

THE DETECTION OF DISCONTINUITY FLAWS OF METAL IN POWER BRACKETS HEELS OF LOCOMOTIVE SERVICING BY ULTRASONIC ECHO METHOD ON SHALLOW DEPTHS

Valentin Mogila*, Andrey Kireev*, Andrey Mozheyko**

**Volodymyr Dal East-Ukrainian National University, Lugansk, Ukraine*

***JSC Holding Company «Luganskteplovoy», Lugansk, Ukraine*

Annotation. In this article the definition of compact and dispersed discontinuity flaws of metal on shallow depths in power brackets castings of locomotive carts by ultrasonic echo-method is given.

Keywords. Locomotive, casting, discontinuity flaw of metal, ultrasonic control, echo-signal.

INTRODUCTION

One of the urgent tasks of this article is providing the safety of passengers and loads transportation by railway. The solution of this problem directly influences the techno-economic indexes of railway transport work and determines its competitiveness in the market of transport services [Bogomaz 2007, Gavriluk 2005].

The locomotive servicing must provide the safety of motion, minimum influence on the way, high hauling qualities and operational reliability. Therefore high standards of metal quality of elements of the locomotive servicing is required [Aleksandrov 2001, Vardanyan 2003]. Damages of metal continuity appear to be stress raisers [Lahtin 1984]. In the area of concentration of tensions damages develop very intensively. All this sharply reduces operating reliability of the locomotive servicing [Kachanov 1974].

When producing the locomotive servicing of the railway vehicles the steel molded pieces are widely used. Castings of such details are made by the casting of the fused and overheated alloy of the vehicle given in the casting mold. The internal cavity of the form reproduces configuration and size of the future detail with the high degree of similarity. After cooling the metal becomes solid and in the solid state it has the same outlines of the cavity which it was cast in. All this shows that the most effective technology occurs to be the casting technology which allows to get goods of necessary configurations, sizes and qualities directly from fusion at the minimum expenses of energy, materials and labour. The main progress trend consists in quality improving of the casting, increase of dimensional accuracy and reduction of steel intensity. The cooling of the liquid alloy, its crystallization and further cooling in solid state is

accompanied by diminishing of volume and its contraction. The occurrence of hollow spaces in forms of blisters, voids, cracks and other discontinuity flaws is connected with the contraction [Founding production 1987]. Internal friability and concentrated pipes of certain sizes and in set places are permitted by technical requirements to the detail.

Cast power brackets of the truck frames are critical parts. One of the factors providing safety of the train operation is the application of different technologies and nondestructive inspection techniques [Gavrilyuk 2005]. The task of the ultrasonic control is to eliminate the operation of the power brackets with inadmissible discontinuity flaws. Ultrasonic echo-method is the most widespread way of discontinuity flaw control. However the ultrasonic control of the castings entails certain difficulties such as complicated configuration and surface roughness. The brackets castings are produced with shrinkage allowance for obtaining necessary linear dimensions of the truck frame. To provide acoustic contact two perpendicular planes of the power brackets heels are mechanically treated. The position of the grooves in the brackets and the amount of metal removed is detected by the size of assembled and welded truck. The final mechanical processing and grooves' milling is not possible to perform on truck frames without brackets installed. On previously mechanically operated surfaces of the details some exposed casting defects are allowed both defective and capable of being amended by means of chipping till fine metal with following welding. After the final mechanical operation the inadmissible discontinuity flaws which are difficult to amend should be absent because of the linear dimensions changed.

Discontinuity flaws of metal in the subsurface zone will be removed later when mechanically operated. That is why it is necessary to improve the ultrasonic control which lets to detect the discontinuity flaws on shallow depths. There is no necessity to repair some of these discontinuity flaws. These will be removed after the final mechanical operation.

THE SUBJECT OF RESEARCH

The purpose of the present research is to improve the detection of discontinuity flaws of metal of power brackets' heels by means of echo-method on shallow depths.

To attain this aim it is necessary to resolve the following problems:

- to ground the type of transducers used,
- to study the echo-signals from discontinuity flaws on shallow depth experimentally,
- to suggest the improvement of the real depth detection of the discontinuity flaw.

The object of research: The process of casts of power brackets of track-side frame of engines production.

