AVT-357 Research Workshop on "Technologies for future distributed engine control systems (DECS)"

Turbine engine resonance parameter monitoring as a condition prediction tool

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Introduction

Starting point for the proposed method of predicting the condition of turbine engines is experimental modal analysis (EMA). EMA is a process based on the experimental determination of the resonance frequencies of the tested system. Using appropriate techniques, it is also possible to determine the mode of natural vibrations. EMA has many advantages: it is a fast and relatively cheap method of determining resonance frequencies. In the proposed method, the authors assume that changes in the stiffness of the rotor system caused by changes in its condition will affect on the values of resonance frequencies

Introduction

$$m\ddot{x}(t) + c\dot{x}(t) + kx(t) = f(t)$$

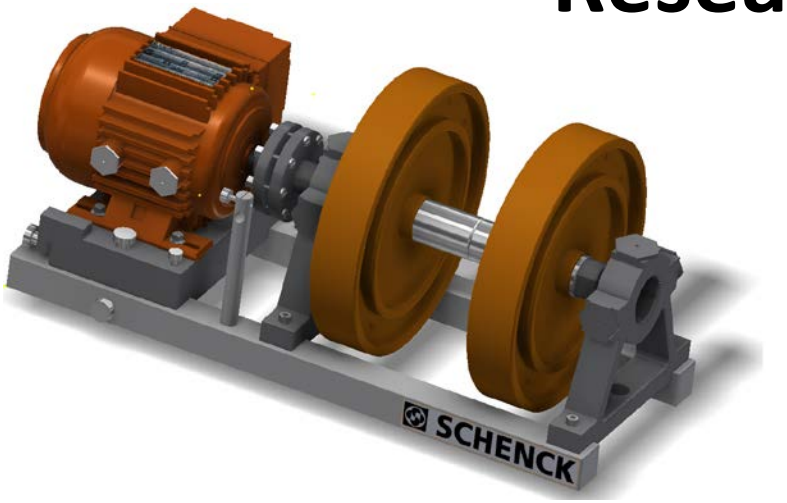
$$[-m\omega^2 + jc\omega + k]X(\omega) = F(\omega)$$

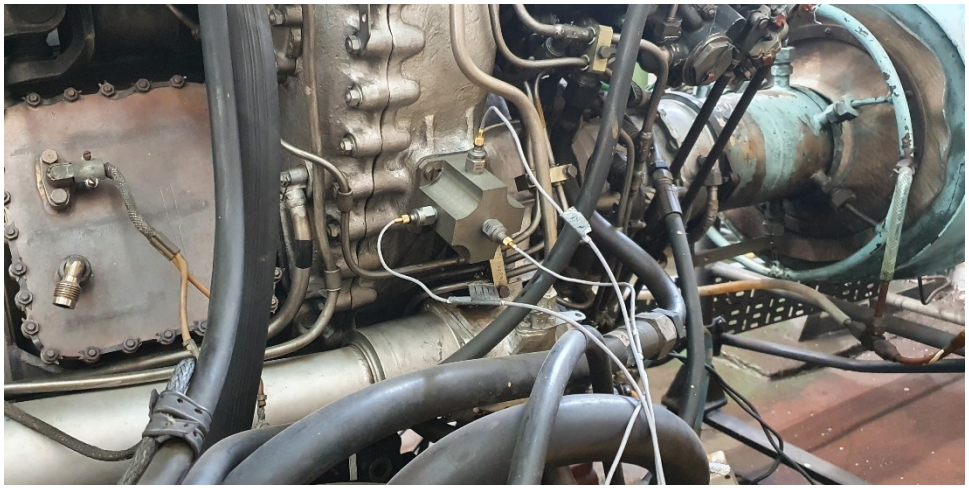
$$H(\omega) = \frac{1}{-m\omega^2 + jc\omega + k}$$

