THE LIFE CYCLE ASSESSMENT OF THE USED RAILS ACCORDING TO THE RESULTS OF CYCLIC HIGH-FREQUENCY TESTS

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Передовые технологии в материаловедении, машиностроении и автоматизации

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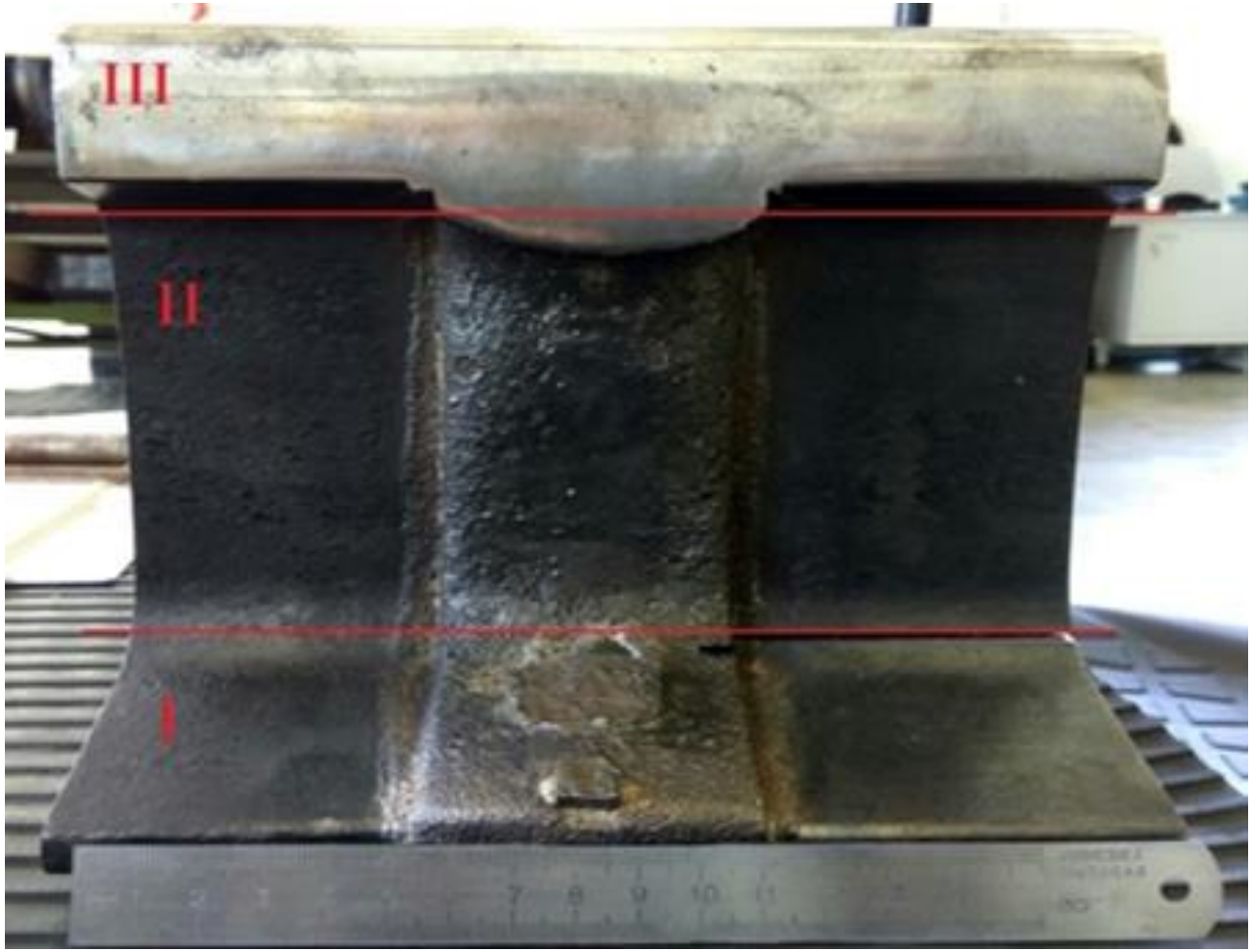
Methods

The acceptance control of the used rails, the welded joints of rails and the switch elements is done according to the technological control instructions for a specific type of non-destructive testing tool. The research of the samples from a continuously welded rail fragment before its destruction is also carried out. This type of control is recommended to be used selectively at the rate of one primary sample per 10 continuously welded rails, removed from the track. The primary sample, cut off from the end of the continuously welded rails and the example of each is shown in Figure 1, is used to produce three samples from the rail head (III) and the rail base (I) and two samples from the rail web (II).

