5.3.6. NON-STANDARD SPESIMENS ULTRASOUND DEFECTOSCOPY OF PIPES

Klymenko S.M., Poltava branch of Ukrainian Government Geological Research Institute, Poltava, Ukraine;
Malaychyk V.P., Mozgovoy A.V.,
Dnepropetrovsk National University, Dnepropetrovks, Ukraine

Traditional ultrasound defectoscopy assumes the use of samples of controlled articles with applied standard defects to set the settings for the equipment. With this way of settings and followed by control, the influence of unstable acoustic contact with transformer and the surface of the pipe is not accounted for; and also the difference in reflective abilities of real and controlled (standard) defects. Aside from that, with control of real long measured articles, which are pipes, that approach does not allow to differentiate the variable measure of speed of ultrasound waves and their disbursement in one pipe, and also in the same pipes in one batch. Also, the companies-producers and companies-consumers, which use those pipes, in present time use the samples in which the defects are imitated by different ways: drill holes, creases, scratches and cuts. All this leads to great errors in making a decision on the quality of controlled pipe.

The influence of this deficiency can be greatly reduced, using the non-standard approach to defectoscopy, which is based on using limited quantity of priority information about the norms of defects and processing of a large quantity of data.

With ultrasound control, the measures $x(k)$ are a sequence of random values, formed by echo-signals $s(k)$, modulated by interference $m(k)$ and measured noise $n(k)$

$$x(k) = m(k)s(k) + n(k).$$

The measurements $x(k)$ are processed after control of each pile with the purpose of finding and evaluating echo-signals, which include the information about defects in the sample. The evaluation needs to satisfy two opposite requirements: 1) the need to make a correct decisions based on the results, and not to dismiss the defective sections of the pipes; 2) the need to avoid the incorrect false decisions – dismiss the pipes without defect. The measure of effectiveness and quality of non-destructive testing can be the median number of false decisions. Considered are the optimums of the decision rule with which the possibility of finding defect sections of the pipe will be the highest of all the decision rules. It is shown that the decision rule of Newman-Pierson, formed by condition that the possibility of false reading would not be higher then the allowed value, is a an optimal rule for decision making with the criteria of minimum average risk. In this case, with the given possibility of false reading, the possibility of correct reading with be the greatest. If the possibility of correct reading needs to be not less then given value, then the possibility of false reading will be minimal (modified criteria of Newman-Pierson).

From this analysis it is assumed that for the realization of control with the criteria of minimum average risk, the knowledge of parameters of dispersion laws is needed, that is the presence of standard of defects and norms; and with the use of criteria Newman-Pierson – only the knowledge of parameters of the norm, which can be evaluated by recorded sample of measurements. Forming the threshold of comparison z_0, can be achieved by using the average value and selective dispersion of received sample of measurements of all $x(i)$. The specification of value of threshold z_{0j} is achieved by method of interactive approaches with help of Newman-Pierson criteria.

Conclusion

1. Shown is the possibility of ultrasound control of pipes without use of standard samples for setting the defectoscope by the method of comparison of average and selective dispersions of high values of echo-signals on separate section of control.

2. Proposed algorithms of processing measurements, allowing to find defective sections and evaluate the values, characterizing the condition of controlled pipe.

3. Optimal processing of measurements using criteria of minimum average risk (the cost of false decisions) can not be realized in practice because of the lack of initial data needed to form the threshold of detection and recording the measurements including echo-signals, reflected from defect sections of the pipes.

4. Non-standard defectoscopy can be used if the recorded sample measurements of controlled pipes are remembered. The Newman-Pierson rule is optimal in this case: with given possibility of false detection of defects the possibility of the correct detection will be maximum. If the possibility of correct detection is a given that is less then allowable, then the possibility of false detection of defects in this case will be minimal – modified Newman-Pierson criteria.

5. The threshold of comparison of average measurements is determined by sequential forming of function of decision on the basis of valuation of mathematical expectation and selective dispersions on non-defect sections of pipes. The specification of threshold stops, if the related measurement of values does not exceed the given value from their average value.

6. Function of detection of defective sections of pipes is formed by account of number of current averages, exceeding the threshold of comparison, and if their number is greater the size of moving window, then the decisions is made about the detection of defected section of pipe.

7. With the results of processed measurements the statistical portrait is formed, included are the number values, characterizing the condition of the pipe: the relative number of measurements on defective and non-defective sections, the number of defects, their coordinates, the average values of measurements and their variation on defective and non-defective sections.

References:

1. **Klymenko S.M., Mozgovoy A.V., Malaychyk V.P.** Method of non-standard detection of places of defects in metal parts, which have defects. Patent of Ukraine, invention № 85809, Bulletin N 4, 25.02.2009.

2. **Malaychyk V.P., Mozgovoy A.V.** Mathematical defectoscopy: Monograph. Dnepropetrovsk: System technologies, 2005. 180 p.