The topic of research ultrasonic check operations of power brackets of track-side frame of engines production.

Research methods: for resolving the risen problems the following experimental methods were used:

- 1) method of layerwise opening by milling,
- 2) ultrasonic pulse echo-method.

THE RESULTS OF THE EXPERIMENTAL RESEARCH

For the detection of discontinuity flaws of metal on shallow depths the use of the normal transducers is difficult because of the inequality of the acoustic field in the nearest area and the presence of dead area. The use of acoustic delays brings to occurrence of extra echo-signals on the screen of the flaw detector. Therefore for the detection of discontinuity flaws of metal on shallow depths separate and combined transducers are used [Aleshin 1989, Ermolov 1986].

The research was conducted by echo-method with the help of the ultrasonic flow pulse detector UD2-70. On the screen of the flaw detector we can see the sent sounding signal which is reflected from the back surface of the item and the echo-signal from the discontinuity flaw. The echo-signal from the discontinuity flaw is disposed on the screen of the flaw detector before the back echo-signal [Aleshin 1989]. The detection of the flaw in the middle part of the bracket heel is presented on the screen layout of the flaw detector in fig. 1

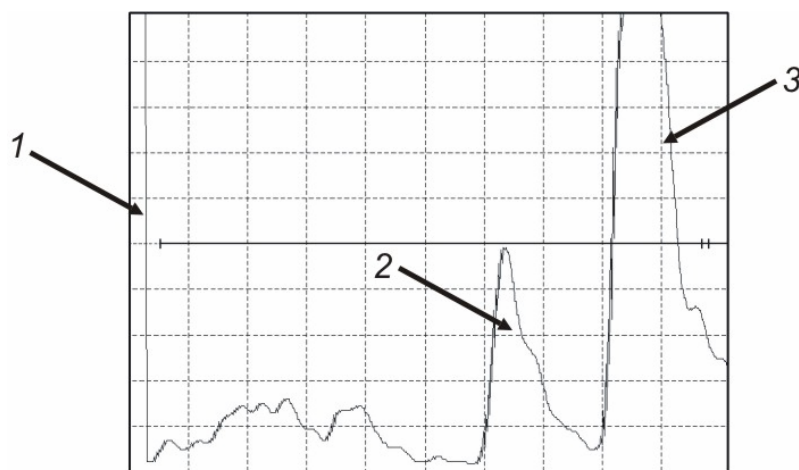


Fig. 1. The screen layout of the flaw detector on tracing the flaws on the depth of 55 mm by separate and combined transducer

1 - sounding signal; 2 – echo-signal from the discontinuity flaw 3 – back surface echo-signal.

The detection of the flaw on the depth of 10 mm of the bracket heel is presented on the screen layout of the flaw detector in fig. 2.

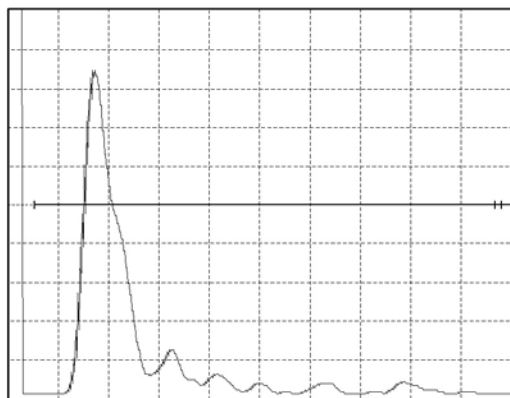


Fig. 2. The screen layout of the flaw detector on tracing the flaws on the depth of 10 mm by separate and combined transducer

The echo-signals of the discontinuity flaws in pictures 1 and 2 are typical signals from the discontinuity flaws described in the references [Aleshin 1989].

When checking the castings of the power brackets on a frequency of 2,5 Mhz with the help of separate and combined transducer the type of the echo-signal presented in fig. 3 was detected.

