down of these revisions based on the same 7 categories used in Figure 2. Over half of the cost increasing revisions (12 out of 22) were due to fire suppression, 5 were evacuation safety, 2 each were Safety in Use and Well-Being, and 1 due to improvements in structural safety. No revisions motivated by improved hazard protection, aesthetics, and environment affected the prototype.

These costs were determined based on consultation with cost valuation expert about incremental components and type of labor required due to the revision. When possible costs of incremental components were identified at the local level using R.S. Means Online, or else the valuation expert assumed to represent the national average, which was then weighted by R.S. regional cost index for each city. Based on national averages and previously mentioned cost overheads, these incremental costs were estimated to be $495,863, or $15.12 per square foot, for the prototype multifamily building. Table 2 lists the 5 most expensive required revisions.

The bottom panel of Figure 5 breaks these costs by intended benefit. The 12 revisions motivated by fire suppression increased costs by $7.26 per square foot and represented 72% of the cost increase. The revisions motivated by evacuation safety increased cost by $1.51 per square foot and represented 15% of the cost increases. The three other categories of revisions amounted to less than $1 in incremental cost per square foot.

V. Impact on Break-Even Rents

Eriksen and Orlando (2024) develop a model to calculate the break-even rents of new housing developments taking into the 3-input factors of construction, land acquisition, and capital costs. We adopt their model and base assumptions with updated data on land and capital costs. The cost of 1-acre of residential land obtained by US Federal Housing Finance Agency (FHFA) and last

updated in 2022. Stabilized income capitalization (cap) rates of Class B urban infill apartments for last half of 2024 was provided by CBRE.[4] Identical assumptions regarding vacancy and operational expenses by Eriksen and Orlando (2024) to transform gross to net operating income were also adopted.[5] CBRE estimates stabilized income capitalization rates of urban infall Class B multifamily were 5.6% in 2024. The national average of urban residential land located in CBSA was estimated to be $974,900 per acre in 2022.

Our national average baseline estimate of break-even rent before proposed code revisions for the 32,790 square foot structure is $19.24 annually per square foot in 2024 prices and labor productivity. The square footages per apartment outlined in Table 2 were 873 square feet for a 1-bedroom apartment, 1,157 for a 2-bedroom, and 1,477 for a 3-bedroom apartment. The above estimated pre-revision break-even rent translates to $22,261 per year, or $1,855 per month, for a 2-bedroom apartment in our prototype building.

We calculate the national average break-even rents increased to $21.28 per square foot following 2012-2021 code revisions. This translates to an additional $2.04 psf, or a 9.6% increase, for a 2-bedroom unit holding all other assumptions constant. Although this may seem relatively modest, it translates to an additional $2,360 annually, or $197 per month, in break-even rent potentially collected from tenants depending on incidence only due to these revisions. It also translates to the average renter in the United States in 2024 contributing an additional 4.3% of their annual income towards rent if costs of revisions are fully capitalized.[6]

Regional Increases in BER

Significant variation in changes in break-even rents pre-/post-code revisions occurred across the largest city in each state based on local development input factors. The average price per 1-acre of residential land was reported to cost a high of $4,952,600 in Honolulu, HI to a low of $61,300

[4] The income capitalization rates used from CBRE are the upper limit of the range for the last half of 2024 with the median of tertiary cities in respective regions used when city estimates unavailable.

[5] Those additional assumptions to translate from gross to net operating income are 5% vacancy and operating expenses equal to 44% of effective gross income. See Eriksen and Orlando (2024) for additional details.

[6] The average renter in 2024 was estimated by the US Census Bureau to earn $54,712 annually.

in Jackson, MS. The income capitalization rates similarly varied with a reported low of 5.5% in in 5 cities (Phoenix, Salt Lake City, Charlotte, Las Vegas, and Washington DC) to a high of 7.5% in Detroit, MI. Break-even rents are positively related with land prices and capitalization rates (i.e., more expensive land and higher capitalization rates mean larger break-even rents holding construction costs fixed), but land prices and capitalization are negatively correlated with each other (i.e., capitalization rates are generally lower in cities with more expensive land). Although soft costs, vacancy and operational expenses also vary across cities, they assumed fixed to focus the analysis on the 3 stated factors.

The bottom panel of Figure 4 illustrates pre-2012 IBC break-even rents. These rents ranged from $14.92 psf in Charlotte, NC to $40.12 in Los Angeles, CA, with a median of $18.46 in Charleston, SC. The top panel of Figure 6 illustrates post-revision break-even rents as a percentage above the 2009 vintage standard across the most populous city in each state. Those increases on average increased break-even rents 11.21% with a median increase of 11.69%. The largest percentage increase is estimated to occur in Huntsville, AL with a 12.34% increase due to relatively low land prices and among the highest income capitalization rates across the cities. The lowest percentage increase pre-/post-code revisions were in Honolulu, HI (6.96%) and Los Angeles, CA (7.22%). These increases result in the average renter household in 2024 paying an additional $168.83 to $279.40 per month in rent due only to these revisions.

The bottom panel of Figure 6 illustrates the percentage point increase in 2024 median renter household income necessary to pay for the cost of IBC revisions over this period. These increases this translates to an additional 2.9 percentage point (pp) increase in Washington, DC to 7.4pp increase in Charleston, WV in share of income devoted towards rent.

