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Technical note

Traffic noise analysis in railway station zones

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A B S T R A C T

The interim railway noise modelling method RMR, recommended by Directive 2002/49/EC, was developed with the aim of creating strategic noise maps for all major railways, as well as for tracks in urban areas, and harmonizing the parameters for noise level evaluation. Studies conducted in several European countries have shown that the interim method does not meet local conditions of these countries, and that noise levels determined by this method differ from noise levels obtained by field measurements. Traffic noise modelling in the vicinity of Ivanić Grad Railway Station, located near Croatia's capital Zagreb, is described in this paper. Noise levels were determined by means of the RMR interim method, recommended by Directive, and Schall 03, German national method that is still widely used in Croatian noise protection practice. Furthermore, two different scenarios were considered so as to determine the impact of railway vehicle dynamics on noise levels. Vehicle acceleration and deceleration segments were defined in detail in the first scenario, while changes in vehicle moving speeds were neglected in the second scenario. Research results have shown that the noise levels determined by the RMR interim method are lower than those obtained by field measurements, and that the Schall 03 noise modelling method presents more accurate results, which points to the pressing need to develop a national railway noise modelling method in Croatia. Previous noise analyses, conducted on other railway stations in Croatia, have also pointed to this problem.

1. Introduction

Traffic noise levels in the vicinity of railways can be determined through noise model analysis, which is a time consuming and highly demanding process that requires collection of a large quantity of input data. The quality of such models significantly depends on the quality of preparation of input data, and on the effort spent on defining the exact and precise overview of actual situation for which calculation is made, [1]. These claims especially refer to railway segments in urban areas, more precisely railway stations and surrounding zones, where traffic conditions and traffic flow rates are highly variable, and changes of vehicle moving speeds are frequent, [2]. Under the Environmental Noise Directive, relating to the assessment and management of environmental noise, all European countries are obliged to model their environmental noise levels in heavily populated areas, [3,4]. European countries that have developed their own noise modelling procedures use different noise indicators and define noise analysis time periods in a different manner, [5]. These differences have prompted the European Commission to place emphasis on the development of a unique European calculation method that would harmonize noise assessment parameters, as well as the time periods in which the assessment is made, [6]. Annex II of the Environmental Noise Directive recommends the use of interim railway modelling method in all Member States that have no national computation methods in the period until the harmonized method is devised. This interim method is based on the Dutch calculation method RMR02 (equivalent to SRM II RMR96 method). For strategic noise mapping, this Directive recommends the following adaptations to the Dutch calculation method: noise analysis should be carried out in the daytime, evening and nighttime periods; traffic volume should be expressed via yearly average train data; meteorological and atmospheric conditions should be modified; additional vehicle categories and track types should be defined, [7].

Results of empirical investigations conducted on railways in various European countries indicate that the interim RMR method is not adjusted to local conditions of these countries, and that the noise levels determined by this method are not in accordance with the real noise situation. A study from Latvia shows that the difference between noise levels determined by the interim RMR method and noise levels obtained by field measurements in this country amounts up to 20 dB(A), [8,9]. Another study from Poland shows that noise levels determined by the interim RMR method are lower than noise levels obtained by field measurements, because the roughness of rails in this country is greater than the roughness of rails in the Netherlands, [4]. Apart from the above, research conducted in the United Kingdom has shown that the

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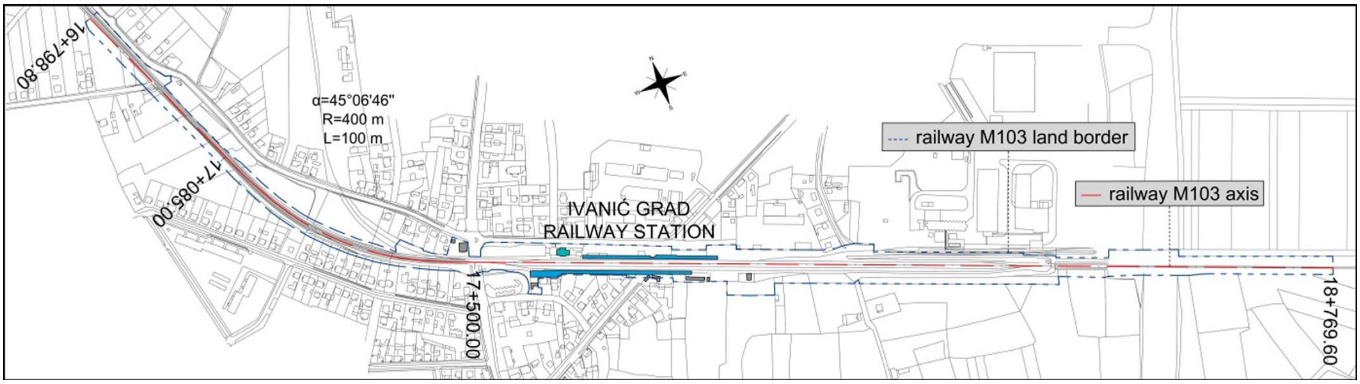

Fig. 1. Section of railway M103 covered by noise analysis.

adjustment of their national method to recommendations given in Directive 2002/49/EC would cause fewer problems for users compared to development or adoption of a completely new method, [10]. The United Kingdom has a database related to the existing method and thus the adoption of a new method would result in data loss.

