Evaluation of the soil thrust interference effect in track systems from model track tests

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ABSTRACT

The tractive performance of an off-road tracked vehicle depends on the soil thrust generated by the shearing action on the soil-track interface. In the development of soil thrust, as the continuous-track system of a tracked vehicle consists of a number of single-track systems connected to one another, the interference effect occurs between the adjacent single-track systems through the supporting soil. For this reason, the total soil thrust of the continuous-track system would not be equal to the sum of the soil thrust of single-track systems, and its probable interference effect has to be properly considered. To address this, a series of model track experiments was performed on the single and double model track systems under different relative densities of soil and different shape ratios (length of a track plate to a grouser depth) of the model track system. The experiment results showed that the soil thrust of the double model track system was less than two times that of the single model track system, indicating that the soil thrust was reduced by the interference effect. The decrement of the soil thrust was more obviously observed as the relative density increased and the shape ratio decreased.

KEY WORDS: Off-road tracked vehicle; model track experiment; soil thrust; interference effect.

INTRODUCTION

With the expansion of the construction market for undeveloped areas such as offshore and polar areas, the demand for off-road construction vehicles utilized under severe conditions has increased. For off-road construction sites, a tracked vehicle with the continuous-track system as the mobility system has been widely used. This is because the continuous-track system, which consists of a number of single-track systems (a track plate and a grouser) connected to one another, provides lower contact pressure and higher tractive force compared to the wheel system (Wong & Huang, 2006).

In the design of off-road tracked vehicles, the evaluation of the trafficability on the off-road condition is critical. When a tracked vehicle moves off-road, the driving torque generated by the engine is transmitted to the continuous-track system, resulting in a shearing action on the soil-track interface. Consequently, the relative displacement known as “slip displacement” takes place on the soil-track interface, developing “soil thrust” acting as a traction force. In the development of soil thrust, the soil beneath the continuous-track system is divided into separate sections (soil blocks) by the grouser attached to each single-track system (Fig. 1), resulting in a separate shearing action on each soil block (Bekker, 1956; Lvov, 1952). Therefore, the total soil thrust of the continuous-track system is calculated by obtaining the sum of the soil thrust developed on each single-track system.

To assess the total soil thrust of the continuous-track system, it should be noted that the soil thrust of each single-track system within the continuous-track system is substantially different from that of an isolated single-track system. Similar to the group pile effect on the pile resistance (Brown et al., 1988), the “interference effect” between adjacent single-track systems takes place in the continuous-track system, meaning that the soil thrust developed on each soil block is affected by the shearing action of the neighboring soil blocks. Hence, the total soil thrust of the continuous-track system is not equal to the simple sum of the soil thrust of the isolated track systems, and its interference effect has to be considered based on the track-soil-track interaction.

Even though several studies have tried to investigate the total soil thrust of the continuous-track system, the interference effect has yet to be clearly understood. Bekker (1960) described the total soil thrust as being determined through the integration of the shear stress over the shearing area, based on the assumption that a long continuous shear plane takes place along the continuous-track system (Fig. 2). As aforementioned, however, the soil beneath each single-track system is sheared off as an autonomous object so that an associated soil thrust separately occurs on each soil block. This means that the interference...