Development of a model and numerical simulations of a single bucket tracked excavator

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Abstract: In the article a model of a single bucket tracked excavator, developed in MSC Adams, is presented. The model is meant for simulating static and dynamic tip-over stability. In the second part of the article, selected results are presented.

INTRODUCTION

When designing an excavator, one has to consider how will the selected design solutions influence the properties of the final product. Nowadays such predictions are done using CAD software. Results of simulations are useful for designing and modifications of various types of steering systems, systems aiding the operator as well as interpretation of phenomena occurring during exploitation of excavators. It is worth mentioning that numerical models of excavators are currently widely used in various simulators allowing cheaper and more effective training of the operators.

Models available in the literature enable credible prediction of many work parameters of excavators. Even though there are many problems with modeling tracked undercarriages and the tool-soil interaction. In [1, 2] some examples of track modeling can be found as well as comprehensive literature on previous works on this topic.

Within the scope of this paper, the authors present their model of a single bucket tracked excavator. The model was built with a multibody dynamics software. It was made mostly in order to identify the loads acting on the supporting rollers during the work cycle of the machine. Additionally, the information helping predicting static and dynamic tip-over stability was gathered.

Model and virtual excavator simulations

In the article a numerical model of an excavator made using MSC Adams software is presented. The first version was done within the scope of a master thesis conducted at the Faculty of Mechanical Engineering at Wrocław University of Science and Technology [3]. The model was extended and modified afterwards. Visualization of one of the versions is depicted in the fig. 1. Basic version of the model consists of 160 rigid bodies. Most of the are the track segments. Interactions between the track links and supporting rollers and wheels were modelled using solid-solid contact elements. Interaction between grouser plates and the ground were modelled in a similar manner.

Apart from description of the model, in the article presented are selected simulation results. In particular the authors present results showing the extent to which the dynamic loads acting on the machine during rotation of the excavator's body can influence it's tip-over stability. Results are presented for different ground slopes, on which the machine was standing. Analyzed is also the influence of variations in the tip-over stability surplus on normal loads acting on the supporting rollers and wheels. Visualization of tipping-over process based on exemplary simulation results is depicted in the fig. 2.

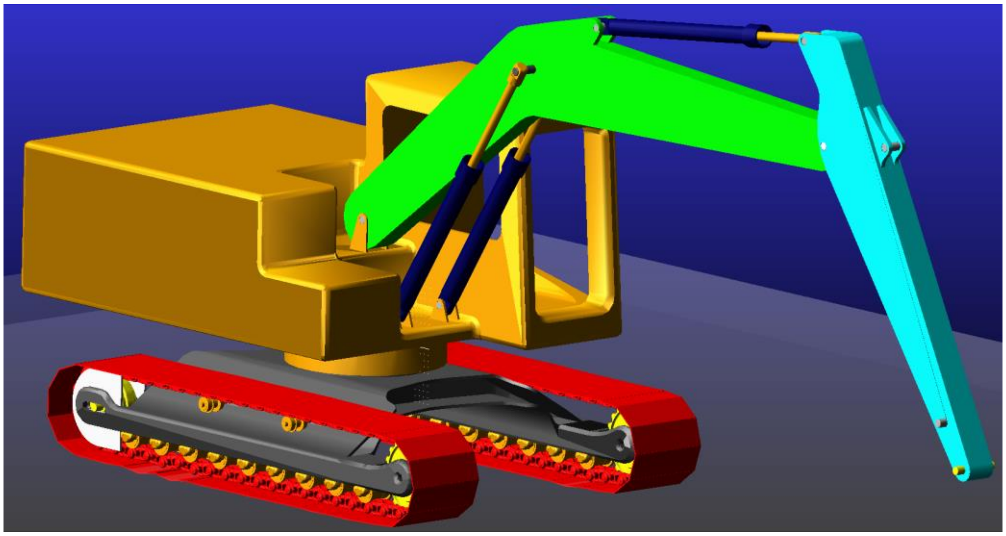

FIGURE 1. Visualization of the model without a tool.

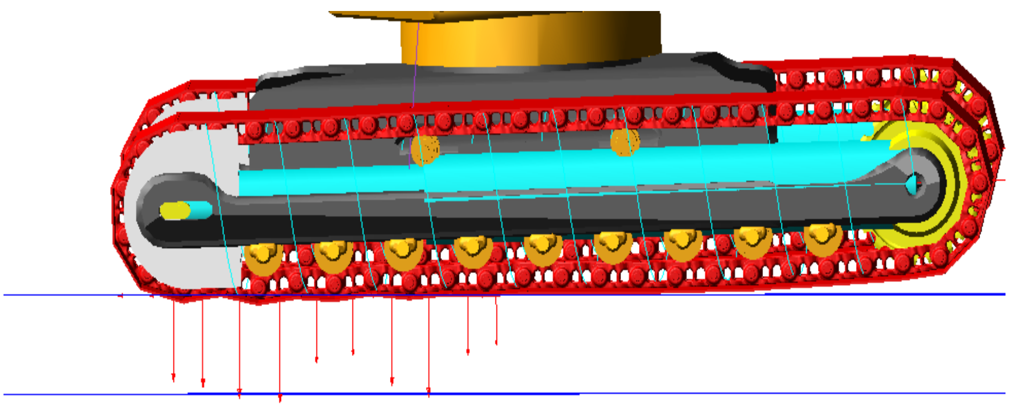

FIGURE 2. Visualization of contact forces acting at the track-ground interface during tipping-over.

Summarizing it can be stated that the presented model allows reliable predicting of a medium sized excavator's tip-over stability. The mass of the tested virtual excavator was equal to 21 tons. Other mass and geometrical parameters were patterned after real, mass produced excavator. Duration of particular simulations were, despite model's complexity, acceptable. Simulations could be carried out even on a PC's with average computational capacities.

REFERENCES

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