$$H(\omega) = \frac{X(\omega)}{F(\omega)}$$

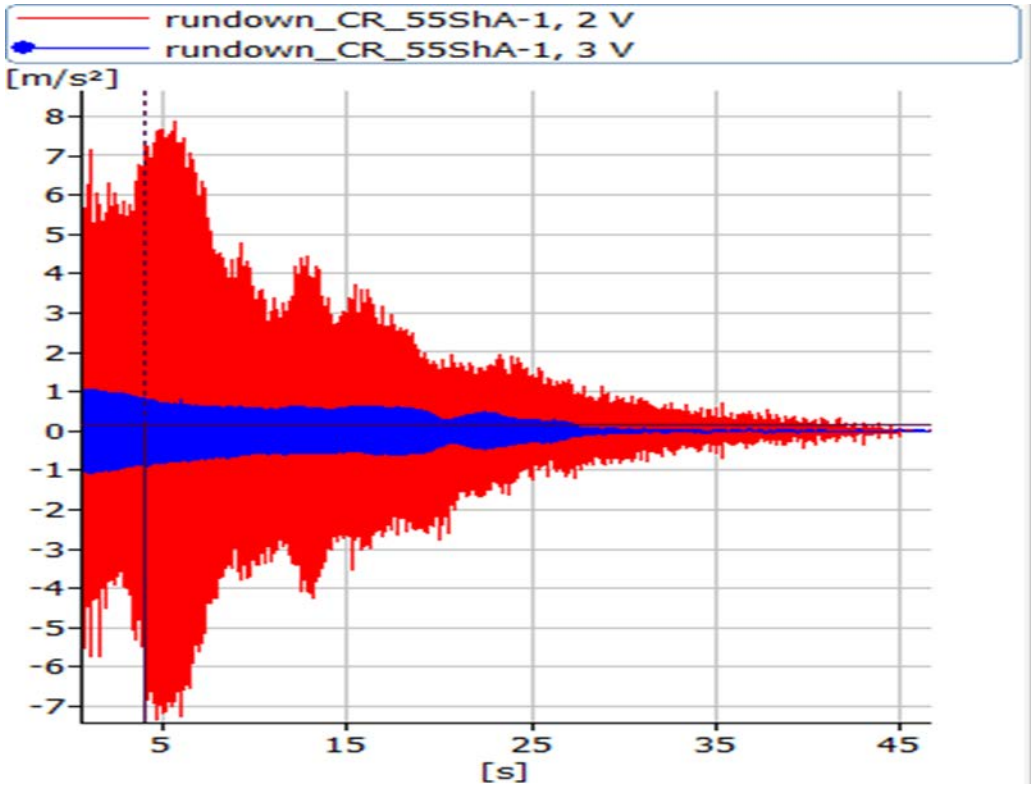
The quantity *H(ω)* is known as the frequency response function (FRF). The FRF describes the ratio of the Fourier transform at the output of the *X(ω)* system to the Fourier transform of the forcing applied to the *F(ω)* system

