

Busting the Myth of Adaptive Reuse: structural challenges for diverse building types

LPA



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Learning Objectives



Review the key structural design factors for laboratory adaptive reuse in existing buildings.



Learn about common structural systems and their unique challenges to meet complex laboratory design criteria.



Understand the strategy for setting realistic and effective design criteria for structural retrofits.



Explore innovative solutions tailored to each structural system that can optimize functionality and sustainability in adaptive reuse projects.

Adaptive reuse is more sustainable
than new construction

KEY FACTORS FOR ADAPTIVE REUSE



- The case for adaptive reuse

Sustainability

- Recycle / reuse
- Decarbonization
- Carbon sequestration

Value

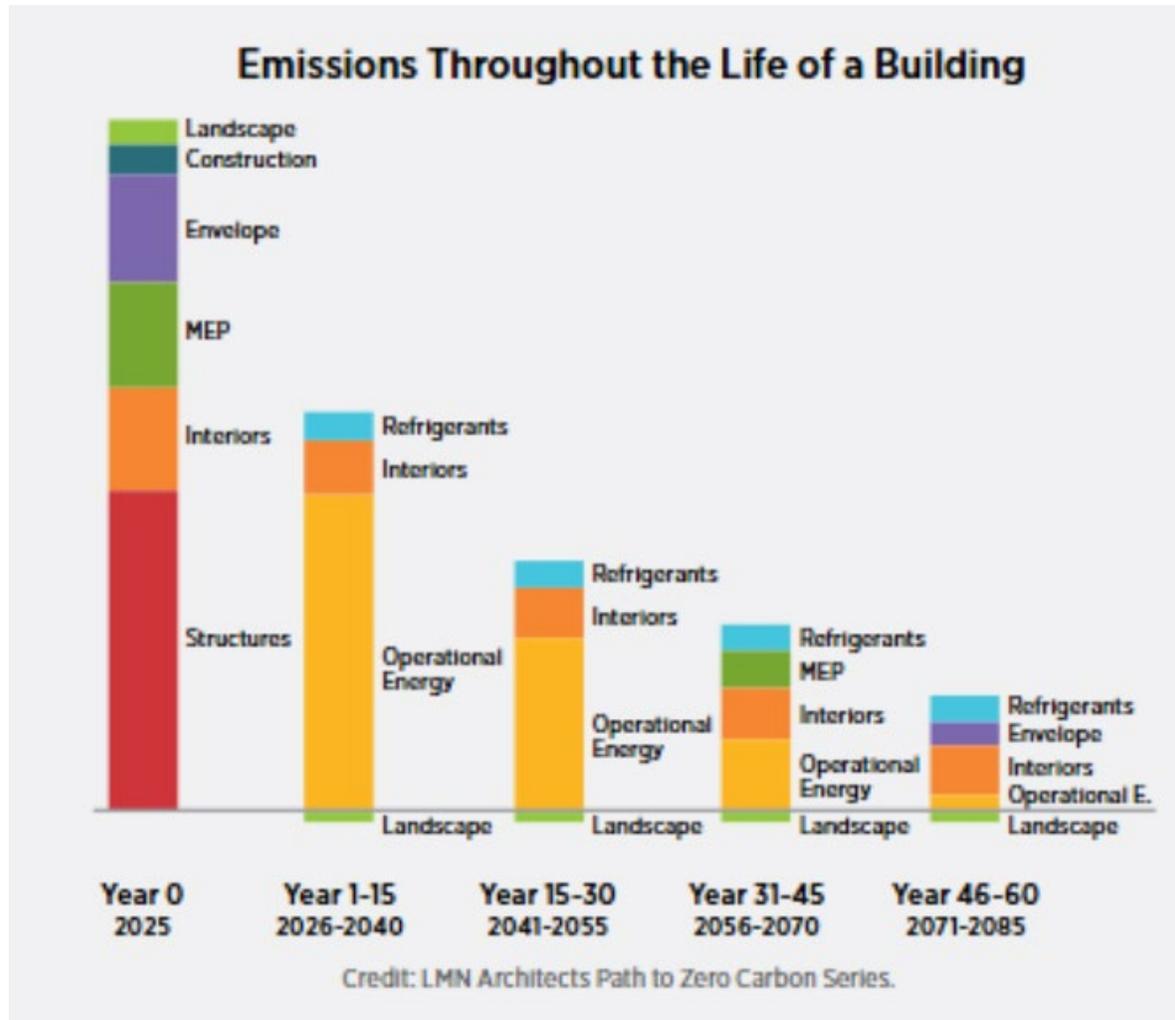
- Speed-to-market
- Lower cost
- Energy efficient retrofits

