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IMPACT OF EXPANSION JOINTS ON NOISE POLLUTION, CASE STUDY IN CLUJ-NAPOCA

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Rezumat

Această lucrare dorește să ridice problema pe care o pun aparatele de rost, tipul acestora precum și gradul lor de degradare din punct de vedere acustic, ridicând nivelul de poluare sonoră în zonă datorită traficului rutier.
Studiul a fost efectuat în trei locații distincte din municipiul Cluj-Napoca, pe trei pasaje/poduri rutiere, toate având aparate de rost metalice cu următoarele particularități: prima locație avea aparate de rost recent instalate în stare foarte bună, a doua avea aparatele acoperite cu mixtură asfaltică iar cea de a treia locaţie avea aparatele de rost în stare vizibilă de degradare. Am ales aceste trei locaţii pentru a evidenţia anumiti factori care influenţează în mod direct poluarea sonoră cauzată de trafic şi pentru a vedea cum se poate îmbunătăţi confortul acustic în acele zone.

Cuvinte cheie: aparate de rost, poluare sonoră, trafic rutier, Cluj-Napoca

Abstract

The aim of this paper is to study the impact that certain types of expansion joints have on noise levels produced by regular traffic on the streets of Cluj-Napoca. The study was carried out on three distinct locations, all three road bridges had steel expansion joints, the first one had asphalt covering the joints, the second one was in excellent condition, as it was a newly refurbished bridge and the last one with visible signs of degradations.
After a full spectrum noise analysis, the results showed that good maintenance and quality control on the installation of expansion joints are necessary, not only to lower noise levels but to also provide a solid and sealed transition to the bridge deck.

Keywords: expansion joints, noise pollution, traffic, Cluj-Napoca

1. INTRODUCTION

Pollution due to noise is a growing problem in urban areas all over the world. Noise pollution leads to increased stress, fatigue, psychic instability, reduced efficiency at the workplace, diminished or even loss of hearing. In relation to the environment and in the presence of noise levels of high intensity, it can cause structural cracks, broken windows or damages to different equipment or instruments. According to [1], the noise due to road traffic is a major environmental problem that affects the health and well-being of millions of people across Europe. It was estimated that about 20% of the Europeans are exposed long term to noise levels that are harmful to health, that is about 100 million people. The findings of the report [1] estimate it is very unlikely to have a decrease in the future in the number of people exposed to high levels of noise, because we are noticing an increase in the urban areas and the mobility.

The noise from road traffic comes from the interaction between the tire and the pavement, from aerodynamic sources and from the noise produced by the vehicle (engine, transmission, etc.) and it is well known. Part of the noise produced by road traffic is generated when the vehicle passes the expansion joint, when entering of exiting a bridge superstructure. One study investigating measures to reduce noise impact from bridge expansion joints was conducted by the University of Washington for the Washington state Department [2]. The report states that the noise generated by the expansion joint can be emanating from the cavity below or from the top of the joint. Another study was published this year and it investigates the noise produced by the vehicle passing across bridge expansion joints in the city of Ningbo [3]. This study investigates the noise of three different types of expansion joints: single-gap expansion joints, modular expansion joints and comb-plate expansion joints. Spuler, Moor and Suilleaghain [4] explored what they called “quiet” expansion joints available on the market. At the time of their research, they identified four types of expansion joints that were satisfying the durability and noise requirements according to the German and Austrian standards: cantilever finger joints, sliding finger joints, modular expansion joints with noise reduction plates and single gap expansion joints with noise reducing plates.

This paper investigates the effect observed in terms of noise pollution due to road traffic of the expansion joints of three bridges in different conditions: newly rehabilitated bridge, an old bridge with deformed expansion joints and asphalt degradation near the joint and a bridge rehabilitated recently where it was decided to cover the expansion joint with a layer of asphalt. The noise produced

by the vehicle passing over the joint expansion is registered when the tire passes across the discontinuous surface profile of the expansion joints or the bumps created in case the expansion joints were covered by a layer of asphalt as is in the case of some old bridges. The location of the sites investigated in terms of noise pollution is in the city of Cluj-Napoca, one of the Romanian cities with a rapid growth and increase in terms of traffic and mobility. The present paper comes to complement other studies made around noise pollution, such as [5-8].