VI. Conclusion

This research has provided the first estimates of how recent revisions to building code impact break-even rents of new multifamily housing development. Earlier research has mostly focused on how land-use regulations impact single-family construction costs. We first extend that literature by specifying required components of 3-story apartment pre- and post-adopted-revisions

to the IBC from 2012-2021 to find that construction costs increased on average 12.44% as a directly result of those additional requirements based on 2024 prices and labor productivity. We then use associated land acquisition cost and income capitalization of investors to find those differences translate to an additional 10.6% increase in break-even rents, or $197 per month for a 1,157 square foot 2-bedroom apartment if fully capitalized. Based on median income of households who rent in 2024, this means that renters occupying those units could be required to contribute an additional 4.3pp of their income towards rent on average. Significant variation exists across states, with the largest increases in non-coastal areas with inexpensive land and relatively high-income capitalization rates of equity investors.

We find the majority of the revisions weighted by cost over this period were motivated by increased fire suppression (72%) with the next highest evacuation safety (15%). Real or perceived benefits of these revised standard by tenants relative to costs are outside the scope of this study, although important to recognize building codes would not be required if developers felt tenant would be willing to voluntarily pay for such revisions Similarly, this study has purposely excluded revisions motivated due to reduced energy usage and other perceived environmental benefits due to uncertain future internal and external benefits.

An important caveat is that not all states and municipalities having local jurisdiction have fully adopted the latest IBC vintage and associated revisions. Some states (i.e., Maryland) adopt latest IBC vintages with few amendments quickly after published by the ICC whereas other states (i.e., Indiana) lag over a decade behind in adoption with significant amendments. Last, it is important to recognize that the incidence of increased development costs as a result of these mandated revisions are unclear, and could alternatively result in lower than otherwise land prices or reduced profits of developers. Future research is the above areas is needed.

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Figure 1 – Significant Revisions to International Building Code (IBC) Affecting Multifamily Housing Development, by Year and Cost Category

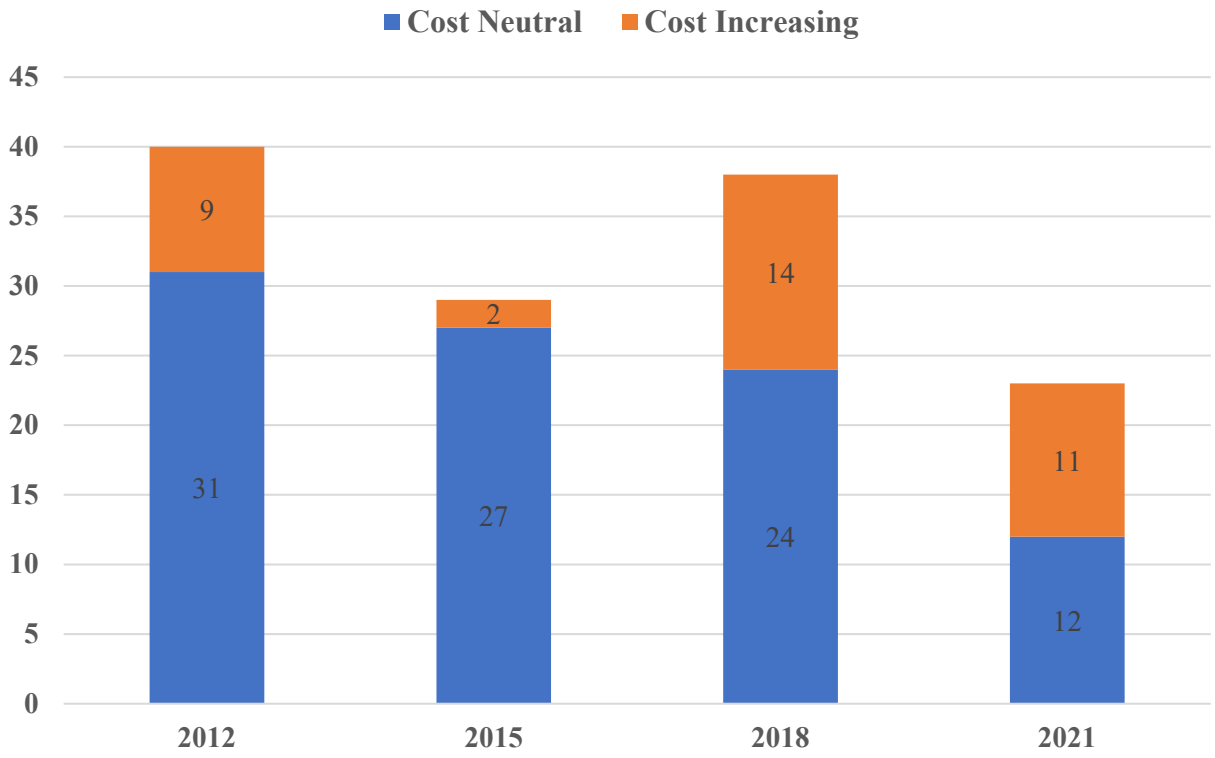


Figure 2 – Intended Benefit of the Significant Revisions to the International Building Code (IBC) from 2012-2021 Affecting Multifamily Housing Development.

