UTC Project Information	
Project Title	MPC-415 – Framework of Performance-Based Earthquake Design of Curved and Skewed Bridges
University	Colorado State University
Principal Investigator	Suren Chen
PI Contact Information	Phone: (970) 491-7722 Email: suren.chen@colostate.edu
Funding Agencies	USDOT, Research and Innovative Technology Administration
Agency ID or Contract Number	DTRT12-G-UTC08
Project Cost	$122,000
Start and End Dates	January 1, 2013- December 31, 2013
Project Duration	1 Year
Brief Description of Research Project	Earthquakes pose serious threat to society and transportation infrastructure in the United States and around the world. Among all the highway bridges, most of them are straight ones with short and simple spans, which have been extensively studied during the past decades. Comparatively, there are a group of complex bridges which are more vulnerable to earthquake but not yet been sufficiently investigated, such as curved and skewed bridges. It is known that the offset angle of the superstructure of the skewed bridges may present advantages to the transportation layout. However, the dynamic response of this type of bridge has in the past led to failures, particularly due to unseating, under seismic loading. Examples of this kind of failure of skewed reinforced concrete bridges have been observed after the earthquakes in Northridge (1981), Costa Rica (1991), and more recently in Chile (2010) (Moehle & Eberhard, 2000). Curved bridges are also susceptible to the same asymmetrical failure response as that of skewed bridges. An example of where the curved geometry may have contributed to failure was the collapse of the South Connector Overcrossing during the 1971 San Fernando earthquake of magnitude 6.6 M_w. The South Connector Overcrossing (SCO) suffered collapse of two of its deck segments in addition to the column supporting it (Williams and Godden 1979). Despite the significant risk associated with failure and poor performance of those complex bridges, the related studies are still very limited (Bignell et al. 2005; Saadeghvaziri and Yazdani-Motlagh 2000; Maleki 2001; Saiidi and Orie 1992). There are also very little information which can be used for the design of these vulnerable bridges. The PI (along with a co-PI and a graduate student) is currently conducting a study on seismic analysis of Colorado bridges through advanced FEM modeling, which is sponsored by Colorado Department of Transportation. In this study, curved and skewed bridges are of special interests and will be modeled in detail. By taking advantage of the CDOT-funded study, the proposed study is to further develop the

	performance-based design framework specifically for curved and skewed bridges. It is expected that some useful design guidelines and insights can be found through the proposed study by applying the performance-based concept. **Research Objectives:** This study aims to develop the performance-based design (PBD) framework for curved and skewed bridges. With the PBD framework, people can (1) assess the probability of failure of the critical member and the whole bridge subjected to different earthquake hazard level; and (2) identify optimal design solutions based on the expected performance criteria.
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	Results show the curved and skewed geometries can considerably affect the bridge seismic fragility in a complex manner. Further detailed seismic risk assessment of skewed and curved bridges is needed in regions with low-to-moderate seismic activity.
Impacts/Benefits of Implementation (actual, not anticipated)	The findings will lead to improved seismic designs for curved and skewed bridges in moderate seismic zones.
Web Links • Reports • Project Website	http://www.ugpti.org/resources/reports/details.php?id=855