2. CASE STUDY PRESENTATION

The main purpose of this paper was to determine how a specific expansion joint influences the noise levels caused by normal traffic in correlation with its age, state of degradation.

All acoustic measurements were made with a professional NTI Minilyzer model ML1, which is a full spectrum noise analyzer measuring from 20 Hz to 20.000 Hz. On each location, noise data was collected on each of the expansion joints and in the middle of the bridge for reference. On these three points multiple readings were collected in order to generate a more accurate average noise spectrum and also an envelope of the maximum values for each of the studied frequencies.

All studied locations are presented on the map (Figure 1) and are representative as some of the most crowded roads in Cluj-Napoca. They are as follows:

1. First location was the bridge over the Someş river on Bulevardul 1 Decembrie, an older bridge where the expansion joints were fully covered by asphalt (Figure 2) during older restorations and had some small degradations visible on the surface (no.1 in Figure 1), the state of the asphalt.
2. The second location was the nearby overpass on Calea Floreşti, a recently rehabilitated bridge with relatively new asphalt surface and new expansion joints in very good condition (Figure 3, no.2 on the map).
3. The third and final studied location was the old overpass on Bulevardul Aurel Vlaicu in Mărăşti neighborhood, one of the most problematic areas in Cluj-Napoca regarding traffic and polution. As can be seen from Figure 4, the expansion joint is deformed, with holes in the asphalt near the expansion joint.

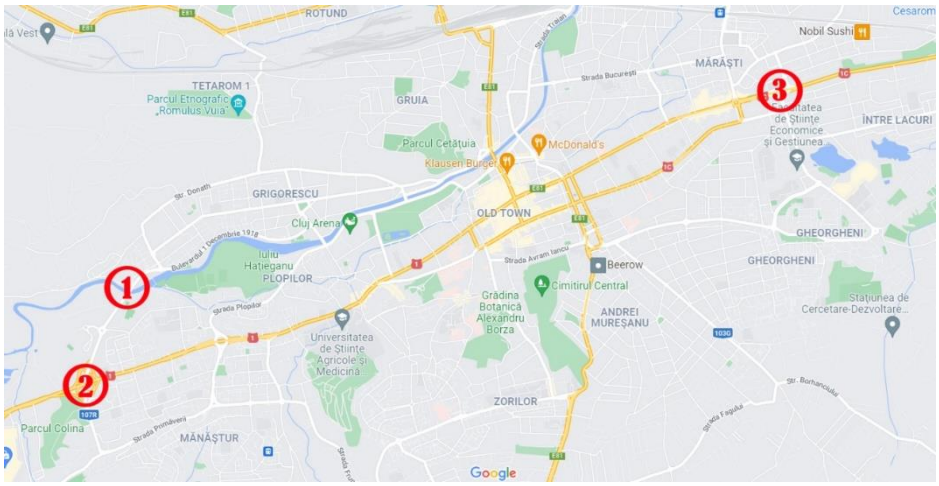


Figure 1. Location of the three bridges investigated



Figure 2. Location 1 – expansion joint covered by asphalt



Figure 3. Location 2 – expansion joint in very good condition



Figure 4. Location 3 – degraded expansion joint

3. MEASUREMENTS

At each location and at each point, we made three measurements to validate the correctness of the registered values. Figures 5-7 present, under a graphical form, the measurements made at the first location, at each of the expansion joints and at the midspan. The similarity in curves, with very little variation, validated the correctness of the results.

