Appendix 4. Summary of the seismic mitigation risk programmes

Jurisdiction	Date started	Programme type	Building type and scope limitations	Number of buildings	Prioritisation	Timeframe for compliance	Standard / criteria used to show compliance	Incremental or phased retrofit encouraged	Financial incentives	Compliance	Comments
Long Beach, CA	1971 with revisions in 1976 and 1990	Mandatory strengthening	URM Pre-1934	936	Grade I – Excessive Hazard (most dangerous - top 10% of the buildings); in addition, buildings with dangerous parapets and appendages were classed as Immediate Hazard; Grade II – High Hazard (more dangerous - the next 30% of the buildings); Grade III – Intermediate Hazard (least dangerous - the remaining 60% of the buildings).	Grade I – repaired immediately or demolished from notice; Grade II – until 1985; Grade III – until 1991	1970 edition of Uniform Building Code (UBC)	In cases of partial retrofit to Grade I and II, the city had discretion to grant a compliance extension until 1991	Special Assessment Bond Loans; The city formed an assessment district composed of URM properties which allowed the city to issue bonds for seismic retrofit financing. The bonds were repaid by the rating assessments that were placed on the owners. Financing was at the prevalent market rate. 137 URM buildings were included in the assessment district	100% by 2007; by 1989 Grade I and II buildings complied with the ordinance (approx. 376 buildings).	After the 1933 Long Beach earthquake, the construction of the URM was prohibited (Riley Act), therefore all URM's in the city are pre-1934. In 1959, the city adopted regulations requiring mitigation of parapets and falling hazards; Highest demolition rate (40% - 372 URMs) attributed to strong enforcement of demolition orders for non-complying owners.

Los Angeles, CA	1981 (Division 88 ordinance)	Mandatory strengthening	URM, Pre-1934 (detached residential buildings with < 5 dwelling units excluded from the ordinance)	9,211	I - Essential; II – High risk (>100 occupants); III – Medium risk (>20 occupants); IV - Low risk (<20 occupants)	Notification: Class I – 0 - 3 months; Class II – 3 – 12 months; Class III – 1 – 3 ¼ years; Class IV – 3 ¼ - 4 years; Compliance: (without anchors) – 3 years from notification; (with anchors) – 1 year to install anchors, full compliance 4-10 years after installation of anchors (depending on class)	Alesch and Petak (1986, p. 79) note that the ordinance imposed 50-70% of the 1980 Los Angeles Building Code requirements for new construction	The city ordinance promoted dual-time phased retrofit. Owners could either strengthen their buildings within 3 years to conform with the ordinance or anchor URM walls within 1 year and depending on building classification were permitted additional 4-10 years for full compliance.	No comprehensive financial incentives; National Development Council (2019) notes that from approx. US$1.7B spent on URM retrofits, less than 10% came from government funding. Building owners were permitted to pass through 50% of retrofit costs amortised over 120 moths and a cap of $38 per month to residential tenants. CA state law exempts seismic retrofits from revaluation (Proposition 13) and owner of historic buildings could claim 20% tax credit.	As of 2006 (CSSC report): 88% mitigation rate: Retrofitted – 6,146; Demolished – 1942; No progress – 1,123	LA was the first major city to adopt a seismic retrofit ordinance for URMs (the URM Law passed in 1986). Mandatory programmes within the URM law were based on the Division 88 ordinance; the ordinance is also the basis for UCBC Appendix Chapter 1.
The URM Law, CA	1986; Seismic Zone 4	Required 365 local governments to: Inventory URM buildings within each jurisdiction; Establish loss reduction programmes for URM buildings by 1990; Report progress to the CSSC.	URM	25,536	Types of loss reduction programmes implemented locally included: Mandatory strengthening; voluntary strengthening; notification only; other types (variations of other programmes with unique requirements)	Within mandatory programmes, time for compliance were scheduled around the number of occupants. Average timeframe for compliance was 10 years	CA required all jurisdictions to adopt 1997 UCBC Appendix Chapter 1. UCBC standards are intended to significantly reduce but not eliminate the risk to life from collapse. Some retrofitting was performed under local ordinances that preceded the UCBC.	Some ordinances permitted phased retrofits	Range of incentives are presented in case studies in FEMA-254 (1994) Seismic Retrofit Incentive Programs	By 2006, 70% of URMS were retrofitted or demolished – 18,144. Majority of these are in jurisdictions with mandatory programmes – 16,563 (this represents 87% mitigation rate of buildings within mandatory programmes)	Mandatory programmes typically results in higher retrofit rates than other programme types. However, demolition rates are also higher in mandatory programmes (17% vs 8% in voluntary).

