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Transportation Research Procedia 20 (2017) 301 – 304

Transportation Research Procedia

www.elsevier.com/locate/procedia

12th International Conference "Organization and Traffic Safety Management in Large Cities", SPbOTSIC-2016, 28-30 September 2016, St. Petersburg, Russia

# Development of Methods for Evaluating the Impact of Stress-Strain State Uniformity of Composite Pavements on Road Safety

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**Abstract**

The most important quality indicator to optimize the cement concrete and composite structural and technological solutions is the uniformity indicator which is not duly covered in existing regulatory and procedural documents.
The proposed findings will increase the service life of pavements and as a result will improve road safety.

Peer-review under responsibility of the organizing committee of the 12th International Conference “Organization and Traffic Safety Management in large cities”

*Keywords:* Uniformity, composite pavements, calculation and designing of road pavements, stress and strain state, sections, reliability, service life

## 1. Main text

According to the results of research and practical works, the most important quality indicator for optimizing cement concrete and composite (asphalt concrete pavements on cement concrete base course) design and technological solutions is the indicator of uniformity of the composition of materials and the technology which ensures uniformity of concrete during laying and consolidation as well as uniform temperature and humidity conditions when curing the concrete layer, selection of the most preferable stress and strain state for the structure (in this case, preferred compression behaviour of the structure); establishing the links between layers and layer components which provide

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Peer-review under responsibility of the organizing committee of the 12th International Conference “Organization and Traffic Safety Management in large cities”
doi:10.1016/j.trpro.2017.01.027

the pavement with the stress-strain state with the maximum degree of uniformity based on the minimum coefficient of variation.

Uniformity is the degree of stability of physical and mechanical properties, geometric dimensions, process parameters, operating and production conditions [Federation Council (2007)].

The study of the indicator uniformity of the stress and strain state (SSS) of road pavement is not duly covered in existing regulatory documents and, therefore, constitutes the subject of this research.

The scope of research is composite pavements.

The target of research is to develop a method to study the uniformity of indicators of stress-strain state (SSS) of road pavement to improve traffic safety and their service life.

The introduction states that according to the regulations the basic principles of construction of pavements are:

- alternative solutions for selection of the optimal "uniformity" as a quality indicator which ensures the longest road service life;
- design with regard to "the category of a road, traffic composition, traffic density, climatic conditions, stress state and strain mechanism (including the nature and type of SSS) of individual layers and structural components [Ministry of Regional Development (2012)];
- minimum number of layers of a pavement with maximum use of local and modern building materials;
- increasing the robustness of a road (due to high load carrying capacity of all layers except for the upper wear layer in a composite structure) due to the use of rigid pavement layers;
- appreciation of the use of joint structural and technological solutions for design, construction and operation of a road structure.

Currently used traditional design and technological solutions are not consistent with the principles presented above regarding the quality indicators and do not meet the requirements of modern road and transport infrastructure, including:

modern competitive cement concrete pavements and cement concrete bearing layer of composite structures are currently not used, except for one standard alternative, and are rejected in the projects.

Currently, the researchers deal only with the analysis of operation of existing structures and fail to address issues of development of new improved structures by carrying out calculations for a standard design using more precise (analytical and more often numerical) methods.

Uniformity criteria are considered normally only for materials and are not applied for the study of SSS uniformity of structural elements, and especially road structure in general.

Issues related to controlling the SSS of a road structure in terms of its reduction, and most importantly, in terms of its transition into another kind (for example, for concrete from SSS with tensile bending into SSS with compression) are completely disregarded.

The accepted design practices are particularly fraught with negative consequences for composite road structures, where the thickness of the asphalt pavement with a high load-bearing capacity of the bearing layer is recommended to be 14-26 cm, which requires three-layer asphalt pavements.

In accordance with existing regulations [Ministry of Regional Development (2012)] the following requirements must be met to maintain the necessary transport and performance and load bearing capacity of rigid pavements:

- strength, cracking resistance of a pavement and structural layers that can resist bending [Ministry of Regional Development (2012)]. The main criterion is considered to be the permissible tensile stress in bending a cast-in place plates on the elastic base course when exposed to repeated dynamic loads and temperature. At the same time, a major disadvantage of cement concrete with its extremely low resistance to bending is disregarded. Apparently, the main target for optimizing structural solutions is to develop a structure where concrete could work primarily in compression or where tensile stresses go down abruptly;
- strength of a pavement on the whole [Ministry of Regional Development (2012)]. Since shear stress is used here as a criterion of strength in discrete layers of the base course and working layer of the subgrade, we believe it correct to speak about the importance of pavement vertical stability, related to changes in the calculation scheme, including areas of where plates have no contact with the base course; emerging of ledges in joints due to incorrect selection of plate sizes, types of joints and their connections. For stability purposes the structural solutions of plates