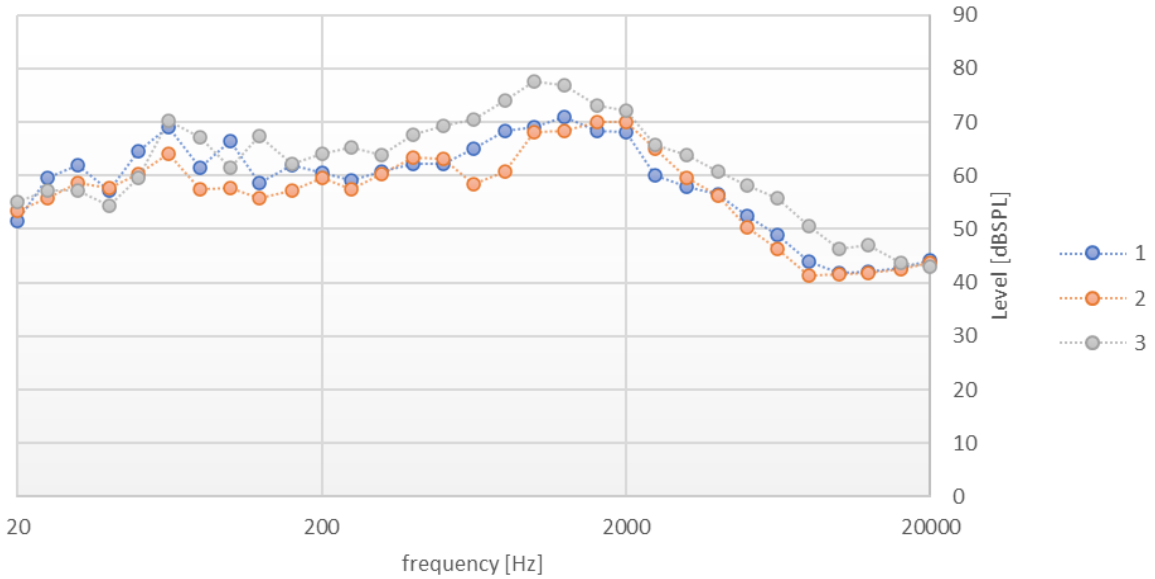


Figure 5. Location 1, first expansion joint measurements

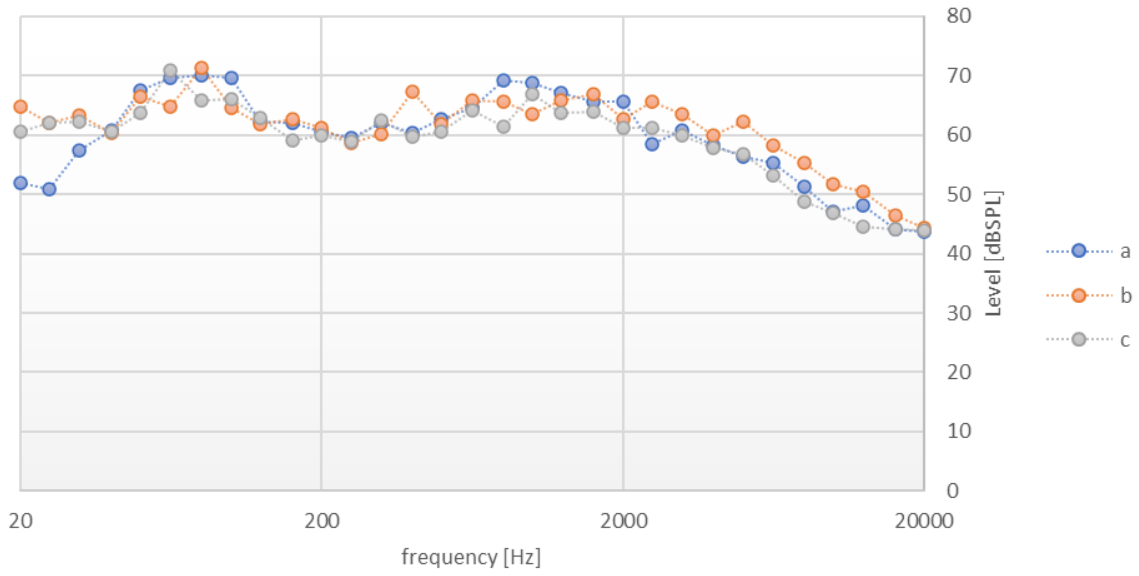


Figure 6. Location 1, mid-span measurements

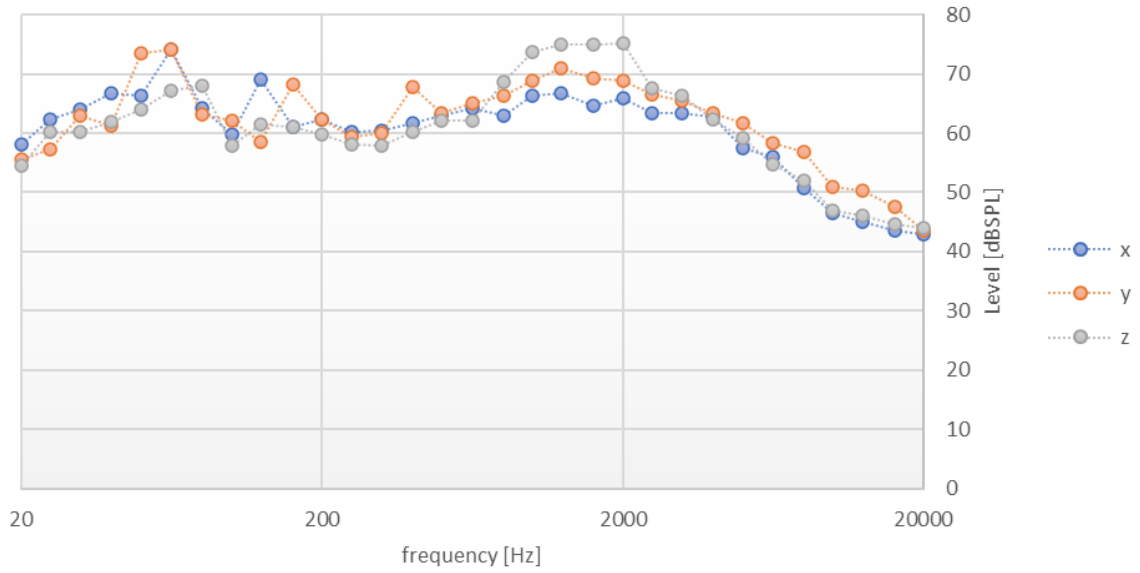


Figure 7. Location 1, second expansion joint measurements

4. RESULTS

In order to show the impact the expansion joints have with regard to the noise generated by traffic, we made comparative graphs on both the average spectrum values and the envelopes of the maximum values recorded. Figures 8-13 show the full spectrum results in each of the three locations.