San Francisco, CA	1992	Mandatory strengthening	URM Pre-1934	1,976	Level 1 - Assemblies (>= 300 occupants), >3 stories on poor soil (areas of poor soil mapped); Level 2 - Non-level 1 on poor soil in certain mapped locations Level 3 - Buildings in Level 2 mapped areas not on poor soils Level 4 - All other URMs	Ranged from 3.5 to 13 years	1991 UCBC Appendix Chapter 1 with modifications; allowance of seismic upgrade to Bolts Plus level for certain types of buildings	Bolts Plus was allowed for certain buildings : <6 stories, w/out significant vertical irregularities or weak stories at the ground level, had qualifying cross walls and a specified min areas of solid URM wall)	Low interest loans: 2.5% for retrofits on affordable housing units; other URMs could access loans at 8.5% (interest rate at the time) through SF voter authorised issuance of US$350M in bonds (US$150M for low-interest and US$200 for market-rate loans	As of 2019, around 15-20 buildings remained non-compliant. By 2006, the latest date for compliance (level 4 buildings), mitigation rate was at 86% (1,555 retrofits and 158 demolitions). As of March 2000, only 17 market-rate loans were issued (US$10.4M) because private banks started to offer loans at competitive rates	The 1992 ordinance followed the previous Parapet Safety Program of 1975. It is estimated that ~1/4 of URMs were retrofitted to Bolts Plus standard. Comerio (1994) notes that “structural engineers were not very happy with the outcome of this code [Bolts Plus provisions], but they did not formally oppose it”.

Palo Alto, CA	1986	Mandatory evaluation	URM except for those smaller than 1,900 square feet or with six (6) or fewer occupants	47	All hazardous URM buildings	Notification within 6 months of ordinance; 18 months from notification submit engineering report identifying structural measures to bring to at least up to the seismic standards of the 1973 UBC; following that notify occupants in writing and submit a letter to the city indicating intentions regarding mitigation of seismic deficiencies 12 months are engineering study Historic structures were given an additional 18 months to comply	1973 UBC for voluntary retrofits	n/a	Development incentives (bonus floor areas, exemption from onsite parking requirements); capping the floor area of new developments to the size of the site area (floor area ratio 1:1)	As of 2014, 77% mitigation rate: 22 retrofitted; 14 demolished	The 47 URMs were in the downtown area and primarily commercial use. In addition to URMs, the ordinance classified two other types of hazardous buildings: pre-1935 structures with 100+ occupants (19 buildings); pre-1976 structures with 300+ occupants (23 buildings); 25 buildings in these two categories were retrofitted or demolished (60% mitigation rate)

Berkeley, CA	1991	Mandatory strengthening	URM, pre-1956	587	Risk cat I: Hospitals, fire and police offices/stations, emergency operation centres, buildings housing medical supplies, government administration offices, or any building with an occupancy load of one thousand (1,000) or more. Risk cat II: Commercial buildings - Businesses, assembly buildings, educational and institutional occupancies with an occupancy load of three hundred (300) or more; Residential buildings - Hotels, motels, apartments or condominiums containing more than one hundred (100) living units/bedrooms; Mixed use occupancies - Any building with a combined occupancy load greater than three hundred (300). Risk cat III: Commercial and mixed use – load >100; Residential - >50 units.	Risk category I buildings - by March 1, 1997; Risk category II buildings - by March 1, 1997; Risk category III buildings - by June 30, 1997; Risk category IV buildings - by December 31, 1997; Risk category V buildings - by December 31, 1998; Risk category VI buildings - by December 31, 2001.	Current edition of UCBC at the time of the ordinance adoption; in 2001 the ordinance was updated to adopt 1997 UCBC Appendix Chapter 1	Bolts Plus was allowed for certain buildings: regular (square or rectangular) simple buildings which were 1 or 2 storeys	Limited financial incentives; tax break on the city's real estate transfer tax – commercial buildings excluded; Since 2018 the city offers retrofit grants: design grants (up to 75% of design costs, max USD 5,000) and construction grants (up to 40% of construction costs, max USD 25,000 – 150,000)	By 2004 compliance was at 85%; 2006 compliance rate – 92%; as of January, 2025, three buildings remain on the current list of URMs	The programme's demolition rate was only 1%. It has been noted that Berkeley's approach has been one of the strictest in California from creating six compliance categories and compliance schedules to close monitoring of compliance where the city enforced regulatory laws and penalties for non-complying property owners. The city has been credited for investing in community resilience and leading by example by rebuilding or retrofitting every public school, fire station and numerous administrative buildings.