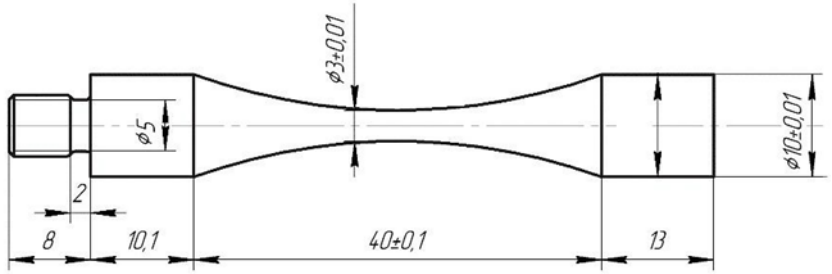


Cyclic high-frequency tests

Summary table of the experimental data for the samples of the welded joints

Amplitude Δa, MPa	Number of cycles N	Failure cause
800	$1{,}0783 \cdot 10^4$	Crack
750	$2{,}8376 \cdot 10^5$	Crack
700	$1{,}0783 \cdot 10^4$	Crack
650	$1{,}8663 \cdot 10^5$	Crack
370	$1{,}1624 \cdot 10^9$	Without failure

Cyclic high-frequency tests are carried out with a symmetrical loading cycle (R = -1) on an ultrasonic unit. For the experiments only those samples are taken that have the shape of a rotation body with cylindrical ends and the middle part, which is an arc of a large radius (Figure 2). During the test, the sample is put into the resonant vibrations with a frequency of up to 20 kHz. The test ends up when the sample goes out of the resonance due to the structural changes.



The test of microhardness

Sample center						Average value of microhardness
389 HV	376 HV	366 HV	355 HV	366 HV	375 HV	–	359,8 HV
382 HV	366 HV	407 HV	389 HV	359 HV	357 HV	–	
400 HV	377 HV	367 HV	349 HV	405 HV	355 HV	–	
407 HV	341 HV	343 HV	368 HV	379 HV	377 HV	–	
200 mkm from the center							
318 HV	384 HV	357 HV	348 HV	437 HV	392 HV	347 HV	374 HV
365 HV	370 HV	393 HV	377 HV	415 HV	363 HV	–	
342 HV	372 HV	353 HV	412 HV	373 HV	390 HV	–	
363 HV	355 HV	376 HV	413 HV	357 HV	377 HV	–	
400 mkm from the center							
395 HV	358 HV	362 HV	355 HV	379 HV	396 HV	415 HV	378,4 HV
416 HV	393 HV	359 HV	356 HV	348 HV	399 HV	390 HV	
357 HV	381 HV	393 HV	367 HV	386 HV	412 HV	–	
365 HV	345 HV	376 HV	368 HV	363 HV	405 HV	–	

Разработана специальная методика измерения микротвердости с помощью автоматического микротвердомера. Микротвердость измеряется по всей ширине образца – от его центра к хвостовику с шагом 100 мкм, а на расстоянии 1000 мкм от центра шаг увеличен до 500 мкм. Данный метод дает возможность выделить зоны локального повышения микротвердости, которые могут стать концентраторами напряжений и негативно сказываться на материале при последующих нагружениях.

Conclusions

- **The issues connected with the proper usage of the used rails that are laid into a distance-based limit, and with the replacement of the defective and acute-defect rails in a single order, are especially important on the sections with the overpassed tonnage, since the share of such used rails in the total single removal of the first laying rails is ranged from 7 to 34 %.**
- **In 36 % of cases, the service life of the used rails laid in a single order on the load-stressed directions does not exceed 100 mln. tons of gross, in 18% of cases — less than 50 mln. tons of gross. The major amount of rails 75-95 % is removed due to defects 10, 11, 13, 21, 30, developed during the first term of the life cycle and which are not detected during the repair and relaying.**
- **An important parameter that allows to assess the possible reuse of the rail is the number of dynamic loading cycles that the prototype can withstand before it failures under high-frequency impacts, the value of microhardness after high-frequency tests of the prototype, the specific values of which are calculated with the help of the method mentioned above.**
- **Carrying out the proposed control of the used continuously welded rails will allow to control the risk of pre-defect condition. Besides, the proposed method can be used as the addition to the method of operational rail testing and the statistical analysis of the rail life cycle on the lines of JSC "Russian Railways"**