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Experimental study of stoneblowing track surfacing technique

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Abstract

Ballast is known to be one of the most widely used materials for railtrack construction. Although ballast is comprised of crushed hard stones, it undergoes gradual and continual degradation under cyclic rail loading and requires constant maintenance. Due to the limitations of the commonly used ballast tamping technique for recovering railway track geometry, other technical solutions are currently being considered. Stoneblowing is an alternative technique of track level adjustment, that is defined as injection of the premeasured amount of small fresh stones with pressurized air under the sleepers, lifted to a desired level. This technique has been reported to lack most of the known disadvantages of tamping. However, postmaintenance behavior of ballast was found to be sensitive to the procedure aspects, thus further investigations in controlled laboratory conditions are required. This paper is focused on measurement and analysis of ballast settlement under cyclic loads after reinstating of a railway track with stoneblowing. Experimental results show that usage of stoneblowing leads to a predictable level of settlement, which remains constant even after a large number of loading cycles. Moreover, we propose a two-step stoneblowing technique and provide experimental evidence that this approach is more effective for reinstating the railway track than a conventional single step approach.

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Keywords:stoneblowing; dynamic load; laboratory tests; settlement

Tamping can be described as lifting of sleepers to the required level and packing of ballast around the sleepers into the gaps beneath them. Due to a number of drawbacks, such as ballast damage [1], loosening of ballast bed and

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subsequent quick revert to a pre-maintenance geometry [2], usage of this method leads to high costs of track maintenance. Stoneblowing is another technique of track level adjustment, originated in the UK [3]. It is reported to cause less disturbance to the existing compacted ballast than tamping and to result in improved track quality [4,5]. Unfortunately, this technology has not got enough attention and has not found wide application, despite the potential benefits. In order to understand all the possible effects on the mechanical properties of railway track after the maintenance with new method, more in-depth studies should be carried out. In this paper we discuss laboratory experiments of the ballast settlement under dynamic loads after adjustment of track level by stoneblowing. The obtained experimental results are used to examine the potential of stoneblowing for track maintenance.

2. Materials and methods

Preliminary tests were conducted to choose a ballast sample which shows minimal settlement and thus is expected to cause negligible impact on the experimental results. The chosen ballast sample was collected at railway turnout № 47 of Likhobory station on 50th kilometer of Little Ring of Moscow Railways. Table 1 presents size distribution of stones in the ballast sample, which was determined by means of sieve analysis. For pneumatic ballast injection commercially available small-sized (5 – 10 mm) sidewalk gravel was used. According to conducted tests this gravel corresponds to the Russian technical standards (GOST 8269.0-97) in terms of abrasion and impact values.

Table 1. Ballast sample size distribution.

Stone size, mm	60-70	40-60	25-40	10-25	2-10	0.1-2	< 0.1
Mass fraction, %	3	33	24	30	5.7	3.0	1.3

The experimental setup [Fig. 1a] included a universal testing machine EUS-40, produced by Werkstoffpruefmachinen, Leipzig (frequency 5 – 25 Hz, maximum load 400 kN), box (300 mm by 600 mm by 400 mm deep) and two hard flat wooden stamps 290 × 590 mm^2 and 240 × 250 mm^2 for static and dynamic load procedures respectively.

Stage 1, “Compression”. In the first step the box was filled with ballast sample (base ballast) and a static load was applied through a stamp over the whole horizontal surface. After 5 minutes the load was removed and the stamp settlement was measured. This procedure was repeated iteratively until the change in settlement between two subsequent iterations was less than 1.0 mm.

Stage 2, “Stoneblowing”. In the next step the stamp was lifted above the surface of compressed ballast and fixed at a height of 30 mm [Fig. 1b]. Stones of base ballast were placed around the stamp to prevent the small gravel particles to be thrown out of the sample. One side of the stamp was left free to make it accessible for the stoneblowing apparatus. Then the stoneblowing procedure was performed. After that the last side was covered with base ballast stones as well.

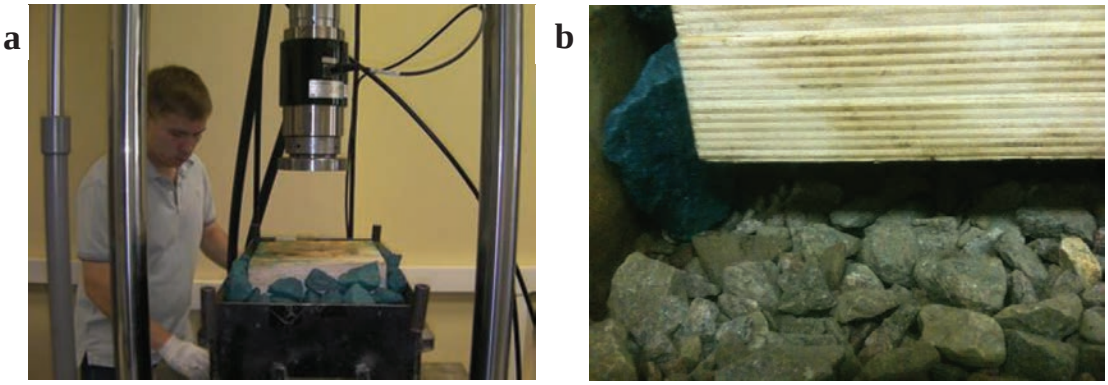

Fig. 1. (a) View on experimental setup. One can see the sample on the measurement stage with a hard wooden stamp on top of it and coloured base ballast stones; (b) Sample on the stage of stoneblowing procedure.

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