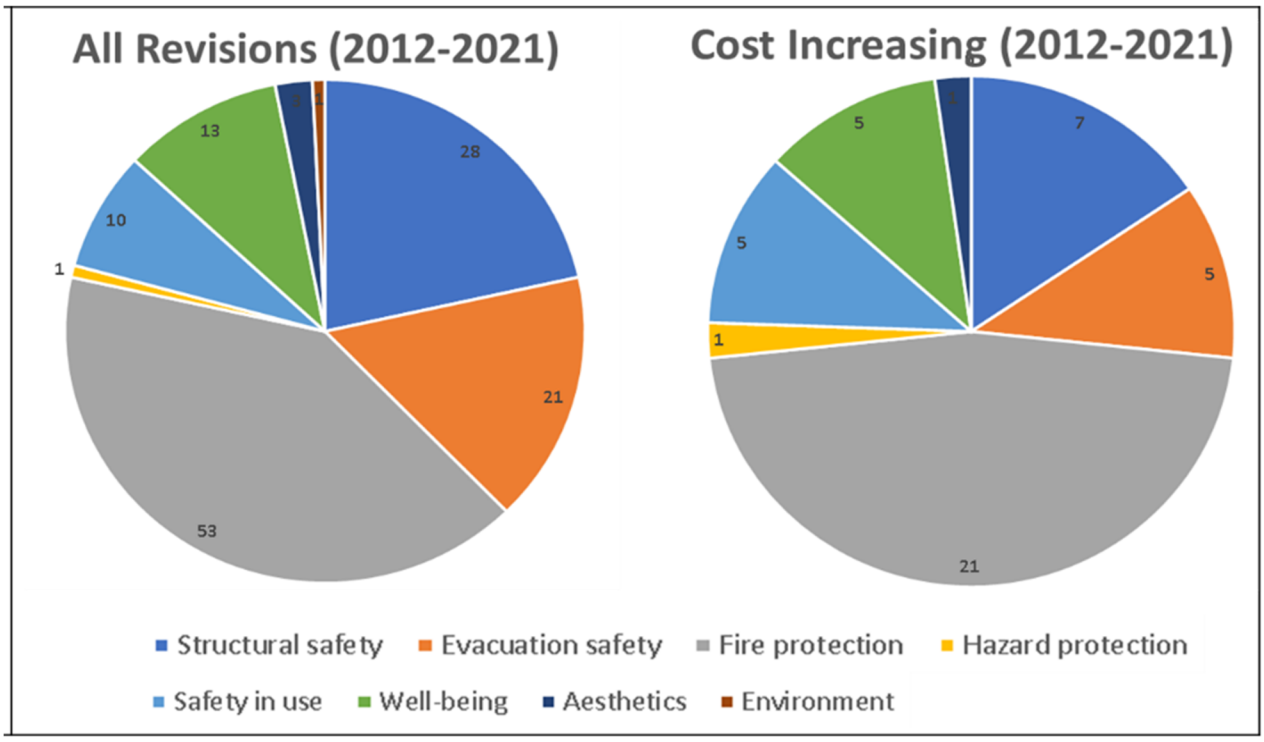


Figure 3 - The layout of a 32,790 square foot 3-story multifamily building with color code representation of the one-bedroom apartments (blue), two-bedroom apartments (yellow), three-bedroom apartments (green). The five niches outside of the entrance doors represent the staircases.