Location

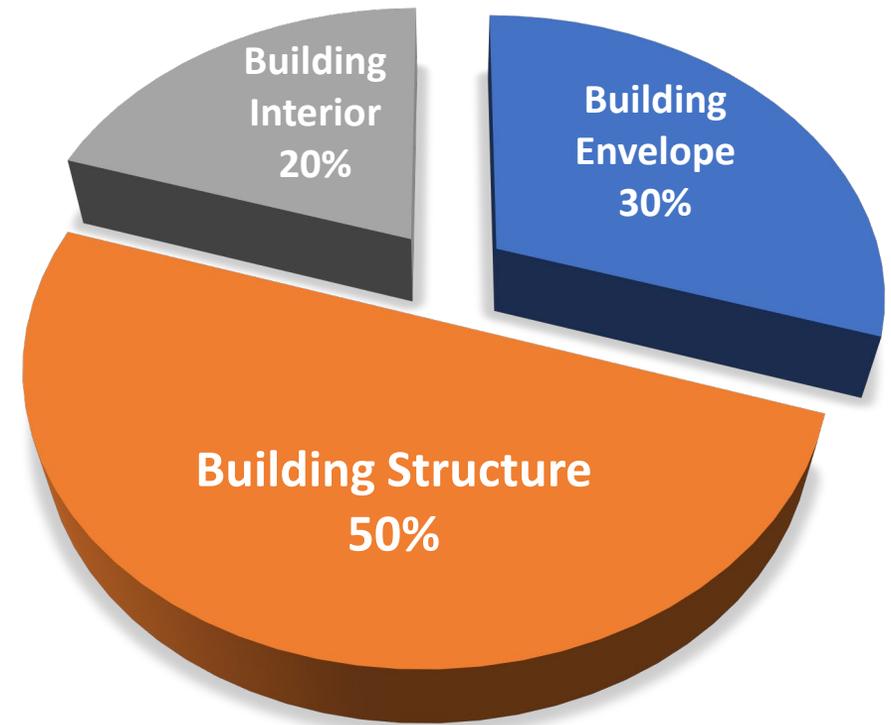
- Cultural value
- Sense of place / community
- Gifts of the site



- Structures role in carbon reduction potential



Embodied carbon breakdown



Any building can be
converted for laboratory
use

BUSTING THE MYTH



One size
does not
fit all.

Not every solution works for every
individual, nor for every organization

- Life Science Companies Lifecycle

	Research & Development	Pre-Clinical / Clinical	Commercialization
PHASE	DRUG DISCOVERY 	DRUG DEVELOPMENT 	REGULATORY 
WHO	Small life science tenants, start-ups, incubators	Medium life sciences companies	Large established life sciences companies
WHAT	Office / Research Labs	Office / Research Labs Analytical / Computational / Animal Research Labs Pilot plant / manufacturing	Office / Research Labs Analytical / Computational / Clinical / Animal Research Labs cGMP Manufacturing / Warehouse
WHERE	Office buildings	Combination	Industrial / warehouse

All Structural systems are
retrofited the same way
STRATEGIES FOR LABORATORY RETROFITS



- Structural performance criteria for lab buildings

PERFORMANCE	TYPICAL CRITERIA	ADAPTIVE REUSE IMPACTS
STRUCTURAL BAYS MODULE	33' TO 36' (10'-6" TO 12'-0" MODULE)	PLANNING INEFFICIENCIES
FLOOR TO FLOOR HEIGHT	14' TO 16'	LOW CEILINGS, SELECTIVE DEMOLITION HIGH CEILINGS MEZZANINES
FLOOR AND ROOF LOADS	100 TO 125 LBS / SF	STRUCTURAL RETROFITS TO INCREASE PERFORMANCE
VIBRATION CRITERIA	8,000 TO 2,000 MIPS	STRUCTURAL RETROFITS OR MOVE PROGRAM TO GROUND LEVEL
FIRE RATING SEPARATION	2-HOUR	LIMIT HAZARDOUS MATERIAL QUANTITIES

