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Air Gap Design of in-Tire Repeater Coil for Dynamic Wireless Power Transfer System Considering Tire Deformation

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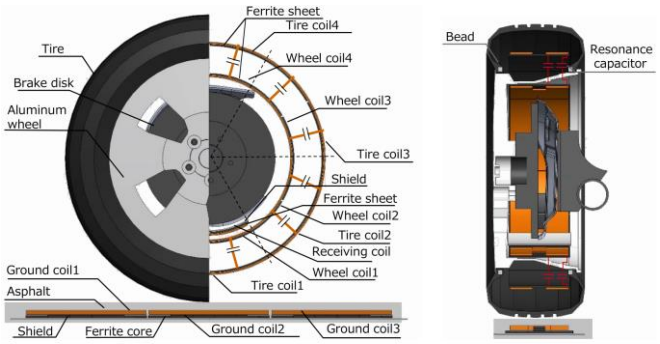
Wireless power transfer (WPT) to in-motion electric vehicles can extend the cruising range without additional batteries. Our group has already proposed a novel dynamic WPT (DWPT) system using in-tire and in-wheel repeater coil as shown in Fig .1, which can shorten the air gap between the coils on the road and tire sides. In WPT system, the air gap should be as small as possible from the viewpoint of efficiency and leakage electromagnetic field. However, it is necessary to have a sufficient air gap to avoid coil damage by tire deformation. The maximum amount of tire deformation when overcoming bumps of various heights at different speeds is measured with a high-speed camera as shown in Figs .2 and 3. The measured results (Fig. 4) show that self supporting runflat (SSR) tires can reduce air gap compared to normal tires. Under the conditions of the air gap designed based on the measurement results, the coupling coefficient between the ground coil and the in-tire repeater coil is compared between normal tires and SSR tires by simulations and measurements. The coupling coefficient in SSR tire system is larger by more than 10%. Since the leakage electromagnetic field and efficiency in the DWPT system are improved by the larger coupling coefficient, the performance of the proposed DWPT system will be improved by utilizing the SSR tire.



(a) Frontview. (b) Cross section view.

Fig. 1 In-tire and in-wheel repeater DWPT system.

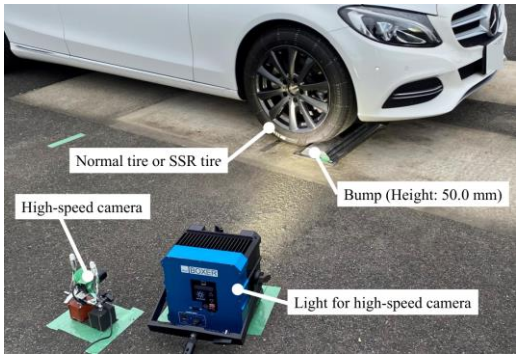


Fig. 2 Experimental setup for the riding over experiments.

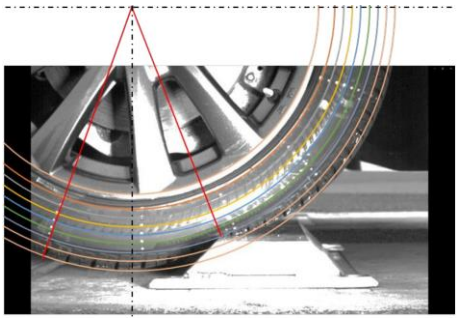


Fig. 3. Tire maximum deformation when riding over 50. 0mm height bump at 15 km/h.

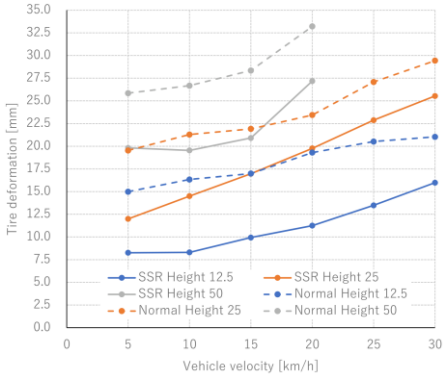


Fig. 4 Experimental results of tire maximum deformation.