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MODEL OF DATABASE FOR DEVELOPMENT OF URBAN TRAFFIC NOISE MODELS

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Key words: *database, noise, traffic*

Abstract: *The paper presents the concept, structure and implementation of the relational database for description of the noise produced by transportation means in the urban areas. The implementation of the database was performed in the Microsoft Access. Presented database stores measured noise levels, as well as data on traffic flow composition, measurement location and meteorological conditions. Therefore, it is significant tool for not only data collection and analyses, but also development of traffic noise prediction models and their further improvement.*

1. INTRODUCTION

Noise can be defined as unwanted sound that can significantly affects physical and psychological health of the people. During past decades, many studies have shown that noise can cause stress, sleep disturbance,cardiovascular problems, etc. Sincenoise has become a major concern for communities, in June of 2002, European Parliament passed the Environmental Noise Directive (2002/49/EC) [1] relating to the assessment and management of environmental noise.Under this directive, Member States were obliged to make strategic noise maps no later than 30th June 2007. Furthermore, the competent authorities, based on results of noise mapping, had to draw up action plans designed to manage noise issues and effects, including noise reduction if necessary, no later than 18th July 2008. In accordance to strategy, FP5 project "Harmonoise" [2], FP6 project "Imagine" [3], and FP7 project "Silence" [4] were established. "Harmonoise" project developed common European noise prediction models for road and railway traffic. Project "Imagine" improved the existing models and developed common European noise prediction models for aircraft and industrial noise. Project "Silence" has been developing methodologies for drawing of Noise Action Plans. Also various non-European projects [5][6][7][8] were established to support combating noise.

As Serbia is in accession process to the European Union, Serbian legislation related to noise protection is in accordance to Environmental Noise Directive. Law on environment

noise protection [9], which was passed by Serbian parliament in 2009, and following by-laws [10][11][12] determinate principles of assessment of noise impact, noise mapping and drawing of Noise Action Plans. Serbian Ministry of Education and Science funded project "Development of methodologies and means for noise protection of urban environment" (acronym "urbaNoise") [13], which should support providing measures prescribed by legislation, that are still not provided. The project is realized by three major Serbian state universities, University of Kragujevac, represented by Faculty of Mechanical Engineering Kraljevo, University of Niš, represented by Faculty of Occupational Safety and University of Belgrade, represented by the Faculty of Traffic Engineering.

Road traffic, beside railway vehicles, represents the main source of noise pollution in the urban areas. For the purpose of noise assessment and reduction, various noise prediction models have been developed. The application of prediction models enables estimation of the traffic noise levels from collected data on traffic composition, such as number of the vehicles, type of vehicles, etc., as well as measurement location data. For the purpose of data classification and storage, traffic noise measurements database was developed.

Databases representa significant tool for data collection, classification and analyses, and, therefore, an important tool for development of models for noise prediction and their further improvement. While the "Harmonoise" and "Imagine" projects provided databases for prediction models of railway noise, aircraft noise and industrial noise, database developed within "urbaNoise" project is intended to describe the noise generated by transportation means like cars, trucks, etc.

2. BACKGROUND

In the past 50 years, various traffic noise prediction modelswere developed. The first model for prediction of the noise generated by road traffic was developed in 1952 and reported in the Handbook of Acoustic Noise Control [14]. In the following years new models were developed, such usNickson et al. [15-16], Johnson et al. [17], Galloway et. al [18], Burgess Model [19], Griffiths and Langdon model [20], Fagotti et all [21]. The prediction of the traffic noise levels according to those models isbased on the traffic volume data (the number of the vehicles per hour) and distance between the observation point and the road axis.