- Floor loads



- Roof loads



- Vibration criteria

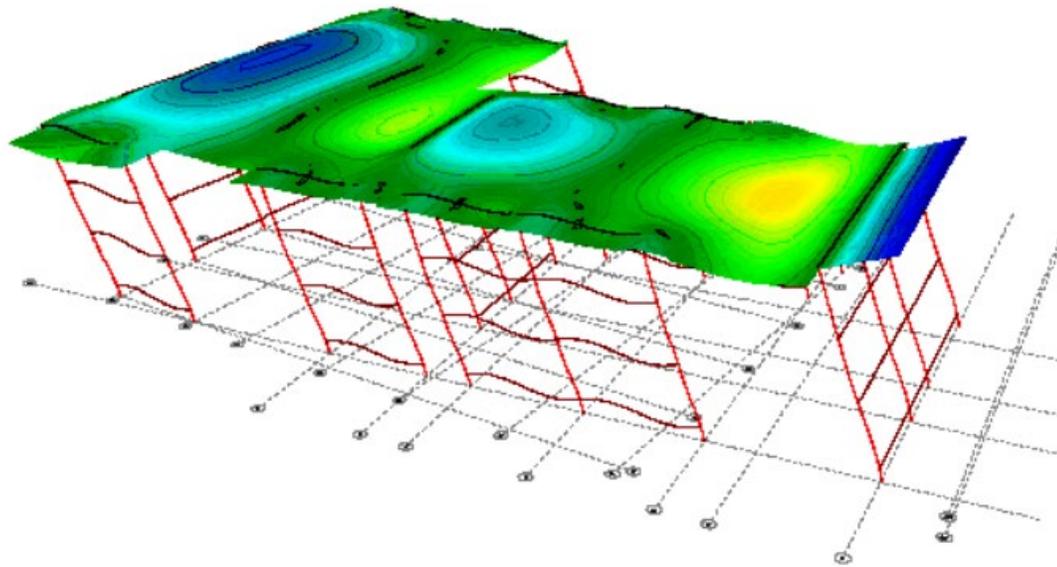


Table 6-2. Generic Vibration Criteria Tolerance Limits

Designation	Tolerance Limit ¹ , mips	Applicability
—	32,000	Ordinary workshops ²
—	16,000	Offices ²
—	8,000	Computer equipment Residences ^{2,3}
—	6,000	Hospital patient rooms ⁴
—	4,000	Surgery facilities, laboratory robots Bench microscopes up to 100×, operating rooms ⁵
VC-A	2,000	Microbalances, optical comparators, mass spectrometers Industrial metrology laboratories, spectrophotometers Bench microscopes up to 400×
VC-B	1,000	Microsurgery, microtomes and cryotomes for 5 to 10 μm slices Tissue and cell cultures, optical equipment on isolation tables Bench microscopes at greater than 400×, atomic force microscopes
VC-C	500	High-precision balances, spectrophotometers, magnetic resonance imagers Microtomes and cryotomes for <5 μm slices, chemotaxis Electron microscopes at up to 30,000×
VC-D	250	Cell implant equipment, micromanipulation Confocal microscopes, high-resolution mass spectrometers Electron microscopes (SEMs, TEMs) at greater than 30,000×
VC-E	125	Unisolated optical research systems, extraordinarily sensitive systems

¹ As measured in one-third octave bands over the frequency range 8 to 80 Hz (VC-A and VC-B) or 1 to 80 Hz (VC-C through VC-E); see Figure 6-2.
² Provided for reference only. Evaluate using Chapter 4 or Chapter 7.
³ Corresponds to approximate average threshold of perception (ASA, 1983).
⁴ When required by FGI (2014). Evaluate using Section 6.2.
⁵ Corresponds to approximate threshold of perception of most sensitive humans (ASA, 1983). Evaluate using Section 6.2.

