# FIELD TESTS OF THE SCISSOR-AVLB TYPE BRIDGE

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Summary

Scissor-AVLB type bridges are subject of studies presented in a paper. The bridge span is extended automatically by means of a mechanical bridge-laying gear carried together with bridge sections on a self-propelled chassis. The single-span scissors-type BLG (a manufacturer's designation) bridge length available is up to 20m and the load bearing capacity is of 500kN. In connection to the BLG bridge modernization (bridge deck widening), there arose the need to conduct basic engineering analyses in order to verify the structure's correctness. Some aspects of an experimental test of the single-span scissors-type BLG bridge operation were presented. Displacements and strains in particular sections of the structure were measured during field tests with different load modes. Results of load tests performed on a modernized BLG bridge structure made it possible to verify the correctness of the BLG numerical models.

Keywords: modernized AVLB scissors-type bridge, load tests.

BADANIA POLIGONOWE MOSTU TOWARZYSZĄCEGO TYPU NOŻYCOWEGO

Streszczenie

Przedmiotem badań przedstawionych w pracy jest most nożycowy AVLB. Przęsło mostu nożycowego rozkładane jest automatycznie za pomocą układacza mechanicznego transportowanego razem ze złożonym przęsłem mostu na podwoziu gąsienicowym. Długość pojedynczego przęsła mostu nożycowego wynosi 20m, a nośność 500kN. W związku z modernizacją mostu BLG (poszerzenie pasa jezdni) powstała potrzeba przeprowadzenia podstawowych analiz inżynierskich w celu zweryfikowania poprawności konstrukcji. W pracy omówiono próby poligonowe pojedynczego przęsła mostu BLG. Podczas badań poligonowych zmierzono przemieszczenia i odkształcenia mostu poddanego działaniu różnych wariantów obciążeń. Wyniki prób obciążeniowych umożliwiły weryfikację poprawności modeli numerycznych mostu BLG.

Słowa kluczowe: modernizowany most towarzyszący typu nożycowego, próby obciążeniowe.

## 1. INTRODUCTION

Scissor-AVLB type bridges are subject of studies presented in a paper. These bridges are characterized by high mobility and modular structure [1, 5, 7, 8]. Single module-span consists of two spanning parts of the bridge; two main trucks and support structure joined with a coupling pin. The bridge span is extended automatically by means of a mechanical bridge-laying gear carried together with bridge sections on a self-propelled chassis. The single-span scissors-type BLG (a manufacturer's designation) bridge length available is up to 20m and the load bearing capacity is of 500kN. The bridges offer obstacle/gap-crossing capability to tracked and wheeled vehicles [1, 4].

In connection to the BLG-67 bridge modernization (bridge deck widening), there arose the need to conduct basic engineering analyses in order to verify the structure's correctness. Considering the fact that the structure of a BLG bridge is a typical thin-walled one of a complex internal structure, innovative engineering systems (CAD/CAE) were implemented in analyses [2, 3, 6].

Some aspects of an experimental test of the single-span scissors-type BLG bridge operation were presented here. Displacements and strains in particular sections of the structure were measured during field tests with different load modes.

## 2. I STAGE OF THE FIELD TEST – MEASUREMENTS OF DISPLACEMENTS

Field tests on an actual structure of a BLG scissors-type bridge were performed in Military Engineering Works. A fully efficient BLG bridge that underwent a general overhaul in Military Engineering Works was used for that purpose (see Fig. 1). The bridge was deployed to a crossing position on a test stand intended for tests and examinations of bridge structures that are repaired, modernized and produced in Military Engineering

Works. The test stand in the form of a dry pool with concrete abutments located on the premises of Military Engineering Works is illustrated in Fig. 1.

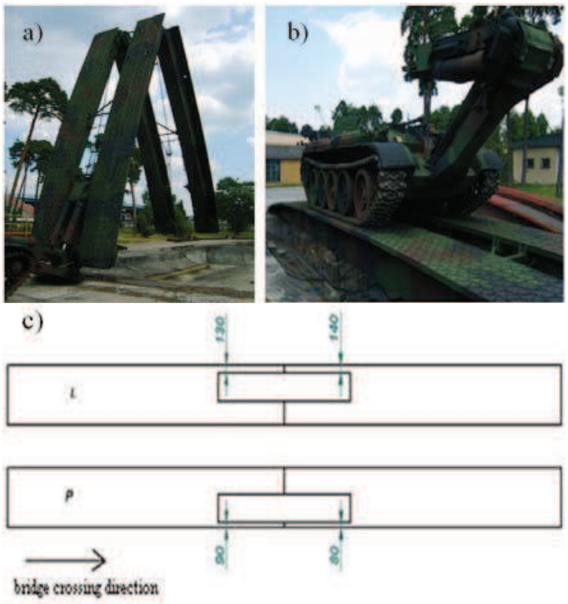

Fig. 1. a) A view of the tested BLG bridge during the deployment process,
b) BLG tracked carrying chassis without the transported span during the load test,
c) A schematic of the location of the contact between caterpillar tracks and the bridge span at the point where the vehicle had stopped

