

DIVISION OF RESEARCH AND INNOVATION
Research Initial Scope of Work
FY 10/11

I. Project Number: P285

Project Title: LRFD & LRFR Specifications for Permit & Fatigue Truck Loads

II. Task Number: 2122

Task Title: California Permit and Fatigue Truck Load Development and Calibration

III. Project Problem Statement:

Traffic loads used by Caltrans in Load and Resistance Factor Design (LRFD) and Load and Resistance Factor Rating (LRFR) applications are based on truck data collected largely outside California in the early 1980's. Real truck loads are widely recognized to vary significantly from site to site, and from state to state. A substantial body of weigh-in-motion (WIM) data collected since that time indicates that California truck loads have increased and load distributions have become more variable. These trends are reflected in accelerated rates of bridge deck deterioration. Thorough analysis of the WIM data and conversion into current LRFD and LRFR load factors for California is needed to improve bridge design and permit management practices.

California expects to improve the safety and service life of its bridges and get an effective return on the proposed study based on extensive WIM data collected over the past decade. New calibrated and WIM-based permit and fatigue live loads are vital to minimizing infrastructure costs, minimizing construction- and maintenance-related traffic congestion and supporting effective goods movement throughout California and the nation.

IV. Background/Objective:

The US bridge design and evaluation are rightly moving towards reliability-based practice using the American Association of State Highway and Transportation Officials (AASHTO) LRFD and LRFR specifications. This is realized by calibrated truck load models and associated load factors to cover uncertainty involved. There is a significant non-uniformity in loads over the country, and California is unique in many aspects of truck loading on its highway systems. Actual traffic loads on California highways need to be better understood, especially for annual permit truck loads that can control the safety of bridges for the Strength II Limit State and can dominate for the fatigue limit state.

Current Caltrans Amendments to the AASHTO LRFD Bridge Design Specifications for fatigue design are based on a comparison study of fatigue moments for steel girder bridges using the AASHTO LRFD and the Standard Specifications. The AASHTO Load and Resistance Factor Specifications for design and evaluation both prescribe a design truck with a load factor of 0.75, meant to equivalently model fatigue damage induced by actual truck loads. This provision is based on National Cooperative Highway Research Program (NCHRP) Report 299 (1987)

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which contains weight data of about 27,000 trucks collected from about 30 sites around the country in 1981. An equivalent weight of 54 kips was found, leading to a load factor of 0.75 applied to the 72 kips the gross vehicle weight of the design truck. WIM technology was used to collect this data but side-by-side truck occurrence on the same span was not incorporated due to the infancy of WIM technology. Further, the load data used in developing the LRFD and LRFR fatigue checking provisions are out of date, compared with today's load spectra and truck volume.

V. Task Description of Work and Expected Deliverables:

This project will conduct a thorough analysis of California WIM data to establish modern LRFD and LRFR load factors for both Strength II and Fatigue Limit States. Permit and fatigue load models and associated load factors for California will be recommended for adoption in the California Amendments to the AASHTO LRFD Bridge Design and LRFR Bridge Rating Specifications, and relevant examples and commentary will be prepared.

Proposed tasks and deliverables:

Task 1:

Review NCHRP 12-76 and other literature findings for state-of-the art WIM data applications to bridge design and evaluation, and WIM usage in calibrating reliability-based load and resistance factors. Review the attached results of the [preliminary investigation](#) conducted by CTC & Associates LLC (December 2009).

Task 2:

Gather relevant data and information on California WIM data, California annual and single permit vehicle configurations and permit routing policies, current California Amendments to the AASHTO LRFD Bridge Design Specifications, and current California bridge rating and evaluation practices.

Task 3:

Scrub/sort based on Caltrans permitting policies/analyze WIM data as required to modify Strength II in LRFD using California permit truck and permit practices.

Develop a work plan: calibration method, what and how much WIM data, target reliability values to be used for specification development.

Deliverable 1: Submit a work plan for Task 3 in collaboration with Caltrans project panel and have a face-to-face meeting in Sacramento, CA.

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Task 4:

Scrub/sort/analyze WIM data as required to develop a family of six permit truck configurations that will be used to issue annual permit, single permit, or super-loads permit considering frequency of the permit trucks, ADTT, and possibility of traveling with and without routine legal trucks for LRFR.

Develop a work plan: calibration method, what and how much WIM data, target reliability values to be used for rating. Discuss the six proposed permit truck configurations with the panel until consensus is reached.

Deliverable 2: Submit the proposed permit truck configurations and work plan for Task 4.

Task 5:

Scrub/sort/analyze WIM data as required to modify the fatigue load and load factor in LRFD as well as LRFR.

Develop a work plan for Task 5: calibration method, what and how much WIM data, target reliability values to be used for both design and rating. Seek and consider feedback from the panel

Deliverable 3: Submit the work plan for Task 5.

Task 6:

Scrub/sort/analyze WIM data as required to

Develop a load spectra (statistical parameters) of axle loads by considering side-by-side axle loads and differences between sites for deck design. Seek and consider feedback from the panel.

Deliverable 4: Submit work plan based for Task 6

Task 7:

Attend a face-to-face meeting in Sacramento, CA with project panel to discuss Deliverables 1-4. Also, discuss and develop consensus on examples that will be completed as a part of Task 9 and presented to Division of Engineering Services managers at a future meeting.

Task 8:

Carry out the work plan.

Task 9:

Develop recommendations for revisions to the specification language for the new models and load factors, in the form of California Amendments (template to be

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provided by Division of Engineering Services staff) and Caltrans structure maintenance guidance material. Prepare application examples of the proposed California Amendments and rating methods.

Deliverable 5: Prepare a presentation to discuss the research results, design examples, and proposed revisions to Caltrans documents with the Division of Engineering Services managers and the project panel

Task 10:

Deliverable 6: Prepare a final report to document the process and results of the research effort.

VII. Estimate of Duration: Approximately 24 months.

VIII. Related Research:

A Preliminary Investigation (PI) was completed by CTC & Associates LLC on December 16, 2009 at the request of Caltrans Division of Engineering Services. See the attached document for more information about the PI.

IX. Deployment Potential:

The project will produce revised LRFD and LRFR load factors for both Strength II and Fatigue Limit States based on current WIM data. The improved understanding of actual bridge live loads will allow for better bridge deck designs and better management of permit loads which in turn will reduce the rate of deck degradation and extend bridge service life. This outcome supports Caltrans stewardship goal as it both preserves and enhances California's transportation infrastructure.

The project intends to produce revised LRFD load cases based on California WIM data for both overweight permit and fatigue truck loads along with associated standard bridge-deck designs, specifications, and detail sheets for Structure Design. The project will also yield new or revised LRFR definitions regarding acceptable permit loads in Structure Maintenance guidance materials.

The project intends to produce a revised load factor for the Strength II- Limit State and a fatigue truck load and load factor for the Fatigue Limit State for LRFD, and a revised permit vehicle and a family of six permit vehicles and load factors for LRFR based on California WIM data and permit routing policies. The load factors need to be developed for longitudinal and transverse elements of superstructure and substructure and be based on approximate analysis methods and refined analysis methods. The project will also produce the axle load spectrum distribution for California

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