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GEODEZJA I TRANSPORT

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### **Wpływ raportowania pozycji pociągu na przepustowość linii kolejowej**

Impact of the train position reporting  
on railway line capacity

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## **Abstract**

Digitalization, hydrogen traction, ATO (Automatic Train Operation) and ETCS (European Train Control System) are the main directions of rail transport development in the coming years. The transformation of the economy towards eco-friendly solutions, as well as the growing demand for rail transport both in Europe and worldwide increase the overall share of railway transport in the transportation system. The costs and time of implementing modern train control and management systems necessitate the verification of design assumptions for the operational performance and capacity. Moreover, due to the growing demand for transport services provided by rail operators, the possibility of increasing the capacity through an appropriate process of controlling and managing rail traffic has gained in significance. This possibility opened up when solutions based on wireless data exchange between the on-board and the trackside train control devices were introduced in train control systems. Solutions that enable the capacity of metro systems to be achieved in mainline high-speed lines have already been in use in some parts of the worldwide railway network.

In Europe, including Poland, mainly for historical reasons train control systems and signalling principles are specific for a given country unlike the construction of a closed line or a railway network, with dedicated rolling stock. Additionally, there is a highly mixed traffic movement of rail vehicles - of various types, with different characteristics of acceleration and braking and on-board control equipment. For these reasons, the implementation of solutions in train control systems in Poland and in Europe, which are to increase the capacity, requires detailed analysis.

The paper proposes to use a proprietary simulation software built in the MATLAB&Simulink environment. The simulation software is based on two developed models of train controlling. The first model is based on the train control process performed by the driver based on the trackside signalling signal aspects. The second model is based on the process of train control with the use of cab signalling and safety supervision of the train running by the ETCS system. The simulation software enables a wide range of parameterization, both in terms of the parameters of trains used in the simulation, as well as the parameters of the trackside control system and the layout of trackside train control equipment. An important functionality that distinguishes the proposed train run models from other commercial solutions is the ability to include the real train running characteristics (acceleration and braking characteristics) acquired through measurements, as well as the ETCS braking characteristics.

The paper proposes a way of estimating the maximum capacity of the railway line segment based on the controlled departures of subsequent trains from the station. Consecutive trains depart from the station with a predicted delay based on the known train running characteristics. This is to eliminate an unintentional braking and re-accelerating the train due to interaction with the preceding train.

In terms of train control systems solutions related to increasing the traffic capacity, the concept of additional division of classic blocks on a segment of a railway line using of virtual blocks has been proposed. Virtual blocks assume the non-occupied status based on the position reported by the ETCS onboard system installed on the train. This solution allows not to use additional conventional trackside train detection devices (i.e., wheel detectors of the axle counter system).

The developed simulation software, the proposed methodology of capacity assessment and the concept of using virtual blocks were applied and verified on Psary-Góra Włodowska railway line segment of the railway line no. 4 (Central Rail Line, pl. Centralna Magistrala Kolejowa CMK). As a part of the simulation research, the actual data acquired through executed measurements of the braking performance and acceleration of real trains was used.

The results of the simulation research carried out concerning the capacity determination for the selected line segment confirmed the increase in capacity in the case of using an additional division of classic blocks based on virtual blocks when running trains under the supervision of the ETCS system. Furthermore, the possibility of using simulation software and the proposed way of capacity assessment for the purpose of research and development design solutions in the railway train control and management systems was confirmed.