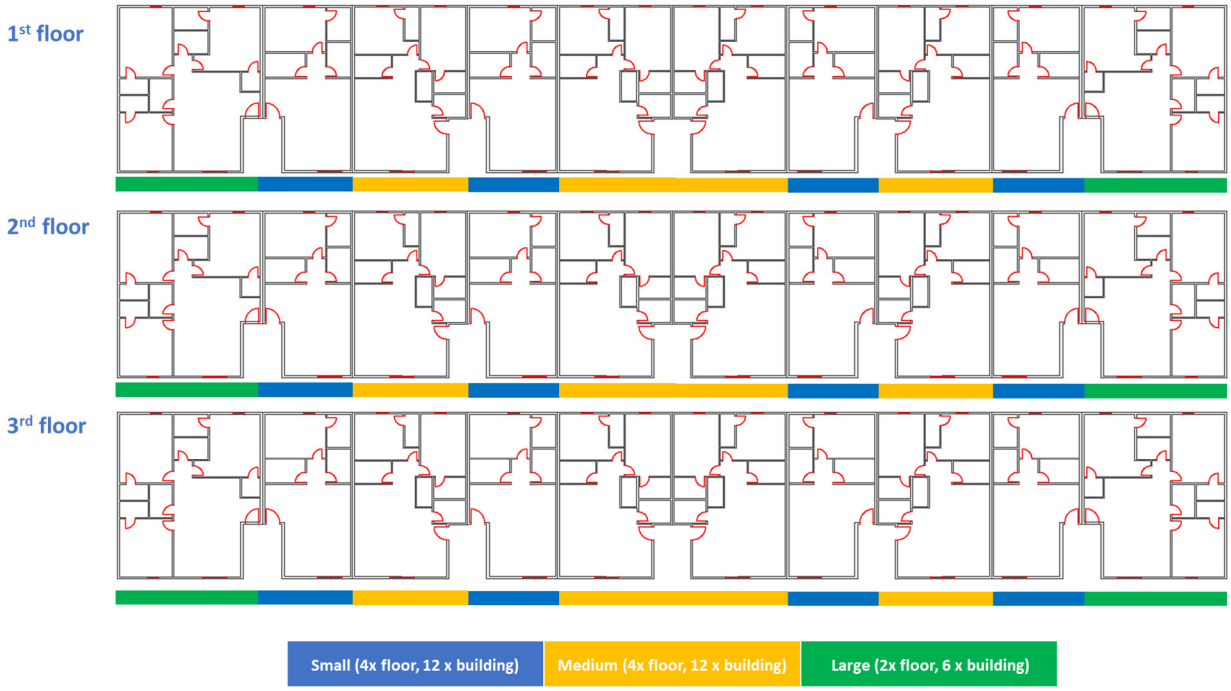
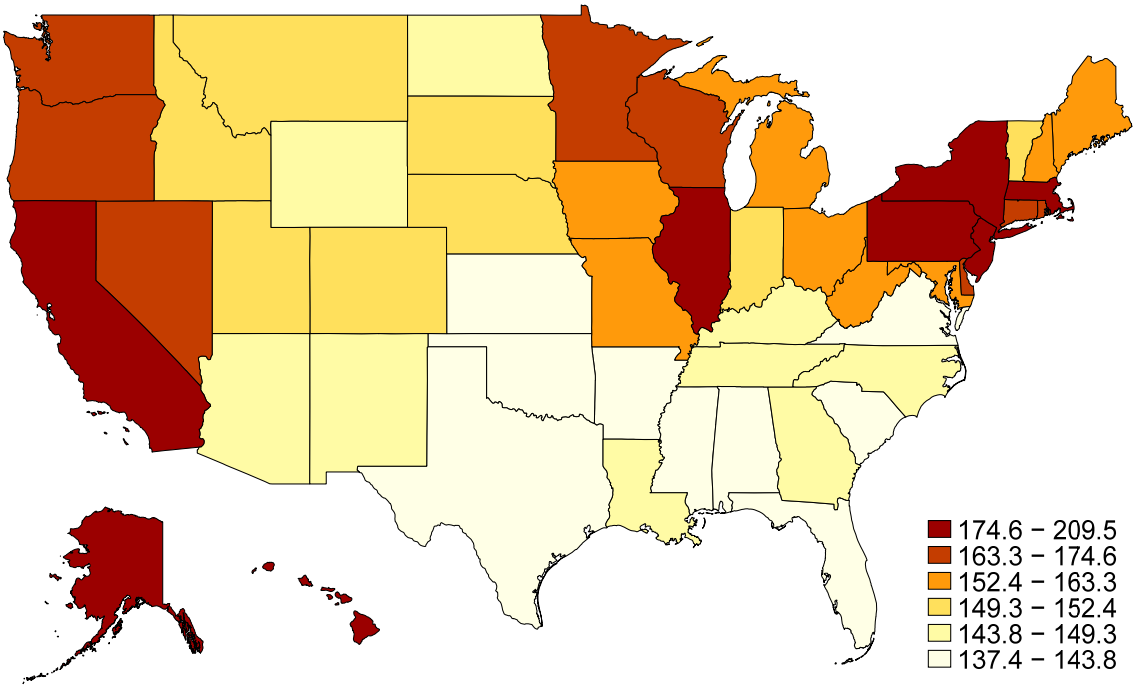


Figure 4 - Construction Costs and Break-Even Rents per Square Foot of Prototype 3-story Apartment with 32,790 square feet across most populous city in each US state based on 2009 IBC standards with 2024 prices and productivity.

Panel A. Construction Costs Per Square Foot



Panel B. Break-Even Rents Per Square Foot with Land Acquisition and Investor Cap Rates

