TECHSUMMARY October 2014

SIO No. 30000160 / LTRC Project No. 11-3P

The Rideability of a Deflected Bridge Approach Slab (LTRC Project 02-2GT Continuation: Phase II)

INTRODUCTION

DOTD has made attempts to use the standard international roughness index (IRI) to index bridge bumps. However, it was discovered that IRI has problems indexing localized roughness. A research effort was undertaken to investigate if there might be a means to overcome the aforementioned problem. As a result of this effort, completed in 2009, DOTD was able to develop the Posted-Speed Localized Roughness Index (LRIPS), which attempted to overcome the problems by returning to a response-type road roughness measuring systems (RTRRMS) approach. It was then discovered that the LRIPS could isolate the positions of localized roughness phenomena. However, with it being an RTRRMS, it did suffer from "transportability" and "suspension degradation" problems, which prevented it from being a tool adequate for measuring distress magnitude. The profiling community had also recognized that the standard IRI has problems coping with localized roughness. Through their efforts, the so-called 25-ft. moving base-length method of evaluating localized roughness ($IRI_{25\text{-}ft}$) was developed. Louisiana's attempts to use the $IRI_{25\text{-}ft}$ approach met with some difficulty, however. While the $IRI_{25\text{-}ft}$ methodology indexed bumps adequately, DOTD had difficulty using it to locate the position of bumps on the pavement. This research sets details as to how the $IRI_{25\text{-}ft}$ method and the LRIPS method can be used in a complementary fashion to overcome the limitations of each.

OBJECTIVE & SCOPE

This research was initiated in order to determine the means by which the $IRI_{25\text{-}ft}$ and LRIPS localized roughness testing methodologies might be employed in combination so as to take advantage of their respective strengths and to overcome their respective weaknesses in localized roughness testing. Forty bridges along I-10 located across six parishes, comprising five control sections, were analyzed using DOTD's high speed laser profiler (HSLP). The data collected were analyzed using both the $IRI_{25\text{-}ft}$ and LRIPS methodologies. A series of synthesized profiles were then developed in order to parametrically investigate $IRI_{25\text{-}ft}$ and LRIPS reaction to special profile cases not available in the field so as to better refine and understand the combined index.

METHODOLOGY

An HSLP equipped with laser and accelerometer was used to simultaneously collect and record $IRI_{25\text{-}ft}$ and LRIPS plots during testing. $IRI_{25\text{-}ft}$ was calculated using traditional methods: on-board laser and accelerometer employed to backcalculate road profile; ProVAL, a software package specially designed for the purpose, was used to calculate the $IRI_{25\text{-}ft}$ curves for the profiles. LRIPS was calculated solely from the HSLP's accelerometer signal using a specially developed algorithm developed by DOTD. $IRI_{25\text{-}ft}$ and LRIPS plots were then comparatively analyzed. Special note was taken of instances where the $IRI_{25\text{-}ft}$ and LRIPS methodologies complemented each other (i.e., cases where LRIPS plots could be used to reveal distress magnitude, location, or type wherein the $IRI_{25\text{-}ft}$ plots could

LTRC Report 531

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not and vice versa). Three areas of assessment were examined:

Distress Magnitude: Ability of index to produce consistent, repeatable results that clearly index the magnitude of the localized distress.

- $IRI_{25\text{-}ft}$ and LRIPS both register bumps similarly
- LRIPS registers significant bumps where the $IRI_{25\text{-}ft}$ does not
- $IRI_{25\text{-}ft}$ registers significant bumps where the LRIPS does not

Distress Location: Ability of the index to produce consistent, repeatable results that clearly and accurately determine the location of the distress on the road.

- Distress location could be clearly discerned in both the $IRI_{25\text{-}ft}$ and LRIPS plot
- Distress location could be clearly discerned in the LRIPS alone
- Distress location could be clearly discerned in the $IRI_{25\text{-}ft}$ alone

Distress Type: Ability of the index to produce consistent, repeatable results that identifies distress type, such as fault, rut, bump, etc.

- Distress type could be discerned in both the $IRI_{25\text{-}ft}$ and LRIPS plot
- Distress type could be discerned in the LRIPS alone
- Distress type of distress could be discerned in the $IRI_{25\text{-}ft}$ alone

In addition to the preceding analysis, it also needed to be proved that the LRIPS distress "types" would be maintained on vehicles other than HSLP. To investigate this, a mathematical model was developed that could be used to test vehicles with different suspension characteristics on specially prepared profiles.

CONCLUSIONS

Both the $IRI_{25\text{-}ft}$ and the LRIPS must be derived from the same accelerometer signal for the combined index to work. $IRI_{25\text{-}ft}$ was better at indexing bump magnitude than LRIPS as expected. The $IRI_{25\text{-}ft}$ did not miss any localized bumps that LRIPS had confirmed existed. The LRIPS was able to clearly and correctly locate the position of bumps for almost every case examined. LRIPS was better at assessing distress types than was $IRI_{25\text{-}ft}$ because LRIPS allowed for bumps to be closer together. LRIPS could identify distress type independently of the vehicle used, provided that the shock absorber constant was held to a value where the ratio of the HSLP's shock absorber damping factor to its sprung mass was close to or equal to 6.0 s-1. The $IRI_{25\text{-}ft}$ often could not reliably locate the position of bumps on pavements. $IRI_{25\text{-}ft}$ peaks lagged or led the LRIPS peaks by as much as ± 30 ft. (as much as ± 8.0 ft. in 44 % of the cases examined). In many cases, the $IRI_{25\text{-}ft}$ could not be used to locate the position of bumps because it was not possible to find clearly delineated leading edges or peaks in the $IRI_{25\text{-}ft}$ plots. As expected, LRIPS was not able to index bump magnitude due to transportability and suspension degradation problems. Both indexes (LRIPS and $IRI_{25\text{-}ft}$) showed that they could be used to determine distress type provided there was enough separation between bumps.

RECOMMENDATIONS

It is recommended that the $IRI_{25\text{-}ft}$ and LRIPS indexing system should be utilized in a complementary fashion to index bumps. The $IRI_{25\text{-}ft}$ should be used in that regard to assess bump distress magnitude and the LRIPS should be used to determine where on the pavement bumps occur and to define distress type.

It is recommended that the $IRI_{25\text{-}ft}$ and LRIPS indexing system be used by DOTD's Bridge Maintenance Section to assess the Department's bridge inventory. The findings from this effort should be used to establish a bump specification.

It is recommended that the $IRI_{25\text{-}ft}$ and LRIPS indexing system be incorporated into ProVAL. At present, LRIPS indexing is accomplished through a spreadsheet analysis that utilizes macros to arrive at the LRIPS score.