A Brief Introduction to: Segmental Displacement Control Design for Isolated Bridges

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Introduction

Structural Engineering

Structural engineers analyze and design past, present, and prospective structures. The main goals in designing a structure are that the strength and serviceability requirements are met.

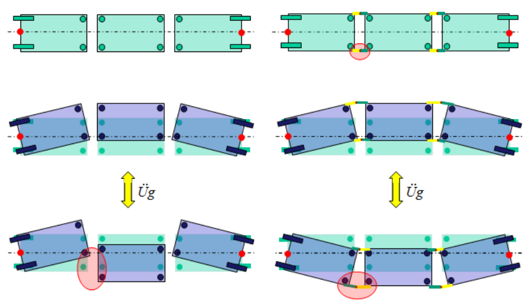
Earthquake Engineering

Earthquake engineering has grown in the past several decades as more people occupy and build in seismic areas. Seismic requirements have typically been met to safeguard from major loss of life before maintaining structural integrity. However, post-earthquake, structural integrity is becoming more necessary so that response and relief efforts can provide resources to affected communities.

Base Isolation

When engineering a structure, design strength must be greater than the required strength and new innovations like base isolation are very effective retrofits. Structures can be designed with a lower design strength as the base isolators absorb the earthquake loads through their own deformations. Base isolation allows the strength and serviceability to be met at a lower cost as losses are minimized.

Segmental Displacement Control

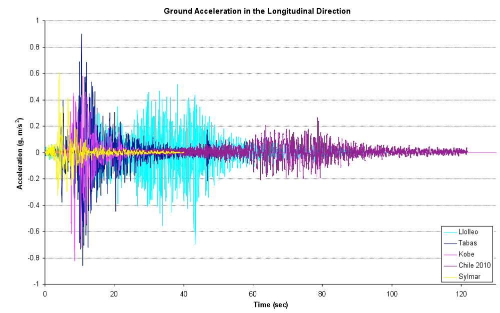


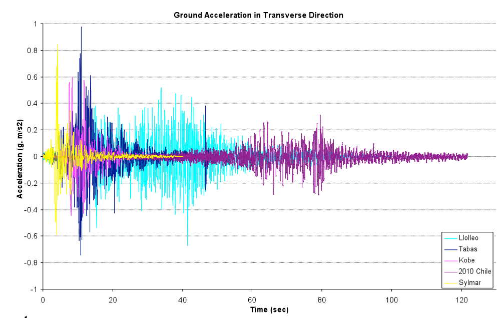
The figure above shows how a bridge specimen (in plan view) utilizes two isolation bearings, the triple pendulum bearing and the linear bearing, along with lock-up guides that all allow for segmental displacement control (SDC). Current practices utilize isolation devices, but these alone, as seen on the left side, may render the bridge inaccessible post-earthquake. SDC however helps reduce damage of expansion joints by limiting the span collisions. The lock-up guides act as connectors between the spans to guide their movements relative to one another when the earthquake loads and displacements are being applied. In this experiment, SDC is applied to allow for functionality post-earthquake.

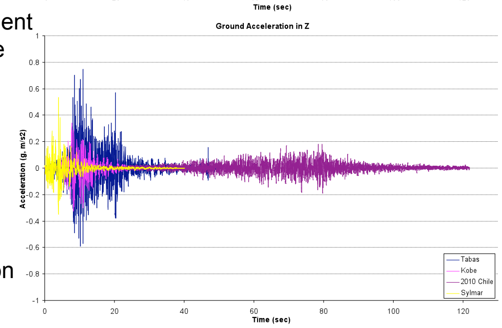
Ground Motions

The bridge specimen was tested on the shake table using five different specific ground motions, along with sine waves in the longitudinal and transverse directions. The five ground motions and their respective accelerations are displayed:

- •1978 Tabas, Iran XYZ
- •1985 Chile, Llolleo XY
- •1994 Northridge, Sylmar XYZ
- •1995 Kobe, JMA XYZ
- •2010 Chile XYZ

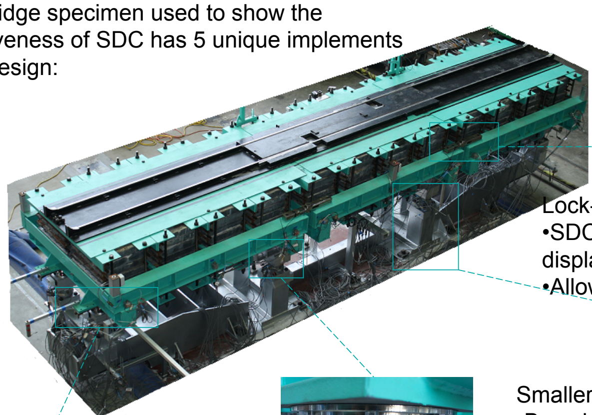






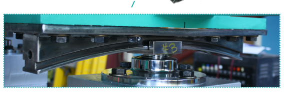
Bridge Specimen

The bridge specimen used to show the effectiveness of SDC has 5 unique implements in its design:

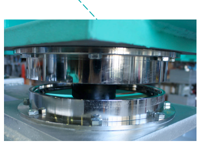


Rail
•Rotations reduced at bridge abutment
•Hinged only at ends to limit relative track displacements

Lock-Up Guide:
•SDC in relative transverse/longitudinal displacements
•Allow rotation and longitudinal translation

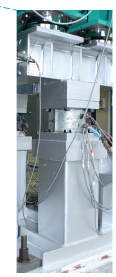


Linear Isolation Bearing:
•Allow rotations
•Limit displacement to movement along track



Triple Friction Pendulum Isolation Bearing:
•Allow for small and large displacement depending on local displacements

Smaller Column:
•Base isolation allows for:
•Attenuated column forces
•Reduced superstructure accelerations



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