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Measurement and simulation of dynamic systems parameters

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Abstract. Linear guiding systems are usually dynamically loaded. The similar situation emerges in the bearings of compactors drums. During the tests of the compactors are bearings dynamically loaded and reaction forces are transmitted through the test facility to the ground. For minimization of transmitting dynamic forces and emerging vibrations, is desirable to test the compactors on the suspended test facility. The aim of this paper was to identify initial conditions for the test facility suspension considering minimization of the emerging vibrations. We first identified operating conditions of the compactors - especially a loading uniformity and force amplitude transmitted to the ground. Force distribution we determined by ODS measurement. Force amplitude was calculated through mathematical model as a solution of differential equations. These results were further used for dynamic analysis of the suspension. The dynamic analysis performed showed efficiency of designed suspension. The force amplitude transmitted to the ground decreased significantly.

Introduction

Soil and asphalt compactors are usually designed with two tandem drums. During the operation those drums are excited by centrifugal force of the unbalanced mass, which is powered by hydraulic engine. Value of the centrifugal force and the oscillation amplitude are one of the most important machine parameters. For proper soil and asphalt compaction, it is necessary to inspect these parameters via experimental testing. The experimental tests are based on measuring the force and the amplitude on test facility that allows simulation of the compactor operating conditions. However, during tests the dynamic forces of the machine drums are transmitted through the test facility to the ground. It leads to high-intensity vibrations of the building construction. These vibrations affect negatively the building service life and labourers health. Minimization basic principles of the emerging vibrations are described in [1, 2].

Operating deflection shapes

Operating deflection shapes point to the asymmetric loading and mass distribution on the base desk. The machine tends to tilt especially around the transverse axis (Fig. 1).

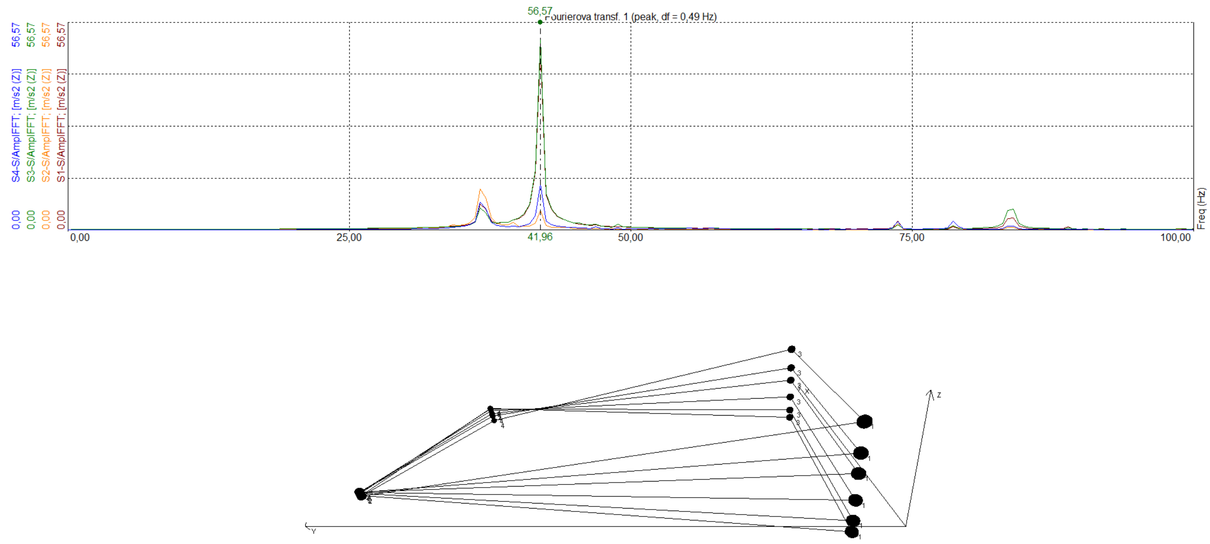

Fig. 1: Operating deflection shapes of base desk

Current state of the test facility with the compactor represents a dynamic system, wherein an elastic and damping links between the machine and the test facility and between the test facility and the ground are made of rubber elements. In the first case the links are rubber wheels on that the compactor drums are seated. Second elastic and damping link is rubber sheet between the test facility frame and the ground.

One of the most important criterion of a suspension system is the value of the force amplitude FZR transmitted to the ground. Fig. 2 shows amplitude frequency response of that force FZR and its detailed view.

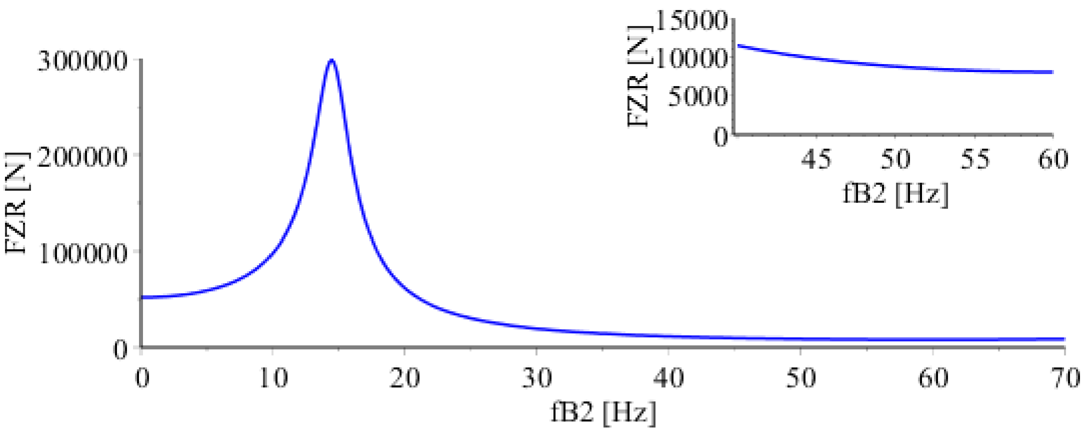

Fig. 2: Force amplitude transmitted to the ground

Results presented of the mathematical model solution shows relatively high values of the force amplitude transmitted to the ground.