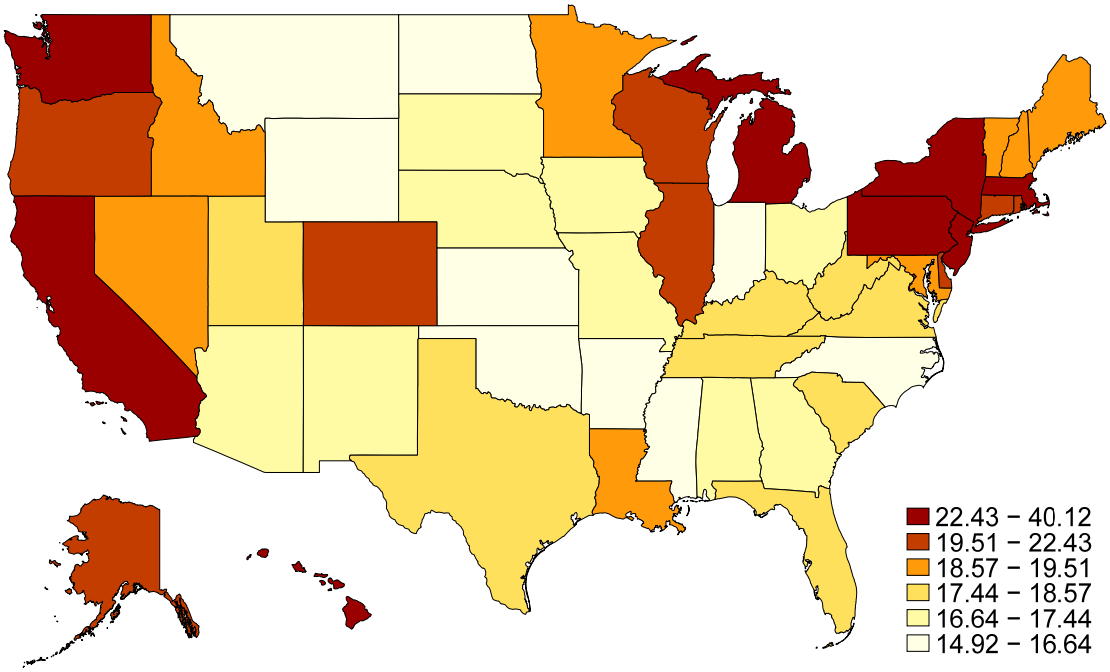
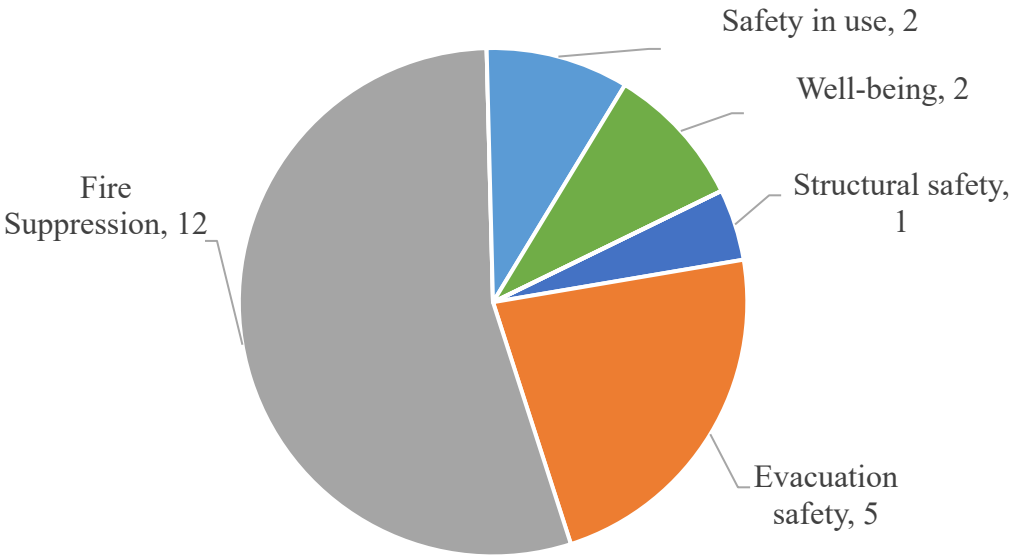


Figure 5. – Intended Benefit of the 22 Cost Increasing Significant Revisions to the International Building Code (IBC) from 2012-2021 Affecting Multifamily Housing Development

