Design live load model for long span bridges

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Summary

This paper deals with the development of live load model for long span bridges. New live load model reflects real truck traffic data in Korea using Weigh-In-Motion system that was installed on the road with the heaviest truck traffic volume. By using collected WIM data, various truck traffic scenarios are considered assuming traffic jam condition. To analyze the load effect, typical long span bridge such as a suspension bridge and a cable stayed bridge are modeled by the structural analysis program. Based on the traffic scenarios, equivalent uniformly distributed load (EUDL) are calculated and loaded to the selected bridge. Based on the results of analyses, new live load model for long span bridges for Korea Bridge Design Code (LSD) is proposed as a combination of design truck and design lane load which the magnitude is decreased as influence line length become longer. Effects of effective influence line length are also analysed to specify the guideline for loading method of design lane load model.

1. Introduction

Current design code is mainly focusing on conventional bridge types with span length up to about 200m. Live load model in design code was also developed for these bridges. However, in Korea, with development of western and southern coast area where many islands are located, many long span bridges are being built or planned. With the urgent need of design code for long span bridges, Design Guideline for Steel Cable Bridges was developed in 2005 but live load model was based on limited truck data. The purpose of this study is to develop rational design live load model for long span bridges with span length up to 2,000m.

New live load model reflects real truck traffic data in Korea using Weigh-In-Motion system that was installed on the road with the heaviest truck traffic volume. By using collected WIM data, various truck traffic scenarios are assumed based on congestion condition. To analyze the load effects, typical long span bridge such as a suspension bridge and a cable stayed bridge are modeled by the structural analysis program. Based on traffic scenarios, equivalent uniformly distributed load are calculated and loaded to the selected bridge. The results of load effects are compared with other load model in internationally renowned design code such as AASHTO LRFD(2007), Honshu-Shikoku bridge design code(1989) and current Korea Bridge Design Code(2010). Based on the results of analyses, new live load model for long span bridges is proposed.

2. WIM system

In this study truck weight data are collected using WIM (Weigh-In-Motion) system. The WIM system measured each truck axle weight from piezo sensors installed in the surface of the pavement. Weight data and other information are stored in the main unit and can be downloaded to computer. WIM system was installed in January, 2010 on national road in Pohang area where heavy truck traffic is one of the highest in Korea..

3. Structure modelling

To analyze effects of truck traffic through WIM data, two typical long span bridges such as In-cheon Bridge(cable stayed bridge) and Lee Sun Shin Bridge (suspension bridge) are selected.

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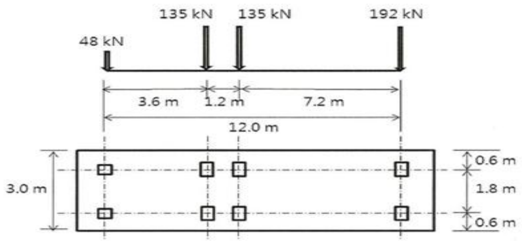
4. Development of live load model

Based on the results, new live load model is proposed that consist of 4 axle design truck as shown Figure 3 and design lane load as shown in Equation (1). The live load effect is selected either from design truck loading or design lane loading with 75% of design truck loading. This model is chosen to be consistent with newly proposed bridge design code with reliability-based design concept in Korea. The different values of *n* in Equation(1) is compared with EUDL of different scenarios as shown in Figure 4 and 0.15 is proposed since it is close to the results of Scenario 1-2, 2-1 which is considered to be reasonable scenarios.



$$L \le 60m : w = 12.7\ kN/m$$
$$L > 60m : w = 12.7\left(\frac{60}{L}\right)^{n}\ kN/m \qquad (1)$$

Fig 3: Proposed design truck model

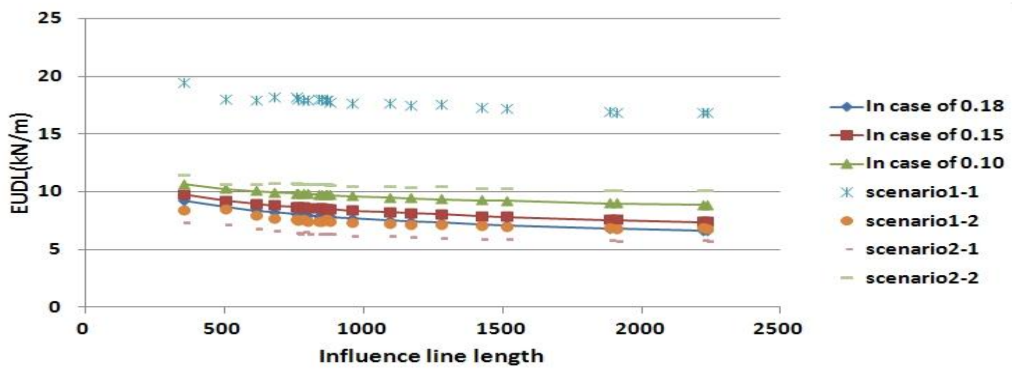


Fig 4: Comparison between truck traffic and live load model

5. Examination of the influence line analysis

Since some influence lines show the cusped shape (high peak with low and long tail), considering shorter influence line length may show larger load effect. To find out this phenomena, the load effects are calculated for various influence lengths that ranges 0 to 10 percent of the maximum influence line value. It can be concluded that effects of considering shorter influence line length may vary for each members and section forces and need engineering judgement.

6. Conclusions

This paper deals with the development of live load model for long span bridges using data from Bridge Weigh-In-Motion system. Various traffic scenarios based on congestion situation, are assumed and compared. New live load model is proposed as a combination of design truck and design lane load which the magnitude is decreased as influence line length become longer. From the comparison with other design load model in typical cable stayed and suspension bridge, the load effect by proposed model is smaller than AASHTO LRFD or current bridge design code in Korea and greater than Honshu-Shikoku bridge design code. Further study should be performed for longer period of WIM data and to analyze the multi lane loading effect.