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THE ROLE OF REGIONAL PLANNING DOCUMENTS IN SUSTAINABLE TRAFFIC NOISE PROTECTION DESIGN

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Abstract

Noise protection design is an integral part of any project document when constructing new or reconstructing existing transportation facilities. It has been common practice so far to design and construct noise protection barriers in order to protect the existing, i.e. previously built structures on which a new road or motorway might have an impact. In view of the ever-growing expansion of construction areas it is necessary to consider the regional planning aspect and analyze areas next to the existing and planned transportation facilities from the viewpoint of present as well as planned conditions. When the financial factors and potential modifications of the regional planning documents are taken into account adequate protection of future structures is not possible during the design stage alone.
This paper aims to estimate the possibilities of developing better and sustainable designs as well as the possibility of reviewing the noise protection designs in certain time intervals considering the fact that the land use surrounding the motorways is prone to change, as are the regional planning documents which define it.
The goal is to test the possibilities and to propose the method of identifying planned construction areas which will be impossible to protect in the future by means other than modification of the land use as defined by regional planning documents.

Keywords: traffic noise protection, motorways, sustainable design, preventive design, preventive planning

1 Introduction

Over the past several decades an increase of noise emission was observed, mostly caused by road traffic [1]. In the European Union about 40% of the population is exposed to road traffic noise with an equivalent sound pressure level exceeding 55 dB(A) daytime, and 20% are exposed to levels exceeding 65 dB(A). At night, more than 30% are exposed to equivalent sound pressure levels exceeding 55 dB (A) [2].
It has been established that exposure to noise affects health and quality of life, causing many behavioral, cognitive, biochemical and neurological disturbances [3]. This has prompted the European Commission to pass European Directive on Assessment and Management of Environmental Noise (2002/49/EC). Environmental Noise Directive (END) was adopted in June 2002. END requires prevention, avoidance and decrease of harmful consequences and disturbances caused by environmental noise [4]. The field of research covers the possibilities of anticipating, preventing and avoiding the origin of negative noise impact using physical planning documents and noise protection designs.
The goal of the paper is to check the possibility for coordination of roads and the buildings, for the purpose of minimizing the traffic noise impact on the planned construction, i.e. future population density.

1.1 Analysis of Traffic Noise Impact in Practice

Environment Impact Study (EIA) is a part of the planning stage of a new highway route. Through EIA screening, it is possible to define the most suitable alternative of the route in regard to the sensitive components of the environment (impact of noise on settlements and population). Once the route is established, active protection measures (noise protection barriers) are specified within the design stage in order to protect existing buildings against noise. If active protection measures are not sufficient passive protection measures are planned (traffic planning and technical measures for the noise-endangered buildings).
Noise impact on the planned construction, however, is not taken in consideration in any of the planning/designing stages.
Already there are examples of insufficient noise level reduction, when even the maximal noise barrier height coupled with passive protection measures fails to reduce the noise level to statutory noise exposure limits [5].
The problem occurs due to:

- Newly constructed building being located along the traffic route
- Increase in traffic density

This can be avoided on two levels: Preventive Design and Preventive Planning.

1.2 Preventive Design

Preventive design relates to laying out basis for design revision possibilities over certain time periods.
It is proposed to develop a plan of thought-out periodical noise level measurement of a newly constructed road over the course of several years. According to monitoring results, additional elements for noise protection can be added or additional protection measures can be implemented as needed [6].
After a new road is put in service periodical noise measurements are required in order to undertake design revisions if deemed necessary. However, all of the potential changes of the design during a certain planned period have to be anticipated during the design in order to avoid technical problems, such as subsequent placement of new barriers or increase of height for the existing barriers.
If no corridors are foreseen in advance along the traffic route, for future placement of noise protection barriers, there may be problems during foundation work because of the existing installations (electro-installations or drainage, sewerage). One must also take care about the dimensioning of the foundations/piles for the barrier. If the barrier is dimensioned, for instance, for the height of 3 meters and HEA or HEB girders are used, the height increase will be possible without any greater problems, but it is also necessary for the foundations/piles to be previously dimensioned for the future barrier height.