Research objects



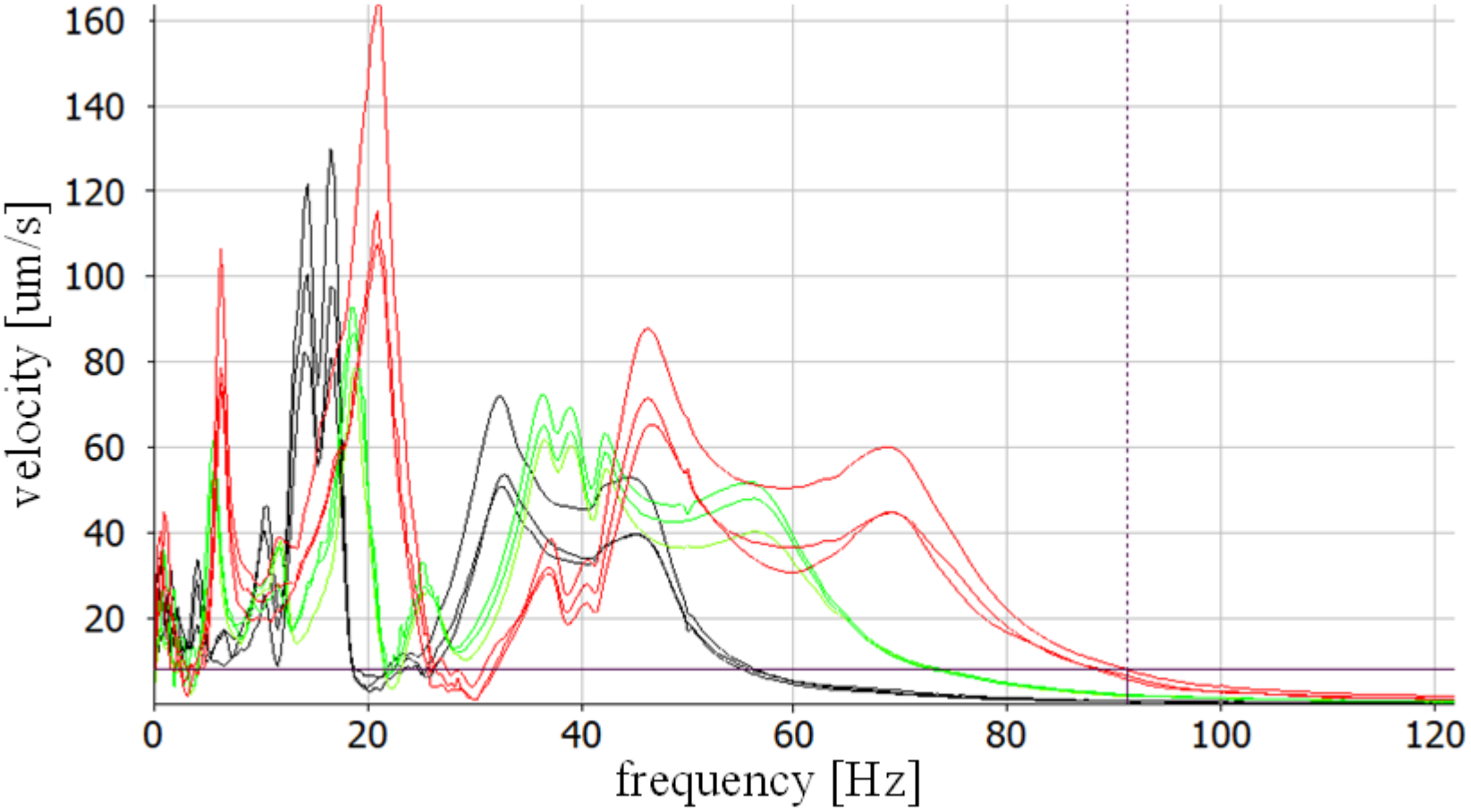


Results

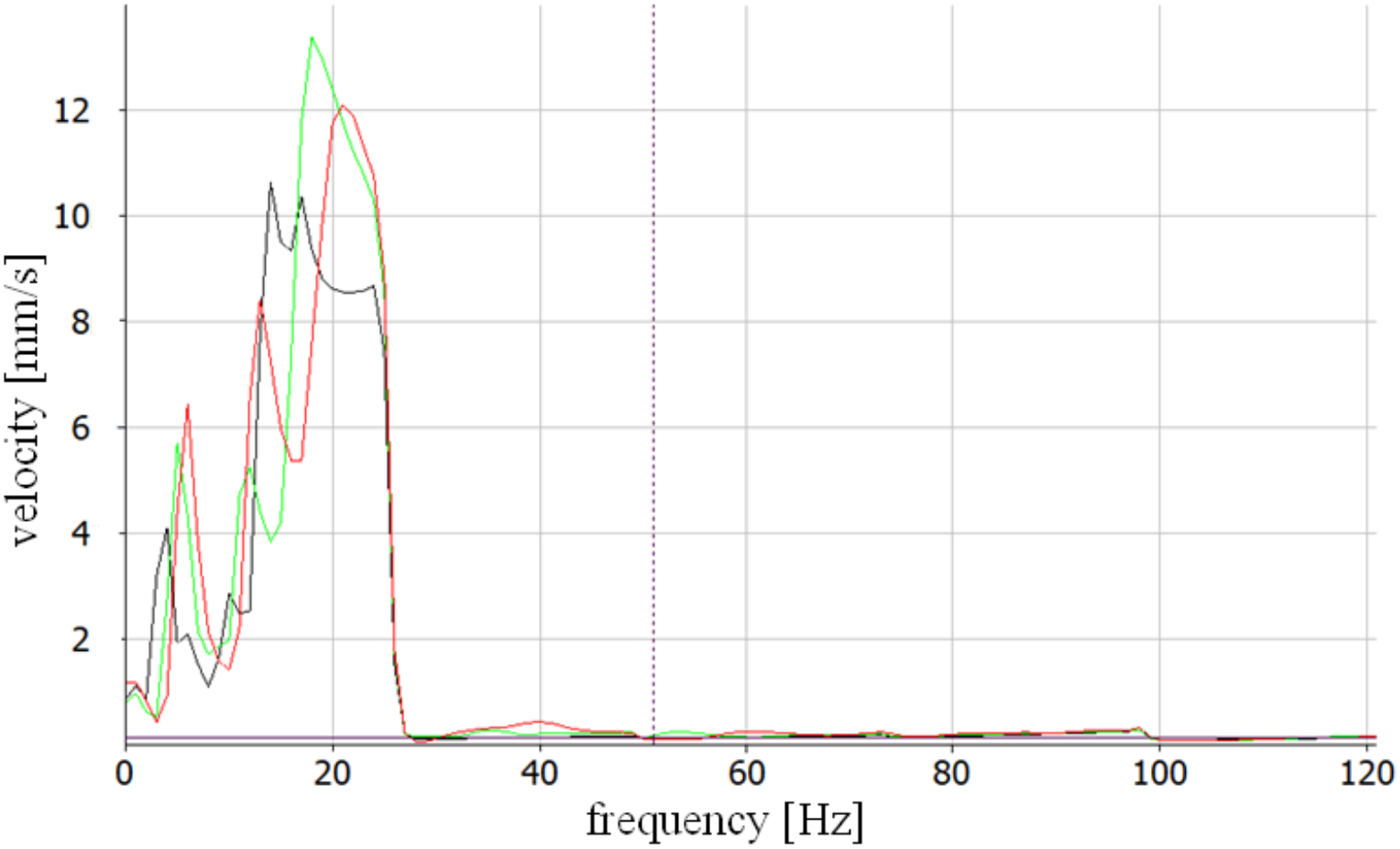


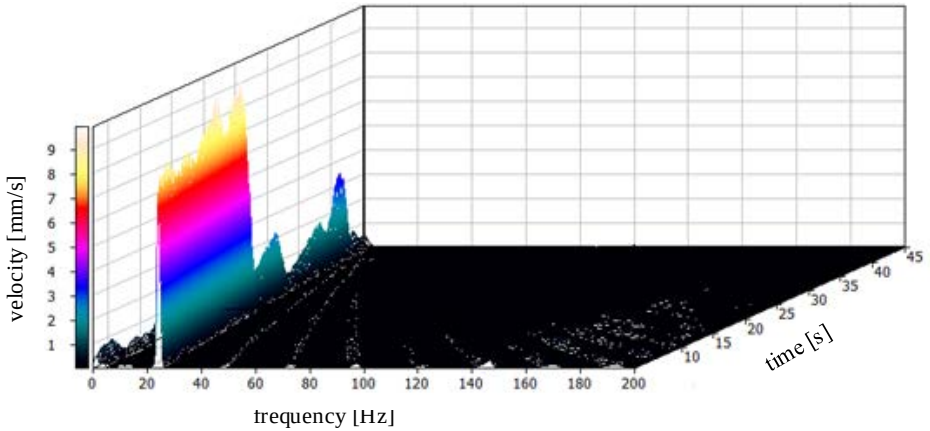
Time courses of vibration accelerations in the vertical direction before the shock absober (red) and behind the shock absorbers (blue) - measurement direction vertical (V).

