A PROBABILISTIC ENGINEERING LOAD MODEL FOR PEDESTRIAN STREAMS

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Summary

Numerical simulations of pedestrian streams are very time consuming and a special software has to be available that is able to do time step simulations with advanced load models. This is not acceptable for an estimation of the structural response in the design stage. Hence, a spectral load model by applying Monte-Carlo-simulations for four different traffic scenarios is derived, in which the stochastic properties of the pedestrian traffic are considered but which can be easily applied by the structural engineers in the design stage. It allows for a variation of modal properties, e.g. damping, natural frequencies, or the loading, e.g. pedestrian density, mean step frequency to perform sensitivity analysis in the design stage, because natural frequencies are normally not exactly determined and damping and traffic scenarios are only estimated values. The spectral model for pedestrian streams is based on extensive measured data and takes into account probabilistic requirements. It allows to calculate the 95 % fractile of the acceleration response of sinusoidal vibration modes and hence can be used for serviceability limit checks according to Eurocode requirements. The spectral model is easy to apply and is suitable as engineering load model.

Keywords: pedestrian loading, random loads, pedestrian streams, Monte-Carlo simulation, probabilistic load model

1. Introduction

The dynamic structural responses due to arbitrary pedestrian traffic can be determined very well with time step calculations using a recently derived the step-by-step model [1,2,11]. If a sufficient number of time step simulations events, in which the stochastic behaviour of the pedestrian-induced loading is considered, is performed, the statistic characteristics of the structural response can be determined and the characteristic response, i.e. 95 % fractile of the action effect, is determined. But the numerical simulations are very time consuming and a special software has to be available that is able to do time step simulations with the step-by-step model. This is not acceptable for an estimation of the structural response in the design stage. Hence, it is necessary to derive a load model, in which the stochastic properties of the pedestrian traffic are considered but which can be easily applied by the structural engineers in the design stage. Hence a simple spectral model is derived by applying Monte-Carlo-simulations for four different traffic scenarios, which allows a variation of the modal properties, e.g. damping, natural frequencies, or the loading, e.g. pedestrian density, mean step frequency to perform sensitivity analysis in the design stage, because natural frequencies are normally not exactly determined and damping and traffic scenarios are only estimated values.