Panel A. Cost Increasing Revisions by Benefit



Panel B. Cost Increasing Revisions by Dollar per Square Foot Based on National Average

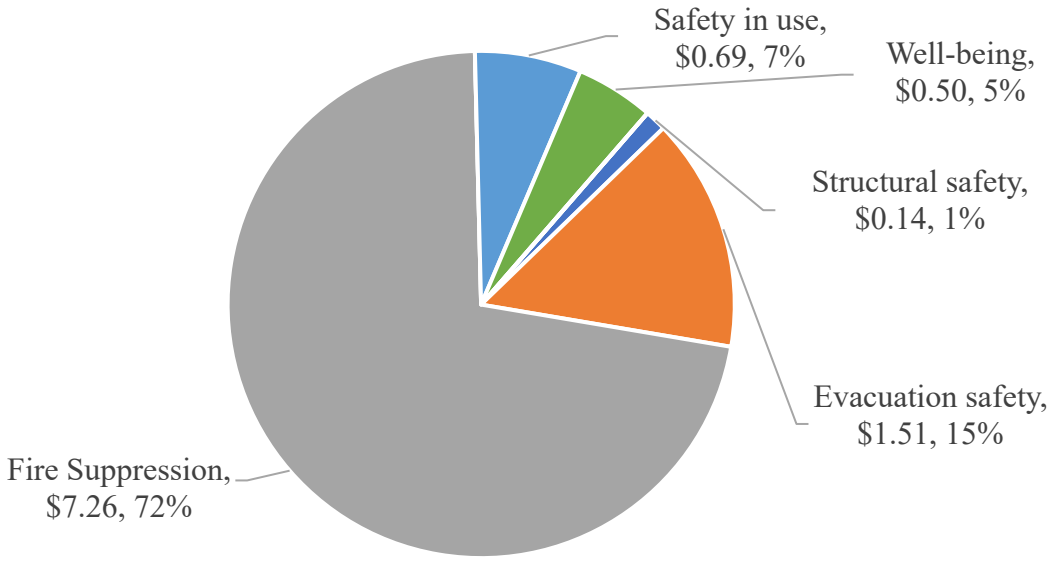
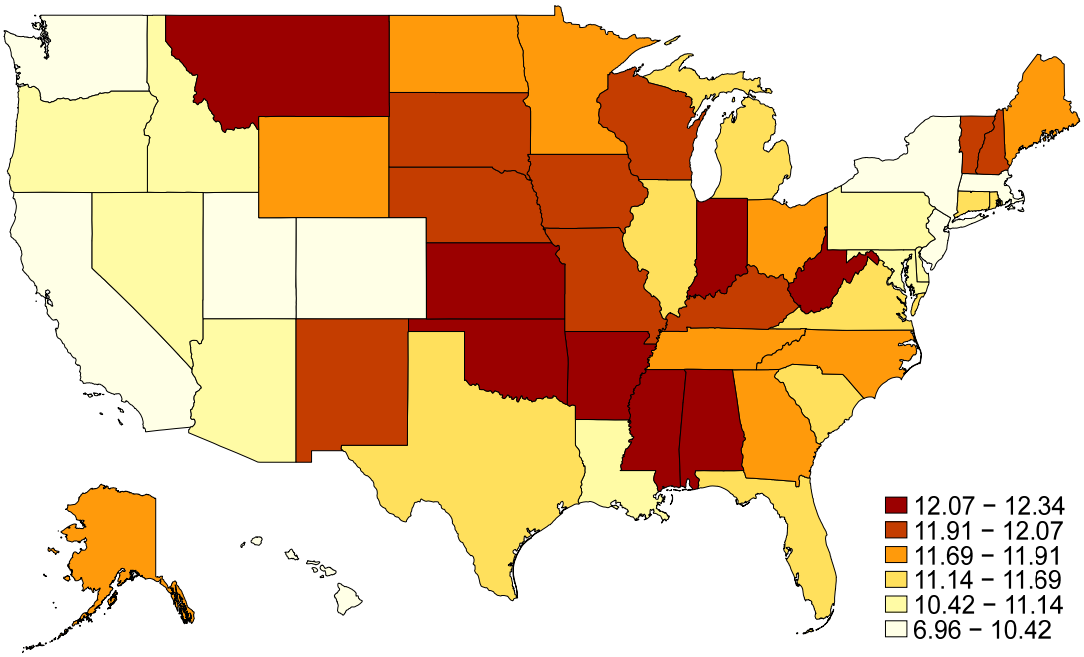


