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Influence of Different Types of Trains on Human in The Buildings

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Abstract. The impact of vibrations on railway lines for people in buildings can cause discomfort. The problem has recently become particularly important due to the increase in the number of objects built within the range of vibrations from the railway line. The article presents selected results of measurements of vibrations from the railway line to a single-family brick building and people staying in them. The presented methodology and test results may be useful in the future in the modernization of railway lines or the development of areas near railway lines.

1. Introduction

Fast urban development means that areas close to railway lines are attractive for residential buildings. Both in the construction of new buildings and the modernization of the railway line in Poland, it is necessary to carry out studies on the impact of noise and vibrations on the development from the railway line. The studies on influence of noise from railway can be found in [1]. Due to the size of the railway line, there is no vibration monitoring system, as it is in the case of the metro in the capital of Poland [2]. The paper presents the selected results of studies on the impact of vibrations on buildings along one of the most important railway lines in Poland.

The tests were carried out in accordance with the current Polish standards [3, 4]. In the world literature and other country standards, the influence of vibrations on people is analysed using various methods [5-8]. Assumed approach requires the analysis of the impact of vibrations on the structure of the building and the humans in the buildings. Similar calculations were also carried out at work [9]. In Poland, the standards also allow to perform the analysis using FEA calculation models. Such results were presented, among others in the work [10]. The Polish regulations assume an analysis based on the measured vibration acceleration values. In the case of the impact of vibrations on people, this is the RMS value in 1/3 octave bands. In the case of the impact of vibrations on the building, this is the peak value from the vibration measured on the foundation of the building in the 1/3 octave bands. The influence of the train type on vibration propagation has already been the subject of research in [11], while the problem of ground vibrations progation was analysed in [12, 13].

2. In situ tests

The research was carried out on the main railway line in Poland. A single-family brick building was selected for the research. The location of the building in relation to the railway line is shown in Figure 1. The distance from the railway line is 60m. The building is a brick structure with reinforced concrete ceilings. Figure 2 presents the view of the building. The location of supporting walls is shown in Figure 3. Figure 3 also shows the distribution of measuring points for the assessment of the impact of vibrations on humans in the building. The railway line in this area runs along a straight line. It is double-track on the ballast. Pre-stressed concrete sleepers ae used. Passenger trains integrated and non-integrated with a permissible speed of 200 km/h are running along the railway line.

Figure 1. Location scheme.

Figure 2. View of the building.

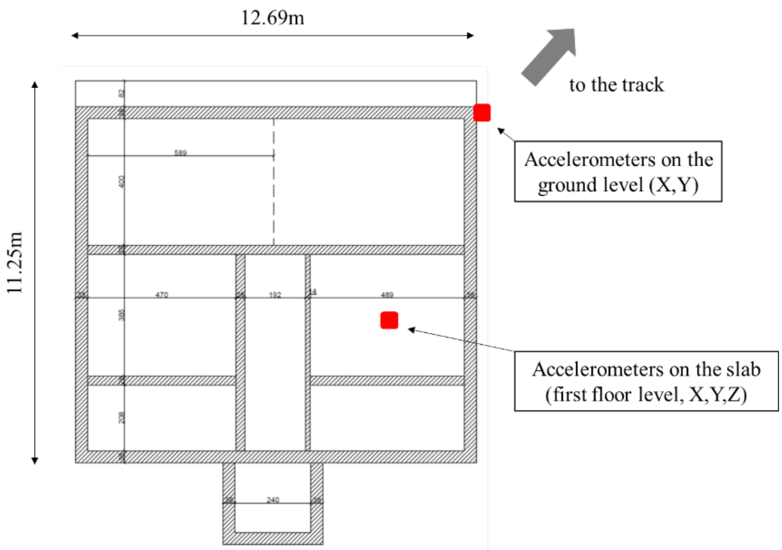

Figure 3. Plan view of the building.

3. Results of measurements

As mentioned above, the analyses were carried out in accordance with the standards [3,4]. Figure 4 presents the results of recorded vibration accelerations on the roof above the basement from the Pendolino train (integrated train type) running at a speed of 193 km/h. Vibration accelerations from Figure 4 and from other runs (not shown here) were analysed in accordance with the Polish standard [4]. The results of the analyses on human in the buildings are shown in Figures 5 and 6. A significant difference in vibration level is visible for non-integrated and integrated trains. In the case of non-integrated trains, the level of acceleration of vibrations is greater.

