International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

Available at http://inpressco.com/category/ijcet

Research Article

The Quality of Wooden Railway Lines in North Macedonia and Kosovo

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Received 25 Aug 2017, Accepted 20 Oct 2017, Available online 28 Oct 2017, **Vol.7, No.5 (Sept/Oct 2017)**

Abstract

All the railway tracks on the territory of Kosovo and Macedonia were in general built five-six and more decades ago, and wooden sleepers were built as a supporting part of the rails. With the breakup of Yugoslavia, there were divisions of companies that maintained the tracks on the whole territory of the former state. In the new circumstances, new territorial companies have been established that were administered based on different principles of organization and work. The occurred changes led to breakdown in communication, in particular with respect to railway transport. The inherited track installations have been poorly maintained and reconstructed which led to almost complete depreciation, especially of wooden sleepers, which were largely destroyed. The paper presents the results of the research on determining the quality of wooden sleepers on the territory of Kosovo and North-West Macedonia. The results obtained with the research conducted on six locations indicate that there is a decrease in quality of the sleepers depending on the location and the year of production. The greatest decrease in quality was noted on the Skopje-Tetovo section 49%, then Tetovo-Gostivar 38%, Skopje- Kačanik 32%, Gostivar-Kičevo 28%, Kačanik-Uroševac 26%,, and the lowest on the Uroševac-Kosovo Polje section 22%. At the end of the paper, recommendations are provided on how to improve the situation.

Keywords: *Wooden thresholds, wood durability, quality thresholds*

1. Introduction

Tracks across Kosovo and Macedonia are of the traditional type and were built in the 50s and 60s of the last century. The classic tracks consist of upper and lower part. The lower part represents the construction work and facilities (cuttings, embankments, bridges, etc.), while the upper part consists of curtain/screen, rails, crossovers, signaling and controlling tools and equipment, while in the case of electrified tracks additionally there are also upper i.e. power line. Tracks with lower traffic frequency, speed, capacity, vehicle mass and importance may lack certain parts of the lower or upper machine.

The current state of track thresholds, which is the subject of this research, is a specific challenge. The weakest issue is the malfunctioning of the wooden rails. On these tracks, it is the load, speed and safety that are questionable. This is a sensitive issue, which affects the economic sustainability of the railway companies. Given the limited durability of the large number of built-in and defective rails, there should be measures taken to replace the worn and ruined rails. The economic crisis, which has hit the whole region, has led to a difficult situation for the companies responsible for track maintenance. The absence of track maintenance activities, particularly in MK and KS has resulted in squalor tracks whereby the malfunctioning wooden rails have led to railway accidents and derailments. Furthermore, economic losses arise due to reduced train speed, slow trains as well as not taking heavy loads on many sections where the replacement of the wooden rails is not fast. The limited durability of those rails is a result of the fact that most of them, built 6 decades ago, especially in the time between 1948-1952, are impregnated with weak national antiseptics since at the time there was no importation of creosote oil.

All rails, which were built later, according to Yugoslav standards of rail impregnation: creosote oil, a mixture of zinc chloride and chromium and copper slats with a mixture of salts by Wolman. The rails are impregnated with a solution of blue galley, sublimates, zinc chlorides, and various tar oils, often mixed together with other agents. Requirements for eco-friendly rail impregnation agents have led to the use of new impregnates, such as GX-plus group S impregnation oil.

The effect of impregnated agents varies from one type of wood to the other. The smallest effect is on oak while for pine, besides the extension of durability from 4 to 5 years to 15 to 20 years, the strength is also

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increased. Where wooden rail sleepers are concerned, the best type of wood to use is oak, followed by beech (impregnated), pine and spruce. The wooden rails exposed to frequent changes in moisture or drought must be impregnated. A good impregnation penetrates to the core. Wooden sleepers are often fixed on the front with iron clamps or tied with a narrow steel wire so that they do not crack under sun heat. They are made of round timber of varying diameter.

2. Rail sleeper durability

There is a whole range of attacks on wooden sleepers: biological attacks (fungi, molds, insects, biodegradation), physical attacks (climate, water, heat, atmospherics, dimensional variability), chemical attacks (acids, gases, oxidation and reduction of constituents), and mechanical attacks (static, dynamic, permanent, variable, pulsating, etc.).

