TESTS OF FIBRE CONCRETE PRE-STRESSED SLEEPERS

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Abstract:

Results of experiments carried out on pre-stressed railway sleepers in laboratory of ŽPSV, a.s. Nové Hrady in August 2008 are presented in this paper. The static loading test in question is a three point bending of sleepers made of fibre/normal concrete. The aim is to obtain the load–deflection diagrams for two sleeper cross-sections: i) under the rail and ii) in the middle of the sleeper.

Keywords: pre-stressed railway sleeper, steel fibre concrete, static loading test

1 Introduction

Pre-stressed sleepers are dominant elements of the railway construction. The quality of sleepers is inspected in the manufacture to ensure their adequate reliability in operation. Quality evaluation of these pre-stressed beams is provided via standard control tests under three-point bending, carried out on standard hydraulic test equipment.

2 Test procedures

The requirements on concrete railway sleepers are specified by the European standard EN 13230 – Railway applications – Track – Concrete sleepers [1]. In Part 2 of the Code there are defined the technical requirements and procedures for the design and manufacture of pre-stressed mono-block sleepers. There are prescribed the testing arrangements (the test configuration) for the tests of the sleepers in two relevant cross-sections: the cross-section under the rails and in the middle section of the sleeper. Three-point bending represents the test configuration. For each configuration, there are also assessed the values of the test load, the style of loading for static, dynamic and fatigue test and evaluation criteria for these tests.

Experiments to obtain the load–deflection (and also load–crack width) diagrams are based on the configurations depicted in Fig. 1. The load was increased continuously throughout the control tests. To measure the deflection in the cross-section under the rail

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indicator clocks installed on the test equipment were used. At least a pair of indicators on both sides of sleeper should be used in order to eliminate inaccuracies connected with torsion effects and unequal seating on support pads. The values are read from the indicator clocks according to the instructions of the operator of the loading device.

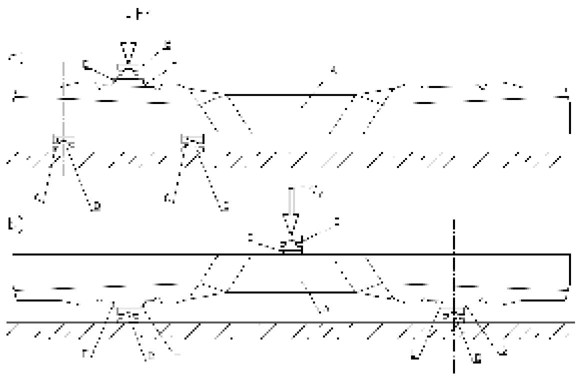

Fig. 1 Test configuration for the test on the three-point bending of the sleeper cross-section under the rail (a) and in the middle (b); adapted from [1]

3 Experimental results

Measurements took place in the ŽPSV a.s. laboratory of the factory Nové Hrady on 12 and 13 August 2008. A load–deflection diagram was recorded – see Fig. 2 for illustration – for sets of 9+8 sleeper. The results obtained are shown in Figs. 3 and 4 for the test of the cross-section under the rail and the middle cross-section, respectively. The value of deflection (horizontal axis) is the mean value of two indicators (with the exception of sleeper No. 0505, when it was applied only one indicator). In Fig. 3 results for the sleeper with fibre concrete (4104) and with steel fibre concrete (5505 / I and 5505 / II) are highlighted (full triangles, diamonds and circles, respectively). Similarly, in Fig. 4 the results for the sleeper with fibre concrete (4103) and with steel fibre concrete (5504) are also emphasized with the full marks (triangles and circles, respectively).

Fig. 2 Detail of the test configuration of the sleeper – three-point bending of the cross-section under the rail (left) / in the middle; indicator clocks for deflection measurement are installed on both sides of the sleeper