4.1. Location 1, bridge over the Someş river

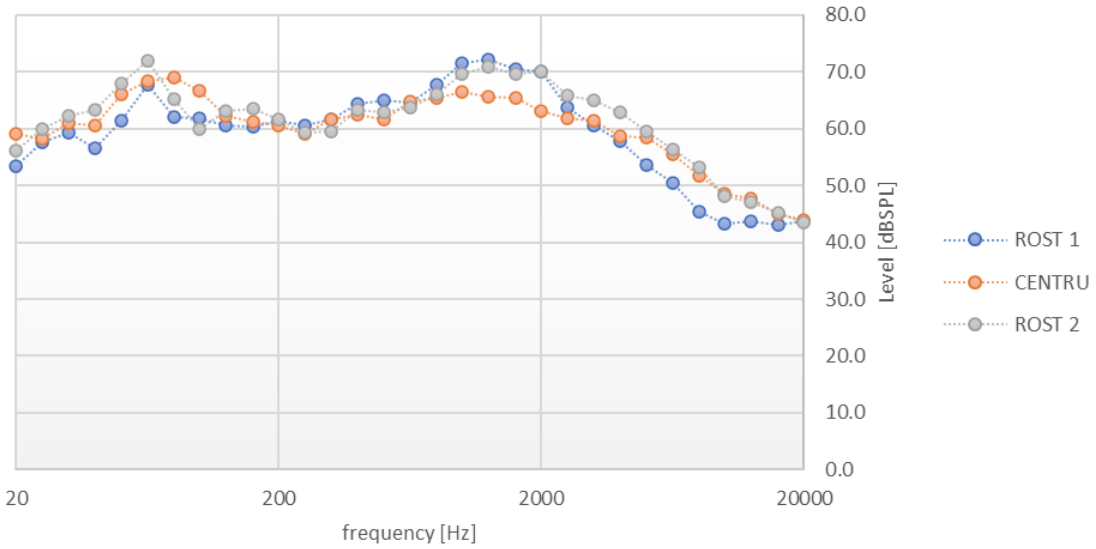


Figure 8. Average noise spectrum levels

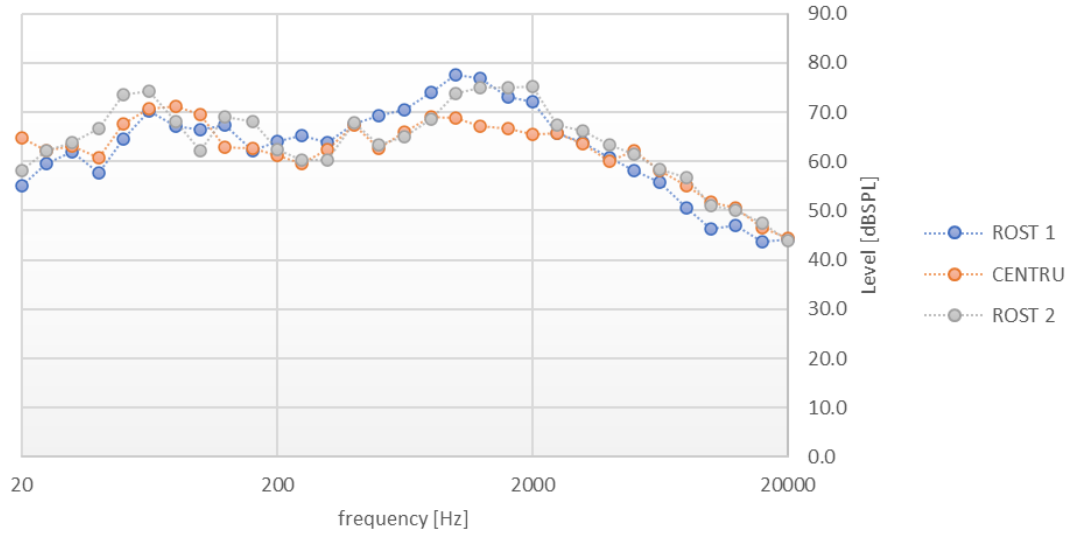


Figure 9. Envelopes of maximum noise spectrum levels

We can see in both graphs corresponding to Location 1 (Figures 8,9) a small amplification in noise levels between 800 and 2500 Hz due to the steel expansion joint. The values are not extremely large but noticeable, varying between 7 and 10 dB, all this mainly due to the dampening effect of asphalt that was poured over the joints.

On the lower frequencies we can see very similar curves on the higher part of the spectrum.

