Possibilities for the innovative IT database technology utilisation for the traffic induced seismicity affecting historical buildings in Slovakia

Daniel Papán*, Zuzana Papánová*, Veronika Valašková*

* Department of Structural Mechanics and Applied Mathematics, Faculty of Civil Engineering, University of Žilina

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Abstract- The aim of research paper is to describe approach to determine the dynamic response of reference historical buildings in Slovakia due to transport involved microtremor by theoretical and experimental way. The dynamic analysis results of the reference historical structures include in the universally accessible database. Summarize standardized criteria for microtremor traffic effect on the historic buildings abroad and for Slovakia region to establish a basis for their assessment criteria as specified group of buildings. Determination of seismic resistance to the effects of traffic seismicity.

Index Terms- historical building, random vibration, technical standards, technical seismicity

I. Introduction

This article is focused to the possibilities for the innovative IT database technology utilisation for the traffic induced seismicity affecting historical buildings.
In according the research outputs it is necessary to express a scientific goals for the researcher team.
Several topics must be solved:

1. Creating a universally accessible database of historic buildings with the assumption of harmful effects from traffic induced vibrations (reference buildings).
2. On the experimental and theoretical analyzes basis to create assessment system for traffic vibration effect on historic buildings in Slovakia.
3. Application of the results in the creation of relevant standards background regarding the evaluation of traffic vibration seismic effects on the historic buildings in Slovakia.
4. Identify vibration levels effects on humans in structures and design reduction through passive vibro-isolation.
5. To determine the seismic resistance of critical parts of historic buildings due to traffic seismicity experimental way.

The research task can be realized with team composed of members of the Department of Structural Mechanics, Faculty of Civil Engineering University of Žilina and its laboratory. Department has a long and high position in structural dynamics and experimental methods field. From the Faculty of Civil Engineering of University of Žilna, the team is also complemented by a researcher from the Department of Building Engineering and Urban Planing as the experts in historical buildings. From the point of view of the security engineering, a researcher from the Faculty of Security Engineering of the University of Žilina is included in the group.
The collective is balanced staff composition for experimental measurements as well as for FEM simulations and technical support.

II. State of art in Slovak region

The assessing of seismic effect due to traffic is addressed in current standard EC8. Whereas the technical standards are recommendatory naturally, civil engineering practice currently uses also repealed standard STN 73 0036 " Seismic actions on structures."
Nowadays the important scientific papers domestic and international presents main objectives to evaluate the dynamic response of structures due to seismic effects.
In the Czech Republic (Slovak Republic near region) the with problems of seismicity and structural dynamics deal respected scientists as J. Máca, M. Pirner , M. Polak and J. Náprstek. From Slovakia is one of the leading scientists who contribute the development of traffic seismicity engineering J. Benčat. Other important scientists in Slovakia which are interesting in seismicity are A. Tesár, J. Králik, N. Jendželovský, M. Sokol. Based on the scientific work and international standards study the evaluation of historic buildings dynamic response is needed in Slovakia.
Also there is no elaborated concept of vibro-isolation and definition of seismic resistance from traffic seismicity.

III. Particular contribution expected

The absenting statistics about the number and structural conditions of historic buildings in the risk of traffic seismicity damage, it is necessary to solve this problem. Expected contribution of the research is to fill the area in which the need to define the current state of historic buildings in cooperation with the Monuments Board of the Slovak Republic and the Municipalities.

The main anticipated contribution of the research includes:

- Development of methodology for evaluation of historic buildings in Slovakia dynamic loaded caused by traffic seismicity.
- Definition - linear transfer characteristics in a dynamic interactive process of road transport system – the existing structure
- Development of a predictive models for assessing the traffic increase and its impact on the existing historic buildings in Slovakia
- The creation of universally accessible electronic database of historic buildings threatened by traffic seismicity
- Use database engineering practice, public institutions, managers and owners of historic buildings
- Based on experimental and simulation analyzes of reference historical buildings to create basis for solving the technical criteria for assessing the effects of traffic seismicity
- Experimentally identified seismic resistance of critical parts of historical buildings will help in defining the limits of the effects of traffic seismicity.

IV. Proposal how to reach the research goals for future for Slovak science

Proposal of the research ways is to reach the research goals, including timetable for each individual year of research:

A. *First part of solution*

- Summarizing the evaluation criteria for the traffic effects seismicity assessment of the historic buildings in foreign literature and standards
- Selection of the historic buildings at risk from the traffic effects seismicity due to as reference structures
- Creation of computational models of reference structures, simulations in the time and frequency domain, extrapolation of the results solutions for increased traffic
- Experimental measurements of the reference structures and evaluation
- Preparation of seismic resistance experiments in the theoretical area
- Publishing partial results of the research and the confrontation with the scientific community

B. *Second part of solution*

- The computational models of reference structures debugging, simulations in the time and frequency domain, extrapolation of the results solutions for increased traffic
- Comparison of experimental measurements and simulations for the reference structures and processing their results
- Creation of an electronic database of historic buildings threatened by traffic seismicity
- Realization of seismic resistance experiments on small-dimensional models of critical parts of historical buildings
- Publishing partial results of the research and the confrontation with the scientific community

C. *Third part of research - outputs*

- Implementation of a database with the results of analyzes of reference structures - run test operation of the database
- Implementation the analysis results to the database – open for engineering community - run the full operation of the database
- Realization of seismic resistance experiments on full scale critical parts of historical buildings
- Publication of the research results and confrontation with the scientific community