Figure 6 –Increase in Break-Event Rents (BER) per square foot from 2012-2021 Building Code Revisions in the most populous city in each of the 50 largest US States for a 32,705 square foot 3-story multifamily building using 2024 development input prices.

Panel A. Percentage Increase Based on 2009 IBC Vintage



Panel B. Percentage Point Increase of 2024 Median Renter Income Devoted Towards Rent

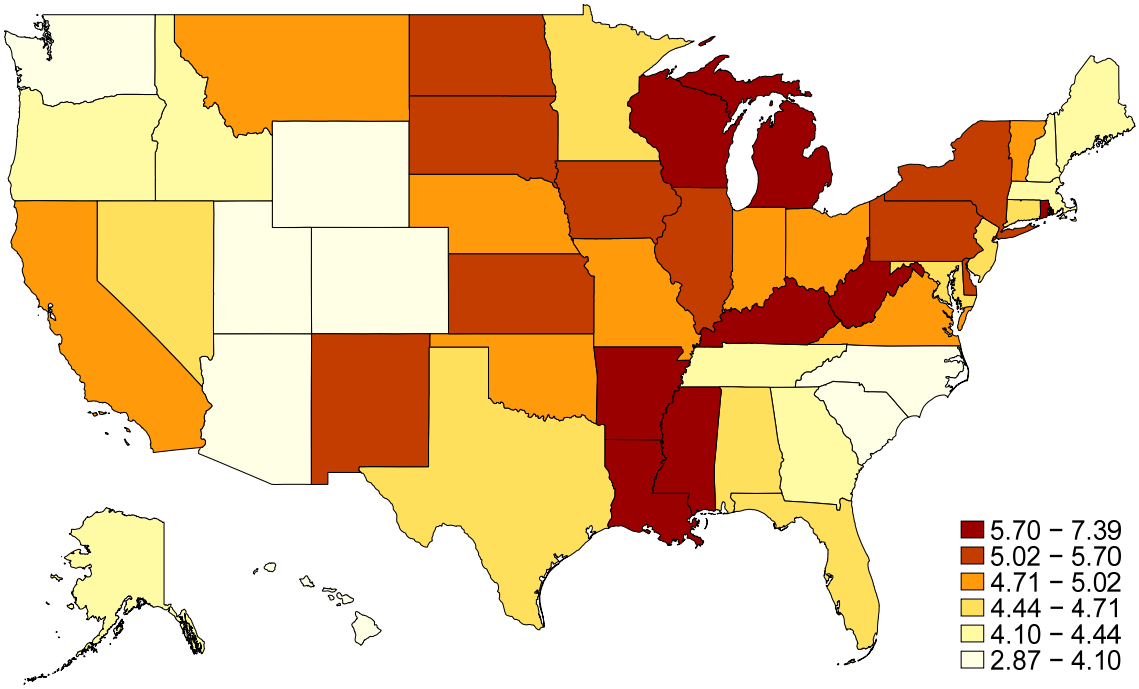


Table 1 – Summary of the building's key characteristics and dimensions

Elements	Small (4x floor, 12 x building)			Medium (4x floor, 12 x building)			Large (2x floor, 6 x building)			TOTAL	
	Per flat	Per floor	Per building	Per flat	Per floor	Per building	Per flat	Per floor	Per building	Total Per floor	Per building
Surface [sq. ft.]	837.20	3,348.78	10,046.34	1,156.73	4,626.90	13,880.70	1,477.19	2,954.37	8,863.11	10,930.05	32,790.15
External doors [u]	1	4	12	1	4	12	1	2	6	10	30
Internal doors [u]	6	24	72	6	24	72	9	18	54	66	198
Windows [u]	2	8	24	2	8	24	5	10	30	26	78
Cabinets [u]	2	8	24	2	8	24	3	6	18	22	66
Laundry [u]	1	4	12	1	4	12	1	2	6	10	30
Bathrooms [u]	2	8	24	2	8	24	2	4	12	20	60
Internal walls [ft.]	407.2	1628.8	4886.4	558.11	2232.44	6697.32	700.95	1401.9	4205.7	5263.14	15789.42
External walls [ft.]	375.55	1502.2	4506.6	411.4	1645.6	4936.8	721.94	1443.88	4331.64	4591.68	13775.04
Roof and foundations [sq. ft.]											3538.6032
Plumbing and cables [ft.]											43047
Roof drain, 10' high [ft.]											88.58
Roof drain, each add foot [ft.]											512.93
Feeder installation [u]											180
Carpet [sq. ft.]	73.63	294.52	883.56	129.02	516.08	1548.24	231.9	927.6	2782.8	1738.2	5214.6
Vinyl [sq. ft.]	744.65	2978.6	8935.8	1028.6	4114.4	12343.2	1213.74	4854.96	14564.88	11947.96	35843.88
Tile [sq. ft.]	10.9	43.6	130.8	33.33	133.32	399.96	31.65	126.6	379.8	303.52	910.56
Tile on walls [sq. ft.]	115.39	461.56	1384.68	106.78	427.12	1281.36	169.1	676.4	2029.2	1565.08	4695.24
Columns [u]	6	24	72	8	32	96	9	36	108	92	276

Table 2 – Top 5 Increases in Cost of International Building Code (IBC) revisions between 2012-2021 affecting 3-story Multifamily housing with an Exterior Entry Prototype

IBC	Cost	Motivation	Revision
2012	50,000	Fire Protection	An automatic secondary on-site water supply having a capacity not less than the hydraulically calculated sprinkler demand, including the hose stream requirement, shall be provided for high-rise buildings assigned to Seismic Design Category C, D, E or F as determined by the International Building Code . An additional fire pump shall not be required for the secondary water supply unless needed to provide the minimum design intake pressure at the suction side of the fire pump supplying the automatic sprinkler system . The secondary water supply shall have a duration of not less than 30 minutes as determined by the occupancy hazard classification in accordance with NFPA 13 .
2018	50,000	Fire Protection	Fire watch during combustible construction. Where required by the fire code official, a fire watch shall be provided during nonworking hours for construction that exceeds 40 feet (12 192 mm) in height above the lowest adjacent grade
2021	45,000	Fire Protection	[BF] CEILING RADIATION DAMPER. A listed device installed in a ceiling membrane of a fire-resistance-rated floor/ceiling or roof/ceiling assembly to limit automatically the radiative heat transfer through an air inlet/outlet opening. Ceiling radiation dampers include air terminal units, ceiling dampers and ceiling air diffusers. Ceiling radiation dampers are classified for use in either static systems that will automatically shut down in the event of a fire, or in dynamic systems that continue to operate during a fire. A dynamic ceiling radiation damper is tested and rated for closure under elevated temperature airflow.
2012	25,080	Fire Protection	Fire-protection-rated glazing in excess of 100 square inches (0.065 m 2) is not permitted. Fire-resistance-rated glazing in excess of 100 square inches (0.065 m 2) shall be permitted in fire door assemblies when tested as components of the door assemblies, and not as glass lights, and shall have a maximum transmitted temperature rise of 450° F (250°C) in accordance with Section 716.5.5 .
2015	21,860	Evacuation	Add new text as follows:2303.1.4 Structural glued cross-laminated timber. Cross-laminated timbers shall be manufactured and identified as required in ANSI/APA PRG 320-2011.2303.1.4 Structural glued cross-laminated timber.

Appendix Table 1. Required Building Components of 32,790 Square Foot Prototype 3-story Apartment with Exterior Entry Based on 2009 International Building Code Requirements.,