Withincrease of the knowledge of trafficnoise, in the recent decade, several complex models for traffic noise prediction have beendeveloped, such asGerman prediction model RLS 90 [22], Nordic model [23], French national model [24], England standard for traffic noise prediction CoRTN [25], Italian model CNR[26], Serbian NAISS model [27]. Beside the road traffic volume and distance fromthe observation point to the road axis, complex predictionmodels account for the types of motorvehicles, as well as data specific to the measurement location (type of the road, road width, ground type, data on natural and artificial obstacles, etc). Developed database enables entry of all required data for traffic noise prediction according to simple mathematical models, as well as some of the complex prediction models, such as Nordic national model.

In the last couple of decades, the composition of the traffic flow in the urban areas became very complex, including a variety of vehicles withdifferent influence on noise pollution. In

order to enable more detailed description of the traffic flow composition, the database contains the traffic flow data for several types of vehicles:

- Light vehicles
- Medium truck,
- Heavy tracks
- Buses
- Motorcycles

Further, the database enables entry of information about the measurement location, (distance from road, description of the buildings, etc.)and data on meteorological conditions duringthe measurement, as well as the measured noise levels.

The data, stored in the database, are collected at different measurement locations at the cityof Nis [28] and the city of Kraljevo [29]. The measured noise levelsare collected in the last few years and represent the results of thesystematic measurements of thetraffic noise in these cities.

3. DATABASE STRUCTURE

The Enhanced Entity−Relationship (EER)diagram of the database structure is shown in the Figure 1. EER diagrams illustratethe logical structure of the database, e.g., the relationshipsbetween its entities (tables). Each table is described by its attributes. Anattribute that uniquely identifies each record in a tableis calleda primary key.Foreign keys are attributes that define relationships between database tables. The foreign key in one table uniquely identifies a record of another table."One-to-one" relationship between two tables indicates that eachrecord in the first table corresponds to one, and only one,record in the second table. "One-to-many" relationship indicates that each recordin the first table corresponds to one or more records in thesecond table, but each record in the second table correspondsto only one record in the first table.

The shown database was developed for storing measurement variables that may be used as input data for traffic noise prediction. Each record in the table Measurement is uniquely identified by its primary key,MeasurementID. The table Measurement keeps information about date of measurement, measurement duration (given in minutes), as well as additional notes about the measurement. Information about meteorological conditions, such as temperature, humidity, wind speed and atmospheric pressure, are stored in the table MeteorologicalConditions. Table NoiseLevels contains information about measured equivalent A-weighted noised level Leq, as well as L10, L50 and L90 levels that represent the sound pressure levels exceeded for 10, 50 or 90 percent of the time of the measurement period, respectively. Traffic composition data (numbers of light motor vehicles, medium trucks, heavy trucks, buses and motorcycles) and average vehicle speed are stored in the table TrafficParameters. Table Measurement is linked by "one−to−one" relationship to the tables MeteorologicalConditions, NoiseLevels and TrafficParameters by the keys MeteorologicalConditions_MeteorologicalConditionsID, NoiseLevels_NoiseLevelsID and TrafficParameters_TrafficParametersID, respectively.

Table MeasurementLocation contains information about the location of traffic noise measurement, such as:the street name, slope of the road, measurement point height,

perpendicular distances of the measurement point from the axis of the road, buildings behind the measurement point and buildings on the other side of the road, as well as reflection coefficients and angles of view of the road segment and buildings, as seen from the receiver position. As multiple measurements of the equivalent noise level may be performed at the same location, table Measurement is connected via "one−to−many" relationship to this table by the key MeasurementLocation_MeasurementLocationID.

Noise emission of the road segment may be estimated from the traffic composition data and average vehicle speed. Data stored in the table MeasurementLocation may be used for calculation of the sound attenuation due to geometrical divergence, as well as for modeling of the reflection of the sound from the buildings. Attenuation due to atmospheric absorption may be estimated using data contained in the table MeteorologicalConditions.

