DIAGNOSTICS OF RAILWAY OBJECTS USING ACOUSTIC EMISSION TECHNIQUE

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ABSTRACT. The research results concerning the revealing of growing defects and their hazard evaluation in the railway objects (metal bridge spans, railways on the bridge, rail welded connections, freight-car truck cast details).

KEYWORDS: Railway Objects, Acoustic Emission

INTRODUCTION

Train motion safety depends first of all from the defect absence in equipment of trains, railway and artificial constructions (bridges). New techniques based on the Acoustic Emission (AE) method allow to increase the reliability of these elements. Its advantages are decrease of human factor influence on the testing results, exception of time-consuming scanning process, the possibility of testing large-sized structures with complex geometry in corpore, testing process automation, accumulation and documenting of the information on testing results.

Significant scientific effort of monitoring of railroad rails and railroad bridge structure elements, revealing of growing defects and their hazard evaluation has been applied for several years in Scientific Certification-Diagnostic Centre of Siberian State University of Railways, Novosibirsk, and Moscow State University of Railways. Our long-term study confirms that AE method is adequate to provide the reliable structure safety. We verified the obtained information and laboratory results in working environment. This monitoring is provided by measuring system for express-diagnostics – that is tensometric installation UIC and by another acoustic emission installation SCAD 16.03.

ACOUSTIC EMISSION AND TENSOMETRIC STEND FOR BRIDGE INSPECTION

AE technique and tensometry are used for inspection of the details of metal bridge spans. AE signals registration is carried out under the load produced by trains passing the bridge. The diagnostics of longitudinal supporting girders of the railroad bridge across the Ob-river are carried out during 2000-2006 years. The presence of both fatigue defects detected early as new advancing cracks with early growth stage is confirmed. The future prospect of the suggested method allows creating of the system for continuous monitoring of the main bridge elements technical state.

Previously found out fatigue defects were acknowledged, and several new cracks progressing at the early stage were revealed. Fig.1 shows the cross crack which was revealed in the stiffening rib using our facilities and software. This kind of faults is rather widespread but it is not an easy task to find it out. Our method is a reliable means for solving this problem.

We have studied different types of deformation in longitudinal beam. These deformations were formed under the loads which developed while the passenger trains were passing along this track section (Fig.2).

The most prospective direction of the further AE complex development combined with the tensometric system for bridge testing is creating stationary measuring systems watching the condition of the tested object and the progress of the incipient defects in real time.