Wooden rails fail as a result of rotting, mechanic effects, fire and, in tropical countries, from worms. Mechanical causes lead to sleeper deterioration before it decomposes completely. The effects of mechanical forces are transmitted through the rails onto the sleeper whereby the holes fitting nails are extended while the nails are loosened.

Decaying of the wooden rail sleepers is mainly due to rotting because hardwood beech has been used, impregnated with creosote or zinc chloride, and it is thus possible to use the sleepers up to the point of decaying if the tiles are of larger dimensions. Literature available on the duration of impregnated sleepers differs significantly based on the method of impregnation, conditions of use, quality of impregnation and a number of other factors. According to maintenance data, the beech sleepers impregnated with zinc chloride last only for 10 years, with zinc chloride and creosote for 22 years, and with creosote for 30 years. Literature on the sustainability of the wooden sleepers is quite different. On the tracks that are the subject of research in this paper, the sleepers were produced in 1967.

3. Rail sleeper's quality

The state of the upper rail track part is checked with inspection and recording as prescribed in the Rulebook which has been in force since 1987. The following is checked: technical parameters, layout of the tracks and built-in track material. Checking the upper part/machine as a whole, as well as certain groups of elements, is done by using a measuring vehicle and other measuring track vehicles, measuring instruments, driving on a towing vehicle and visually. Visual inspection and checking with a hammer helps establish the state of all steel parts of the switch, tools and wooden rail sleepers while visually the state of the wooden sleepers, the signal lamps and the curb are checked as well as the purity and lubrication of the switch. The visual inspection of the upper mechanism, particularly the rail sleepers, is subjective and often unsatisfactory. The specifics of the material used to make the sleepers often lead to the wrong conclusions which results in not taking the required measures so the low quality has led to several railway accidents.

3.1. Materials and methods of quality research

In order to determine the quality of the rail sleepers, surveying the terrain of pre-identified locations and track sections. For this purpose, new rail sleepers have been purchased to replace the worn out ones.

The sleepers selected for the research have been selected carefully to ensure the best sample; only the best and healthiest were selected. The research includes a total of 18 rail sleepers, 3 sleepers per section. Each sleeper is cut into 4 samples/tubes diagonally in the direction of the axes of the timber with a width of 5 cm. Two samples were taken from the area between the tracks and two from each outer side of the tracks at 5cm next to the screw.

In order to determine the declination in volume of the wooden sleepers and in the absence of data concerning volume of sleeper at production time, it has been approved to use the same data for comparison so in this instance I have used the volume of an absolutely dry beech timber – 0.69 gr. /cm^3. The track sections where this research has been conducted were built in the same time period so it can be taken into consideration that the wooden sleepers were produced by the same manufacturers and that they have the same volume of mass. This thesis is based on the fact that the volume of the mass and all other timber characteristics change significantly as a result of internal and external conditions. The internal factors include type of timber, maturity and position within the tree while the external factors include growth area, habitat as a natural factor, and level of care and processing of the soil. The volume, above all, depends on the width of the increment ring, which is the participation of early and late trees. For these and other reasons, the linear dependence of the volume of dry beech timber and of samples taken from dry timber is theoretically set. Prior to the measuring, all samples have been dried out in laboratory drying room to an absolute dry point at temperature of 103º ± 2º. After obtaining a constant sample mass, the volume of the absolute dry timber is calculated as a ratio between the mass and the range, in dry state, without the moisture of the timber. All data is presented in a table and used for comparison and determination of the quality of the sleepers at specific routes or sections.

3.2. Research Results

The analysis of the results of the research shows the state and quality of wooden sleepers on two routes: Skopje-Kosovo Polje i Skopje-Kičevo. For these two routes, data on loss of volume on the samples were obtained for three sections, on the Skopje-Kosovo Polje

route, on the sections: Skopje-Kačanik, Kačanik-Uroševac and Uroševac-Kosovo Polje; whereas for the Skopje-Kičevo route, on the sections: Skopje-Tetovo, Tetovo-Gostivar and Gostivar-Kičevo. The results of the research are shown in the graph in Figure 1.

