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TOWARDS THE EARTHQUAKE-PROOF BRIDGE

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ABSTRACT: The primary objective of most seismic design specifications for bridges around the world is that of life-safety. This usually translates to a 'no-collapse' design philosophy, even for earthquakes larger than the design earthquake. Although this requirement is believed to be satisfied for bridges designed to current codes and collapse is unlikely in an earthquake, these bridges will be damaged and experience extensive plastic hinging in their columns with large residual drifts. In many cases this damage will be so severe the bridge cannot be repaired under traffic and may even have to be replaced. Life-safety may have been preserved but functionality has not, and the cost to rebuild (direct and indirect) will be a significant burden.
This presentation will review current research efforts to improve the post-earthquake functionality of highway bridges to the point that damage-free response appears to be within reach. Use of protective systems, innovative materials and smart configurations, are particularly applicable to new bridges either by introducing a damage reduction mechanism, or a re-centering mechanism, or both. In addition to seismic isolation, examples of innovative materials and smart configurations include (a) shape memory alloys, (b) ultra-high performance concrete, (c) elastomeric elements, (d) fiber-reinforced polymers, and (e) post-tensioning.

Not only are these innovations affordable, they have few, if any, side effects, such as high maintenance costs. Indeed the earthquake-proof bridge may be just around the corner, and particularly so in low-to-moderate seismic zones. However the cost effective seismic retrofitting of existing bridges to the same level of performance remains a significant challenge.