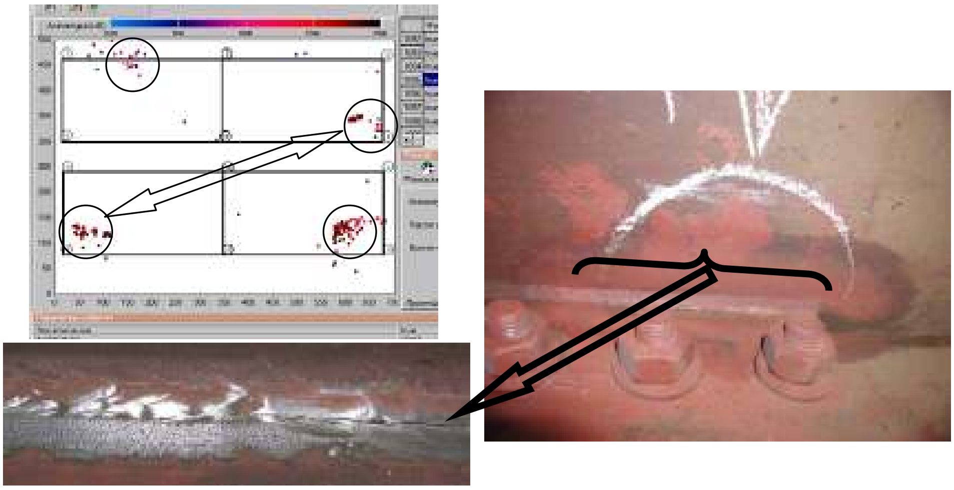

Fig.1. Longitudinal crack along the welded seam of stiffening rib

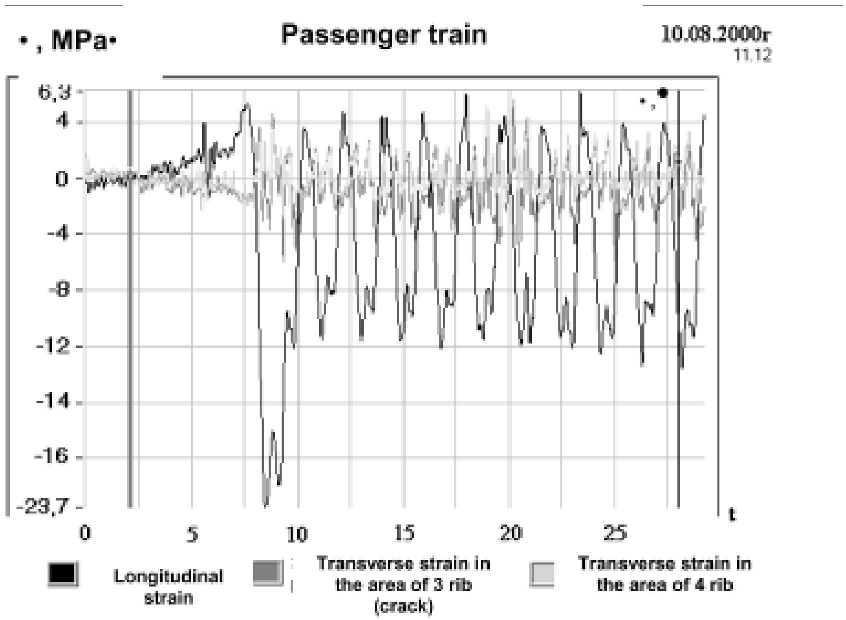

Fig.2. Strain measurement results for longitudinal girder

ACOUSTIC EMISSION METHOD OF NON-DESTRUCTIVE TESTING OF RAILS UNDER OPERATION

At present there are several methods allowing with various degree of probability to find out defects inside the rail. However some progressive defects such as cross cracks in wings of rail base in the area of acoustic shadow of ultrasound testing, cross and longitudinal cracks of vertical orientation in rail head. Moreover there is a possibility of different defects omission at the early stage of their progress. One of the ways to solve the above mentioned problem is to apply AE method for rail strings testing. The successful applying of this method in other fields of non-destructive test testifies in its favour. The main reason for the fact that AE method for rail testing has not been applied yet is the great number of questions which have not been answered.

This research has studied the problems of AE registration possibility under high mechanic and electromagnetic noise. The problem of AE signal transmission along sound pass also has been studied. The investigations were carried out on real rails of the second and third spans of the railroad bridge across the Ob-river at 3333 km. To obtain the complete information about the stressedly-deformed rail condition we used a specially developed tensometric system. The results of investigations are presented on Fig.3.

The method of AE signal registration in the railways on the bridge in conditions of high mechanic and electromagnetic noise is developed. The adequacy of deformation mode level produced by passing train weight is justified. It is shown, that it is necessary to carry out the rails AE diagnostics during the train approaching towards the rail and after train leaving from the rail. The developed way is patented and the technique is applied for diagnostics the rails on the bridge across the Ob-river.

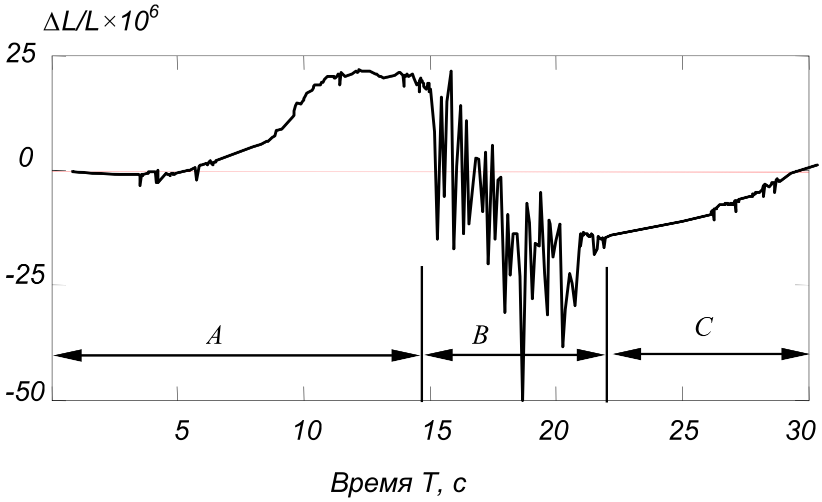

Fig.3. Time law of longitudinal deformation of rail:
A-time before the locomotive goes on controllable rail;
B- time which locomotive goes though controllable rail;
C- time after the locomotive goes off controllable rail

ACOUSTIC EMISSION DIAGNOSTICS OF DEFECTS IN HETEROGENEOUS STRUCTURES UNDER MATERIAL COOLING OF WELDED CONNECTIONS

The AE technique is used for increasing the reliability of nondestructive testing of rail welded connections in conditions of rail welded plant. Here testing of welded areas is being carried out under thermal stress changing while welding seam cooling. The series of experiments resulted in AE signals and their processing allowed revealing the regularities in AE parameters inherent to the various defects (cracks, shrinkage cavity, wormhole, burning, spill, rolled kink, voids, slag inclusions and so on). The technique for AE testing of rail welded connections was prepared on the basis of the obtained results.

The series of experiments resulted in AE signals and their processing allowed revealing the regularities in AE parameters splitting from various defects. The diagrams of Fig.4 show the testing peculiarities in different rail parts. The forms of the registered impulses in rail head, rail web and rail base provide the visual evidence of wear pattern or other kind of faults. The method project for AE testing of rail welded connections was prepared on the basis of the obtained results. This method has been approved at the rail-welding works.