The most common problems with noise mapping in railway station zones in Croatia are the lack of widely available bases of good-quality input data, and the disregard of the fact that traffic conditions in railway station areas differ from traffic conditions on open rail segments, [11]. Furthermore, Croatia does not have a national calculation method that is adjusted to local conditions on its railways, and so the railway noise modelling is carried out in this country by means of Schall 03, German national method that is still widely used in Croatian noise protection practice [12], and the interim RMR method recommended by Directive 2002/49/EC, [13].

2. Traffic noise analysis at Ivanić Grad Railway Station

The traffic noise analysis in the vicinity of Ivanić Grad Railway Station, located near the Croatia's capital Zagreb, is described in this paper. Noise levels are determined by means of two different calculation methods, interim RMR and Schall. Furthermore, two different scenarios are applied. In the first scenario, vehicle acceleration and deceleration segments are defined in detail and in the second one changes in vehicle moving speeds are neglected. The main objective of this study is to determine the impact of railway vehicle dynamics on noise levels, and to establish which of the studied calculation methods is more suitable for noise analysis on railways in Croatia.

2.1. Location description

The Ivanić Grad railway station is located at the 83.4 km long single-track railway M103 Dugo Selo - Novska which constitutes an integral part of the Pan-European Corridor X. This railway station is open for passenger and wagon consignments transport in domestic and international traffic. It was designed for the driving speeds of up to 130 km/h but, currently, due to the poor condition of permanent way, the speed is limited to 80 km/h. In the vicinity of the Ivanić Grad railway station, railway M103 has four tracks: the first track is manipulative, and the other three tracks are main tracks.

In accordance with Croatian negotiating position accepted during negotiations on accession to the European Union, all railway lines on Croatian territory that are an integral part of new TEN-T Corridor 1 (railways M101, M102, M103, and M105) will become a part of the Trans-European Rail network, [14]. According to the adopted strategy of rail network development all railways within this corridor should be double-track. Considering the above, the reconstruction, upgrade and overhaul of railway M103, and reconstruction of several railway stations on this railway, including the Ivanić Grad railway station, is required. The reconstruction of the Ivanić Grad railway station will involve the following: extension and reconstruction of existing tracks in order to achieve the speeds of up to 160 km/h and maximum axle loads of 25.0 t/axis, i.e. 8.8 t/m; construction of new platforms in order to achieve useful lengths that can accommodate operable train lengths of 750 m; installation of new 60E1 type rails with elastic plates on concrete sleepers in gravel ballast; installation of new turnouts; reconstruction of the railway station building, [15]. As can be seen, a traditional track structure has been selected for travel speeds of up to 160 km/h, which is in accordance with experience gained in other countries, as further confirmed by latest research from Lithuania, [16].

2.2. Noise modelling for situation after overhaul of railway M103

According to the Croatian Law on Noise Protection [17], noise analysis should be carried out in the following three periods: daytime period from 7:00 a.m. to 7:00 p.m., evening period from 7:00 p.m. to 11:00 p.m., and nighttime period from 11 p.m. to 7 a.m. Maximum allowed noise levels in these periods, prescribed by the corresponding Byelaw [18], depend on land use. According to a special provision of the Byelaw, noise levels at the railway land border should not exceed 65 dB(A) in the daytime and evening periods, and 50 dB(A) in the nighttime period.

Noise analyses in the Ivanić Grad railway station zone (segment of railway M103 from km 16 798.08 to km 18 769.60) were carried out by means of the specialized noise prediction software LIMA v.4.3 using the German Schall 03 and interim RMR calculation models (Fig. 1). Calculations were conducted at 127 free field receptors placed 4 m above the railway M103 land border and at grid points defined by Croatian regulations (grid 10 × 10 m at the height of 4 m). The digital terrain model was approximated by a horizontal plane due to small longitudinal slopes of the railway and general flatness of the surrounding terrain. The railway M103 axis in the railway station area was located in the axis of the main track. Facilities located within the railway M103 land border were not the subject of noise protection but constituted a barrier to noise expansion. The height of these facilities was 3.0 m per floor. Traffic data for the planned layout was obtained from national railway company Croatian Railways (Table 1).

In the first scenario, the acceleration and deceleration of all railway vehicles that operate on the railway section under study were taken into account - the acceleration and deceleration of local and high-speed trains was assumed to be 0.55 m/s^2, and the assumed acceleration and deceleration of freight trains amounted to 0.20 m/s^2. The driving speed in a horizontal curve at the entrance to the Ivanić Grad railway station (segment of railway M103 from km 17085.00 to km 17500.00) was limited to 90 km/h. It was considered that local trains stop at this railway station, and that high speed and freight trains pass without stopping. Taking all this into account, the railway axis was divided into 40 subsections in this scenario. The driving speed on these subsections

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