Simulation of the influence of surfaces on measured vertical ground reaction forces during fast movements

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Abstract

A four degrees-of-freedom model was developed to simulate the ground reaction force. This model was combined with submodels of the force plate and the surface. The simulations show that the elastic surface reduces the force rate and that fixing a force plate on this surface results in force signals falsified by low frequency oscillations.

Introduction

The ground reaction force (GRF) between the feet and the ground is the dominant force during the working person's movements like walking, running, or material handling. The force is used as a basic measure in the biomechanical analysis of movements and can be easily measured by force plates. However, when the force plates are fixed not on rigid but on elastic surfaces the force signals are superimposed by low frequency oscillations (Peikenkamp et al., 1999). The question arises, if these oscillations result from the response of the working person to the surface properties or by the fixation of the force plate on the elastic surface.

Method

To answer this question a mechanical-mathematical model was developed which simulates the vertical movements of the working person and the vertical component of the GRF. The model consists of four masses which imitate the trunk and both thighs, shanks, and feet. The masses are connected by springs and dampers. This model is combined with two submodels representing the force plate and the elastic surface. From the surface a quadratic segment is represented by 9 x 9 masses and flexible beams. The beams spread out a horizontal grid so that the each mass is connected by beams with its contiguous masses.

The simulations were carried out for a fast movement, namely the landing after a jump on concrete and wooden elastic surfaces with and without force plate.

In D. de Waard, K.A. Brookhuis, S.M. Sommer, and W.B. Verwey (2003), *Human Factors in the Age of Virtual Reality* (pp. 233 - 235). Maastricht, the Netherlands: Shaker Publishing.