1.3 Preventive Planning

As evident above, it is possible to protect the newly constructed buildings to some extent, considering the intended land use and the anticipated noise level in the planned period, by revising the noise protection design with active (barriers) and passive protection (speed reduction). The question raised is what course of action can be taken when such protection is no longer sufficient. The answer lies in preventive planning.
Preventive planning is based on Article 4 of the Noise Protection Act (NN No. 20/03), and it refers to thoughtful identification of both noise sources and buildings. In the design stage the source of noise is already defined but relocation of future planned buildings is still possible. According to END, preventive planning places the emphasis on preventing and avoiding of harmful consequences of noise impact in the future, while the designing refers to noise

reduction at the moment of putting the road into service. Through assessment of traffic noise emissions over planned construction areas according to the intended land use, it is possible to define conflict zones which cannot be protected by subsequent design revisions. Thus, it would be desirable to exclude these zones from construction areas defined by physical planning documents already in the designing phase. In this way it is possible to avoid the construction of any new buildings within the zones impossible to protect by any measures against noise emanated from the road.

2 Materials and Methods

The methodology of preventive planning/design with the purpose of sustainable development from the aspect of noise protection was tested on the section of the Zagreb-Sisak highway which passes through the area of the Town of Velika Gorica.
Input materials used were: Noise Protection Design for Zagreb–Sisak highway [7], Regional Plan of Velika Gorica [8], orthophoto and topographic map of the area, appropriate legislation. Traffic noise map was prepared using SoundPlan 7.0 for the acoustic calculation and used to define the location and orientation of noise protection barriers. Existing buildings were also taken into consideration. The noise maps were prepared for the night, in the period from 10 p.m. to 6 a.m. [5]
The increase of road traffic was calculated using a 2% per year increase [9] and the noise spreading map was calculated again, but in this case, it referred to noise spreading in the planned period of 20 years.
The concerned map was overlaid with the built and unbuilt construction areas as defined by Regional Plan in order to extract the zones in conflict - all planned construction areas on which the night noise level exceeds 40 dB (A).
Although the proscribed value in Croatia is L_{night} 50 db (A) [5], World Health Organization (WHO) recommended values were used because of long-term planning aspect. With regard to the results of the scientific research on the consequences of exposure to noise by night it was concluded that END-defined $L_{night/outside}$ (2002/42 EC) must not exceed 40 dB in the interest of general public protection, including the most vulnerable groups, such as children, chronically sick persons and the elderly [3].
Along these areas it is necessary to foresee (at the level of preparing the main design) the possibility for a subsequent barrier placement: through foundations dimensioning and coordination with other designs (installations, landscape).
Areas where it is possible to reduce noise to legally proscribed values by revision were excluded from the conflict zones. Those areas were obtained by overlaying the planned construction areas with the noise map. Noise map was prepared with maximal height barriers (5m) inserted along the whole length of the route.
The remaining areas can only be protected if land use change is implemented in the Regional Plan. In order to prevent construction in these areas, it is necessary, even during design phase, to identify them correctly.

3 Results

In the phase of creating the Main noise protection design, a traffic noise map was prepared (Fig. 1). By predicting the noise spreading during the period of 20 years, a significant noise corridor increase was shown, which exceeds the allowed 40 dB (A) for the night, and encompasses a large part of the planned construction areas (Fig. 2). We can predict future locations of barriers during this phase, marked in Figure 2 with a blue line. Of course, this is only the general location of barriers, whose height and position will be defined in detail by subsequent measurements in the field, performed in defined intervals.