Results - model

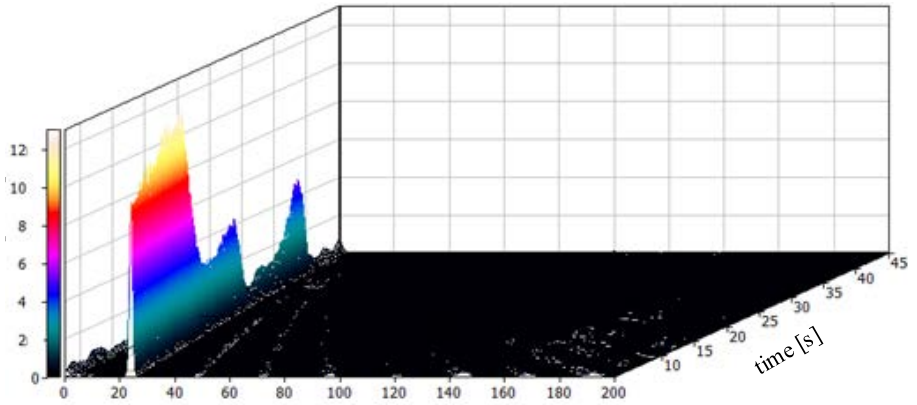


Results - model

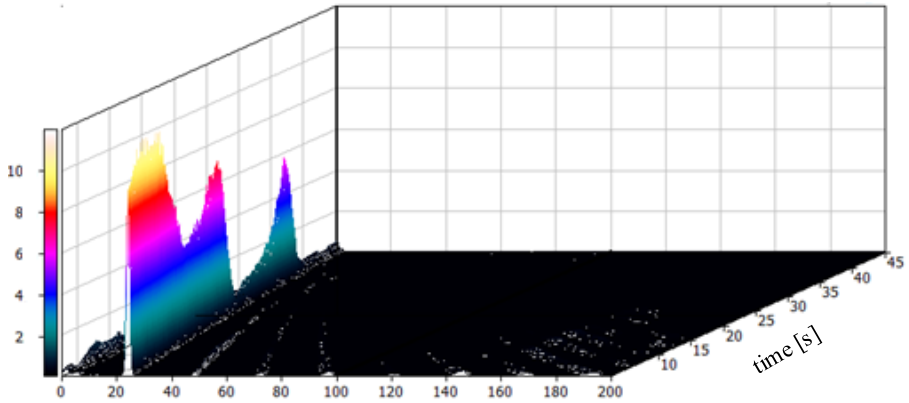




Velocity of accelerations during rundown proces for CR 55 ShA dampers

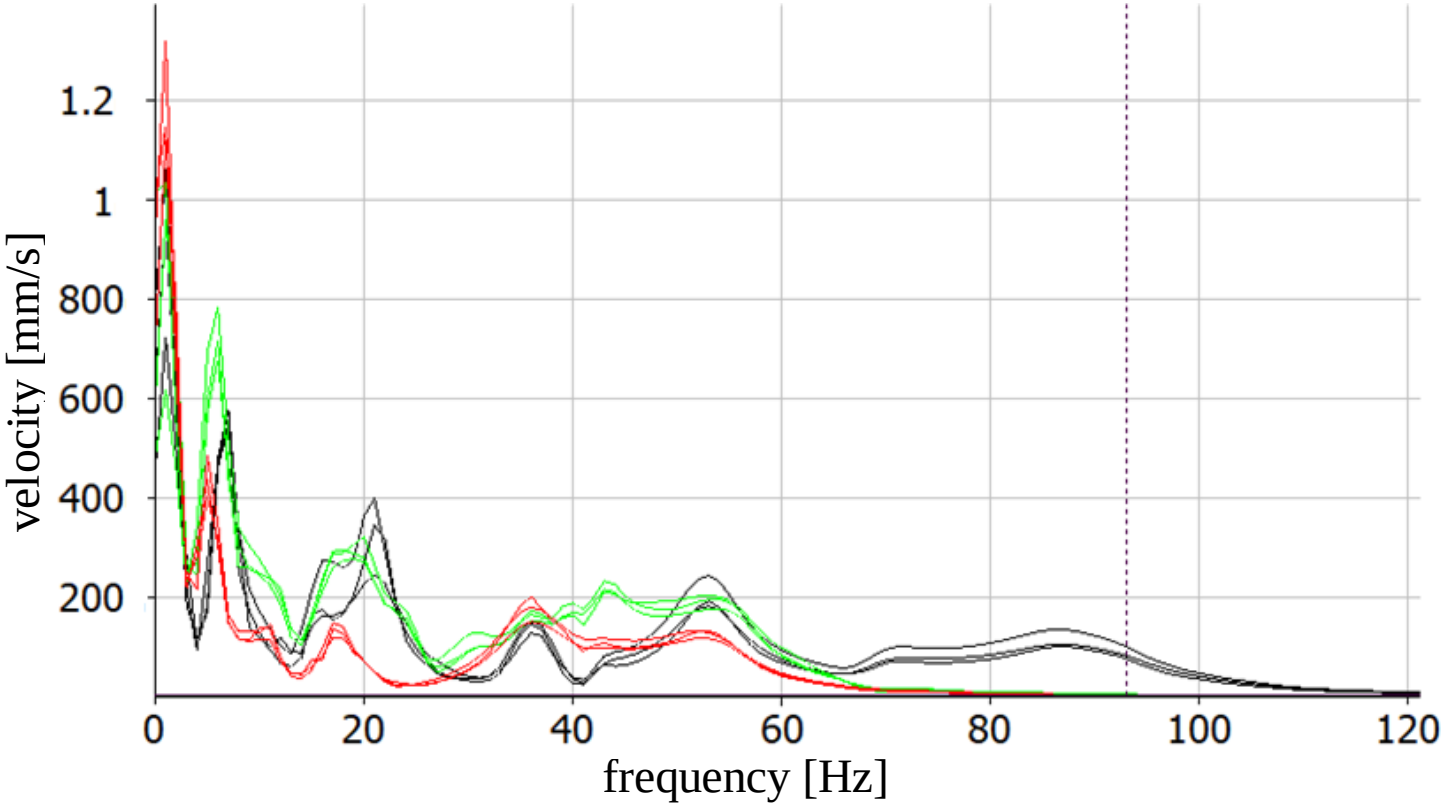


