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SIMPLE MODELING FOR STIFFNESS EVALUATION OF BOLTED JOINTS USING INTERFACIAL ELEMENT

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Bolted joints are one of major joining methods of dissimilar materials required to construct multi-material structures. Bolted joints have high joint strength because the external load is supported by bolt axes. On the other hand, the stiffness of bolted joints easily changes depending on the surface texture at the contact surface of jointed members and the clamping force of the bolt and nut. This is caused by the contact state between the microscale asperities at the contact surfaces which affects the transmission of the force between the members. In particular, the effect of the clamping force is remarkable. The interfacial stiffness and the natural frequency of the jointed part decrease with the decrease of the clamping force.

The previous study developed a novel finite element named interfacial element which simulates the contact between microscale asperities at contact surfaces of bolted joints [1]. In this element, the contact is assumed to be the Hertzian contact of elastic asperities whose peak heights obey the Gaussian distribution [2][3]. Based on this assumption, the stiffness of the interfacial element is derived from the compressive stress and the surface texture of the interfaces.

This study has further proposed simple modeling for stiffness evaluation of bolted joints using the interfacial element. It is necessary for large-scale simulations that target the entire vehicle body to reduce the number of nodes and elements in the finite element models. Finite element simulations by simplified models in which heads, axes and holes of bolts were ignored were conducted and compared with detailed models and hammering tests. The results revealed that the natural frequency of the simplified models had good agreement with that of the detailed models and hammering tests. The calculation accuracy of the simplified models decreased with the decrease of the clamping force because the bolt holes and the bolt axes affected the natural frequency in the detailed models when the clamping force was low.

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