Prior to beginning actual load tests on a span of the BLG bridge, a test drive of a BLG tracked carrying chassis onto the bridge span laid on concrete pool abutments was realized (see Fig. 1, 2). The purpose of the operation was to initially locate metal anchorages built at the bottom of the abutments of the bridge girders on pool edges under the influence of an external load. Once the chassis/carrier had left the bridge span, there was performed a calibration of the measuring apparatus that corresponded with the state of being loaded only by the deadweight of the span structure. Subsequently, load tests on the BLG span were performed. A BLG tracked carrying chassis without the transported span constituted load in this test. A vehicle in such a configuration, which is presented in Fig. 1b), has a mass of 33.3 tons.

Displacements were measured by means of mechanical indicators located in the section that corresponded to the half-length of the bridge, and by means of potentiometric indicators located in the selected section of girder ( see Fig. 2).

In addition to span bending, there simultaneously occurred girders’ torsion both during a normal operation of the scissors-type bridge and a load test conducted on the test stand. The presence of an additional load in the transverse plane of the tested structure is the consequence of the eccentricity of the external load which occurs as a result of the displacement of the center of gravity of the vehicle that crosses the bridge relative to the longitudinal axis of the bridge.

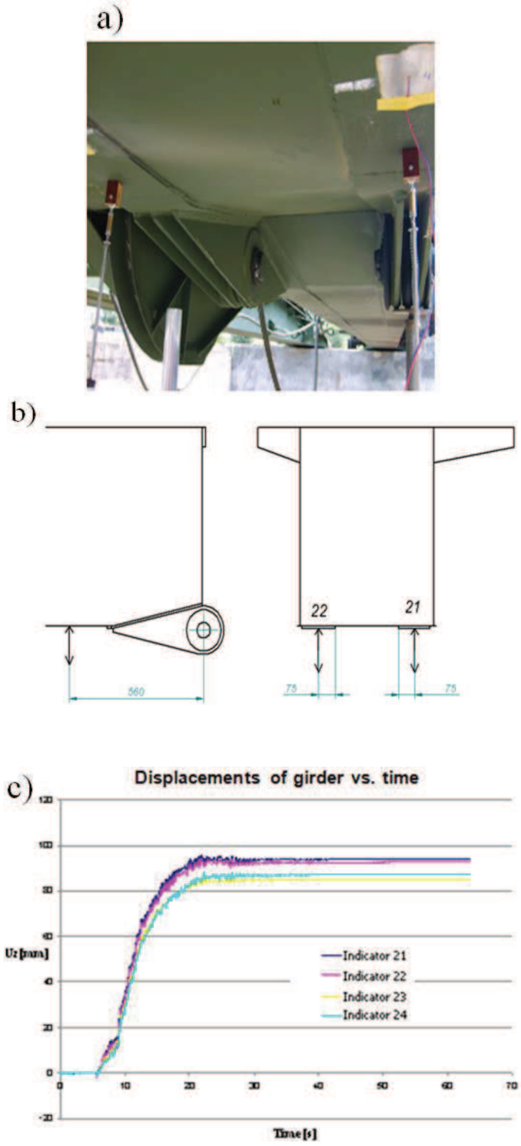

Fig. 2. a) A view of the location of potentiometric indicators used for measuring displacements,
b) A schematic that interprets the location of indicators on the right girder of the bridge, c) Diagram of vertical displacements vs. time recorded during load test

The above-described measurement of the deflection alone by means of mechanical indicators makes it possible to assess the operation of the bridge in the plane of longitudinal bending but is insufficient to estimate the torsion of the structure’s members which results from imprecise driving of the vehicle across the bridge and the occurrence of the eccentricity of the external load.

In order to gather sufficient data and prepare a more complete description of the deformations, four potentiometric indicators (two indicators per each girder/deck of the tested bridge) were additionally used. A schematic of the location of the potentiometric indicators on the right girder as well as the view of them on an actual object is presented in the schematic in Fig 2b) and the photograph shown in Fig 2a)

Since indicators were placed on both sides of the girder, the difference between vertical displacements recorded with the use of them will make it possible to assess the torsional deformation of the girder in the analyzed section accurately. It will allow a more precise interpretation and assessment of the correctness of the results of simulations obtained with the use of the numerical model and the actual BLG bridge structure.

Displacement values measured by means of particular potentiometric indicators were recorded while the tracked chassis was driving across the bridge. Displacements process in the function of the duration of load action on the bridge is shown in diagram presented in Fig. 2c).

The maximum deflection value was recorded for the right span and was equal to 94mm in the analyzed section. The value the reading of which was taken from the scale of the mechanical indicator for the right girder was 95mm. For the left girder, the maximum deflection value measured by means of the mechanical indicator was 87mm and was equal to the value recorded with the use of potentiometric indicators.

