論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	A Study on Load Sensing and Local Stress Approach for Fatigue Assessment of Steel Bridge Deck Structures
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出典(和文)	学位:博士(学術), 学位授与機関:東京工業大学, 報告番号:甲第10680号, 授与年月日:2017年9月20日, 学位の種別:課程博士, 審査員:佐々木 栄一,廣瀬 壮一,WIJEYEWICKREMA ANIL,岩波 光保,福田 大輔,小林 裕介
Citation(English)	Degree:Doctor (Academic), Conferring organization: Tokyo Institute of Technology, Report number:甲第10680号, Conferred date:2017/9/20, Degree Type:Course doctor, Examiner:,,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	土木工学　専攻	申請学位（専攻分野）： Academic Degree Requested	博士　（ 学術 ） Doctor of
学生氏名： Student's Name	Cao Vu Dung	指導教員（主）： Academic Supervisor(main)	佐々木　栄一
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Steel bridge deck structures have experienced fatigue damage due to overweight vehicles and inappropriate structural details. The study aims to enhance the fatigue assessment of steel bridge deck structures through the following approaches.

First, a vehicular live load sensing system using power-generating polyvinylidene fluoride (PVDF) sensors was proposed for live load evaluation using bridge weigh-in-motion (BWIM) algorithms. BWIM measurements in steel bridge deck structures generally demands the sensing ability of sensors in the low frequency region of about 0.1 to 20 Hz and linearity between the applied load and the sensor response. These features have been demonstrated by PVDF sensors through fundamental laboratory experiments including tensile tests using tensile specimens and impact tests using a cantilever beam on which PVDF sensors were attached. The ability of PVDF sensors to reasonably capture extremely low amplitude loading equivalent of a micro strain was demonstrated. The effect of strain distribution over the sensor area on the sensor response was clarified through both experimental impact tests with varying impact force locations and parametric studies on the effects of sensor size and sensor position using numerical simulation of the sensor response to impact forces. The output voltage response of a PVDF sensor attached to a steel cantilever beam subjected to impact loading could be reasonably predicted based on the fundamental knowledge of piezoelectricity, classical beam theory, and signal conditioning. Excellent capability of PVDF sensors in capturing the fundamental natural frequencies of the cantilever beam was demonstrated. Linearity between high strain-rate loading and the response of PVDF sensors was demonstrated through identification of impact forces applied to a cantilever beam on which a PVDF sensor was attached. The temporal history of the impact forces could be reasonably identified using the concept of Green function.

Next, a first-time application of PVDF sensors for live load evaluation using BWIM algorithms in an actual RC-deck steel bridge was conducted. The applicability of PVDF sensors for the axle- and gross vehicle weights identification has been demonstrated through running tests using a three-axle calibration truck. Performance of PVDF sensors was demonstrated through identification of vehicle speed and axle spacing which are the two most critical parameters for BWIM algorithms. Both in-lane transverse sensors and in-lane longitudinal sensors exhibit sensitivity to individual axle passages, thus, can be utilized to detect vehicle axles. A good accuracy of vehicle speed by both longitudinal and transverse sensor pairs located on the same lane was demonstrated. Moreover, the axle spacing of the calibration truck could also be identified with good accuracy, which verifies the accuracy of vehicle speed identification. BWIM algorithm using the time-domain influence line method was employed for vehicle weight identification to verify the applicability of PVDF sensors for identification of axle weight of vehicles. An acceptable accuracy of vehicle axle and gross weight identification using BWIM algorithm based on the influence line method was achieved. Furthermore, in-lane transverse sensors have demonstrated abilities of both weighing sensors and axle detecting sensors and thus are recommended for a BWIM algorithm using two sensors per lane in RC-deck steel bridges. Overall, PVDF sensors have proved to be a promising alternative technology for the conventional foil-type strain gauges in vehicle weight identification.

In addition, to improve fatigue assessment of orthotropic steel bridge decks (OSDs), investigation on the effect of weld-root existence on fatigue assessment and fatigue strength of rib-to-deck (RD) welded joints in OSDs using a local stress approach based on the FEM effective notch stress (ENS) and the newly proposed RD welded joint with no-root weld (100% WP) was conducted. The local stress approach using the ENS method was employed to evaluate local effective notch stresses at the weld root and toes of the RD joints for fatigue strength evaluation. The obtained local stress distribution agrees with the crack

initiation locations and propagation direction observed in fatigue tests. A parametric study on the effect of weld penetration (WP) indicates that a deeper partial penetration ratio results in a slightly higher local effective notch stress at the weld root. The effect of WP is not significant for partial penetration (from 75% to 90% WP ratios). However the open angle has a governing effect on the local effective notch stress at the weld toes of the RD joint with 100% WP. A combination of 100% WP and an open angle of 1350 could result in about 20% stress reduction (i.e., doubled fatigue life) of RD joints. Fatigue strengths of the RD joints employed in the fatigue tests were evaluated using the results of local stress evaluation and the fatigue lives obtained from the fatigue tests to create a S-N curve.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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