4.2. Location 2, overpass on Calea Floreşti

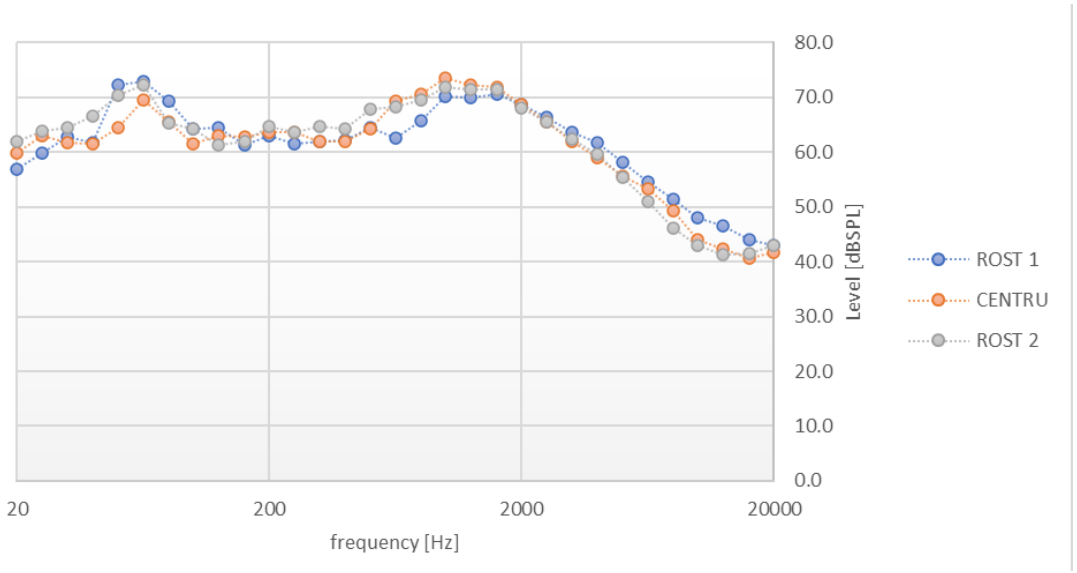


Figure 10. Average noise spectrum levels

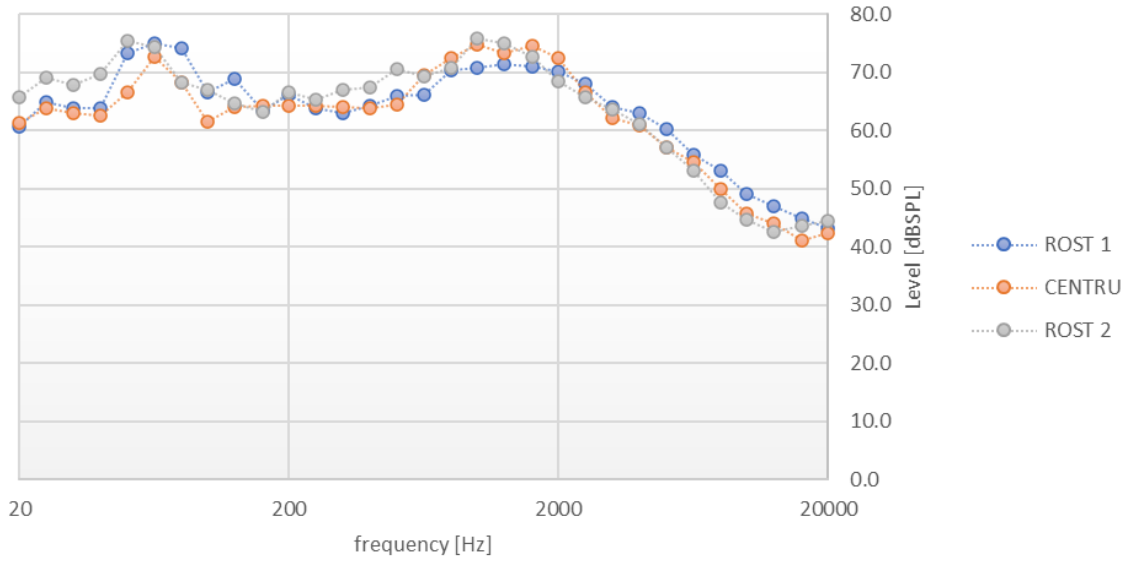


Figure 11. Envelopes of maximum noise spectrum levels

In the second location where expansions joints are almost new and without visible signs of degradation, the spectrum curves are very similar, with very little differences on both expansion joints and in the center of the bridge.

The graphs (Figure 10, 11) are very similar to the ones form the previous location which validates that this curve is representative for traffic noise levels.