## 3. II STAGE OF THE FIELD TEST – MEASUREMENTS OF STRAINS

Electro-resistant extensometers were used for measuring strains. Extensometers were stuck up on two sections selected on the basis of the assessment of failures that occurred in the process of bridge operations (see Fig. 3).

EA-06-060LZ-120/E electro-resistant extensometers and EA-06-060RZ-120/E rosettes manufactured by Measurements Group Vishay were used for measuring deformations. Measurement signals were recorded by means of an ESAM Traveller EPP Plus extensometric bridge manufactured by ESA-Meßtechnik GmbH as well as a computer with a specialist software for extensometric measurements (Fig. 3a).

Extensometers were stuck up on two sections selected on the basis of the assessment of failures that occurred in the process of bridge operation. Locations of sections are illustrated in figure 3. The section A and B ( see Fig. 3b) is located between the 4th and the 5th bulkhead of the girder. In the aforementioned area, there were recorded cracks in the structure that appeared during the bridge operation.

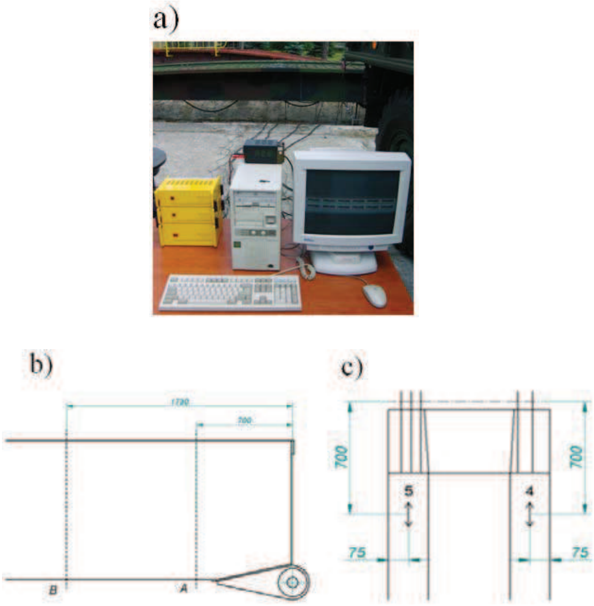

Fig. 3. a) Measuring position used in load test of the AVLB-bridge, b) A schematic of the locations of sections on the left and the right girders, in which deformations were recorded,
c) A schematic that illustrates the locations of extensometers No. 4, 5 on the bottom strips of the right bridge girders

Extensometers were stuck up on symmetrically located sections for the right and the left bridge birders. Strain values were measured simultaneously in 16 points during load tests.

Stress values determined on the basis of the results of measurements the readings of which were taken once the vehicle had stopped at the mid-length of the bridge were 187MPa for extensometer No. 4 and 129MPa for extensometer No. 5. Stress values obtained from numerical analyses were 175MPa and 141MPa for extensometers No. 4 and 5 respectively. Relative differences between the aforementioned stress values were 7% for extensometer No. 4, which was located on the outer strengthening strip, and 8.5% for extensometer No. 5. Table 1 contains correlated normal stress values obtained from the numerical analysis and determined on the basis of the values of deformations recorded during extensometric tests. Relative differences between the aforementioned values are also given in the table.

Table 1

| Extensometer No. | Experiment [MPa] | FEM [MPa] | Difference [%] |
|---|---|---|---|
| 4 | 187 | 175 | 7 |
| 5 | 129 | 141 | 8.5 |

Exemplary stress curves determined on the basis of the results of measurements recorded by extensometers No. 4 and 5 (section A) are presented in Figure 4.

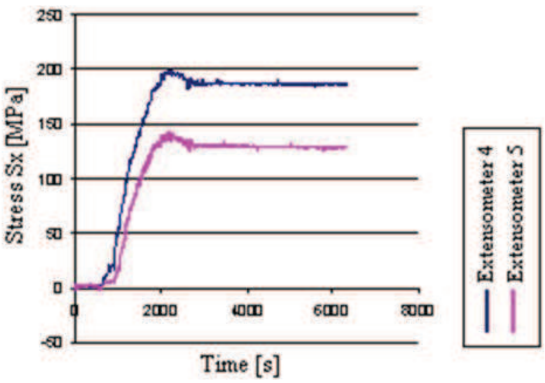

Fig. 4 The diagram with exemplary stress curves determined on the basis of the results of strains measurements

## 4. CONCLUSIONS

Load tests performed on a modernized BLG bridge structure made it possible to verify the correctness of numerical models, which will be used for assessing stress distribution in the analyzed structure as well as analyzing the bridge in different configurations in special uses, taking crisis situations into particular consideration. Verification of the correctness of models was performed by comparing deflections obtained in load mode that corresponded with the test performed on the test stand.

Displacements were measured by means of mechanical indicators located in the section that corresponded to the half-length of the bridge, and by means of potentiometric indicators located in the selected section of girder. In the considered load mode, the maximum difference between experimental results and the results developed by means of numerical analyses was approximately 9%.

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