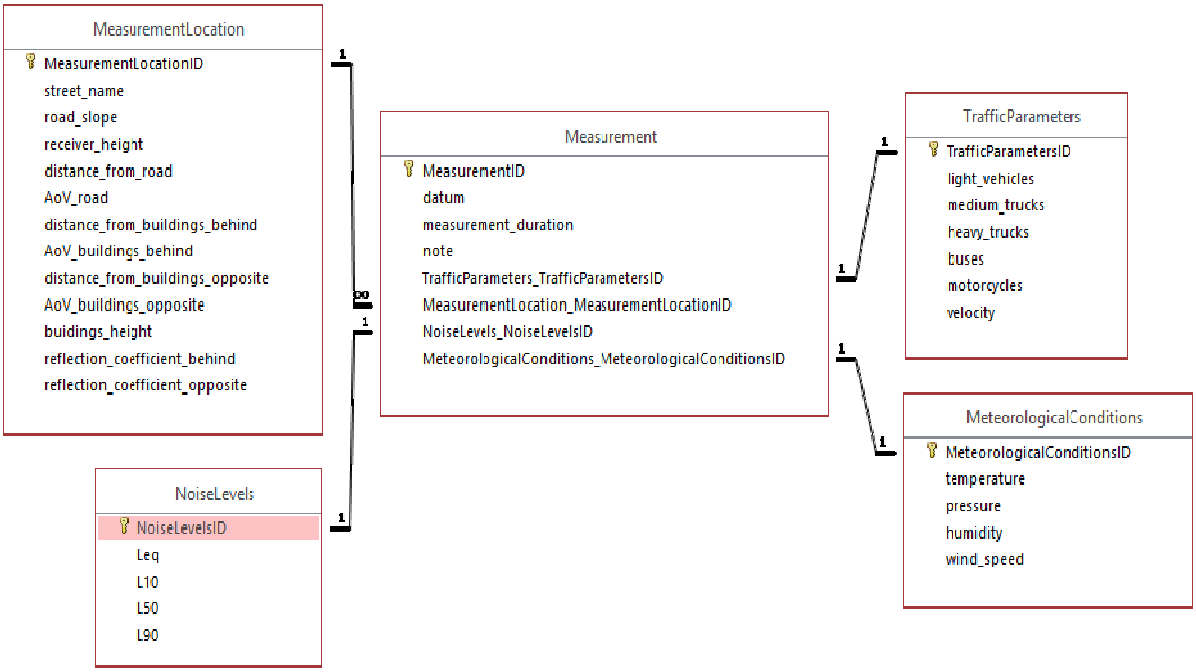

Figure 1. EER diagram of database structure

4. IMPLEMENTATION AND CLOSING WORDS

The implementation of the database was performed in the Microsoft Access, under Window operating system. Currently, the database has local character and the access to the database islimited to researchers working on the project UrbaNoise.

Since the database stores the measurement data collected at different measurement locations during the last few years, it is possible to perform analysis of changes in noise levels in the urban areas. Based on collected data, a variety of analyzes of the impact of road traffic on noise levels may be performed. In addition, basic principles for traffic noise reduction by traffic management may be established.

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МОДЕЛ НА БАЗА ОТ ДАННИ ЗА УСЪВЪРШЕНСТВАНЕ НА МЕТОДИТЕ ЗА ИЗСЧИСЛЯВАНЕ НА ШУМА ОТ ДВИЖЕНИЕТО В ГРАДСКА СРЕДА

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Ключови думи: *база от данни, шум, движение*

Резюме: *Докладът има за цел да представи концепцията, структурата и приложението на взаимообвързана база от данни за отчитане на шума, създаден от транспортните средства в градска среда. Въвеждането на базата от данни е осъществено чрез софтуерния продукт Microsoft Access. Представената база от данни съдържа информация за изчислените нива на шума, както и данни за потока от превозни средства, тяхното разположение и метеорологичните условия. Ето защо тази база от данни е важно средство, с помощта на което може да се събира и обработва информация, а също така да се правят прогнози за шума от трафика и да се определят възможностите за неговото ограничаване.*