4.3. Location 3, Bulevardul Aurel Vlaicu overpass

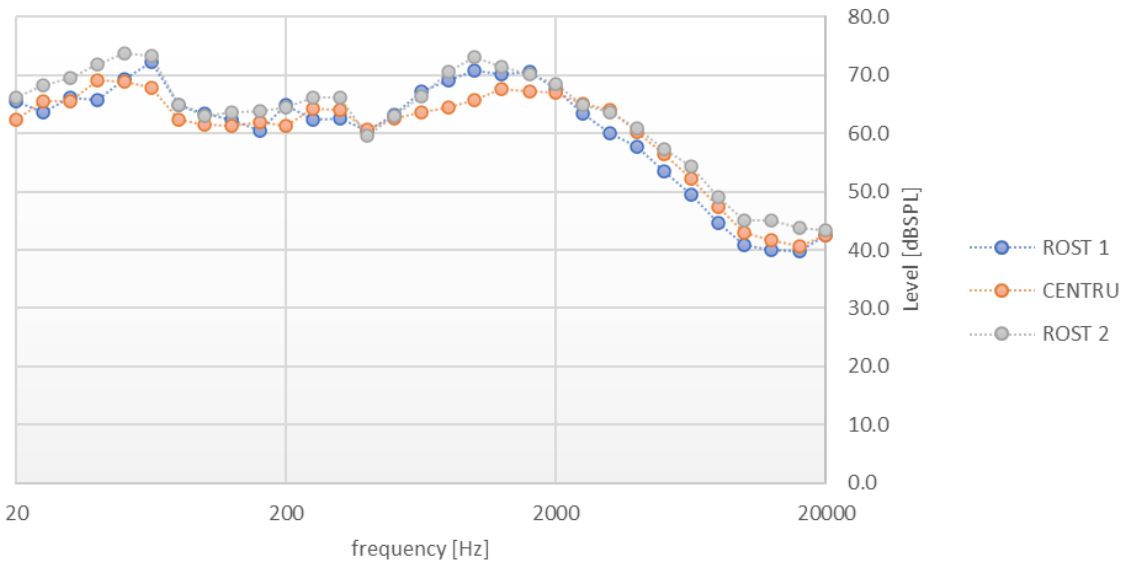


Figure 12. Average noise spectrum levels

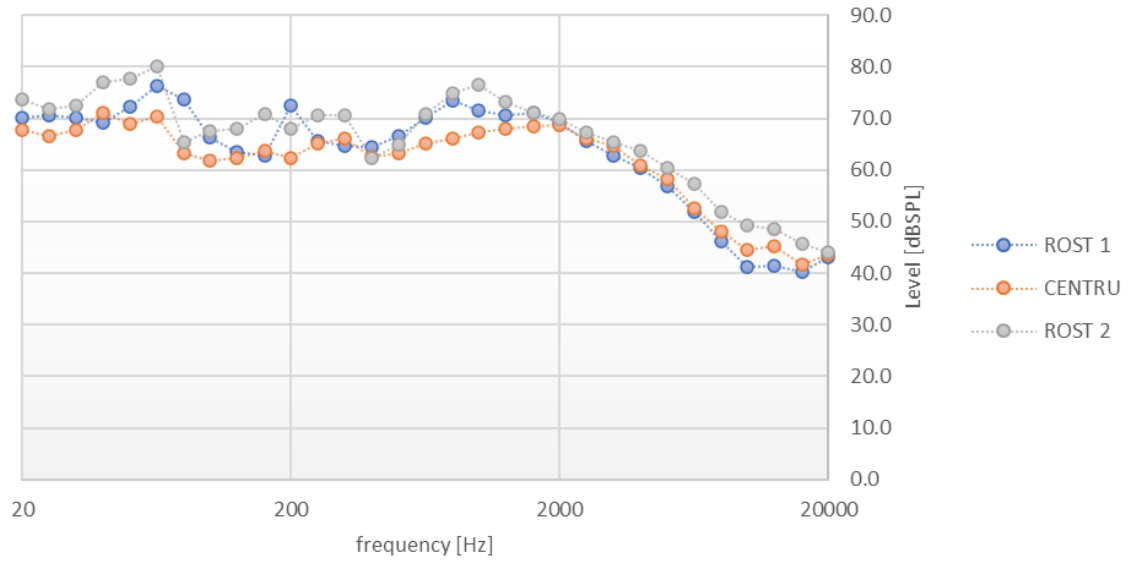


Figure 13. Envelopes of maximum noise spectrum levels

At location 3 we can clearly see a rise in noise levels around 630-2000 Hz, similar to the one measured on the first location, again confirming that expansion

joints have a negative impact on noise pollution on medium frequencies in that part of the spectrum.

Specific to this location we can observe a bell like rise in the lower part of the spectrum, around 50 to 80 Hz due to the impact of the wheels passing the degraded expansion joint.

5. CONCLUSIONS

As seen in the previous section, we can conclude that steel expansion joints have a serious impact on traffic generated noise levels, and that an increase can be noticed around medium frequencies, between 630 to 2500 Hz, and it is closely related to the degradation level of the joint.

Constant inspection and maintenance of the bridge's roadways and their structural and non-structural elements can lower the impact of traffic on noise levels in the area.

Covering the expansion joints with an asphalt layer can have a dampening effect on traffic noise but comes with other disadvantages.

This study must be correlated with future research in order to understand the causes and the propagation of traffic noise in urban areas so that the best solutions can be proposed in terms of improvements in the the quality of life.

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