					Risk cat IV: Commercial and mixed use – load >50; Residential <50 units. Risk cat V: Commercial and mixed use – load <50; Residential - <20 units. Risk cat VI: Any non-residential building that is used less than twenty (20) hours per week, or any building with a masonry veneer of at least ten (10) feet in height or with a masonry parapet exceeding a one and one-half (1-1/2) ratio or masonry in-fill that is located in a high pedestrian traffic corridor.						

Oakland, CA	1990	Other	URM, pre-1948	1,612	Three priority levels based on the type of soil on which the building is located, number of stories, pedestrian and vehicle traffic adjacent to the building, use of building, number of occupants and complexity of retrofit work	Priority 1 – submit building permit for mandatory standard – 1 year; complete construction – 2 years. Priority 2 – permit 2 years; complete construction 3 years. Priority 3 – permit 3 years; complete construction 4 years.	1973 UCBC Appendix Chapter 1	Mandatory standard - Bolts Plus tie roof and floors to exterior walls, brace parapets, remove or fix other exterior falling hazards; Voluntary standard - UCBC Appendix Chapter 1	Permit fee discount, rent pass through (70% of costs amortised over 5 years); URMs retrofitted to voluntary standard were exempt from future retrofits.	As of 2006 compliance rate was 89%: Mandatory – 1,107; Voluntary – 222; Demolition – 106. Media reports indicated that in 2014 around 80-90 URMs remained unretrofitted (NDC, 2019).	URMs upgraded to mandatory standard issued a "Certificate of Compliance of the Mandatory Requirements," but remain on the city's list of potentially hazardous URM buildings. After the building has been upgraded or demonstrated to be in compliance with the applicable voluntary standards the building is removed from the inventory list of potentially hazardous URM buildings.

Los Angeles, CA	2015	Mandatory strengthening	Soft story (Wood frame buildings with soft, weak or open front walls – SWOF), pre-1978	~12,500	Priority I - buildings containing 16 or more dwelling units. Priority II - buildings with three stories or more, containing fewer than 16 dwelling units. Priority III - buildings not falling within the definition of Priority I or II.	Priority I – order to comply issued May-July 2016; Priority II - order to comply issued October 2016; Priority III - order to comply issued July-November 2017. From the receipt of the Order to Comply, building owners had: 2 years to submit plans to retrofit or demolish, or proof of previous retrofit; 3.5 years to obtain permit to start construction or demolition; 7 years to complete construction or demolition	The design force in a given direction shall be 75% of the design base shear specified in the seismic provision of ASCE 7.	n/a (targeted retrofit to ground floor)	Due to the large number of buildings in the inventory, implementing financial incentives and subsidies was deemed less feasible, leaving building owners responsible for covering retrofit costs. To alleviate some financial pressures, the city enacted a cost-sharing ordinance, allowing property owners to pass through 50% of seismic retrofit costs to tenants, amortised over 120 months, with a monthly cap of US$ 38.	As of February, 2024 76% of the buildings had either completed construction or been demolished (9,377 – complied, 2,970 – pending compliance).	Ordinance was adopted following recommendations in the *Resilience by Design* report prepared by the Mayoral Seismic Safety Task Force and presented to the city in January 2015.

