УДК 542.46
DOI: 10.30838/J.BPSACEA.2312.281221.83.818

INVESTIGATION OF THE MICROSTRUCTURAL AND MECHANICAL PROPERTIES OF R260 QUALITY RAIL STEEL AFTER HEAT TREATMENT

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Abstract. In this study; It is aimed to determine the effect of cork hardening applied to R260 quality rail steel in laboratory environment on microstructure and mechanical properties. Within the scope of this study, the appropriate internal structure was determined by giving only water and water + air to the rails austenitized at 800 °C in the laboratory environment. Heat treated rails have been subjected to hardness and compression tests. The hardness values closest to the standards were obtained from the rails austenitized at 800 °C and cooled with a water + air mixture in 10 seconds.

Keywords: *R260 quality rail steel; heat treatment; compression test*

ДОСЛІДЖЕННЯ МІКРОСТРУКТУРИ ТА МЕХАНІЧНИХ ВЛАСТИВОСТЕЙ РЕЛЬСОВОЇ СТАЛІ R260 ПІСЛЯ ТЕРМІЧНОЇ ОБРОБКИ

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Анотація. ***Метою дослідження*** є визначення впливу зміцнення пробки, що застосовується до рейкової сталі якості R260 в лабораторних умовах, на мікроструктуру та механічні властивості. У рамках цього дослідження визначено відповідної внутрішньої структури шляхом подавання тільки води та води разом з повітрям на рейки, які аустенізовані за 800 °C в лабораторних умовах. Термооброблені рейки піддавались випробуванням на твердість та стиснення. Значення твердості, найближчі до стандартів, отримані з рейок, аустенізованих за 800 °C та охолоджених сумішшю вода + повітря протягом 10 секунд.

Ключові слова: *рейкова сталь якості R260; термічна обробка; тест на стиснення*

Introduction. Rails are the most important element of railways. Railroad tracks are subjected to various stresses and loads on curves and straight lines. As a result, the rails are damaged and their life is shortened. Especially in curves with a radius of less than 2 000 m, the service life of the rails is reduced by 50 %. Although it varies from country to country; bends with a radius of curvature of 2 000 meters or less on railways are called "narrow bends". On average, 34.2 % of the railway lines in our country are narrow winding roads. Rail life; While it varies between 20…25 years on straight lines, this period decreases to 2…3 years on narrow winding roads. In this case, the use of hardened cork rails is recommended by the UIC.

Within the scope of this study, the appropriate internal structure was determined by giving only water and water + air to the austenitized rails at 800 °C in the laboratory environment. Heat treated rails have been subjected to hardness and compression tests.

Experimental studies. In this study, 1 cm thick samples taken from R260 quality rails were brought to austenitization temperature of 800 °C and kept at this temperature for 45 minutes. Two samples were kept in water at 800 °C for 1 and 10 seconds and then allowed to cool in air. Full quenching heat treatment was carried out by immersing the ends of the other sample in water at 800 °C.

Fig. 1. Rail sample kept in the heat treatment furnace

Microstructure studies were carried out according to metallographic methods and the photographs were taken under optical light microscope and scanning electron microscope. The samples to be examined were cut to the appropriate size; Microstructure photographs were taken by sanding, polishing and etching processes.

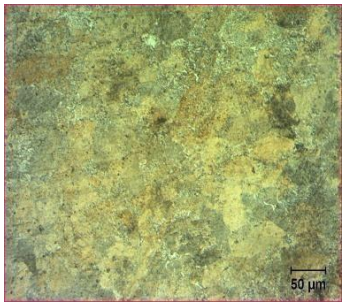
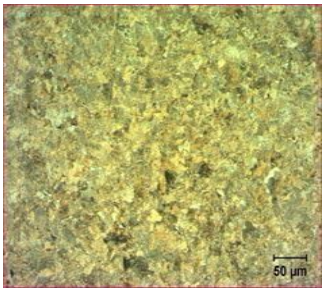
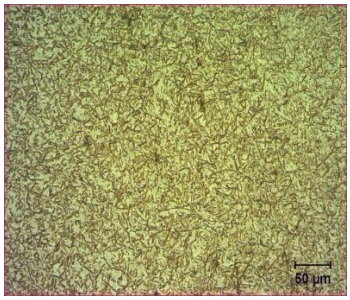
Hardness tests were carried out from the cross-sections of R260 quality rail steel samples. The device in which the hardness tests are performed under a load of 187.5 kg for 15 seconds in accordance with the standard is the Zwick/Roell brand hardness device.

In the compression test, cube-shaped samples of 10 by 10 mm were prepared from the upper part of the rail cork. The prepared samples were quenched for 1, 10 seconds and full quenching. After quenching, a compression test was performed on the rails under 20 N load.

Experimental results. It has a tighter and thinner perlitic structure than the samples that are quenched for 1 and 10 seconds and kept for 10 seconds. On the other hand, in the fully quenched rail sample, a very hard and finer microstructure, likely to be martensite, was obtained.