In Figures 5 and 6, the vibration comfort thresholds are shown in solid lines. From the bottom, the first line indicates the level of perceptibility of vibrations, the next is the level of the comfort at night and the last is the level of the comfort during the daytime. The solid line means vibrations in the vertical direction (z) while dashed line means the horizontal vibrations (x, y). The studies also showed a significant impact of the train speed on the level of vibrations.

The impact of vibrations on the structure is shown in Figure 7 and 8. In both cases (non-integrated and integrated train) there are no over the level of vibration perception by the building (the lowest line). For such a distance from the railway line, there are no negative effects of vibration on the structure of buildings from railway lines [9].

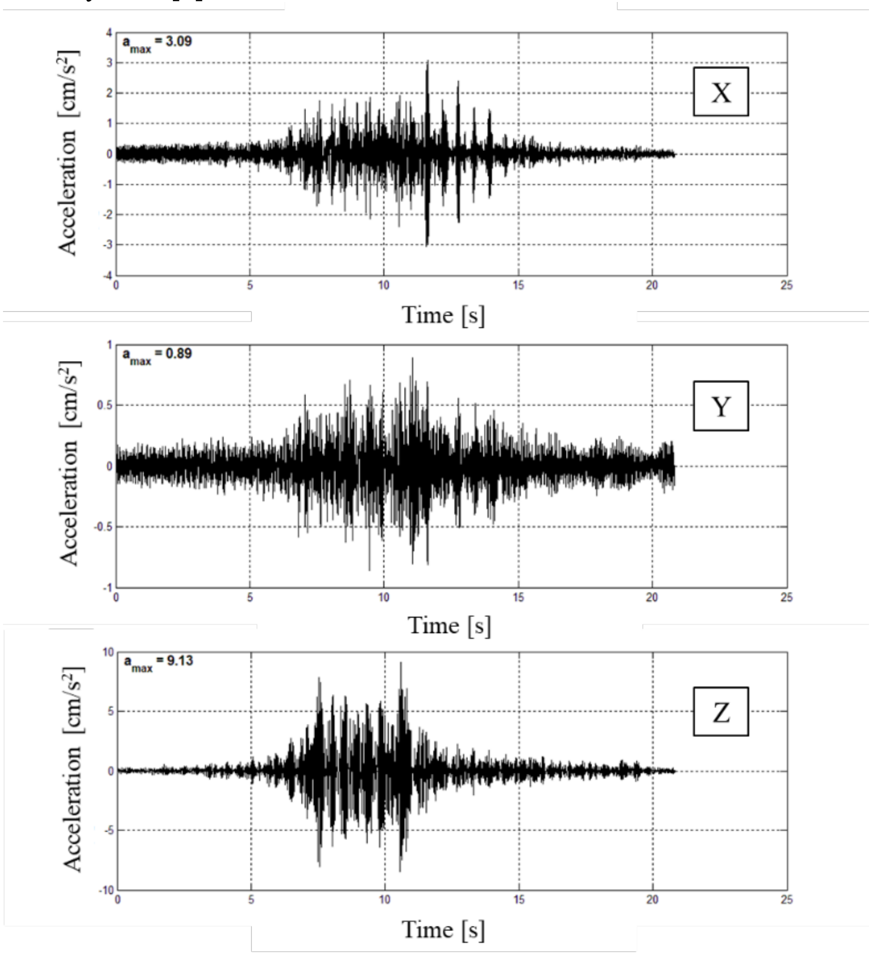

Figure 4. Vibration accelerations on the slab - integrated passenger trains.

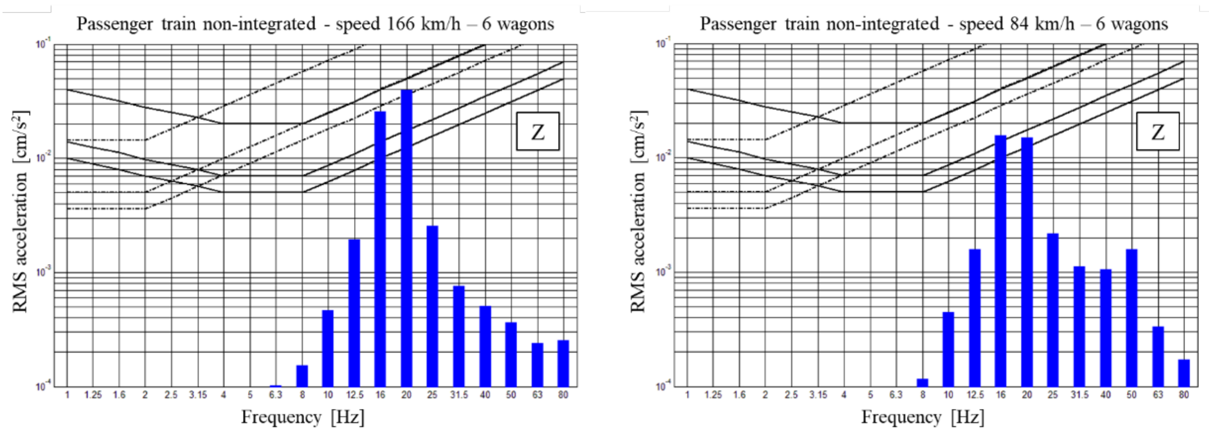

Figure 5. Results of influence of vibrations on human – non-integrated passenger trains.

