Prediction and Monitoring of a Superload Passage

Prepared for:

The Iowa Department of Transportation

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In the summer of 2003, a series of superloads were scheduled to depart from the Waterloo, IA area for a location near Mason City, IA. Given the magnitude of the expected loads (600,000 to 900,000 lbs), the Iowa Department of Transportation (DOT) Office of Bridges and Structures requested that the Iowa State University Bridge Engineering Center (BEC) assist them in assessing the load carrying capacity of the most critical bridge along the scheduled route. The critical bridge is a 5 span, prestressed concrete girder bridge crossing a small creek and a railroad line. One span of this bridge was found, through traditional calculations, to be of greatest concern. This span has a total length of approximately 120 ft – 6 in. and has a six girder cross-section.

To assist the DOT in assessing this bridge, the BEC conducted a traditional load test on the bridge using various combinations of one and two loaded tandem axel dump trucks (see Fig. 1). Strain data was collected at three cross-sections of the critical span: near the west abutment, at mid-span, and near the first pier (see Fig. 2). Four girders were instrumented with 2 strain gages each (one each on the top and bottom flanges) at the sections near the abutment and pier and all six girders were instrumented with 2 strain gages each (one each on the top and bottom flanges) at the section near midspan.

From the data collected during the above mentioned test, a finite element model was created and calibrated. The final model had less than a 9% error at predicting the field test results. This model was then used to predict the response of the bridge to the first superload expected to cross the bridge (approximately 640,000 lbs). Typical strain results from this prediction are shown in Fig. 3. It was assumed for this analysis that the truck crossed the bridge centered on the bridge (not the roadway). As one would expect, a symmetric behavior was predicted as shown in Fig. 3. From this model, and further consultation with the DOT, it was determined that the bridge did have sufficient strength (both flexural and shear) to allow passage of the loads.

During passage of the first superload (see Fig. 4), the same instrumentation scheme was installed on the bridge prior to the load arriving. The response of the bridge was then measured as the load crossed the bridge. Typical results from this can be seen in Fig. 5 which shows the response at the same locations shown in Fig. 3 (note that the “truck position” scale in figures 3 and 5 are different as the monitoring and modeling were initiated from different locations). As one can see in comparing Figs. 3 and 5, there is very good correlation between the predicted and actual response at midspan. In Fig. 5 one can note, however, that the response does not appear to be symmetric (i.e., strain levels are different in symmetric girders). However, it should be pointed out that the truck did not track down the centerline of the bridge. This may be the source of some of the behavior seen in Fig. 5. Although not shown here, the predicted strain at the pier was not as accurate as that predicted near midspan and near the abutment. A brief post-loading visual inspection of the bridge reveled that additional cracking in the barrier wall and deck had occurred. This may account for the generally less accurate prediction.

In general, this approach (preliminary testing, modeling, and prediction) proved to be relatively easy to complete. Further, the results obtained show that, in general, good accuracy can be attained using this system and can provide bridge owners with additional valuable information.

Figure 1. Test trucks used to perform preliminary testing of Bridge.

Figure 2. Photograph of instrumentation used to monitor bridge response.

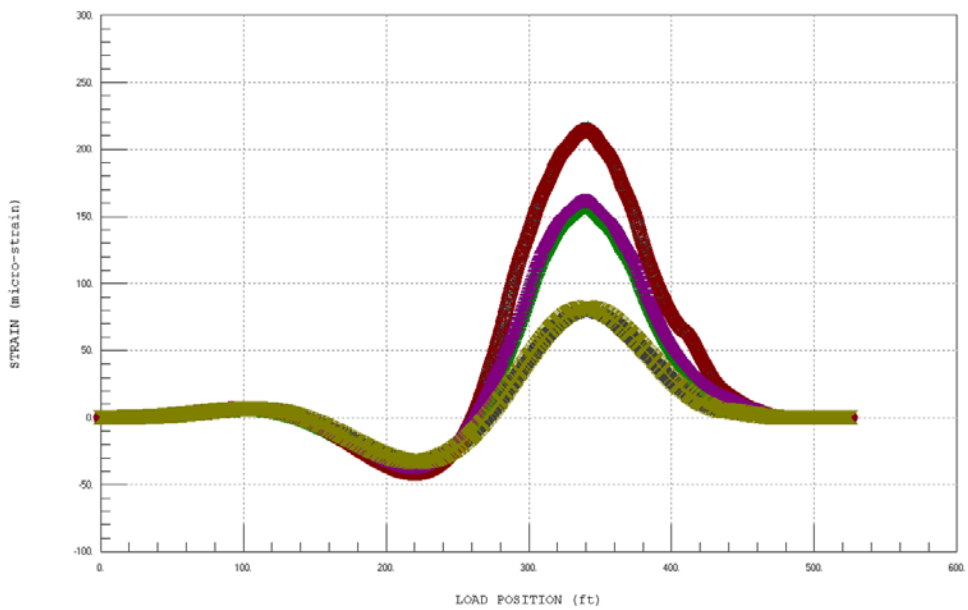

Figure 3. Predicted response at midspan to first superload passage.

Figure 4. Photograph of superload passage.

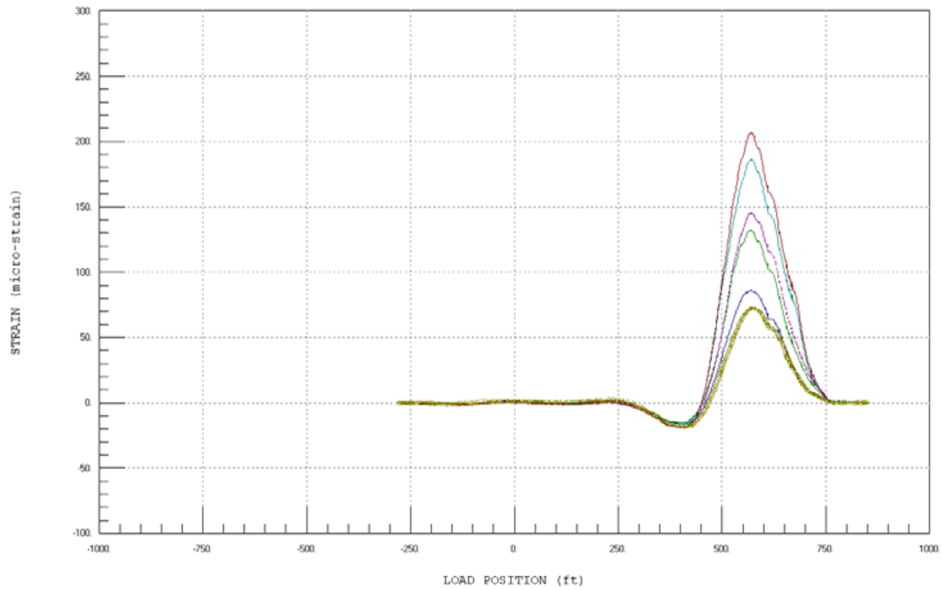

Figure 5. Actual response at midspan to first superload passage.