Table

200X magnification microstructure images of rail samples quenched for different times

200X			
	1 second quenching Coarse perlite	10 second quenching Perlite	Full quenching Martensite

The hardness values of the examined rail samples increase with increasing heat treatment time in the cork hardening method. Thin pearlitic microstructure is seen on the rails which are quenched for 1 and 10 seconds. The rail sample, which is cooled for 10 seconds, tends to meet the hardness values required for the R350HT quality rail. However, the rail sample undergoing full quenching has very high hardnesses and these high hardness values are undesirable in the material. In materials with high hardness, problems such as brittleness and rapid progression of crack formation may occur.

As the height/width ratio decreases in a fully quenched rail sample, friction increases and the material reaches a higher strength value. The fully quenched sample is also the most brittle sample. The high height/width ratio of the sample, which is quenched for 1 second, causes the sample to bend during the test and the stresses are not distributed homogeneously.

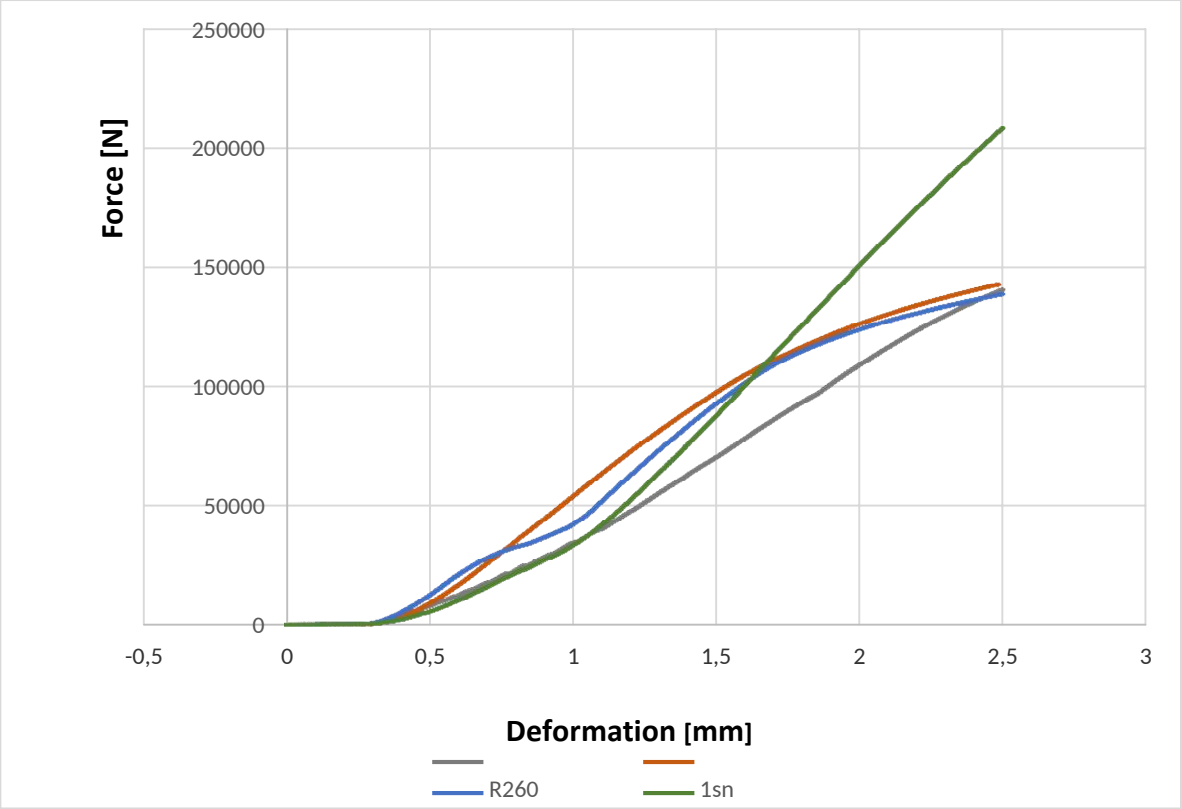


Fig. 2. Hardness values measured at different quenching times

Results. The general results of the mechanical and microstructural values obtained as a result of the heat treatments applied to the R260 quality rail steel are listed below:

- R260 quality rail, which has not been heat treated, is in coarse pearlitic structure. It was observed that the material reached a tighter and finer pearlitic structure as the quenching time increased in the samples quenched at 800 °C for 1 and 10 seconds. In full cooling, the structure is now martensite.
- The hardness values of the samples whose mushrooms were cured reached from 290 HB values to 360 HB values.
- In the compression test, the rail sample, which was fully quenched at 800 °C, reached a higher strength value and was brittle. It was observed that the most ductile material was the R260 quality rail sample, which was not heat treated.

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Надійшла до редакції: 21.11.2021.