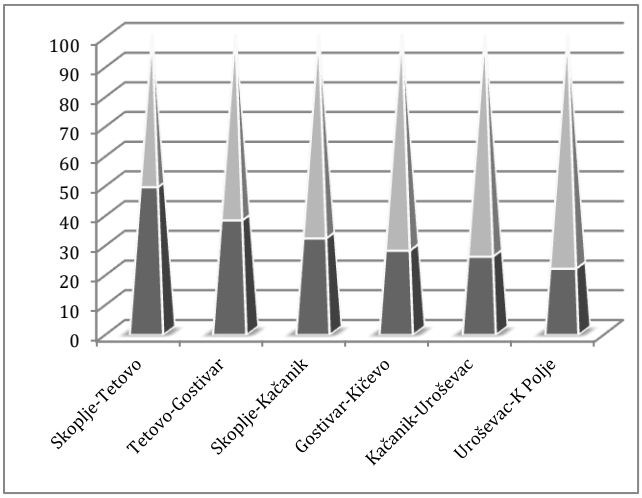

Fig.1. Overview of the loss of mass of wooden tracks

The results obtained by researching the volume loss of wooden tracks differ in percentage, and individually for each section, as follows:

1) Skopje-Tetovo 49%;
2) Tetovo-Gostivar 38%;
3) Skopje-Kačanik 32%;
4) Gostivar-Kičevo 28%;
5) Kačanik-Uroševac 26% i
6) Uroševac-Kosovo Polje 22%.

From the results obtained, it is clear that the greatest decrease in quality of the tracks was recorded on the Skopje-Tetovo section, while the lowest on the Uroševac-Kosovo Polje section. If the abovementioned routes are observed, it is clear that there is a greater decrease in quality of the tracks on the Skopje-Kičevo route, and the average decrease percentage is 38.3%, while the quality decrease is 26.6% on the Skopje-Kosovo Polje route. The reasons for this kind of different decrease in quality are most likely due to different climatic conditions (temperature differences, precipitation), usage patterns and load on the railway connections, the manner of periodical and permanent maintenance, as well as other factors.

3.3. Visual Overview

The inspection of the upper machine of the railway tracks is carried out by a person in charge of, among other things, determining the actual state of all of the railway elements. The visual general overview of the upper machine is performed with trolleys or on foot and covers the general state: built-in rails, track accessory, rail sleepers, curtain/screen, dilatation, bolts next to the track rails, track level and direction, draining of the tracks, and regularity of the track as a whole. The railway transport company needs to determine the number of visual inspections for the executive staff according to the state of the upper and lower machine, length of the section, traffic size, and local conditions. In Macedonia and Kosovo due to economic difficulties and the railway maintenance sectors, the track installations have lately been neglected leading to failure to maintain the track as prescribed by Law.

For the wooden tracks, in addition to the use of hammer for determining their quality, which is an uncertain and subjective method, other parameters should also be taken into consideration, such as: the connection between tiles and rail sleepers and their state, the state of the screw and the attachment to the surface, the state of the wedges and their attachment to the surface, and the general state and the cracks of the wooden tracks.

In some parts and sections, the rail sleepers are replaced in a way that should ensure stability of the tracks, and new rails are built in alternatively, for every 5-10 m in length of the track by filling.

Conclusion

The quality of the wooden rail sleepers on the sections used for the elaboration of this paper suggests that activities to remedy the existing situation have to undertaken, in particular the following:

- Activities to determine the quality and the health condition of the rails and the other sections that were constructed and the tracks that were examined.
- To replace all rail sleepers of poor quality that cannot hold tight screws in a satisfactory manner.
- To make a partial or complete replacement of rail sleepers found to be defective and that cannot remain in track until the next periodic or main repair.

The recommendation is to replace all rail sleepers where one of the following defects was found during the inspection:

- Cross cracks.
- Weakness of rail sleepers in the rail track area due to mechanical action.
- Deep local rotting in the screw or wedge areas.
- General rotting or rotting to such an extent that during caulking the ends of the rail sleepers are raised considerably.
- Cracks in entire height, and in length of more than half of the length of the rail sleeper, and
- Damaged by fire or exceptional events.

Having in mind the results from the research that showed that there is a significant decrease in quality of the rail sleepers, in particular on the section Skopje-Tetovo, Tetovo-Gostivar and Skopje-Kačanik, where a decrease of more than 30% was observed, it can be concluded that special measures need to be taken and a complete reconstruction should be done, that is, to replace all wooden rail sleepers due to deterioration.

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