Center for Buildings, Infrastructure and Public Space

Bridge Resilience

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Seismic Performance Assessment of Isolated Continuous Girder Bridges with Lead-Rubber Bearings.

- This study evaluates the seismic performance of a five-span continuous steel-girder bridge retrofitted with lead-rubber bearings (LRBs). Monte-Carlo samples covering material strength, bearing properties, and ground-motion uncertainty are subjected to nonlinear time-history analysis. Performance levels for piers and superstructure are defined in displacement terms. Results show that LRB isolation lengthens the fundamental period from 0.8 s to 1.9 s, cutting column shear forces by 60 % and deck accelerations by 55 % under 975-year motions. Median bearing displacement stays below 200 mm, well within seat limits. A life-cycle cost study indicates isolation is 35 % cheaper than column jacketing for the same reliability target.

San Francisco–Oakland Bay Bridge – From 1989 Collapse to a Resilient Lifeline

Traffic & Economy	1989 Quake Damage	Seismic Upgrades & Transit Shifts
• ≈260k vehicles/day; 9% freight (~23k trucks) • Peak 7-9 AM / 4-7 PM; summer tourism up • One-month closure ≈ $1 B loss; BART ridership +30%	• 50-ft upper deck collapsed onto lower deck • Exposed cantilever span's low ductility & unseated bearings	Western Span – steel jacketing, viscous dampers, isolator bearings New East Span – self-anchored suspension bridge, 480 LRBs, shear-link tower fuses Alternatives – ferries, BART, Caltrain, other bridges

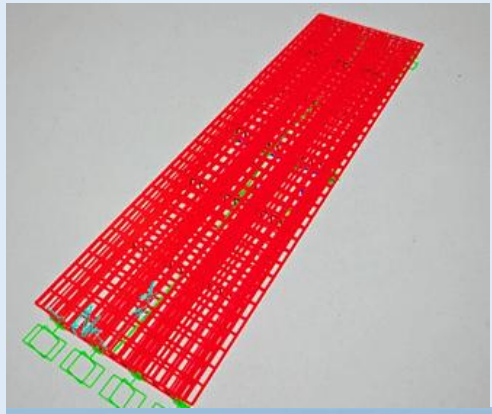
WHY IT MATTERS

- Design gap → disaster: 1936 east span ignored modern seismic demand despite active faults.
- Hard lesson, big cost: 1989 collapse & $1 B loss proved 1930s risk assumptions obsolete.
- Code-changer: drove Caltrans/AASHTO to add base-isolation, ductility & seat-extender rules.
- Blueprint: retrofit/new east span now reference for U.S. lifeline bridge upgrades.
- Network resilience: isolation + SHM target <48 h reopening after 975-yr quake.

Next-Step Plan & Recommendations

Five action-oriented bullets

- **Quantify Redundancy & Robustness** – apply graph-theoretic load-path metrics to rank critical components and flag zones requiring selective strengthening..
- **Economy-Integrated Resilience Planning:** set life-cycle, risk-adjusted cost targets and choose the retrofit that delivers the required resilience at the lowest total ownership cost.
- **Embed Probabilistic Multi-Hazard Loading** – run Monte-Carlo scenarios that blend Hudson Valley seismicity, NYC wind climatology, scour and vessel-impact events.
- **Test mitigation options** – introduce LRBs, friction pendulums, tuned mass dampers, and aerodynamic baffles.
- **Compare & recommend** – rank each scheme by performance and cost, then select the optimal retrofit for NYSDOT.



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