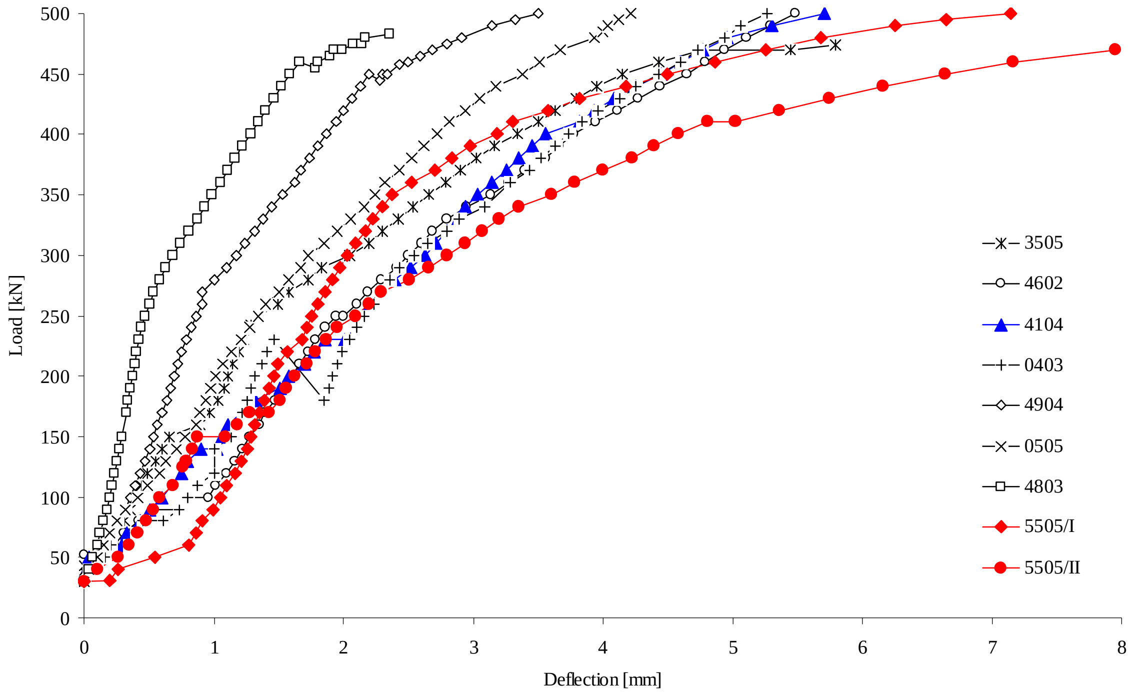

Fig. 3 Measured load vs. deflection diagrams from three-point bending test of sleepers for the cross-section under the rail

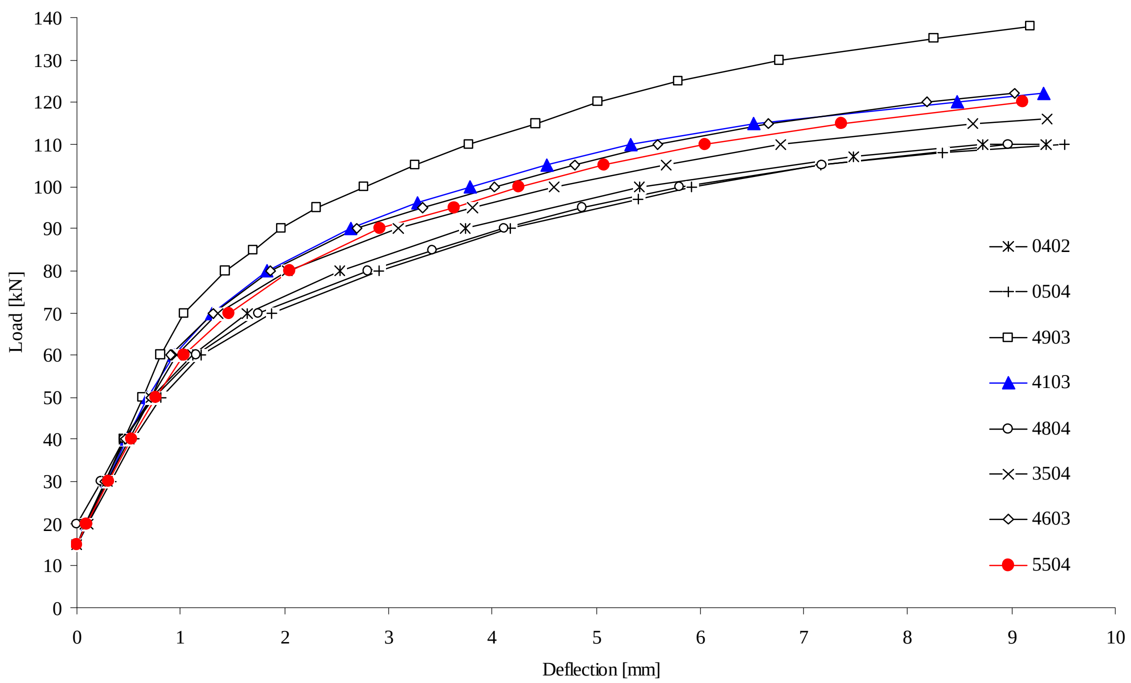

Fig. 4 Measured load vs. deflection diagrams from three-point bending test of sleepers for the middle cross-section

4 Conclusions

Results of static three-point bending tests of pre-stressed monoblock railway sleepers were presented. These tests were carried out in laboratory of ŽPSV, a.s. Nové Hrady to obtain the load–deflection diagrams for sleeper's cross-sections under the rail and also in the middle of the sleeper. From the above-presented results it is possible to conclude:

- Response of pre-stressed sleepers from steel fibres concrete have not significant effect on load bearing capacity of these elements in comparison with normal concrete sleepers.
- An addition of fibres is reflected by an increase of ductility in the case of the test on the three-point bending of sleepers for the cross-section under the rail, which can be viewed as positive effect.

It is obvious that the main advantage of materials like fibre-reinforce concrete is not a maximum load-bearing capacity but an improvement of ductility, fracture toughness and other properties. For that reason, as a next step, fracture/mechanical parameters will be evaluated using two-parameter effective crack model and work-of-fracture method [2, 3]. Along with this classical evaluation the parameters identification using artificial neural network based method [4] will be done to support virtual numerical simulation of experimental tests. As a material model, SBETA model with softening law for fibre-reinforced concrete implemented in ATENA software [5] or model with smeared reinforcement with appropriate stress-strain diagram reflecting delayed activation of fibres can be used.

Acknowledgements

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