Source	Qty	Line Number	Description	Frequen	Crew	Unit
Assembly	176.00	A10101051560	Foundation wall, CIP, 4' wall height, direct chute, .148 CY/LF, 7.2 PLF, 12" thick			L.F.
Assembly	176.00	A10101103100	Strip footing, concrete, reinforced, load 14.8 KLF, soil bearing capacity 6 KSF, 12" deep x			L.F.
Assembly	34.98	A10102107700	Spread footings, 3000 PSI concrete, load 200K, soil bearing capacity 6 KSF, 6' - 0" square			Ea.
Assembly	3539.00	A10301202240	Slab on grade, 4" thick, non industrial, reinforced			S.F.
Assembly	3539.00	A20101104560	Excavate and fill, 10,000 SF, 4' deep, sand, gravel, or common earth, on site storage			S.F.
Assembly	32790.00	B10102103450	Wood column, 8" x 8", 20' x 20' bay, 10' unsupported height, 133 BF/MSF, 160 PSF total a			S.F.
Assembly	21860.00	B10102643050	Wood beam and joist floor, 12"x16" girder, 8"x16" beam, 2x10 joists @ 16", 20'x20' bay,			S.F.
Assembly	276.00	B10107203750	Fireproofing, gypsum board, fire rated, 3 layer, 1.5" thick, 8" steel column, 3 hour rating,			V.L.F.
Assembly	78.00	B20201066650	Windows, aluminum, sliding, standard glass, 5' x 3'			Ea.
Assembly	30.00	B20302203500	Door, steel 18 gauge, hollow metal, 1 door with frame, no label, 3'-6" x 7'-0" opening			Opng.
Assembly	3539.00	B30101401100	Asphalt roofing, strip shingles, inorganic, Class A, 4" slope, 210-235 lbs/SQ			S.F.
Assembly	15789.42	C10101241200	Wood partition, 5/8"fire rated gypsum board face, none base,2 x 4,@ 16" OC framing,sar			S.F.
Assembly	15789.20	C10101241425	Wood partition, 5/8" fire rated gypsum board face, 1/4"sound deadening gypsum board,			S.F.
Assembly	535.00	C10101280700	Gypsum board, 1 face only, exterior sheathing, fire resistant, 5/8"			S.F.
Assembly	535.00	C10101280960	Add for the following: taping and finishing			S.F.
Assembly	66.00	C10308300115	Cabinets, residential, base, hardwood, 1 top drawer & 1 door below x 24" W			Ea.
Assembly	5.00	C20101101120	Stairs, wood, prefab box type, oak treads, wood rails 3'-6" wide, 14 risers			Flight
Assembly	24869.22	C30102300140	Painting, interior on plaster and drywall, walls & ceilings, roller work, primer & 2 coats			S.F.
Assembly	4695.24	C30102301940	Ceramic tile, thin set, 4-1/4" x 4-1/4"			S.F.
Assembly	5214.60	C30204100080	Carpet tile, nylon, fusion bonded, 18" x 18" or 24" x 24", 35 oz			S.F.
Assembly	35843.88	C30204101600	Vinyl, composition tile, maximum			S.F.
Assembly	910.56	C30204101720	Tile, ceramic natural clay			S.F.
Assembly	32790.00	C30301105400	Gypsum board ceilings, 1/2" fire rated gypsum board, painted and textured finish, 7/8"re			S.F.
Assembly	30.00	D20104101880	Kitchen sink w/trim, countertop, stainless steel, 19" x 18" single bowl			Ea.
Assembly	30.00	D20109262160	Bathroom, three fixture, 2 wall plumbing, lavatory, water closet & bathtub, stand alone			Ea.
Assembly	30.00	D20202401820	Electric water heater, commercial, 100< F rise, 50 gallon tank, 9 KW 37 GPH			Ea.
Assembly	89.00	D20402102040	Roof drain, DWV PVC, 4" diam, diam, 10' high			Ea.
Assembly	513.00	D20402102080	Roof drain, DWV PVC, 4" diam, for each additional foot add			Ea.
Assembly	32790.00	D30105101840	Apartment building heating system, fin tube radiation, forced hot water, 20,000 SF area,2			S.F.
Assembly	10820.70	D40104100600	Wet pipe sprinkler systems, steel, light hazard, 1 floor, 5000 SF			S.F.
Assembly	21969.30	D40104100720	Wet pipe sprinkler systems, steel, light hazard, each additional floor, 5000 SF			S.F.
Assembly	1.00	D50101200400	Overhead service installation, includes breakers, metering, 20' conduit & wire, 3 phase, 4			Ea.
Assembly	180.00	D50102300400	Feeder installation 600 V, including RGS conduit and XHHW wire, 800 A			L.F.
Assembly	1.00	D50102400280	Switchgear installation, incl switchboard, panels & circuit breaker, 120/208 V, 3 phase, 80			Ea.
Assembly	32790.00	D50201100520	Receptacles incl plate, box, conduit, wire, 10 per 1000 SF, 1.2 watts per SF			S.F.
Assembly	32790.00	D50201300320	Wall switches, 2.5 per 1000 SF			S.F.
Assembly	32790.00	D50201350440	Miscellaneous power, 2 watts			S.F.
Assembly	32790.00	D50201400240	Central air conditioning power, 3 watts			S.F.
Assembly	1.00	D50201450720	Motor installation, three phase, 200 V, 15 HP motor size			Ea.
Assembly	32790.00	D50202160200	Incandescent fixtures recess mounted, type A, 1 watt per SF, 8 FC, 6 fixtures per 1000 SF			S.F.
Assembly	1.00	D50309100452	Communication and alarm systems, fire detection, addressable, 25 detectors, includes ou			Ea.
Assembly	1.00	D50309100460	Fire alarm command center, addressable without voice, excl. wire & conduit			Ea.
Assembly	30.00	D50309200102	Internet wiring, 2 data/voice outlets per 1000 S.F.			M.S.F.
Assembly	30.00	E10904100135	Architectural equipment, appliances, range, 30" free standing, 1 oven, gas, average			Ea.
Assembly	30.00	E10904100170	Architectural equipment, appliances, dish washer, built-in, 2 cycles, economy			Ea.
Assembly	3539.00	B10201027100	Wood roof, truss, 4/12 slope, 24" O.C., 30' to 43' span			S.F.
Assembly	198.00	C10201022530	Door, single leaf, wood frame, 3'-0" x 7'-0" x 1-3/8", hollow core, lauan			Opng.
Assembly	32790.00	D30301101360	Packaged chiller, air cooled, with fan coil unit, apartment corridors, 40,000 SF, 73.33 ton			S.F.
Assembly	13775.04	B20101485000	Wood siding, 2"x6" studs 24"OC, insulated wall, 5/8" texture 1-11 fir plywood			S.F.