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**DYSCYPLINA NAUKOWA  
INŻYNIERIA LĄDOWA I TRANSPORT**

## **ROZPRAWA DOKTORSKA**

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**Wykrywanie przejazdu pojazdu szynowego na podstawie  
zarejestrowanych sygnałów drganiowych**

Detection of the passage of a rail vehicle based on recorded vibration signals

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## Abstract

Transport safety is the basic and most important criterion when planning, designing, manufacturing, maintaining, and even decommissioning elements of superstructure and transport infrastructure. At each stage of the life cycle of a technical object, safety can be defined differently, so various factors are considered its determinants. There is quite a clear distinction in terms of defining the safety of infrastructure elements and means of transport. Another division results from the classification of transport branches.

In the dissertation, it was decided to take the issues of intermodal safety into account, and also aspects of infrastructure and superstructure of transport were taken into account. It results from the assumed research object, which is a rail-road level crossing. The intermodal nature of this transport node causes the intersection of rail and road traffic flows. On the other hand, the combination of the safety aspects of infrastructure and superstructure follows from the assumed research subject, which was the detection of an approaching rail vehicle based on vibrations recorded on the rail. In this case, the detection of an approaching rail vehicle was defined as a safety determinant in order to avoid the risk of collision.

In the research, vibroacoustic methods were used, which will make it possible to observe mechanical vibrations and sound propagation, and to analyze the recorded signals representing these processes in order to obtain useful information. These methods are most often used in technical diagnostics in order to search for the state ↔ symptom relationship. In the dissertation, it was decided to adopt similar assumptions while searching in the signals of mechanical vibrations of a rail, the symptoms of the state of detection of an approaching rail vehicle.

The most important achievements of the doctoral dissertation are as follows.

- confirmation of the possibility of separation of signal components correlated with the operation of various railway infrastructure devices and the vehicle's passage through the crossing;
- verification by experimental, analytical, and *in situ* tests of the possibility of detecting the passage of a rail vehicle on the basis of registered vibration signals;
- development of a method of detecting an approaching rail vehicle using vibration signals recorded on a railroad as a source of information;
- confirmation that a dedicated analysis of vibration signals enables obtaining information about an approaching rail vehicle well in advance;
- development of an algorithm for normalization of the values of vibration estimators in the context of their usefulness in logical automatic control systems;
- development of the concept of a vibration prediction system for an approaching rail vehicle.

Due to the assumptions and utilitarian goals adopted, a patent protection was obtained for a rail vehicle crossing detection sensor (patent number 237 398), the operating principle of which is partly based on the concept developed. In addition, the obtained results of scientific research were implemented by preparing a prototype of an innovative fully functional system, which is built as a demonstrator at one of the D category level crossings in the Silesian Voivodeship.