San Francisco, CA	2013	Mandatory strengthening	Soft-story; wood-frame SWOF buildings of three or more stories and containing five or more residential dwelling units where the permit to construct was applied for prior to January 1, 1978	4,941	Tier I -Any building containing educational, assembly, or residential care facility uses Tier II - Any building containing 15 or more dwelling units Tier III - Any building not falling within another tier Tier IV - Any building containing ground floor commercial uses, or any building in a mapped liquefaction zone	All tiers submit screening form 1 year from notification; Submittal of permit application (from notice): Tier I – 2 years; Tier II – 3 years; Tier III – 4 years; Tier IV – 5 years; Completion of work (from notice): Tier I – 4 years; Tier II – 5 years; Tier III – 6 years; Tier IV – 7 years;	*Engineering Criteria:* A proposed seismic evaluation and/or retrofit plan shall demonstrate that the building satisfies one of the following: **1.** FEMA P-807, Seismic Evaluation and Retrofit of Multi-Unit Wood-Frame Buildings With Weak First Stories with the performance objective of 50 percent maximum probability of exceedance of Onset of Strength Loss drift limits with a spectral demand equal to 0.50 SMS, or **2.** ASCE 41-13, Seismic Evaluation and Rehabilitation of Existing Buildings, with the performance objective of Structural Life Safety in the BSE-1E earthquake, or **3.** ASCE 41-06, Seismic Rehabilitation of Existing Buildings, with the performance objective of Structural Life Safety in the BSE-1 earthquake with earthquake loads	n/a		As of January 2025, 94% of buildings in compliance with the ordinance (4,651 buildings); 6% (288 buildings) remain non-compliant, most of these are in Tier IV which include buildings with commercial uses on the ground floor. This is likely due to the complexities of retrofitting these buildings that involve temporary relocation of tenants and requirement to comply with the Americans with Disabilities Act (ADA) for buildings with commercial uses. It was reported that finding qualified ADA specialists willing to work on smaller projects has been a significant challenge.	The Community Action Plan for Seismic Safety (CAPSS), started in the City and County of San Francisco's Department of Building Inspection beginning in 1998, was a nine-year, US$1M study to understand, describe, and mitigate the risk San Francisco faces to earthquakes. The report produced an extensive analysis of potential earthquake impacts as well as community-supported recommendations to mitigate those impacts. In Dec 2010 Mayor Gavin Newsom formed the Earthquake Safety Implementation Committee (ESIC) under the City Administrator's Office, which created the Earthquake Safety Implementation Program (ESIP) in late 2011. ESIP is a thirty-year work plan and timeline implementing the

							multiplied by 75 percent, or **4.** for evaluation only, ASCE 31-03, Seismic Evaluation of Existing Buildings. with the performance level of Life Safety, or **5.** for retrofit only, 2012 International Existing Building Code (IEBC) Appendix A-4, or **6.** any other rational design basis deemed acceptable by the Department that meets or exceeds the intent of this Chapter.				CAPSS. The CAPSS 17 recommendations. The 1st recommendation was to: Require the evaluation of all wood-frame residential builds of three or more stores and five or more units, and retrofit those that are vulnerable to earthquake damage. The soft story ordinance followed in 2013.

Berkeley, CA	2005; 2014	2005 – Phase 1: Mandatory evaluation and voluntary retrofits; 2014 – Phase 2: Mandatory strengthening	Soft story; All existing wood frame multi-unit residential buildings that contain five or more dwelling units, as defined in BMC Title 23, and that were designed under a building permit applied for before January 1, 1978	369	No priority tiers	**Phase 1:** notices sent to 321 buildings; within two years of receiving the notice, the owners were required to submit engineering analysis of their building, notify tenants in writing of the building listing on the inventory and submit a copy of the letter to the city, and post a clearly visible earthquake warning sign until the building is removed from the inventory (voluntary retrofit). **Phase 2:** Mandatory strengthening complete within four years from 2014: apply for a building permit by December 31, 2016, and complete the seismic retrofit work within two years after submitting permit application by December 31, 2018.	Potentially hazardous SWOF buildings shall be retrofitted in conformance with one of the following engineering criteria: **1.** 2012 edition of the International Existing Building Code (IEBC) Appendix Chapter A-4; or **2.** ASCE 41-06, Seismic Rehabilitation of Existing Buildings, using a performance objective of S-5 (Collapse Prevention) in the BSE-C earthquake; or **3.** ASCE 41-13, Seismic Evaluation and Rehabilitation of Existing Buildings, using a performance objective of S-5 (Collapse Prevention) in the BSE-2E Earthquake; or **4.** FEMA P-807, Seismic Evaluation and Retrofit of Multi-Unit Wood-Frame Buildings With Weak First Stories, as a pre-approved "substantially equivalent standard" under procedures of	To evaluate the feasibility of Phase 2, the city conducted an economic analysis of building owners to determine their financial capacity to fund retrofits without incentives or subsidies. The estimated retrofit cost was approximately US$50,000 per building. The study found that most owners would be able to afford retrofits	For owners of soft story buildings with 5 or more residential units, owners can receive up to US$5,000 in design grant (capped at 75% of design costs) and US$25,000-150,000 in construction grant (capped at 40% of construction costs).	As of December 2024, the only remaining non-compliant buildings were not on the original inventory and were newly added (6 buildings). The ordinance resulted in only one demolished building.	While experience of voluntary programmes in jurisdictions within the URM law resulted in low retrofit rates, as the result of the Phase 1 2005 mandatory screening and evaluation ordinance, 40% of buildings were retrofitted.

