DRISI

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Research Results

Pavement

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Load Testing of Bay Bridge Expansion Joint, Phase 2

A study to examine the performance of the newly designed bridge-deck joint.

WHAT WAS THE NEED?

Seismic expansion joints are necessary to accommodate movements in the longitudinal direction of bridge structures caused by thermal expansion and contraction, and by seismic events (when parts of the bridge shake differently). The joints planned for the new Eastern portion of the Bay Bridge are unique to California because they are installed lane-by-lane, instead of across the full width of the bridge. In order to ensure that the joints are robust enough for California traffic, Caltrans Design Engineers will test them with a Heavy Vehicle Simulator (HVS).

WHAT WAS OUR GOAL?

The overall objective of this project is to determine whether a new bridge-deck joint designed to be used on the Bay Bridge and designed for bridges in California that are in seismically active areas, will provide equal or better performance to that of conventional bridge-deck joints.

WHAT DID WE DO?

A relatively unique opportunity was recently identified for accelerated traffic load testing of a new bridge expansion joint design not previously used in California. This study was part of the construction of the new East Span of the San Francisco–Oakland Bay Bridge and assessed whether the new expansion joints (which were designed to function in harmony with the bridge decks in the event of a high-magnitude earthquake) planned for linking the Self-Anchored Span with the Transition and Skyway spans would withstand truck traffic loading.

A test structure incorporating one of the full-scale joints was constructed close to the actual bridge and tested with the California Department of Transportation / University of California Pavement Research Center Heavy Vehicle Simulator in a series of phases.

WHAT WAS THE OUTCOME?

A total of 1.36 million load repetitions, equating to about 46 million equivalent standard axle loads on a highway pavement, were applied in seven phases during the three-month test. On completion of this testing, no structural damage was recorded by any of the Linear Variable Differential Transducers (LVDTs) or strain gauges installed on the steel plates, steel frames, bolts, and washers. There was also no visible damage on any of these components.

Excessive overloading with a 150 kN half-axle load (approximately four times the standard axle load) on an aircraft tire in the last phase of the test caused some damage to the Trelleborg unit in the joint. The damage included abrasion, tearing, shoving and permanent deformation of the rubber inserts, and deformation and shearing of one of the steels supports directly under the wheel load.

Although no vehicle suspension dynamics (i.e., vehicle bounce) or speed effects were considered, based on the results of this limited testing, it was concluded that the Caltrans seismic expansion joint would perform adequately under typical Bay Bridge traffic. The distresses observed on the Trelleborg unit under high loads in the last phase of testing are unlikely to occur under normal traffic.

However, the Trelleborg unit was found to be the weakest point of the expansion joint, as expected. On the actual bridge structure, these units should be checked periodically to confirm the findings of this study, and to assess any effects of higher speeds and vehicle dynamics that were not identified. The joints will require periodic maintenance and replacement in line with manufacturer's specifications.

The findings from this study indicate that the Caltrans seismic expansion joint tested would be appropriate for typical Bay Bridge traffic. No seismic or structural testing was undertaken and no recommendations toward the expansion joint's seismic or structural performance are made. Ride quality, skid resistance, and tire noise studies were carried out by Caltrans in a separate study and are reported on in separate Caltrans reports.

WHAT IS THE BENEFIT?

The study determined that the expansion joints will be robust enough for traffic. It will also identified one potential failure mode, the Trelleborg unit, which then can be evaluated by bridge maintenance on an ongoing basis.

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www.ucprc.ucdavis.edu/PDF/UCPRC-RR-2011-06.pdf