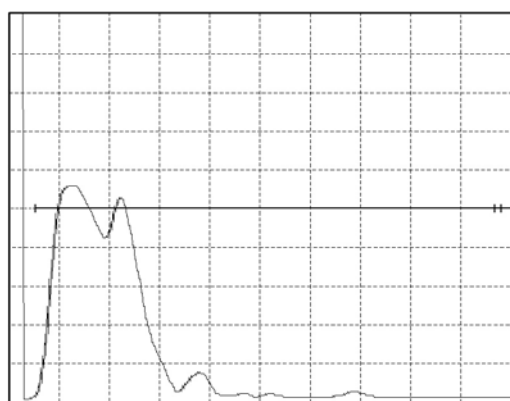


Fig. 3. The screen layout of the flaw detector on tracing the flaws nearby the scan surface by the separate and combined transducer

In left edge of the echo-signal the depth of the discontinuity flaw is about 4 mm. By the look at this echo signal we can suggest that it is the reflection from the dispersed discontinuity at the depth of 12 mm.

By moving and turning the transducer it was possible to get the signal in the form of multiple reflection. In picture 4 the echo-signal from the continuity flow which was previously detected by the echo-signal in figure 3.

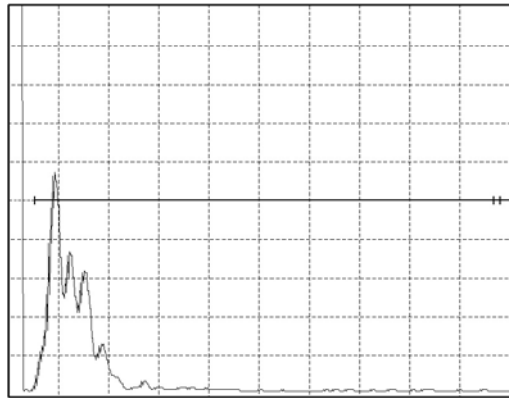


Fig. 4 The screen layout of the flaw detector on tracing the discontinuity flaw (fig. 3.) nearby the scan after surface moving and turning the transducer

Multiple reflection shows the surface of the compact discontinuity flaw. The depth of the nearest reflecting surface of the discontinuity flaw detected by the first echo-signal is 4 mm. However the discontinuity flaw may be volumetric and be extended outside the reflecting surface. For detection of discontinuity flaw extension the check is carried out from another surface perpendicular to the original check surface. If the discontinuity flaw is not detected or detected in the place of metal removal but after the final mechanical operation this discontinuity flaw should be omitted.

In the experiment the checking from the other surface detected the discontinuity flaw in the layer removed after the mechanical operation. The discontinuity flaw will be removed after the final mechanical operation. This type of the discontinuity flaw is allowed.

It was determined by the study of the layer wise opening by milling that the discontinuity flaw detected is on the depth of 4 mm and has the thickness about 3 mm.

If the discontinuity flaw is dispersed it does not show the echo-signal in the form of multiple reflection. It is possible to check the depth of the flaw from another surface but the absence of the echo-signal does not guarantee that it is not spread in the depth, because the other surface of check can be situated much farther from the discontinuity flaw and the weak signal is not registered by the flaw detector. The bracket with the dispersed discontinuity flaw is sent to be repaired.

The reasons of echo-signal presence flaw on the detector screen from the compact discontinuity flaw which is similar to the dispersed discontinuity flaw can be the complex curved surface of the compact discontinuity and the detector's position.

CONCLUSIONS

The use of the separate and combined transducers for detection of discontinuity flaws of metal on shallow depths is grounded.

It is experimentally proved that the type of echo-signals from discontinuity flaws of metal on shallow depths can be in the form of separated pulses, complicated configuration of combined pulses and in the form of multiple reflection pulses.

It is offered to use the multiple reflection signals obtained for detecting the type of discontinuity flaw.

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ВЫЯВЛЕНИЕ НЕСПЛОШНОСТЕЙ МЕТАЛЛА КАБЛУЧКОВ СИЛОВЫХ КРОНШТЕЙНОВ ЭКИПАЖНОЙ ЧАСТИ ЛОКОМОТИВА УЛЬТРАЗВУКОВЫМ ЭХО – МЕТОДОМ НА МАЛЫХ ГЛУБИНАХ

Могила В.И., Киреев А.Н., Можейко А.В.

Аннотация. Изложено определение компактных и рассредоточенных несплошностей металла на малых глубинах в отливках силовых кронштейнов локомотивных тележек ультразвуковым эхо – методом.

Ключевые слова: локомотив, отливка, несплошность металла, ультразвуковой контроль, эхо – сигнал.