							CBC Section 104.11 for Alternative Materials, Design and Methods of Construction, and with a retrofit objective as established by the Building Official; or **5.** Subject to the project specific approval by the Building Official, the 2003 edition of the International Existing Building Code (IEBC) Appendix Chapter A-4, for buildings with Seismic Engineering Evaluation Reports submitted prior to January 1, 2014, that (i) include structural design calculations and construction documents demonstrating conformance to Chapter A4 of the 2003 IEBC; and (ii) are suitable for building permit submittal.				

California	2007-2025	Mandatory strengthening	Soft story (wood frame SWOF), pre-1978	28-12,500	Most existing ordinances prioritise buildings into tiers based on the number of residential units	Completion of construction ranges between 3-7 years	Most common criteria found in ordinances: **Structural seismic evaluation.** Where performed, seismic evaluation of each wood-frame target story shall comply with the latest edition of Seismic Evaluation and Retrofit of Existing Buildings [ASCE/SEI 41] with a performance objective of Structural Life Safety with the BSE-1E hazard or Structural Collapse Prevention with the BSE-2E hazard, as interpreted by the Building Official. **Structural seismic retrofit.** Seismic retrofit of each wood-frame target story shall comply with one of the following criteria. **1.** Chapter A4 of the California Existing Building Code, as interpreted by the Building Official. **2.** The latest edition of Seismic Evaluation and Retrofit of	Not observed, limited extensions are available (typically 6-12 months) in case of significant financial hardship, to prevent or minimise tenant displacement, a temporary shortage of price increase for construction materials or labour.	Retrofit grants available in some jurisdictions. Common incentives are rent pass-through, reduction in permitting application fees, property rates freeze, development incentives (e.g. SF planning rules allow unlimited number of Accessory Dwelling Units (ADUs) on projects undergoing Mandatory or Voluntary seismic upgrades generate additional rental income stream by converting some of the ground floor areas)	While first example of a mandatory ordinance was in 2007 in Fremont, the major cities began implementing mandatory programmes in mid-2010's (SF 2013, LA 2015). Currently there are 14 active mandatory programmes. Several jurisdictions are considering soft story mandates.	Assembly Bill 304, Chapter 525 (2005) amended Section 19160 of the California's Health and Safety Code authorises "cities and counties to address the seismic safety of soft story residential buildings and encourage local governments to initiate efforts to reduce the seismic risk in vulnerable soft story residential buildings." In other words, while the state legislature recognises the risks of soft story buildings, local mitigation efforts are encouraged but no affirmative action is required on the part of the municipalities (this is in contrast to the 1986 URM law). California's approach to soft-story retrofitting has evolved through regional influences, with jurisdictions often adapting and refining ordinances based on neighbouring cities' policies. A

							Existing Buildings [ASCE/SEI 41] with a performance objective of Structural Life Safety with he BSE-1E hazard or Structural Collapse Prevention with the BSE-2E hazard, as interpreted by the Building Official. **3.** For subject buildings qualified as historic, alternate building regulations of the California Historical Building Code.				distinct pattern emerges between Northern and Southern California, where larger cities (LA, SF) lead in implementing seismic resilience measures, prompting smaller jurisdictions to follow suit.

Los Angeles, CA	2015	Mandatory strengthening	Any existing concrete building built pursuant to a permit application for a new building that was submitted before January 13, 1976	1,194	n/a	From the service of order: Within 3 years submit a checklist; within 10 years submit a detailed evaluation; within 25 years complete construction	Retrofit design criteria: 1. Strength of the lateral-force resisting system shall meet or exceed 75% of the seismic base shear specified in "The Equivalent Lateral Force Procedure" of the current Los Angeles Building Code. Elements not designated to be part of the lateral-force resisting system shall be adequate for gravity load effects and seismic displacement due to the full (100%) of the design story drift specified in the current Los Angeles Building Code seismic provisions, or 2. Meet or exceed the requirements specified for "Basic Performance Objective for Existing Buildings" of ASCE 41, using a Tier 3 procedure and the two level performance objective for existing buildings (BPOE) in Table 2-1 of ASCE 41 for the applicable risk category, and using ground	Not specified in the ordinance, however compliance timeframes apply from the receipt of the order which maybe sent out in stages.	No incentives other than commonly available in the retrofits of other building types (URM and soft story)	Compliance is at 6% (72 buildings)	Retrofit cost remains a significant impediment to retrofits. With evidence from a small sample of completed retrofits under the ordinance, it was found that retrofit costs alone range between US$ 30-50 per sqf, however when combined with peripheral works such as partial demolitions, building systems upgrade, tenant relocation, interior fitouts, accessibility etc, the cost of comprehensive seismic retrofit is pushed to US$50-100 per sqf. For an average 7-story, 68,000 sqf (~6,300 sqm) building in the programme, total retrofit work can range from US$2.1m to US$6.8m. It was also observed that it was difficult for property owners or developers to secure bank lending to fund retrofits because presently the retrofitted buildings do not