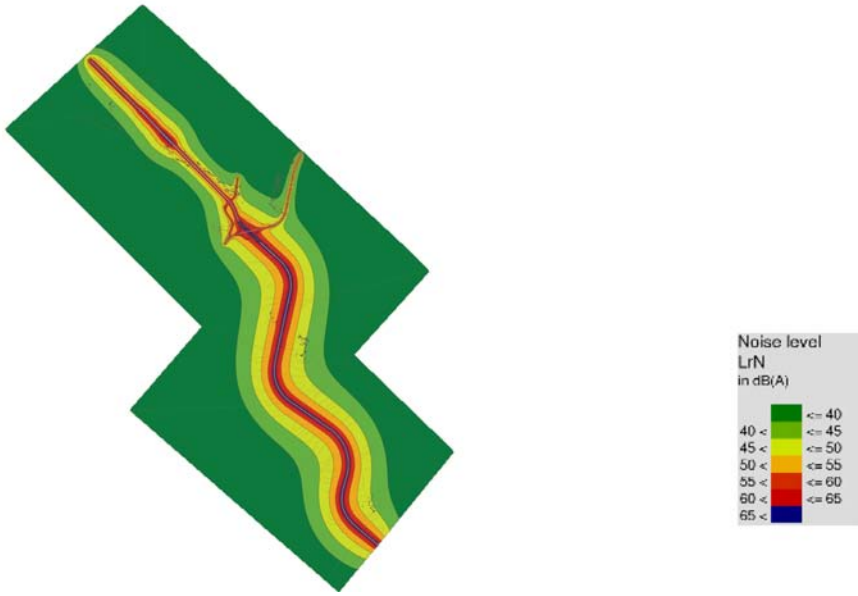

Figure 1 Traffic Noise Map for Zagreb-Sisak highway

The possibilities for noise reduction on the borders of planned construction areas were tested by placement of 5m high barriers along the whole length of the highway (Fig. 3).
By exclusion of the areas which we will be able to protect with additional barriers, parts of the planned construction areas which cannot be protected were obtained. The only possibility of mitigation is a change of land use plan (Fig. 4).

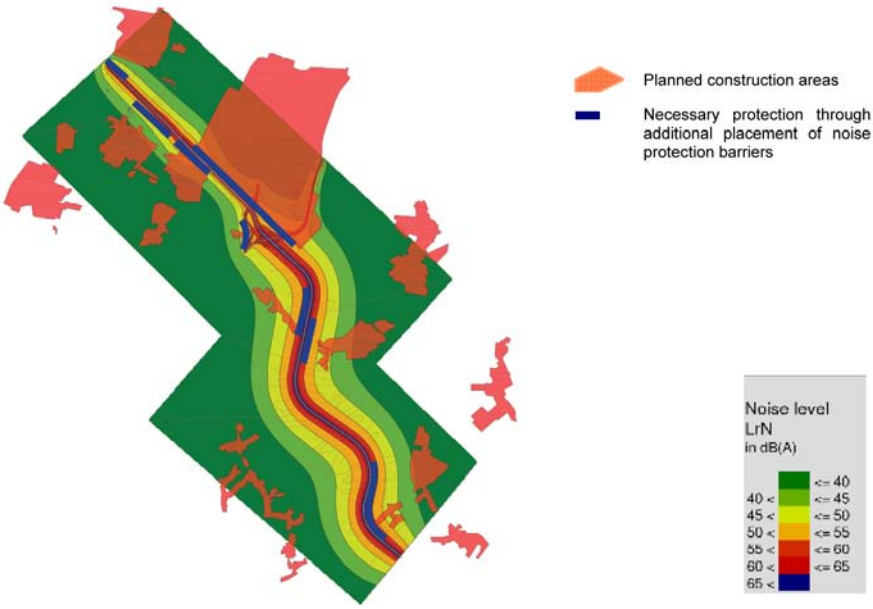

Figure 2 Noise spreading model for the period of 20 years, calculation without barriers

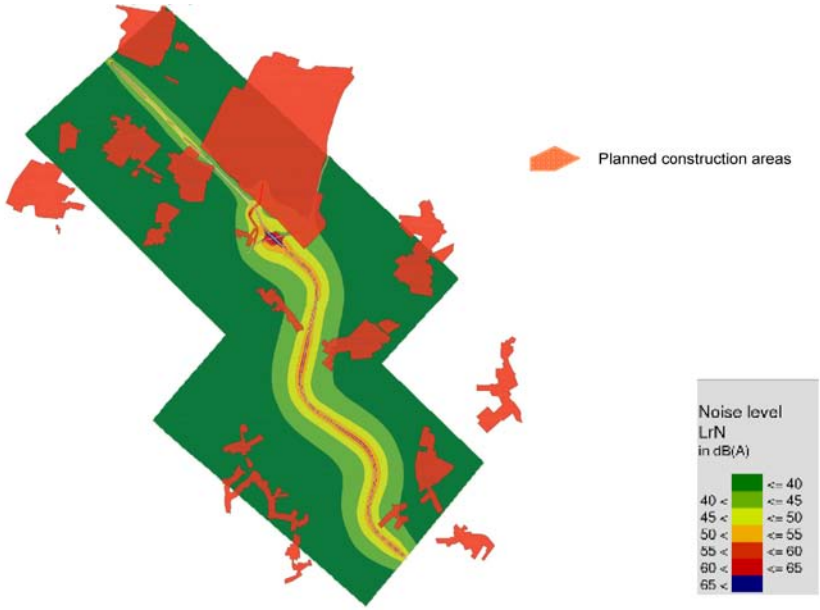

Figure 3 Noise spreading model for the period of 20 years, calculation with barriers