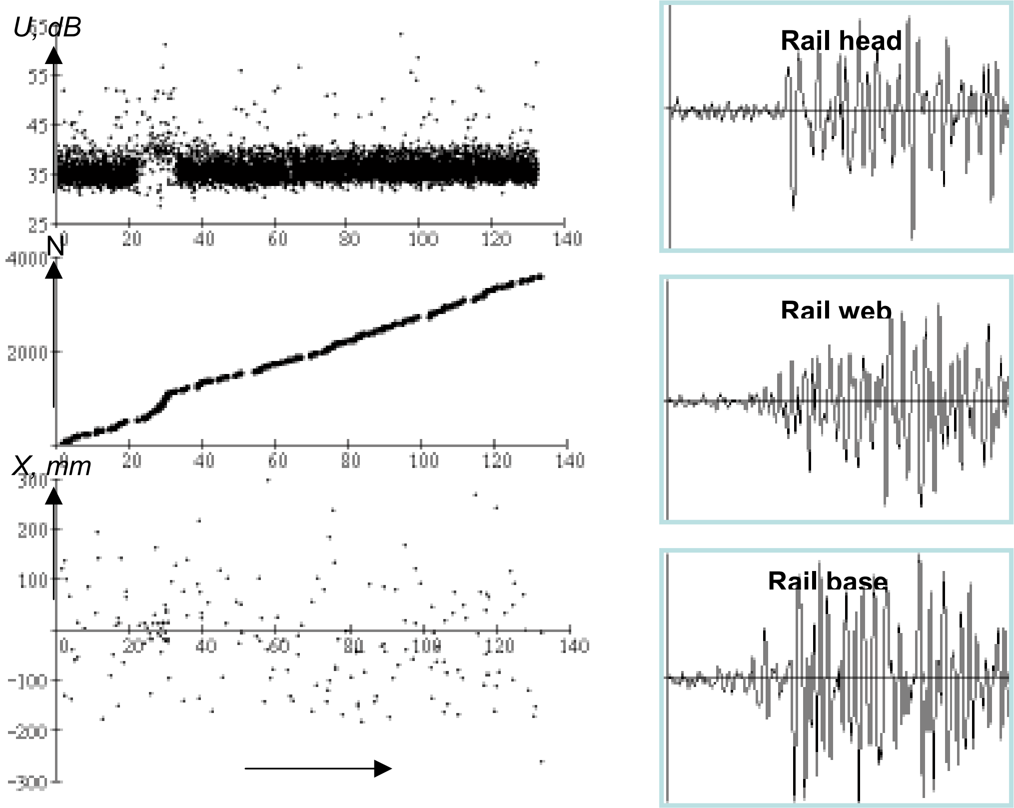

Fig.4. Characteristics of an acoustic emission sources detected and the form of acoustic emission impulses

ACOUSTIC EMISSION DIAGNOSTICS OF CAR WHEELSET PAIRS

AE automated diagnostic installation is developed for revealing defects advancing in car wheelset pairs under static loading (Fig.5). Loading is carried out by hydrocylinders on both axle journals and lateral pressure on a wheel treads. The installation tests are carried out in car repair depot and 35 second-used wheelset pairs are inspected, the defect presence is confirmed by other non-destructive methods in 34 cases (Fig.6).

Fig.5. AE installation for weelset pairs diagnostics

Fig.6. The defects detected in weelset pairs using AE diagnostics

ACOUSTIC EMISSION DIAGNOSTICS OF FREIGHT-CAR TRUCK CAST DETAILS

The results of AE technique development for diagnostics of freight-car truck cast details (solebars and bogie bolster) are presented (Fig.7). The technology of service life prolongation for the cast details which have worked 30 years and more is described. These AE equipment are installed in 104 car repair depots. The defects detected in in basic surface of bogie bolster using AE diagnostics are presented on the Fig.8.

Fig.7. AE installation for freight-car truck cast details diagnostics (solebars and bogie bolster)

The results of AE-testing of solebars and bogie bolster of freight-car truck during 2002-2006 years are presented in Table 2.

Table 2

Operation beginning year	Number of installations	Number of bogie bolster		Number of solebars	
		Tested in total	Life prolonged	Tested in total	Life prolonged
2002	3	385	273	43	31
2003	25	6 998	5 465	3 480	2 627
2004	73	29 540	25 100	14 802	12 293
2005	102	44 074	36 454	19 783	14 074
2006	102	55 488	49 449	24 504	20 076
2007, half-year	102	48 703	44 349	19 855	16 566

Fig.8. The defects detected in basic surface of bogie bolster using AE diagnostics

CONCLUSIONS

The future prospect of the suggested method allows creating of the complex for continuous monitoring of railway objects technical condition. The solving of the monitoring problem connected with the complicated engineering structures provides the possibility to find out the defects at their early stage, to watch their further progress and degree of danger as well as to evaluate the general structure condition.