Velocity of accelerations during rundown proces for CR 65 ShA dampers

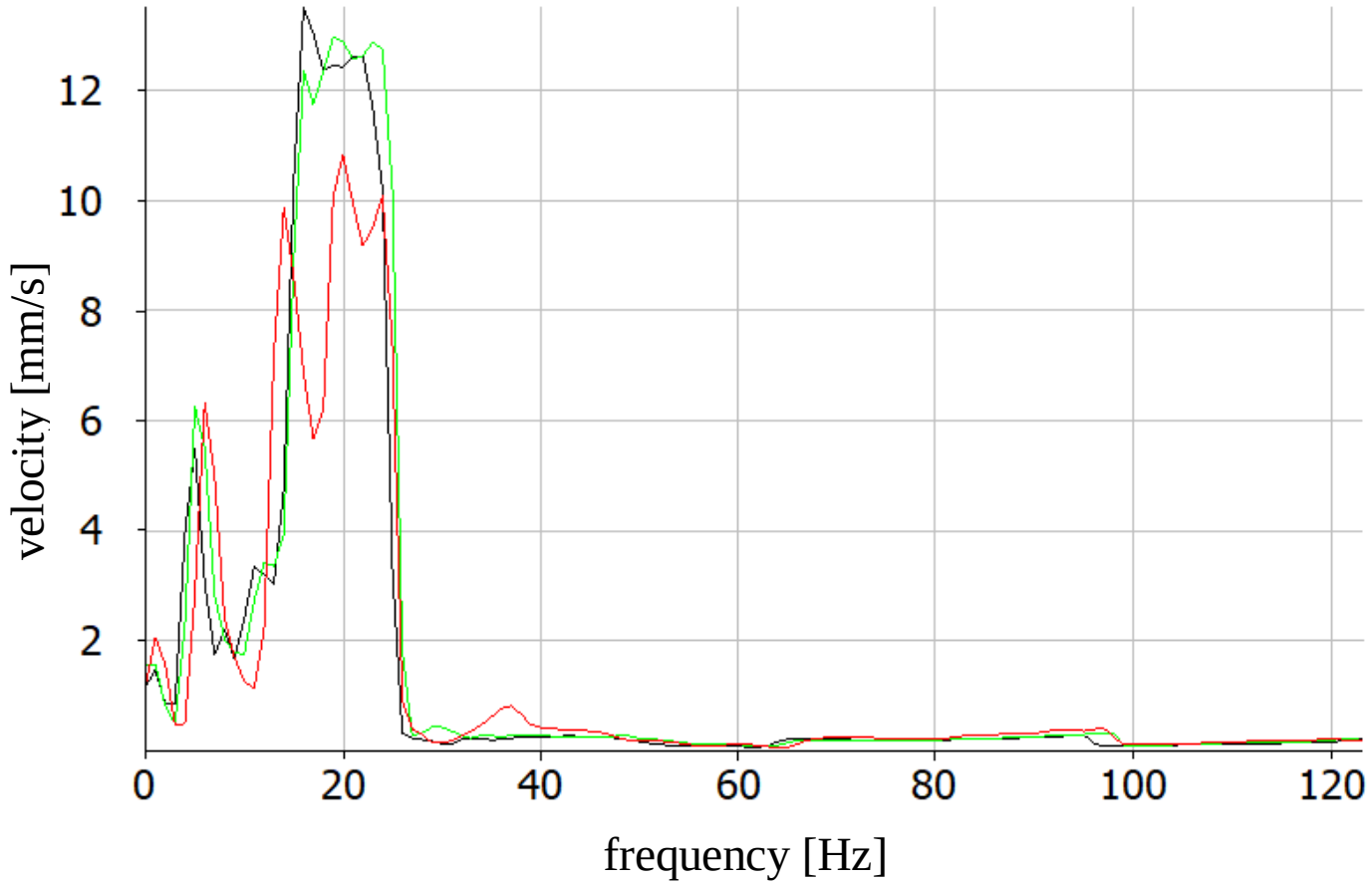


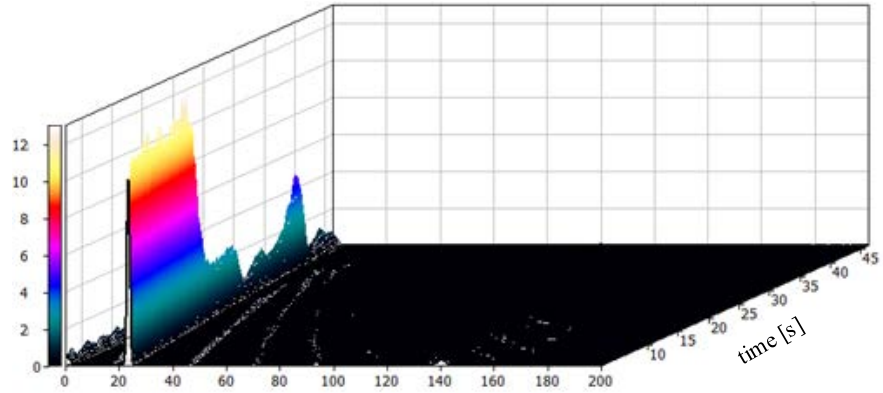
Velocity of accelerations during rundown proces for CR 75 ShA dampers

