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Development of a Fatigue Life Assessment System Based on the Virtual Working Simulation for Wheel Loader

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The main issue in designing construction equipment is to find an optimum point considering numerous design constraints such as durability, productivity, fuel efficiency etc. The fatigue safety is one of the most important design requirements because construction equipment undergoes various and severe loads. Meanwhile, the fatigue safety has been verified through field test, which consumes a large amount of time and cost. Therefore, it is necessary to build up a reliable and nimble fatigue life assessment system which can be used in early design stage before making real prototype.

This study presents the fatigue life assessment system for wheel loader through virtual working simulation as shown in Figure 1. The system is composed of a soil-tool model and an operator model for realistic working simulation, as well as dynamic wheel loader model. The dynamic model was implemented to mimic real equipment in view of the characteristics of weight balancing and cylinder force balancing. The soil-tool interaction model was devised to describe the reaction forces between bucket and soil during scooping and dumping operations. The operator model was developed to generate the time history of bucket, boom, steering cylinders' strokes and driving tire torque corresponding to the specific designer's input

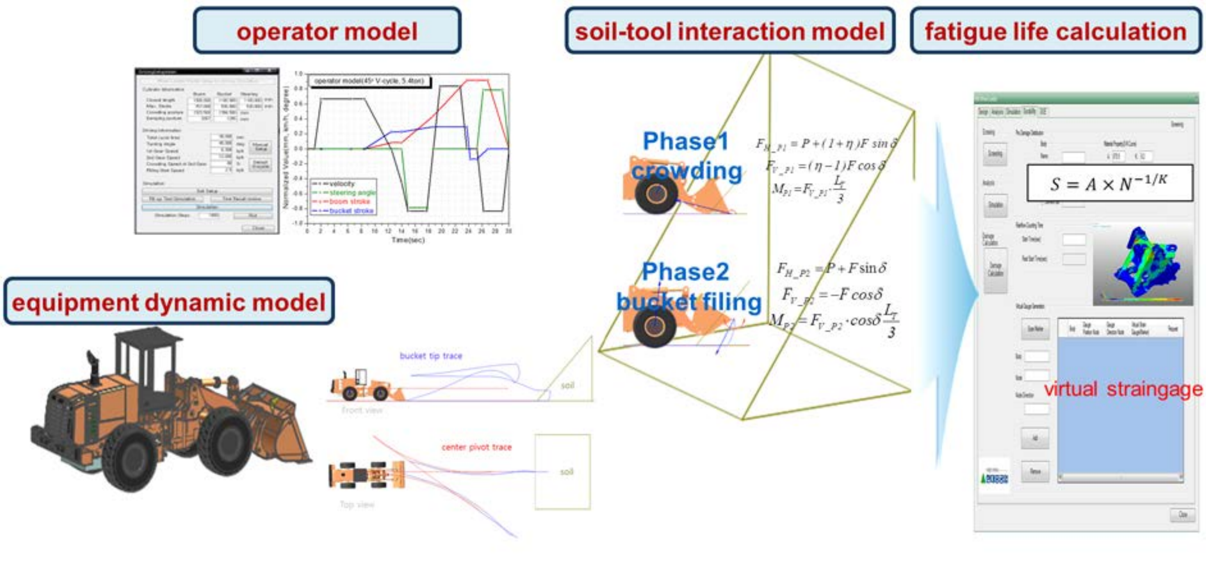
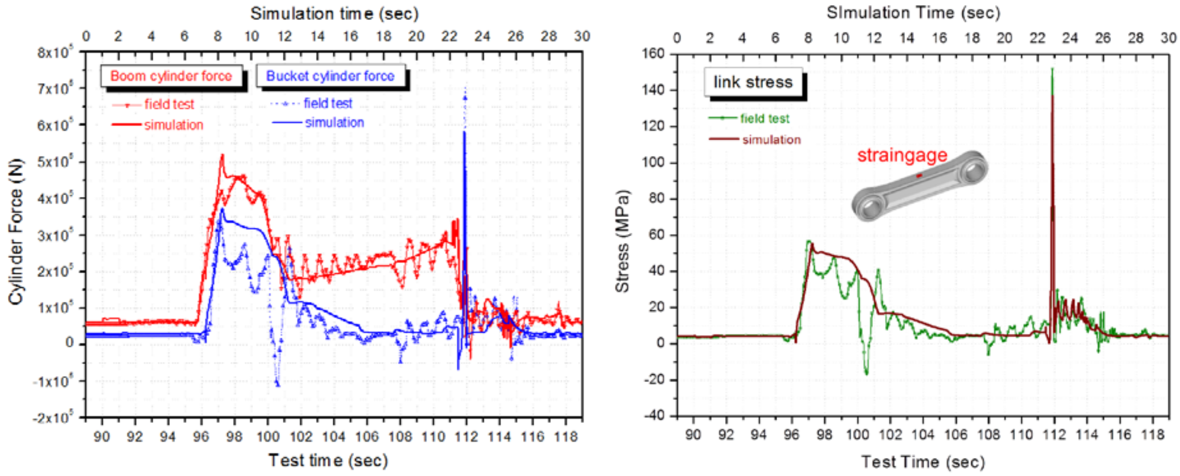


Figure 1. schematic of the virtual working simulation and fatigue life calculation

such as the V-cycle angle and required cycle time and maximum travelling velocity.

The accuracy of the virtual working simulation was verified by comparing simulation results with field test results such as the cylinder force and stress history for a typical working condition. As shown in Figure 2, the simulated forces and stress agree well with the measured ones.



(a) bucket and boom cylinder force (b) link stress

Figure 2. Comparison of simulation and test results

In order to calculate the fatigue life from the simulated stress history, it is necessary to specify the hotspot points and the fatigue sensitive stress component at the hotspots. Therefore, the screening function was implemented to identify and visualize critical damage on whole surface elements. Then the fatigue sensitive stress history on concerned node was extracted using virtual strain gage. In conclusion, fatigue life was calculated in an integrated user interface including equipment modelling, working simulation and fatigue safety assessment.

It is expected that the field test can be substituted by the developed system based on the virtual working simulation.

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