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# “Technical Research and Development for Road Policy Quality Improvement” Study Summary

| No. | Title | Principal Researcher |
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| No.24-9 | Development of Moving Wheel Deflectometer (MWD) and pavement soundness evaluation using MWD | Tokyo Univ. of Agriculture Prof. Yasushi TAKEUCHI |

In this study, in order to grasp rapidly a pavement structural deterioration something like a decline of bearing capacity of subgrade and a cavity by deterioration of the underground life line, Moving Wheel Deflectometer (MWD) as a non-destructive inspection device was developed. And pavement soundness evaluation using MWD was carried out in this study.

## 1. Backgrounds and Objectives

In order to secure smooth and safety traffic, an effective framework to maintain the enormous road stock for million kilometers under a limitation condition of a limited budget and the staff is needed. Therefore, in the pavement management under the network level, it is important to detect a bearing capacity fall point quickly and maintain / repair it effectively.

FWD (Falling Weight Deflectometer) is utilized widely in Japan for a soundness evaluation of the pavement. FWD is a fixed point loading type nondestructive testing device that the deflection of the road surface when impact load acted. Therefore it will need enormous measurement time to perform soundness investigation of the pavement for a long range with FWD.

From these backgrounds, the objective of this study is development nondestructive testing equipment (Moving Wheel Deflectometer, MWD) which can measure deflection of the pavement surface continuously occurring by wheel loading. And the other objective of this study is to establish a pavement soundness evaluation framework using MWD based on the actual road testing results.

## 2. Activities in Research Period

In this study, laser Doppler vibrometers were installed in the metal box which fixed rigidly on the vehicle rear wheel axle of the MWD chassis, and calculated maximum deflection occurred at the vicinity of a rear wheel from deflection speed measured by the Doppler vibrometers. And in this study, measurement precision of MWD was examined by comparing the deflection of FWD with MWD.

In addition, a soundness evaluation method of the asphalt pavement that considered the variation/ unevenness of deflection was examined based on the multilayered elastic theory.

## 3. Study Results

In 2012 and 2013, at the circumference road in the National Institute for Land and Infrastructure Management (Tsukuba), a loading examination use special vehicle (wheel load 49kN) was used for MWD, some deflection analysis precision improvement method and a pavement soundness evaluation method were examined. Furthermore, a new MWD with the medium-sized vehicle, which can run on a general road, was made.

In 2012, concerning about the deflection analysis precision improvement method, in order to remove a noise by the vehicle vibration, the moving average processing was adopted. However, the noise was not able to remove sufficiently. Therefore in 2013, the discrete wavelet analysis was conducted to remove the noise. As the result, as shown in Figure-1, it was found that the analytical results of MWD accorded well with the FWD results and the analysis precision of MWD improved. In addition, it was found that the threshold value of deflection (dashed lines in Figure-1) using FWD and MWD results was almost same and appropriate value.

In 2014, MWD testing with the medium-sized vehicle (Figure-2) in the general road was carried out, and confirmed its measurement precision. Load of the medium-sized vehicle was lower than FWD. Therefore, in order to revise this effect, the medium-sized vehicle based MWD is measuring wheel load continuously. As a result, like an experimental result of Figure-1 using the special vehicle, the experimental result of MWD accorded well with result of FWD as shown in Figure-3 by doing load revision.