							motions and procedures established by the Department.				generate increased rents.
West Hollywood, CA	2018	Mandatory strengthening	Any existing concrete building determined by the Building Official to have been built under Building Code standards enacted before the 1979 Uniform Building Code with local amendments	~55	Prioritisation: I – 8 or more stories; II – 3 – 7 stories; III – 2 or less stories	Phase 1: 10 year from notice evaluation and major deficiency retrofit; Phase 2 – 20 years from notice complete full retrofit.	Building Structural Analysis, Design and Evaluation. The building shall meet or exceed the structural performance level for the associate earthquake hazard levels as indicated in Table C based on the Risk Category as defined in ASCE 41	Two phase approach: **Phase 1:** Engineering report and major deficiency mitigation – within 10 years from notice (major deficiencies include: load path, weak or soft story, vertical irregularity, torsion, captive column); **Phase 2:** complete retrofit – 20 years from notice (10 additional years from Phase 1)	No specific incentives provided by the city	No compliance data available yet	Residential common interest developments are excluded from the ordinance.
Torrance, CA	2023	Mandatory strengthening	Any existing concrete building determined by the Building Official to have been built under Building Code standards enacted before the 1979 Uniform Building Code with local amendments adopted on April 28, 1981	~50	Prioritisation: Priority I: Buildings with 3 or more stories. Priority II: Buildings with 2 stories and 7 or more units. Priority III: Buildings not included in Priority I & II.	Same as in West Hollywood	Same as in West Hollywood	Same as in West Hollywood	Incentives are being explored	No compliance data available yet	The latest jurisdiction to enact a mandatory retrofit ordinance for older concrete buildings.

Santa Monica, CA	2017	Mandatory strengthening	Any concrete building built under building code standards enacted before January 11, 1977.	~70		Structural evaluation report due in 3 years; Application for building permit within 4 ½ years; Retrofit must be completed within 10 years (2027)	*Building structural analysis, design and evaluation*. The building shall meet one of the following criteria: 1. Strength of the lateral-force resisting system shall meet or exceed seventy-five percent (75%) of the base shear specified in the California Building Code seismic provisions. Elements not designated to be part of the lateral-force resisting system shall be adequate for gravity load effects and seismic displacement due to the full (100%) of the design story drift specified in the California Building Code seismic provisions. 2. Meet or exceed the requirements specified for "Basic Safety Objectives" from ASCE 41-13 using ground motions and procedures established by the City based on ASCE 41-13.	None specified		Current list of properties contains 49 buildings (~30% compliance rate)	Building use of listed properties: Church 1 (2 stories) Commercial 27 (number of stories – 1-21, mode 8) Hotel 5 (number of stories 5-15) Parking Garage 6 (number of stories 3-7) Residential 10 (number of stories 2-17. mode 6). SM enacted the most extensive retrofit ordinance which identifies and orders retrofits for URM (100 buildings), concrete tilt-up (30), soft story (1,700), non-ductile concrete (70) and steel moment frame buildings (80). Nearly 2,000 commercial and multi-family residential buildings made a list of sites that need to be assessed for possible structural improvement.

