

TRANSCOM 2017: International scientific conference on sustainable, modern and safe transport

Bridge load tests in Poland today and tomorrow – the standard and the new ways in measuring and research to ensure transport safety

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Abstract

The standard assumption, some results and final conclusions of authors' research on bridge testing are presented in the paper. The results concern more than two thousands bridge superstructures that have been already tested on site. The stiffness of the bridges as well as their behavior under load tests are described. The following values: superstructure displacement, strain and subsidence of supports have been analyzed by the static load tests. Moreover, the identification of dynamic amplification factor, natural frequency, mode shapes and damping have been analyzed by dynamic bridge testing.

The paper focusses on the dynamic method of control the suspension system forces. Based on registration and analysis of free vibration of a suspender, the authors present quick, non-destructive and reliable test as the contemporary method to improve safety of arch and suspension bridge superstructures.

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Peer-review under responsibility of the scientific committee of TRANSCOM 2017: International scientific conference on sustainable, modern and safe transport

Keywords: bridge load tests; construction safety; road bridge; railway bridge; construction monitoring; modal analysis; dynamic parameters

Requirements, studies and suggestions concerning bridge load tests in Poland

Regulations in Poland necessitate carrying out loading tests to put bridges into operation and proof their safety. They are conducted mainly for new constructions. Load tests have to be also performed for rebuilt objects superstructure or as a supplementary examination of existing bridges to determine their carrying capacity.

Standards and norms listed below determine execution and requirements for bridge testing:

- PN-S-10040:1999 [1] for reinforced and prestressed bridges.
- PN-89/S-10050 [2] for steel bridges.

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- Ordinance of the General Director for National Roads and Motorways (GDDKiA) [3] for road bridges.
- Technical standards [4] for railroad bridges.

These documents contain some differences and ambiguities which cause problems with interpretation and comparison to one another. They differ among themselves in requirements and research proceedings. In addition their application is limited to specific types of constructions (Fig. 1).

PN-S-10040:1999	Static load test	Road bridges	$L_t > 20\text{m}$	PN-89/S-10050	Static load test	Road bridges	$L_t > 21\text{m}$
		Railroad bridges	All			Railroad bridges	$L_t > 21\text{m}$
		Footpaths	Not required			Footpaths	Not applicable
	Dynamic load test	Road bridges	Not required		Dynamic load test	Road bridges	$L_t > 21\text{m}$
		Railroad bridges	$L_t > 15\text{m}$			Railroad bridges	$L_t > 21\text{m}$
		Footpaths	Not required			Footpaths	Not applicable
Ordinance of the General Director	Static load test	Road bridges	$L_t \geq 20\text{m}$	Technical standards	Static load test	Road bridges	Not applicable
		Railroad bridges	Not applicable			Railroad bridges	All
		Footpaths	$L_t \geq 20\text{m}$			Footpaths	Not applicable
	Dynamic load test	Road bridges	$L_t \geq 20\text{m}$		Dynamic load test	Road bridges	Not applicable
		Railroad bridges	Not applicable			Railroad bridges	$L_t > 21\text{m}$
		Footpaths	$L_t \geq 20\text{m}$			Footpaths	Not applicable

Fig. 1. Minimum bridge span length for obligatory loading test according to Polish standards and norms.

Specification for Work Accomplishment and Acceptance is written on the basis of these regulations. It defines scope of the studies and may include additional requirements for particular bridges. Due to these discrepancies laboratories support one another by sharing scientific knowledge through publications. Moreover only certified institutes are authorized to carry out loading tests on national roads and railway lines in Poland. Accredited laboratories obtain certificate signed by Polish Center for Accreditation (PCA) which confirms their competence and meet ISO/IEC 17025:2005 [5] requirements. Its main goal is to provide competent bodies for measurement and testing in accordance with the best practice, quality and safety. Aspekt has been accredited since 2012 and was one of the first certified Polish laboratories in the field of load tests.

The issue of Polish standards and norms in the light of bridge testing was one of topics at scientific conferences over recent years. As a result, representants of PKP Polish Railway Lines, PCA and testing laboratories, with the participation of Aspekt R&D laboratory, meet to discuss bridge testing regulations. What is more, a new PCA procedure is being developed that is entirely focused on determining the way of conducting field tests and requirements for objects subjected to the test load.

Road and railway communication significantly increased after accession Poland to the EU and opening the borders for commercial goods and people. That required enhancing quality of Polish transport infrastructure. Government with EU contribution approved plans focused on improving economy. Programme for National Roads Construction (Fig. 2) allowed in the first instance for building strategic motorways and expressways. The next step involves city ring roads and other roads upgrades.

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