Source: AISC Design Guide 11

- Comparing structural systems



SYSTEM 1:
WOOD-FRAMED



SYSTEM 2:
STEEL STRUCTURES



SYSTEM 3:
WAREHOUSE / INDUSTRIAL



SYSTEM 4:
CONCRETE STRUCTURES

- Evaluation Criteria



STRUCTURAL PERFORMANCE

- Loading
- Material Efficiency



DESIGN LIMITATIONS

- Floor to floor
- Bay spacing



PROGRAM FLEXIBILITY

- Planning inefficiencies
- Limitations for day use



CONSTRUCTABILITY

- Ease of retrofit
- Time to implement
- Ease of access



COSTS

- Cost of retrofit
- Cost by building type
- Seismic upgrades (Regional)



FUTURE FLEXIBILITY

- Owner perspective
- Accommodate future changes



SUSTAINABILITY

- Compare to demolition
- Embodied carbon
- Operational energy use

- **Wood framed – retrofit strategies**

- Adding column between bays
- Sistering joists to increase loading and vibration capacity
- Adding concrete topping for vibration capacity
 - Retrofit joists, columns, foundations
- Replacing bays with steel framing
- Strengthening roof framing for mechanical equipment
- Lowering slab on grade
- Add vibration isolated floors
- Locate vibration sensitive program on ground floor



- **Steel framed – retrofit strategies**
- Add column between bays
- Retrofit beams (welded WT or adding new steel beams) to increase loading and vibration capacity
- Add tuned mass dampers
- Strengthen roof framing for mechanical equipment
- Add vibration isolated floors / tables for equipment
- Design strategies – vibration sensitive program on ground floor, retrofit certain bays only



- Warehouse / Industrial – retrofit strategies

Retrofit strategies

- Add mezzanine levels – Might trigger seismic retrofit
- Add ceilings at high volume spaces
- Strengthen roof framing for mechanical equipment
- Consider skylights to provide access to natural light in deep floorplates



- Concrete structures – Retrofit strategies

- Enlarge beam sizes
- Add steel beams
- FRP (fiber reinforced polymer) for additional load carrying capacity
- External post-tensioning

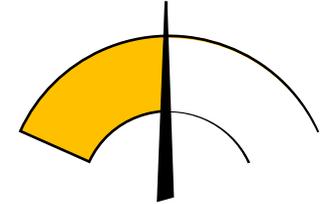
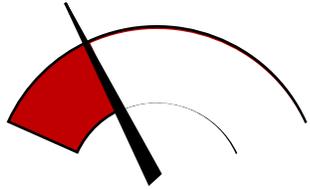


- Comparing structural systems



CRITERIA / SYSTEM	STRUCTURAL PERFORMANCE	DESIGN LIMITATIONS	DESIGN FLEXIBILITY	CONSTRUCTABILITY	COST TO RETROFIT	FUTURE FLEXIBILITY	SUSTAINABILITY	TOTAL
WOOD-FRAMED	*	*	*	***	*	*	**	10
CONCRETE STRUCTURES	***	**	***	*	**	***	*	15
WAREHOUSE / INDUSTRIAL	***	*	***	***	**	***	***	18
STEEL STRUCTURES	**	**	***	**	**	***	***	23

- Comparing structural systems



SYSTEM 1:
WOOD-FRAMED

- Early stage
- Prime locations
- Computational
- Biologics
- Affordable

SYSTEM 2:
STEEL STRUCTURES

- Research & Development
- Multi-tenant
- Urban locations

SYSTEM 3:
WAREHOUSE / INDUSTRIAL

- Manufacturing
- cGMP
- Cleanrooms
- Large footprint
- Affordable

SYSTEM 4:
CONCRETE STRUCTURES

- R&D
- Multi-story
- Pre-clinical
- Urban locations

Key Take-Aways – busting the MYTHS

Adaptive reuse is more sustainable than new construction

Any building can be converted for lab use

All structural systems are retrofitted the same way

Multiple benefits for people, planet and profit

Steel and warehouse works well, location is a major driver for others

Each system has its advantages & disadvantages

When it comes to laboratory uses, no one solution fits all

Understand limitations and manage expectations

Consider cost vs value to understand how far to go

Questions?



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