26. Symposium Bauwerksdynamik und Erschütterungsmessungen, 27. Juni 2025, Empa Dübendorf

BaudynSymp2025_07_Dunand-ResonanceIngenieursConceils-etal.pdf

Industrial washing machines in an office building: vibration diagnosis to mitigation solutions

François Dunand, Sylvette Thomassin, Eleni Koufoudi, Résonance Ingénieurs Conseils SA, Carouge, CH

Abstract

A six-story concrete building constructed in 2020-2021 accommodates both offices and industrial activities. An industrial laundry is located on the 3rd floor, equipped with 16 washing machines ranging from 20 Kg to 50 Kg; the water process and heating systems are located in the basement. A partition connects the 3rd and 4th floors, aligned with the washing machines' axis, to separate the clean and the dirty areas of the laundry. Although vibrations from the washing machines were identified as a potential issue during the early design phase, a soft floor was nevertheless constructed. The resulting eigen frequency of the floor (12 Hz) falls within the range of the washing machines rotation frequencies (up to 14 Hz) leading to a resonance phenomenon. Since the laundry operations began, office workers on the 4th floor have reported discomfort due to vibrations. Measurement at the 4th floor clearly shows that vibration amplitudes (KB_{Fmax} > 1) exceed comfort thresholds defined by the VDI 2038 for office environments.

Several mitigation strategies have been evaluated. However, architectural constraints limit the feasibility of floor stiffening or adding significant mass. Moreover, effective vibration isolation with mass-spring system would require an additional mass 10 to 20 times that of the machines, which is well beyond the floor's load capacity.

Given the limited options, a mass spring system was nevertheless tested with the maximum possible additional mass (1 time the machine mass, which is more than 10 times lower than required). Tests have shown that induced motion on machine is not compatible with machine functioning, confirming the necessity for substantial mass addition.

An active mass damper system was also tested and showed efficiency to reduce vibrations at the resonance frequency. However, this system requires a high number of units, which makes its implementation impractical given the current configuration of the washing machines.

The impact of the partition wall linking the 3rd at the 4th floor on vibration transmission was also assessed by comparing areas with and without the partition wall. Results showed that the presence of the wall amplify the vibration transmission by a factor of 1.7. A system to disconnect the partition wall is now under development, although its effectiveness is expected to be limited in achieving a high comfort level.

This case study highlights that without a rigid floor or significant mass addition, finding effective mitigation solutions is challenging.