Design for extreme seismic event scenarios for long span bridges in the Ring of Fire

Nicholas R. Featherston

Mr

Mott Macdonald Limited

Johannesburg, Gauteng, South Africa
Nic.Featherston@mottmac.com

Senior Bridge Engineer responsible for Technical Governance. Experienced in cable stay bridge design, with a strong interest in materials science.

Contact: Nic.Featherston@mottmac.com

1 Abstract

Approximately 90% of the world's earthquakes and 81% of the world's largest earthquakes occur in a region known as the Pacific Ring of Fire. The very high number of recent earthquakes have given rise to fears that a larger and more cataclysmic event dubbed “the Big One” is simmering in the Ring of Fire. The potential destructive force of the Big One could erase cities and trigger tsunamis along the US East Coast.

It is therefore imperative that the designer of modern long span bridges for this region (and structures in general) recognizes the realities of not just climate change and its effects on extreme weather conditions, but also the changes to the seismic characteristics and topography of these regions. For these extreme seismic scenario events, the challenge to designers is to balance the mixture of solutions that involve the use of replaceable components for assemblies that often perform vital roles in attenuating the seismic response of the structure, with parts that are considered non-replaceable.

Some recent design examples are discussed, with a description of the work flow provided and reasons given for the use of the selected seismic dampening strategies.

Keywords: seismic, ring of fire, long span, bridges, design, isolation.

2 Introduction

On a recent project that the author was involved with, in the Pacific Ring of Fire region, not far from the Philippine Sea - the designer was informed that the structure was to be designed for a massive 0.6 g seismic force on a set of balanced cantilever type bridges of 100m central span. This brought about some significant challenges to the design of these bridges but also got the author interested in how one might design other similar long-span bridges in future, bearing in mind the trickier or more subtle aspects of seismic design that one would need to consider.

3 Dynamic behavior of long-span bridges under seismic loading

Bridges can be constructed to behave in a ductile manner under large earthquake loads. These ductile damage modes generally involve allowing the yielding of various structural members and corresponding plastic deformation in these members (see Figure 1). Once yielding occurs, the forces in the bridge cannot exceed those which

https://doi.org/10.2749/newyork.2019.1898

Distributed by Structurae