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Experimental Verification of the Effect of Asphalt Mixture on Coil Embedment for Dynamic Wireless Power Transfer

-Distance Between Pavement Material and Coil, Rolling Compaction and Heat-

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1. Background

The world is accelerating the electrification of vehicles to achieve a carbon-neutral society. However, electric vehicles currently face issues such as high cost and short cruising range compared to conventional gasoline-powered vehicles, as well as the convenience of wired recharging. In order to solve these problems, research is being conducted on dynamic wireless power transfer (DWPT), in which power is supplied to a moving vehicle from a coil embedded in the road.

Fig.1. Block experiment

Fig.2. Coil case thickness change experiment

2. Research Purpose

The transmission side coils for DWPT are embedded in the road, and it has been reported that the coil characteristics deteriorate. However, it has not been clarified whether this is due to the rolling compaction and heat during road construction or the effect of the pavement material. In this study, it will be determined whether the deterioration of coil characteristics is due to compaction or heat during construction, or whether it is due to the asphalt pavement. In addition, the distance characteristics between the coil and asphalt are verified.

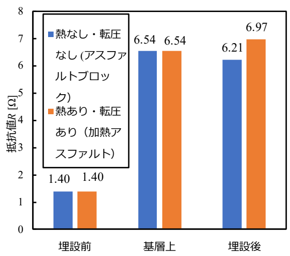

Fig.3. Comparison of rolling compaction and heat (resistance R)

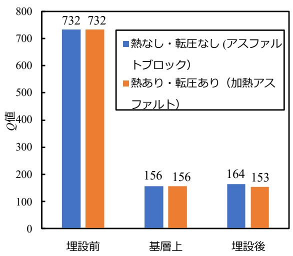

Fig.4. Comparison of rolling compaction and heat (Q-value)

3. Simple coil embedment experiment

In this study, two experiments were conducted: a block experiment and a coil case thickness change experiment in an environment simulating a road environment by installing coils inside a wooden formwork and laying asphalt. Three coils were used for verification, with the transmission side being a self-resonant coil without ferrite and capacitor for low cost.

The block experiment was conducted to verify the effect on the coils due to compaction, which is the process of compacting asphalt. Fig. 1 shows the experimental conditions of the block experiment.

In the coil case thickness change experiment, Styrofoam (XPS) was installed on the top and bottom of the coil case to move the distance between the coil and the asphalt pavement away from the coil, with the objective of reducing the effect of the pavement material. Fig. 2 shows the experimental situation of coil case thickness change.

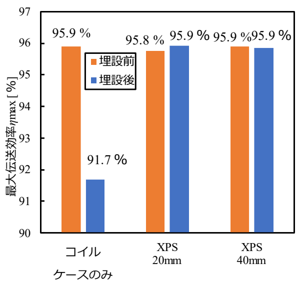

Fig.5. Variation of efficiency with coil case thickness

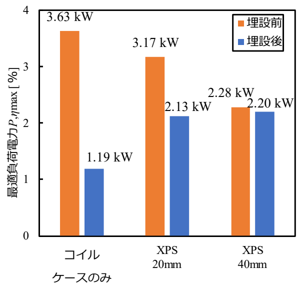

Fig.6. Variation of power with coil case thickness

4. Results of comparative investigation of rolling pressure, heat, and distance between coil and asphalt

The measured Q-values of the coils in the block experiment are shown in Fig. 4. The deterioration of the characteristics after burial is slight, about 10%, compared to when the base layer was installed. The Q-values after embedment were almost similar, with a difference of about 10%. Therefore, it is clear that there is no effect of heat and compaction during installation.

In the power transmission evaluation by VNA in the coil case thickness change experiment, the transmission efficiency was about 0.5% to 1% higher with XPS 20 mm and 40 mm than with the coil case only, and the power was about 2 to 3 times higher. Therefore, it is clear that thicker coil cases and moving the coils away from the asphalt can reduce the deterioration of the characteristics after embedment.

5. Conclusion

In this study, in order to isolate the cause of the deterioration of the characteristics of coils for wireless power supply during road burial, this study focused on the rolling pressure and heat during construction, and the distance between the coil and asphalt, and verified them through experiments. As a result, it was found that rolling pressure and heat during construction had no effect on the coils. In addition, when the coil was moved 40 mm away from the asphalt pavement, there was no deterioration in the properties of the coil before and after embedment.