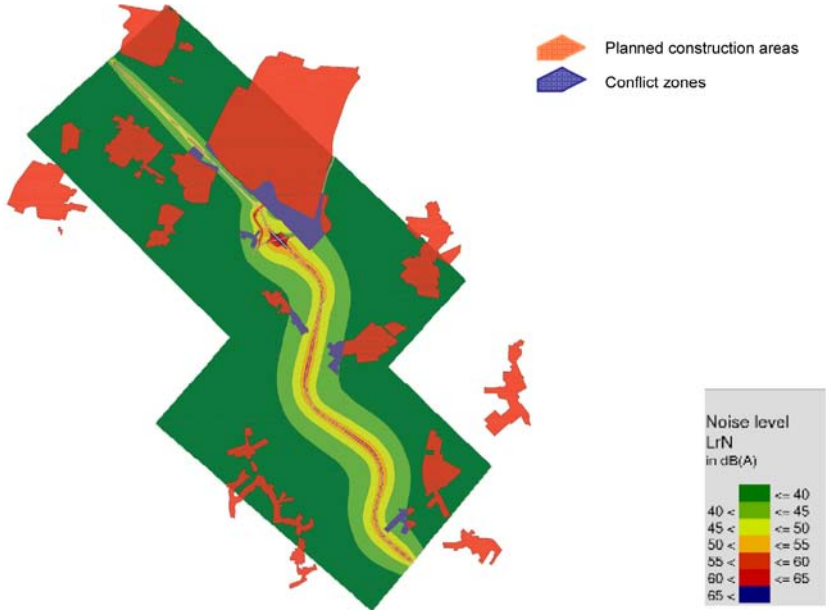

Figure 4 Conflict zones – planned construction areas/potential future construction, which cannot be protected against traffic noise emission

4 Discussion

It is necessary to perform the whole preventive design/planning process (Fig. 5) during the preparation of Main design. Preventive designing refers to timely predicting of adequate foundations and timely coordination of possible revisions for noise protection designs with other designs.
Preventive planning refers to the identification of conflict zones, which cannot be protected by revising the designs i.e. by placement of additional barriers. That is why it is necessary to prepare, based on these zones, a document for the change of the planned construction areas as defined by Regional land use plan.
This procedure makes the preparation of the (main) noise protection design significantly more complex task, demanding a greater effort of the designer in the defining of excessive noise-endangered zones. Therefore, it is necessary to optimize the incoming data.
Since the methodology takes into consideration long-term sustainable design and planning, it is necessary to test the used borderline values and optimize the values, which will be justified from the aspect of development (limits imposed on construction areas and economic factors) while achieving the goal of general public protection against the impact of noise on health and quality of life.

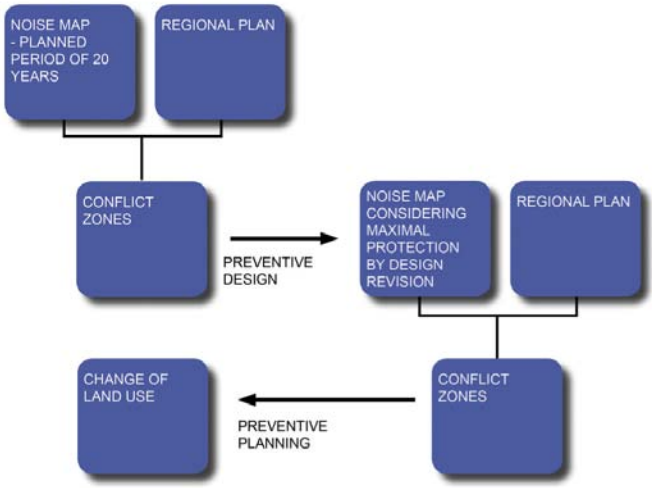

Figure 5 Phases of inclusion of preventive design and preventive planning for noise protection

The obtained results can be integrated in the Noise Action Plan [10] and used as basis for the change of the Regional Plan. It is necessary to test the possibilities for use of the proposed methodology for other sources of noise (railway traffic, air traffic, industry). This would possible raise the quality and potential of Strategic and Conflict noise maps.

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