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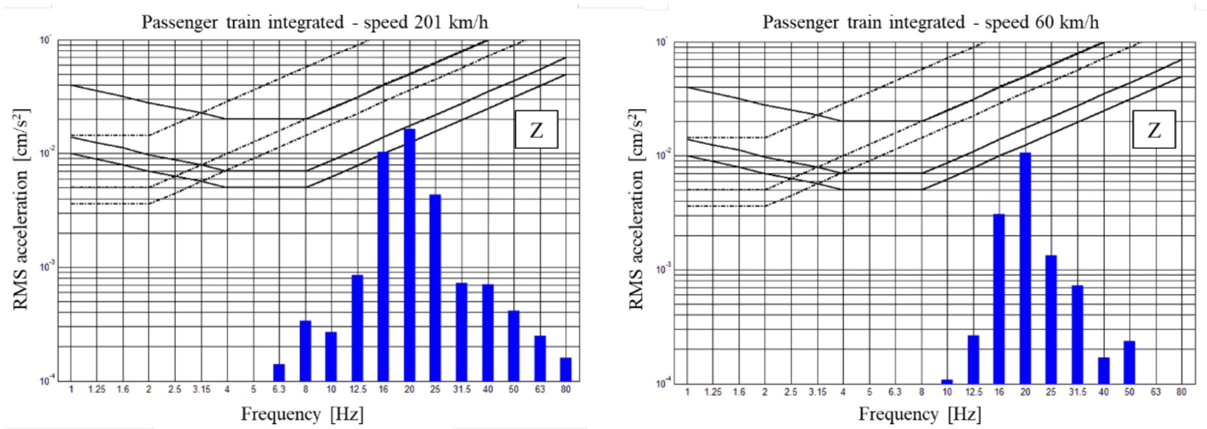

Figure 6. Results of influence of vibrations on human – integrated passenger trains.