Japan	1995; Revised in 2006 and 2013	Act for the Promotion of Seismic Retrofitting of Buildings; Mandatory evaluation and strengthening; Mandatory evaluation and strengthening: Public and critical facilities (government offices, schools and universities, hospitals and medical centres, fire stations and police stations, emergency shelters, public transportation hubs; Large private buildings with public use (>5,000 sqm)(shopping centres, supermarkets, hotels, office buildings etc); Buildings along high priority routes – local authorities have the power to mandate seismic retrofits; Mandatory evaluation and voluntary strengthening:	Pre-1981	Public buildings (government-owned) ~93,000; Private buildings (commercial and industrial with public use) ~80,000; Residential buildings (detached and apartments) ~18.5 million	Public buildings; Large private buildings with public use (commercial and industrial); Residential buildings (detached dwellings and apartments)	The government sets targets for retrofitting: 75% by 2003; 90% by 2015	*Required Seismic Resistance Level* Retrofitted buildings in Japan must meet at least 80% of the current building code. Public buildings, evacuation route structures, and high-risk zones require 100% of code. Under the 1981 seismic code structures should not collapse under a JMA seismic intensity scale 6 upper earthquake (approximately Magnitude 7.0–7.5). The standard requires that buildings withstand both: Moderate earthquakes without structural damage, and Large earthquakes (seismic intensity 6 or higher) without collapse, ensuring occupant safety	Not identified	To encourage building owners to carry out needed retrofit measures, Japan has implemented a system of financial incentives that divides the cost of works between the central government, the local government, and the building owners. This has been delivered through tax breaks, loans, and subsidies: Regular subsidy: Seismic evaluation – 33.3% each central government, local government, building owner; Retrofitting – 11.5% central govt, 11.5% local govt; 77% building owner; Limited-time promotional offer (to 2018): Evaluation – 50% central govt, 33-50% local govt, 0-17% building owner; Retrofitting – 33.3% central govt, 11.5-33.3% local govt, 33.3-55% building owner' for buildings on evacuation	Public schools – 99% (as of 2021); Other public buildings – 75-95% (as of 2014); Earthquake resistance of pre-1981 residential buildings: Detached dwellings – 3.4m earthquake resistant, 5.6m insufficient earthquake resistance; apartment buildings – 2.7m earthquake resistant, 1.4m insufficient earthquake resistance	Japan has made significant progress in retrofitting public buildings but private and residential buildings still face challenges due to high costs and slow adoption. Local authorities can publish the names of non-compliant buildings, thus pressuring owners to retrofit. Rural areas lag behind urban areas in terms of earthquake-resistant residential buildings; in rural areas with high proportion of aging population retrofit rates were below 50% while in many urban areas the rate exceeds 90%.

		Residential buildings.							routes or designated as emergency management hubs – 40% central govt, 33.3-40% local govt, 26.6-33.3% building owner; Supplementary financial incentives: Tax exemptions, low-interest loans		

Taiwan	2000	Building Seismic Assessment and Strengthening Programme (public buildings)	Pre-1997	31,146 Including government offices, hospitals, schools and other essential service buildings; This count includes 27,741 school buildings	All pre-1997 public buildings	3-stage approach: Preliminary assessment; Detailed assessment; Retrofit (or demolition). Retrofits were prioritised based on risk assessments and building age.	Structural analysis of school buildings: The screening evaluation consists of a simple “capacity to demand” comparison based on the ratio of ground floor column and wall areas to building total floor area. If the screening evaluation result in a Capacity/ Demand ratio (Is) that exceeds 0.8, the school building is subjected to a more detailed analysis: The detailed analysis procedure - referred to as Taiwan Earthquake Assessment for Structures by Pushover Analysis (TEASPA) is a non-linear static pushover analysis like those used in ATC-40 and ASCE-41. TEASPA calculates the ultimate seismic base shear capacity of the structure and then uses the results to compute the building capacity in terms of peak	Not identified	From 2009 to 2022, the government funded NTD 128.4 billion (NZ$6.8b) for seismic assessments and retrofitting of schools. 9,550 school buildings were upgraded.	Public buildings: 10,143 buildings required retrofitting and 2,445 buildings required demolition; 10,143 buildings required retrofitting and 2,445 buildings required demolition. As a result, 9,369 buildings completed retrofitting (92%) and 2,179 buildings demolished (89%). From these statistics,	The retrofitting of public schools has been a significant priority of the central government. National Centre for Research on Earthquake Engineering (NCREE) was engaged to develop technologies (more accurate assessments and cost-effective retrofits) for the seismic evaluation and retrofit of schools between 1999-2009.

							ground acceleration (Ap) for comparison to the code derived peak ground acceleration. The analysed school buildings with insufficient strength are tagged for retrofit. A solution is developed to strengthen the building to meet the required demand under the peak ground acceleration. Typical reinforcing schemes include the introduction of new moment frames, shear walls, jacketing of columns or introducing shear panels adjacent to existing columns (Gilsanz et al. 2016)				