V. Description of applied methods and their explanation

Using methodologies for research processing for the reference buildings are follows:

1. establishment of criteria for the building risk classification due to traffic seismicity by basic parameters: age of the structure, structural system, structural materials, structure geometry, distance from traffic line, traffic intensity, technical condition of transport routes
2. creation of a global, or plane (spatial) FEM computing model of structure, the dynamic calculation on FE modeling the frequency and time domain
3. Preparation and realization of experimental measurements, evaluating the results in frequency and time domain, verifying and debugging of structure FE model
4. realization of dynamic calculation for predictive situation in degraded conditions: an increased traffic, decreased traffic road quality, buildings decreased technical parameters
5. create a database of historic buildings threatened by traffic seismicity using PHP script, setting up a central server, creating the system database, opening the system database
6. Analysis of the evaluated structures for assessment evaluation criteria for historic buildings based on the results included in the database

Additional research phases will complement and expand the database of assessed buildings.
In parallel with the first phase of the research, research will be carried out on the seismic resistance and efficiency of vibro-isolation systems designed to reduce the effects of traffic seismicity.

VI. RANDOM PROCESS EVALUATION OF TRAFFIC SEISMICITY BACKGROUND

In the theory of random processes, it is possible to formulate general conclusions on the load, the response of the structure, and their dependence in the dynamic investigation of building structures. A random phenomenon - it is a phenomenon whose occurrence cannot be predicted, even if a certain set of conditions is anticipated. This random phenomenon is related to the load and response of the structure and its dependence. It does not resolve the case conditions. A random quantity - is the most common description of a random event. If all the circumstances are known, it can gain unexpected numerical values. We divide the quantities into discrete and continuous random quantities. The discrete random quantity includes the sum of the range of values. The continuous random quantity includes the interval on the real axis. The random function - is a random function whose execution has a functional course, not a value. The random process - is a process of non-periodic function of one parameter such as time (t). We can only determine it by probability.
The Random Process Theory deals with the study of a random variable dependent on a continuously variable parameter. The processes are divided into deterministic and stochastic. Deterministic processes have a defined added value of excitation force over the entire time interval. The vector of excitation forces defines a set of known functions over time. The system periodically repeats itself in a certain period of time. If the system repeats itself, it is a periodic system, if it is not repeated, it is a non-periodic system. Stochastic processes have defined factors that characterize oscillation as a random function of time. For this process, the time course of the characteristics is unpredictable. They are divided into stationary processes and non-stationary processes. Random processes can be characterized in the following areas: time, correlation, frequency, spectrum, probability, and information.

VII. STATE OF ART IN APPLICATION FIELD

The increase in vibration caused by different modes of transport has an adverse effect on building constructions and man. Also, modern building technology, construction, and design efficiency have raised the challenge of addressing the dynamic response of the construction to the impact of traffic-induced seismicity. The fact that the entire transmission system building construction - geological environment as well as a source of vibration is complex, leads to a stochastic event. Since the dynamic load, in this case, causes a response with the stationarity property, it is possible and practical to divide this task into partial tasks (vehicle-track, geolocation transmission ...). At present, we can notice a sharp increase in the intensity of especially road transport, both passenger and freight, as well as streamlining and accelerating rail transport. This also increases the effects of technical seismicity on buildings. Among the buildings that are built in close proximity to the transport routes are also bridge structures, because it is in the interest of transport safety to build split level junctions.
Vibrations represent the movement of a flexible body or environment whose individual points vibrate mechanically. In mechanical oscillation, this is a physical phenomenon, with a point or rigid body reaching different positions in space over time so that they move within a certain range of distances that do not exceed, around the so-called. equilibrium - middle position. The number of full cycles of oscillation in 1 second is called frequency (frequency) and is expressed in Hertz (Hz).
The main causes of vibration by road or rail transport are dynamic forces entering through the vehicle's contact with the track to the subsoil, geological environment, to buildings and the surrounding environment. Their spread can reach a few hundred meters. The moving vehicle creates vibrations with its own oscillation, component manufacturing inaccuracies, and moving parts. Another reason may be the imbalance of vehicle components with rotating, oscillating, swinging and reciprocating movements or the contact of the components with friction and rolling. The size and the vibration intensity, is, besides the type, weight, and speed of the vehicle, affected by the technical condition of the road or the railway.

VIII. CONCLUSION

Nowadays, rising intensity of traffic is significant effect on entire world, because the endanger risk of adjacent buildings rises with this effect. Endanger risk is caused by traffic vibrations spreading through the bedrock, i.e. by traffic seismicity. Historical buildings are specific group of structures, which are especially sensitive on traffic seismicity effects, if these structures are exposed to them. That is why these effects are needed to be analyzed.

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AUTHORS

First Author – Daniel Papán., University of Žilina, Department of Structural Mechanics and Applied Mechanics, daniel.papan@fstav.uniza.sk

Second Author – Zuana Papánová., University of Žilina, Department of Structural Mechanics and Applied Mechanics, zuzana.papanova@fstav.uniza.sk

Third Author – Veronika Valšková., University of Žilina, Department of Structural Mechanics and Applied Mechanics, veronika.valaskova@fstav.uniza.sk

Correspondence Author – Daniel Papán., University of Žilina, Department of Structural Mechanics and Applied Mechanics, daniel.papan@fstav.uniza.sk, +421 41 513 5615.