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**Selected methods of reducing the deck transverse vibrations
in long-span steel footbridges – case studies**

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ABSTRACT

Horizontal vibrations of the deck in lightweight long-span footbridges, especially those made of steel, with a low damping level may significantly reduce the comfort of use of the whole structure. The natural frequencies of such footbridges are very often in the range of $0.5 \div 1.0$ Hz. This can lead to the excitation of resonant vibrations of these structures by walking people generating horizontal transverse forces characterised by a large amplitude of harmonic components corresponding to two frequencies $0.5f_s$ and $3/2f_s$ (where f_s – frequency of steps during walking). The article presents examples of structural solutions used in long-span suspension footbridges built in Poland in order to reduce the horizontal transverse vibrations of the footbridge decks. The results of dynamic field tests and numerical calculations of two footbridges were presented and analysed. The obtained results indicate a positive effect of reducing the horizontal vibrations of the deck in both footbridges and changes in the frequencies and the mode shapes of the analysed footbridges caused by applied solutions.

Keywords: footbridge, dynamics, vibration, suspension bridge, human-induced vibrations.

1 INTRODUCTION

Walking people generate harmonic dynamic forces (ground reaction forces, GRF in vertical (F_{VGRF} and horizontal (transverse F_{HTGRF} and longitudinal F_{HLGRF} direction. These action can be characterised by the amplitude of their harmonic components. For vertical forces F_{VGRF} , the dominant harmonics are the first and second harmonics, corresponding to the frequencies $1f_s$ and $2f_s$. In the case of horizontal transverse forces F_{HTGRF} , the dominant harmonics are the harmonics corresponding to the frequencies $0.5f_s$ and $3/2f_s$ [1 ÷ 6].

Fig. 1 shows examples of waveforms of normalised horizontal transverse ground reaction forces (F_{HTGRF}/G , where G – mass of a walking person generated during walking with the frequency of steps $f_s = 1.20$ and $f_s = 1.80$ Hz along with the corresponding FFT spectra. Presented forces F_{HTGRF}/G were recorded by the author during laboratory tests of walking adult volunteers using force platforms AMTI BP400600 lined up (one behind the other within a rigid path 10.0m long and 1.50 m wide.