Calculation of suspension

Suspension system calculation is based on solution of the mathematical model as a result of the motion differential equations. The analysed dynamic system may be in simplified way represented by dynamic model of two mass with two degrees of freedom.

Fig. 3 shows influence of the basic dynamic parameters on force amplitude transmitted to the ground. The basic parameters referred to Fig. 3 are stiffness of the machine and test facility connection kSR, the base desk weight mZ and operating frequency fB2.

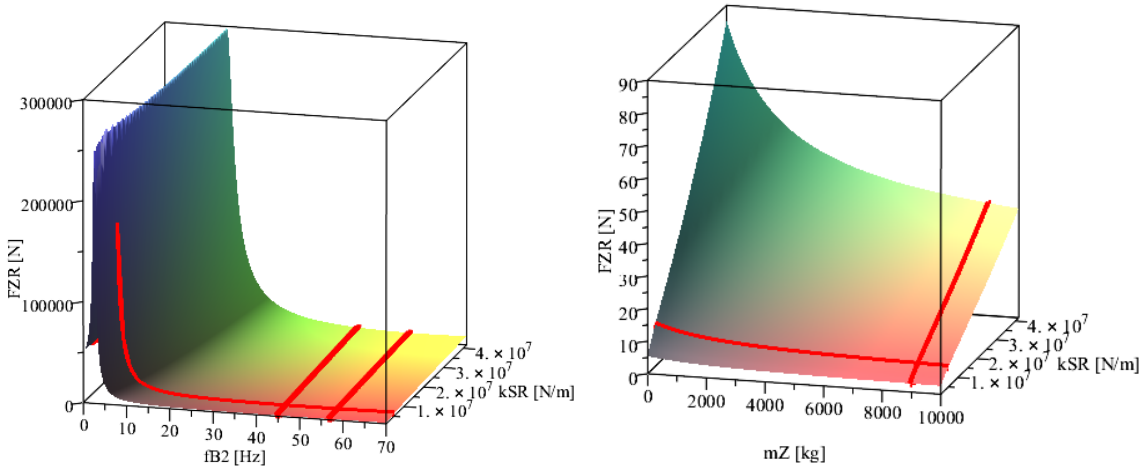

Fig. 3: Force amplitude transmitted to the ground

Higher value of the machine and test facility connection stiffness increases the force amplitude. However, the sufficient value of stiffness is needed regarding the simulation of the machine operating conditions.

Increase of the force amplitude may be partially compensated by the higher weight of the base desk.

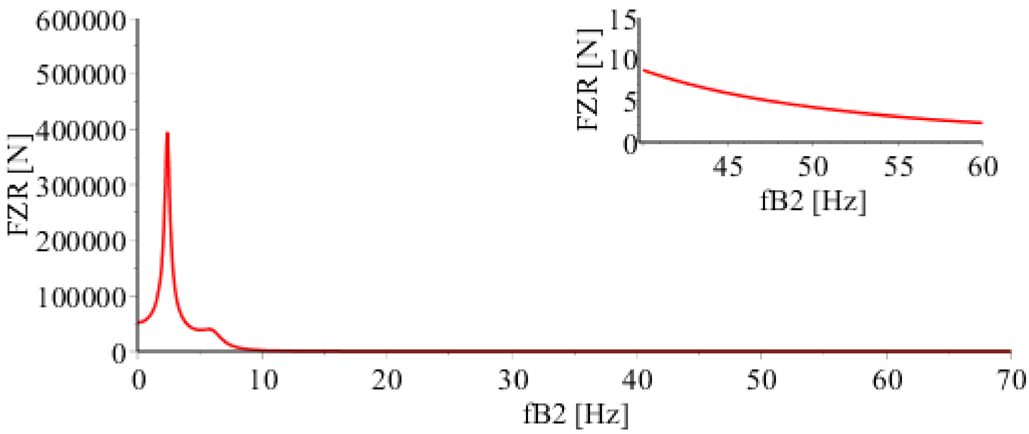

Fig. 4: Force amplitude transmitted to the ground

Fig. 4 shows amplitude frequency response of the force transmitted to the ground FZR and its detailed view with proposed optimal dynamic parameters.

Conclusions

The aim of this paper was to identify the basic dynamic parameters and describe dynamic conditions of the test facility. Dynamic analysis is necessary for efficient suspension design. Especially the stiffness of connection between the machine and the test facility frame and the base desk weight have the effect on minimization of dynamic reaction forces and vibrations. Results of the dynamic analysis showed efficiency of the suspension proposed. The force amplitude transmitted to the ground decreased significantly.

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