Results - model

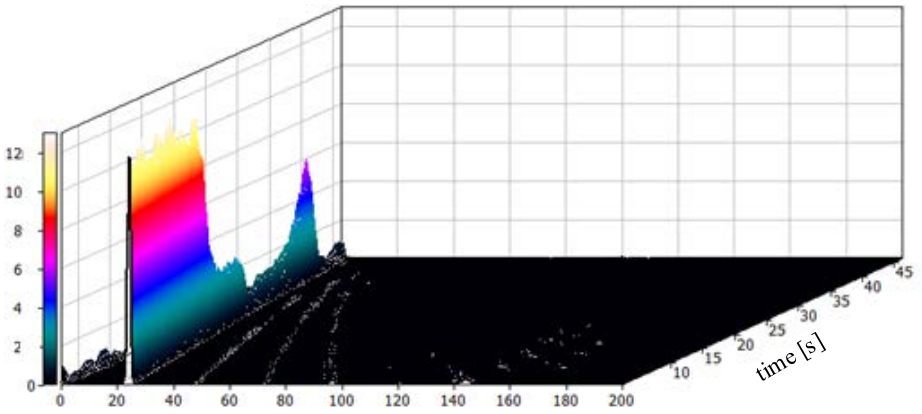


Results - model

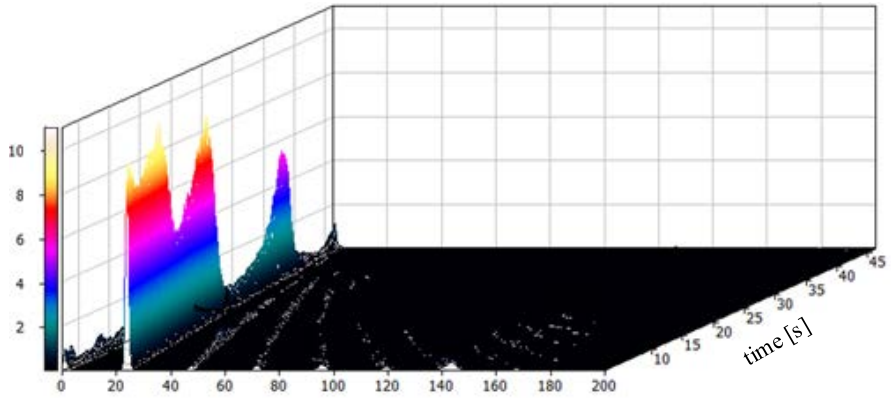




Velocity of accelerations during rundown proces for EPDM 55 ShA dampers

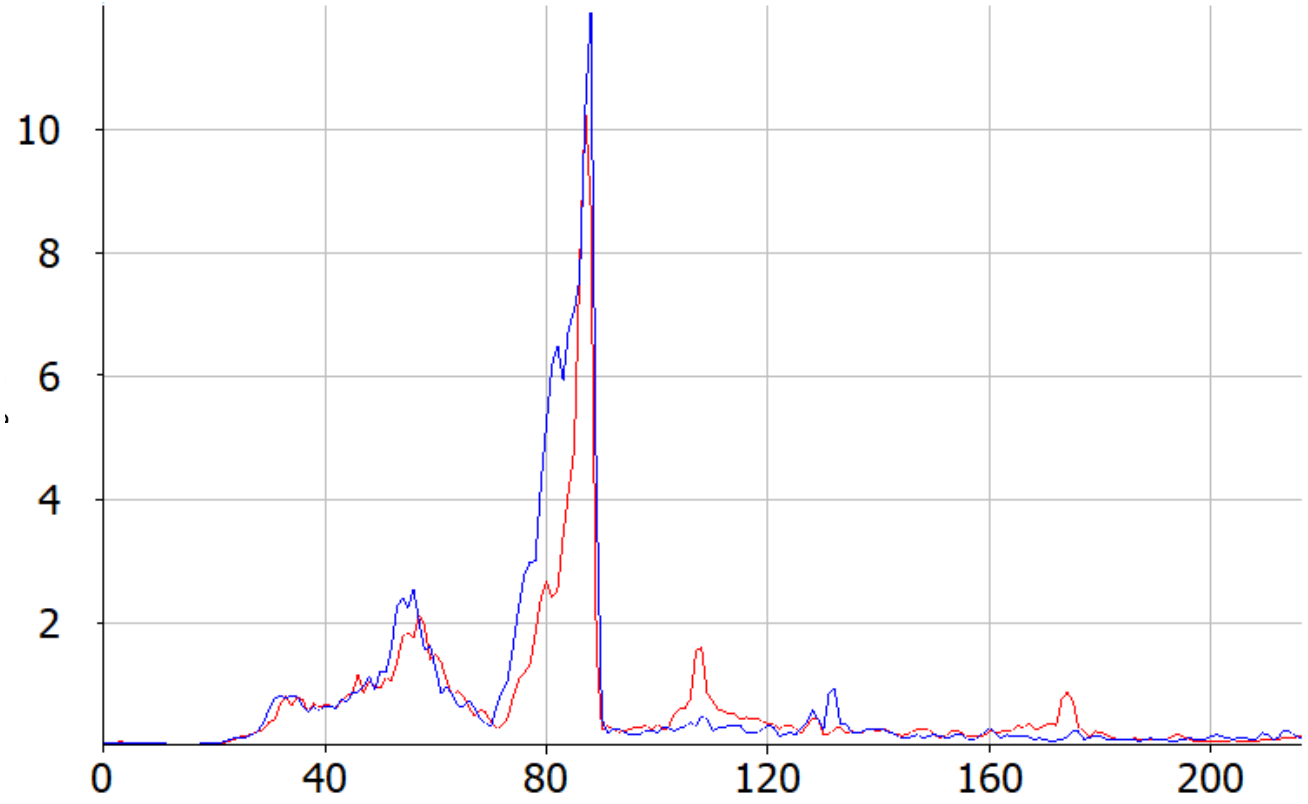


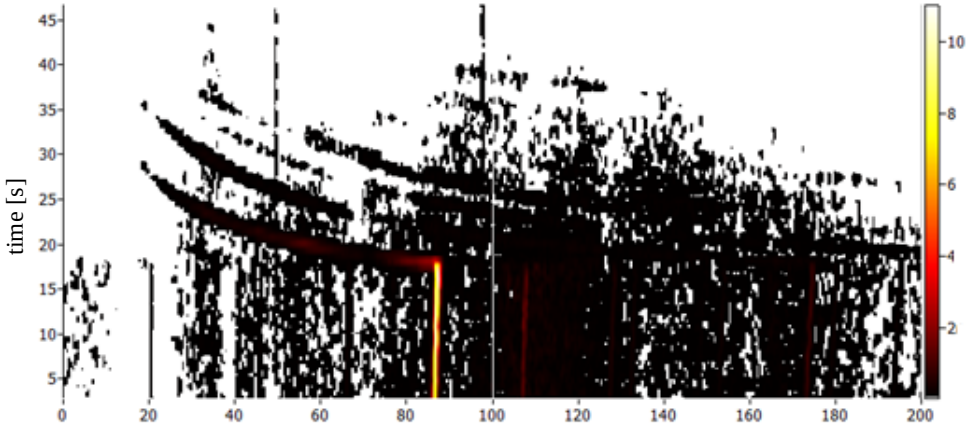
Velocity of accelerations during rundown proces for EPDM 65 ShA dampers



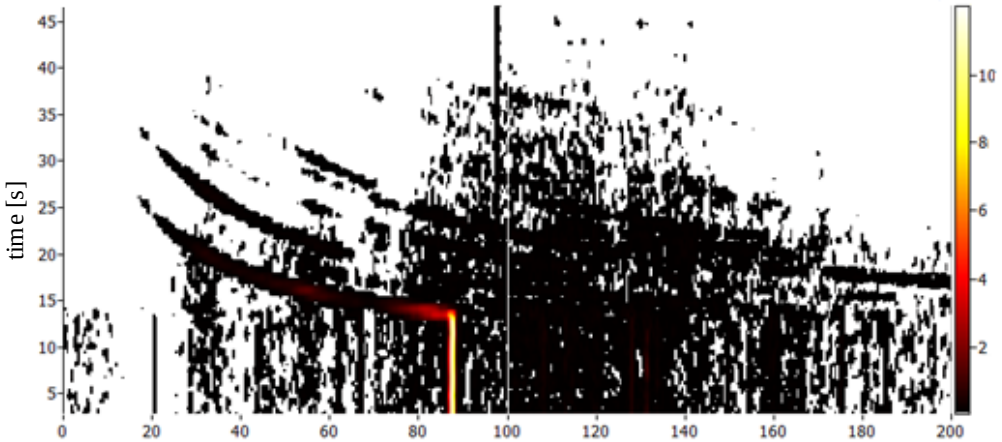
Velocity of accelerations during rundown proces for 75 EPDM ShA dampers

Results – GTD 350 engine





Velocity of accelerations during rundown proces of GTD 350 turbine engine (cold)



Velocity of accelerations during rundown proces of GTD 350 turbine engine (hot)

Conclusions

- The results of the preliminary tests give grounds for the conclusion that monitoring of resonance paramters during rundown proces might be useful to detect reasons of changes in system stiffness.
- Relating the results of future measurements to the reference results and determining the trend of changes will allow for determination and prediction of the tested device condition.