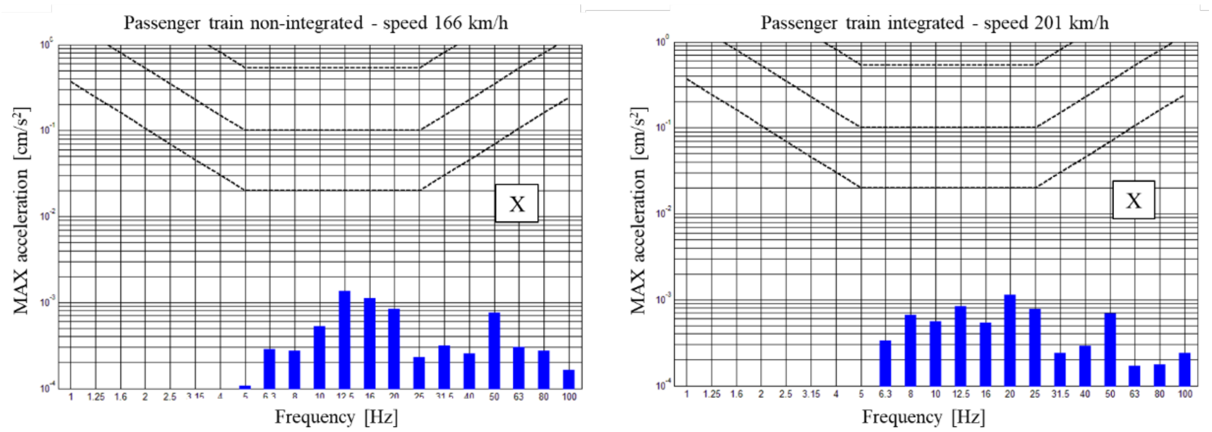

Figure 7. Results of influence of vibrations on building structure – direction X

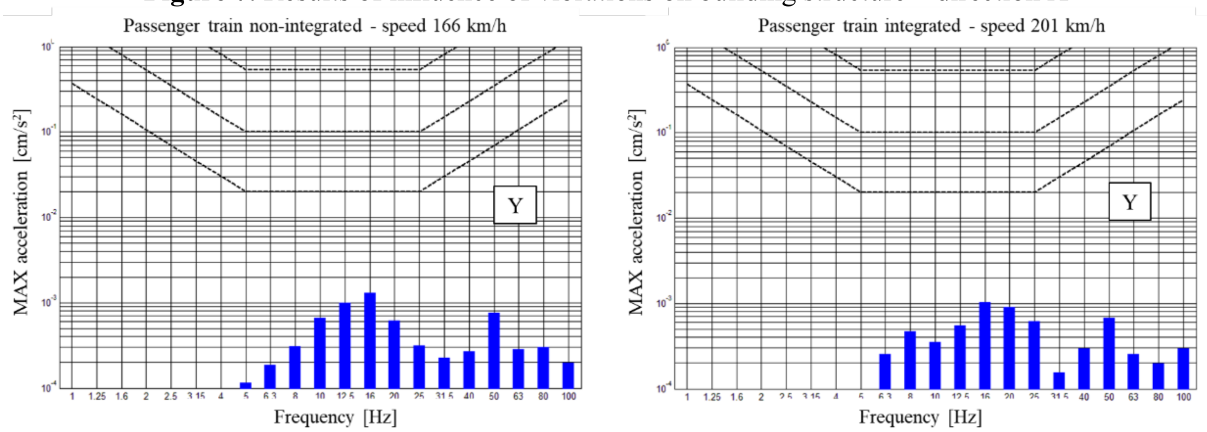

Figure 8. Results of influence of vibrations on building structure – direction Y

4. Conclusions

The article presents selected results of measurements of vibrations from the railway line to a single-family masonry building and humans in the building. The presented test results allow to state that the type of trains has a significant impact on the level of generated vibrations. In the case of integrated trains (new type), the vibration level is lower than in the case of non-integrated trains (old type). Non-integrated trains are characterized by an inferior technical condition. Often the level of vibration can be determined by one wagon or locomotive with poor technical condition. The speed of the train also has a significant influence on the value of accelerations and dominant frequencies. The presented methodology and test results may be useful in the future in the modernization of railway lines or the development of areas near railway lines.

References

[1] Smith M. G., Croy I., Ögren M., Hammar O., Lindberg E., Waye K. P., Physiological effects of railway vibration and noise on sleep, The Journal of the Acoustical Society of America, 141, 2017, 3262-3269.
[2] Kowalska-Koczwara A., Pachla F., Stecz P, Tatara T., Stypuła K., "Vibration-Based Damage Identification and Condition Monitoring of Metro Trains: Warsaw Metro Case Study," Shock and Vibration, vol. 2018, 14 pages, 2018.
[3] PN–B–02170:2016–12 Evaluation of harmfulness of vibrations transmitted by the ground to buildings.
[4] PN-B-02171:2017-06, Evaluation of vibrations influence on people in buildings, 2017 Polish Standard (in Polish).
[5] BS 6472-1:2008 Guide to evaluation of human exposure to vibration in buildings, Part 1: Vibration sources other than blasting, 2008, British Standard.
[6] DIN 4150-2 Structural vibration, Part 2: Human exposure to vibration in buildings, 1999, German Standard.
[7] ISO 2631-2 Guide to the evaluation of human exposure to whole body vibration. Part 2 – Vibration in buildings, 2003, International Organization for Standardization.
[8] ISO 10137 Bases for design of structures – Serviceability of buildings and walkways against vibration, 2007, International Organization for Standardization.
[9] Pachla F., Radecki-Pawlik B., Stypula K., Tatara T. Vibration induced by railway traffic-zones of influence on buildings and humans, Vibroengineering PROCEDIA, 13, 2017, 188-192.
[10] Pachla F., The impact of the passenger train speed on the comfort of humans in a building close to the railway, Vibroengineering PROCEDIA, 19, 2018, 147-152.
[11] G. Kouroussis, D. P. Connolly, and O. Verlinden, "Railway-induced ground vibrations – a review of vehicle effects," International Journal of Rail Transportation, vol. 2, no. 2, pp. 69–110, 2014.
[12] Stypuła K., Tatara T. Vibrations of free-field and building caused by passages of the Pendolino train, Technical Transactions, 114, Vol. 1, 2017, p. 85-100.
[13] Zhai W., Wei K., Song X., Shao M. Experimental investigation into ground vibrations induced by very high speed trains on a non-ballasted track, Soil Dynamics and Earthquake Engineering, vol. 72, 2015, p. 24-36.