

Revisiting the BART Trains Stoppage Thresholds for Earthquake Early Warning System (Phase I)

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INTRODUCTION

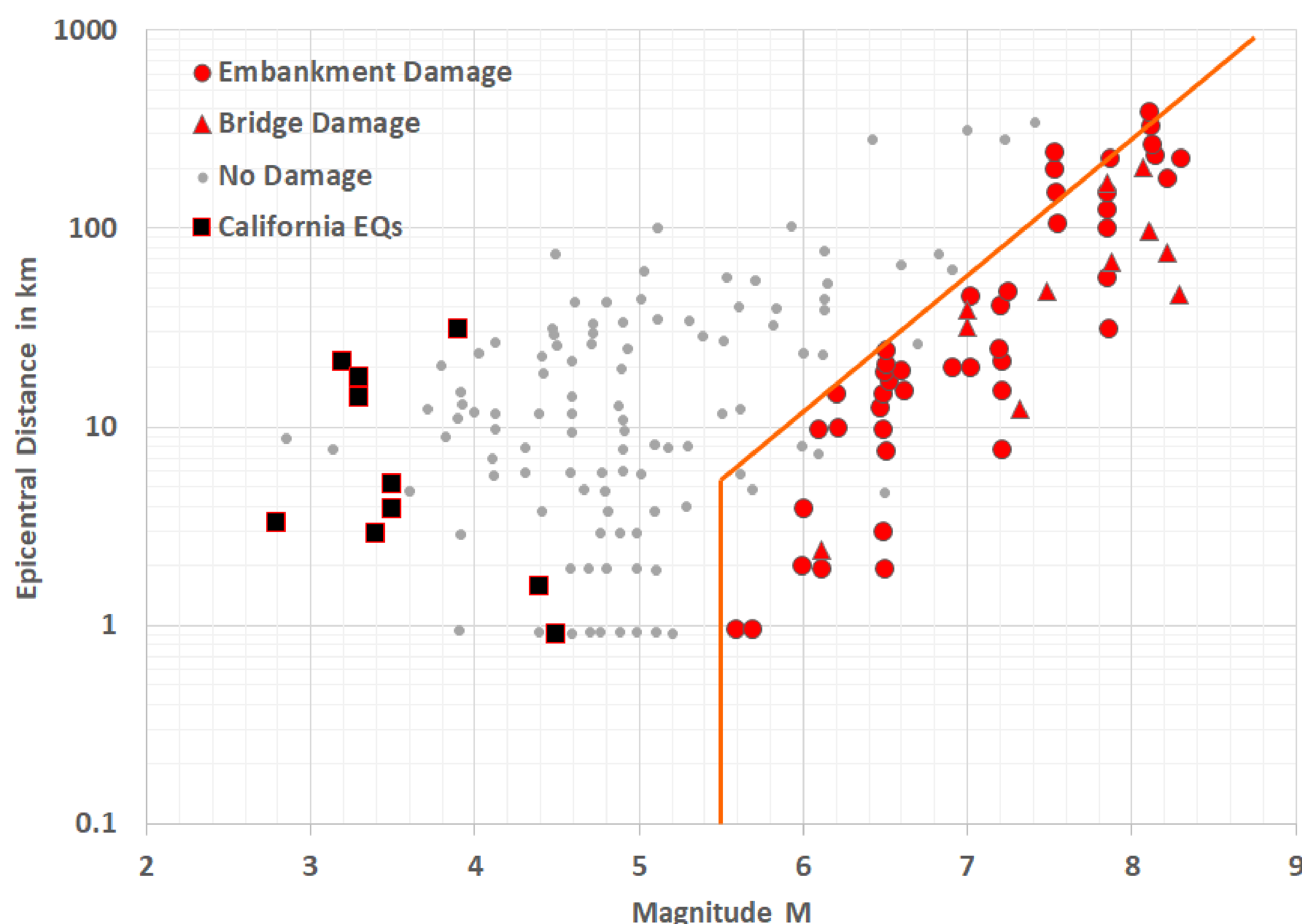
BART (Bay Area Rapid Transit) is the fifth-busiest heavy rail rapid transit system in the United States and serves a major part of the San Francisco Bay Area. Therefore, the seismic performance of BART system is essential for the resilience of the Bay Area communities. Proper slowing down and possibly stopping the trains upon detection of earthquakes are actions that can significantly assist the achievement of the resiliency objectives. The methods and thresholds for determination of slow down or stoppage should be carefully selected. Current phase of the project includes making recommendations to the revisited BART earthquake response plan.

OBJECTIVES OF PHASE I

- A comprehensive literature review of railway EEW (Earthquake Early Warning) systems and thresholds used worldwide.
- A comprehensive literature review of methods used for earthquake response plan of other railway systems.
- Provide recommendation for revisions of BART earthquake emergency plan.

EARTHQUAKE OBSERVATIONS

- A plot of magnitude and distance pairs of past earthquakes is shown below. Data is obtained from two sources: 1. Database by Nakamura and Saita (2007) & 2. Recent San Francisco Bay area, California (CA) EQs.
- Red points are EQs that caused damage. Orange lines represents the boundary between no damage and damage cases.
- Recent CA EQs did not cause damage to the BART system. However, some EQs caused slow down or stoppage of its trains.



WORLDWIDE ALGORITHMS

- Almost all systems currently in use utilize PGA (Peak Ground Acceleration) as the parameter for train stoppage and most of them are based on PGA measured from sensors.
- Most commonly used PGA threshold is 40 gals.
- Some researchers in literature proposed using CAV (Cumulative Absolute Velocity) as the threshold parameter for potential revision of the systems.

Country	System	Parameter	Threshold (gal ²)	Parameter (M or C) ³	Station Interval
Taiwan	HSR ¹	PGA	40	Measured	30 km
China	HSR	PGA	40	Measured	20 km
Japan	HSR	PGA	40	Measured	20 km
France	HSR	PGA	65	Measured	10 km
Turkey	Marmaray tunnel tube	PGA	40 (& several other levels)	Measured	~0.1 km
Canada	Railway	PGA	20 & 12.5 for stoppage & slow-down	Computed	NA
Korea	HSR	PGA	60 & 45 for stoppage & slow-down	Measured	13 km

¹High Speed Rail; ²1 gal = 0.1% g; ³Measured or Computed

WORK IN PROGRESS

- Study other methods, thresholds & parameters available in literature.
- Analyze the pros and cons of current and proposed methods and propose revisions of the BART emergency plan.
- Phase II: Conduct simplified & detailed computational study of the dynamic response of BART system.

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