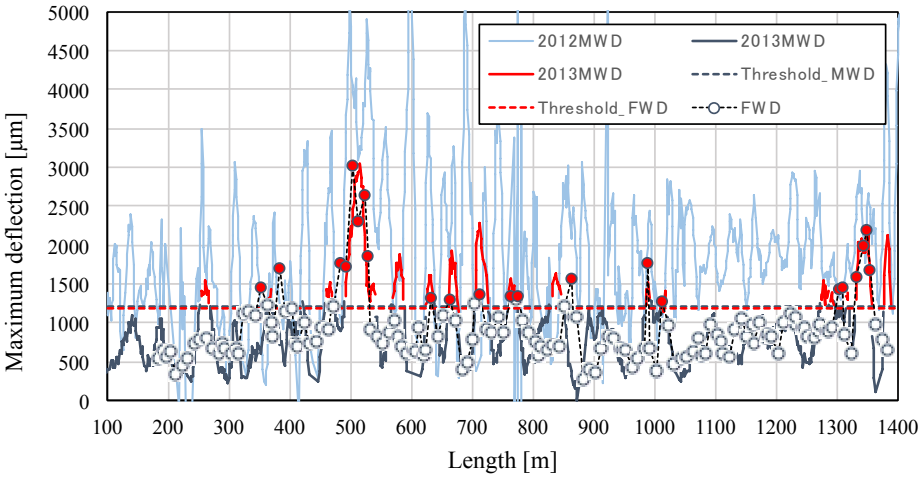


Figure-1 Relationship between MWD and FWD testing results

Figure-2 Medium-sized vehicle based MWD

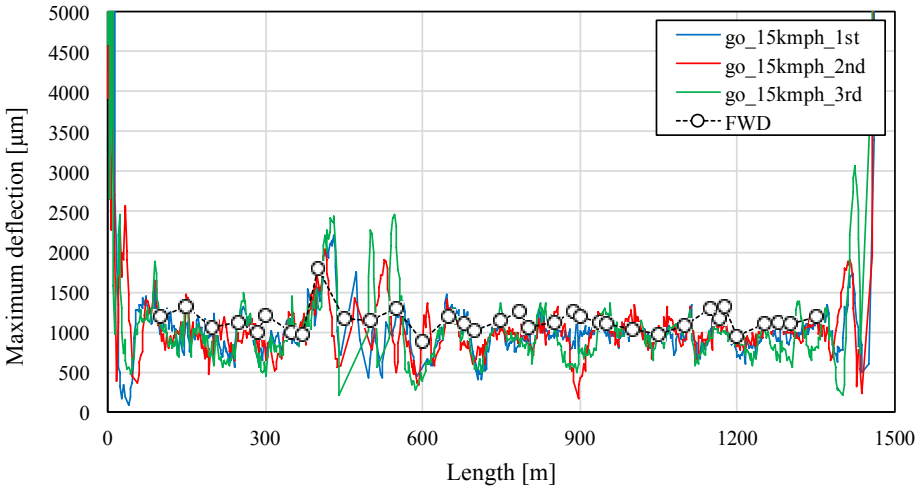


Figure-3 Relationship between MWD and FWD testing results on a general road

## 4. Papers for Presentation

・M.Tanabe, Y.Takeuchi, F.Kawana, H.Okazawa and K.Kubota : Study on soundness evaluation method for asphalt pavement considering variation/unevenness of deflection, Proc. of 69th annual meeting of JSCE, V-284, CD-ROM, 2014.
・Y.Takeuchi, F.Kawana, K.Watanabe and K.Matsui : Development of Moving Wheel Deflectometer (MWD) and pavement soundness evaluation using MWD – Results of special vehicle based MWD -, Proc. of 70th annual meeting of JSCE, V-322, CD-ROM, 2015.
・F.Kawana, Y.Takeuchi and K.Matsui : Development of Moving Wheel Deflectometer (MWD) and pavement soundness evaluation using MWD – Results of medium-sized vehicle based MWD -, Proc. of 70th annual meeting of JSCE, V-323, CD-ROM, 2015.
・K.Watanabe, Y.Takeuchi, F.Kawana and K.Matsui : Development of Moving Wheel Deflectometer (MWD) and pavement soundness evaluation using MWD – Results on a general road using medium-sized vehicle based MWD -, Proc. of 70th annual meeting of JSCE, V-324, CD-ROM, 2015.

## 5. Study Development and Future Issues

Moving Wheel Deflectometer (MWD) developed in this study has very simple constitution as follows:

(1) Install laser Doppler vibrometers in the metal box which fixed rigidly on the vehicle rear wheel axle of the MWD chassis.
(2) Remove noise of measured deflection speed caused by the vehicle vibration by using the discrete wavelet analysis.
(3) Calculate maximum deflection occurred at the vicinity of a rear wheel.

And two kinds of vehicles the large-size, the medium-size were used as a base vehicle of MWD in this study, and it was confirmed that both MWD had equal measurement precision under the condition of this study. However, in the case of the heavily trafficked pavement structure, the measurement precision may deteriorate because wheel load is small by medium-sized vehicle. In this case, a large-sized vehicle should be chosen. Because MWD has very simple constitution, it is thought that such an operation is possible.

FWD has higher measurement precision than MWD, and, however, MWD is more advantageous by the measurement for the long range. Therefore, MWD is positioned as a screening testing device before FWD testing in this study. But the following matters can be nominated as a future problem.

(1) It should be grasped that relationship of run speed of MWD and vibration characteristic of MWD and pavement surface roughness.
(2) It should be accumulated measurement data in order to plan precision improvement as the screening testing device.

## 6. Contribution to Road Policy Quality Improvement

In the pavement management under the network level, it is important to detect a bearing capacity fall point quickly and maintain / repair it effectively. MWD is positioned as a screening testing device before FWD testing in this study. Consequently, FWD has higher measurement precision than MWD, and, however, MWD is more advantageous by the measurement for the long range.

As shown in Figure-1, Figure-3, it is the result in the limited condition, but it is thought that MWD has precision as the screening testing device. From these results, it is thought that MWD can contribute to the effective management (for the road policy quality improvement) of the existing road stock.

## 7. References, Websites, etc.

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