

SEISMIC EVENTS



Risks to Buildings, Occupant Safety & Environment

- ◆ Full or partial building collapse causing loss of life and irreparable damage to the building
- ◆ Access to utility services including power, potable water and sanitary services cannot be guaranteed
- ◆ Life safety and injury risks from structural failure, falling objects, and/or breaking glass
- ◆ Entry to buildings or communities may be compromised due to structural integrity concerns or physical barriers
- ◆ Vulnerable populations without extensive support networks may become temporarily homeless

Site Strategies

Strategy	Cost	Impact	Alignment
Select non-hillside or stable slope sites and avoid cut and fill building sites to reduce risk from landslide and mudslides	\$	***	
Construct channels, drainage systems, retention structures, and deflection walls	\$\$	***	

Design Strategies

Strategy	Cost	Impact	Alignment
Place walls, braced frames, or moment frames in a symmetric and regular layout and allow them to be continuous up the height of the structure.	\$\$	***	
Avoid the design of 'soft stories' that are more vulnerable to collapse (large, engineered buildings)	\$\$	***	
Include shear walls, braced frames, moment resisting frames and diaphragms, and base isolation into building design (large, engineered buildings)	\$\$\$	***	
Make use of energy dissipating devices, such as visco-elastic dampers, elastomeric dampers, and hysteretic-loop dampers (large, engineered buildings)	\$\$	***	
Brace any non-structural components as needed (large, engineered buildings)	\$\$	***	
Bolt the sill plate of houses to the foundation to prevent the building shaking off of its foundation (low rise, wood-frame)	\$	***	
Include the risk of aftershocks into design thresholds	\$	**	
Ensure pipe joints and bracing are reinforced to eliminate breakage and leaks in seismic event	\$	***	
Allow for natural daylighting in corridors and stairwells to enable vital areas to be usable during a power outage	\$	*	
Include luminescent strips to provide safety in dark spaces	\$	*	
Identify a building's critical load and necessary duration of back-up power. Ensure a minimum of 72 hours energy storage/backup energy is provided for critical systems, as well as water booster pumps, sump pumps, alarms and security equipment, outlets for phone charging and medical equipment, wireless/telecomm services, lighting, refrigeration, and bathrooms	\$\$\$	***	
Consider an automatic transfer switch (ATS) to smoothly and safely switch to emergency power – alternatively, install a permanent exterior manual transfer switch to improve accessibility	\$\$	**	
Provide extensive emergency lighting in highly trafficked areas. For lower-cost options, consider solar-powered outdoor lighting or battery-powered LED lighting	\$	*	
Ensure resilient access to potable water by including water taps or fountains that operate on City water pressure alone	\$	**	
Include rainwater storage tanks or rain barrels to maintain an on-site supply of non-potable water	\$	**	
Consider on-site renewable energy opportunities to decentralize the building's energy supply	\$\$	**	

B.C. is considered a high-risk earthquake zone due to the active faults in the Pacific Northwest, including the Cascadia Subduction Zone. This risk presents an enormous challenge to building design, as earthquakes can reveal building deficiencies that lead to poor seismic performance. Building codes have been updated to include seismic considerations but do not guarantee a building's resilience during seismic events. Codes are focused on protecting the lives of occupants as opposed to on earthquake resilience and recovery. In the event of a major quake this can result in significant damage to the building structure, architectural components and facades, mechanical, electrical and plumbing equipment and other building contents. There are opportunities to improve building seismic recovery and resilience over and above what is required by code.

Operations Strategies

Strategy	Cost	Impact	Alignment
Establish maintenance schedule for emergency power systems	\$	***	
Introduce a process for rapid damage assessment of buildings after earthquake and alert people whether they can re-enter given risk of aftershocks	\$	***	
Design or connect to a building emergency communication system (e.g. SMS) with a back-up in the building (e.g. bulletin board in Refuge Area)	\$	**	
Establish operations and maintenance procedures and building management systems (BMS) to include information about resources available to occupants during extended power outages	\$	**	
Allow common building spaces, such as amenity rooms to act as refuge with backup power and basic survival supplies including 72 hours of fuel storage for power to refuge area plus building pumps, fans, emergency lighting and security systems	\$\$	***	

Severe Storms
 Chronic Stressors
 Flood Events
 Power Outages & Emergencies

Relative Cost/ Cost Premium		
Low	Medium	High
\$	\$\$	\$\$\$

Relative Impact		
Low	Medium	High
*	**	***

Community Benefits



Consider the following strategies to help improve the resilience of the community overall:

- ◆ Provide a resilient potable water supply in site design to allow for universally accessible drinking water after seismic events
- ◆ In larger mid-rise to high-rise buildings, designate amenity rooms as refuge areas that can act as a central location for community emergency support and services
- ◆ Provide occupant education on refuge areas, evacuation measures, exit locations, etc. in multiple languages according to building occupancy
- ◆ Designate building or community members with first aid or other experience as emergency coordinators
- ◆ Ensure building and community members have access to key information and contact details

Potential Design Conflicts



Take care and ensure resilient strategies do not exacerbate vulnerability and other risks

- ◆ Ensure structure and envelope design also take energy performance into consideration.

Additional Resources

- ◆ The Resilience-based Earthquake Design Initiative (REDi™) Rating System
- ◆ Minimum Backup Power Guidelines for MURBs
- ◆ Enterprise Green Communities' Strategies for Multifamily Building Resilience
- ◆ Enhancing the Livability and Resilience of Multi-Unit Residential Buildings (MURBs), MURB Design Guide