Taiwan	2019	Private Building Seismic Weak Story Retrofit Programme; Voluntary evaluation and retrofit	Pre-1997;	~36,000	Privately-owned multi-story buildings with weak story			The program offers three distinct plans, each tailored to address different levels of structural vulnerabilities. **Plan A** - Targets buildings with soft-story weaknesses, usually caused by open ground floors used for parking or commercial spaces; **Plan B** - Comprehensive retrofitting to ensure buildings meet at least 80% of modern seismic code standards; **Plan C** - Designed for single-ownership buildings requiring localised structural repairs from earthquake damage	Plan A - Subsidies cover up to 45% of retrofit costs, capped at NTD 4.5 (~NZ$240k) million; Plan B - Subsidies cover up to 45% of retrofit costs, capped at NTD 4.5 million; Plan C - Subsidies are capped at NTD 500,000 (~NZ$27k) focusing on localised repairs	As of January 2025, 120 projects have been approved through the programme including 20 buildings where retrofit has been completed or under construction, 51 projects where subsidies have been approved and remaining projects in the various stages of design and construction.	NCREE plays an important role in the oversight and implementation of retrofit programmes in Taiwan. The centre takes an active role in technology development, public outreach and monitoring of the programme. Currently, the Ministry of the Interior and NCREE are actively evaluating the feasibility of introducing mandatory retrofit requirements for private buildings. The central government (Legislative Yuan) received a draft proposal titled “Seismic Assessment and Retrofit of Existing Buildings Promotion Act”. The act proposes a systematic approach that mandates completion of: Preliminary seismic assessment; Detailed seismic assessment, if preliminary assessment raised concerns;

											Seismic retrofit design and strengthening, if detailed assessment indicated the need for retrofit.
Istanbul, Turkey	2006	Istanbul Seismic Risk Mitigation and Emergency Preparedness Project	Pre-2000		Public buildings				Initial project secured US$563m from the World Bank. The funding was available until 2015. The project remains active after securing additional financing from international financial institutions including European Investment Bank, Council of European Development Bank, Islamic Development Bank and German Development Bank (KfW). By 2018, the total amount of committed financing was in excess of EUR€ 2b	1,624 public buildings (majority schools [1,454] and hospitals [54]) have been retrofitted or demolished; 64 projects are ongoing. 88% of public schools in Istanbul have been retrofitted.	Retrofitting private commercial and residential buildings remains a significant challenge. The government implemented the Law on the Regeneration of Areas Under the Risk of Disaster, no. 6306 in 2012. Known as the Urban Transformation Law, the law introduced the framework for earthquake-focused urban transformation through the rehabilitation, demolition and renewal of areas at risk. Limited financial assistance is available to owners of private buildings including low interest loans, tax exemptions and temporary relocation costs.

Mexico	No active retrofit programmes								In post-disaster response, rehabilitation and reconstruction of housing is typically covered with public funds and support from private foundations.	Following 2017 Mexico City earthquake, by 2020, out of 11,880 damaged single-family masonry houses, 9,050 were under rehabilitation and 2,830 were rebuilt or being relocated . In addition, 525 multi-story residential buildings (containing more than 11,000 apartment units) were rehabilitated. The government was able to recover part of the reconstruction costs through densification by increasing the floor area of new builds by 35%.	Most commonly structural retrofits are because of earthquake damage. Instances of proactive retrofit are rare and likely triggered by change of use or major remodelling.

Italy	2013	Sismabonus	All residential and productive properties located in seismic zones 1, 2 and 3 (zone 4 – lowest risk – is excluded)				The Sismabonus programme categorises buildings into eight seismic risk classes from A+ (lowest risk) to G (highest risk)		The incentive is capped at EUR€ 96k. The deduction rate can range from 50% to 85%: 50% deduction for interventions that do not bring any improvement in the seismic class of the building subject to the work; 70% deduction for interventions that improve one seismic class of the building; 80% deduction for interventions that improve two seismic classes of the building; 85% deduction only for condominiums if the interventions improve two seismic classes.	From 2020 Sismabonus is a sub-scheme within a Superbonus scheme. The other part of Superbonus is a scheme called Ecobonus aimed at energy efficient building improvements. Combined, Ecobonus and Sismabonus cover up to 110% of energy and seismic retrofit costs. No separate statistics are reported for each sub-scheme. As of 2021, 70,000 superbonus application have been received at a cost of EUR 11.9b	The Sismabonus is repaid over 5 years in annual instalments as a credit on their tax return.