1.7.25. ACOUSTIC EMISSION DIAGNOSTICS OF HAZARDOUS DYNAMIC DAMAGES: CRACKING, LEAKAGE, IMPACT

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Depending on the frequency range used by passive acoustic methods of nondestructive testing these methods may be conventionally divided into three categories: low frequency, the range 0.5Hz – 10 kHz (vibrations and loose part detection); middle frequency, 2 kHz – 20 kHz (leakage monitoring); high frequency, 10 kHz – 1MHz (acoustic emission).

Due to fast sporadic character of fracturing process acoustic waves caused by initiation and growth of cracks have wide spectrum. It means that this kind of damaging can be successfully inspected by means of acoustic emission method. The impacts, which also constitute a danger to the structural integrity of material, however, have relatively low spectrums, much lower than the frequency range of AE method. That is a reason why the impact waves are monitored by low frequency acoustic technique, while in AE monitoring the impact signals are regarded as acoustic interferences, which have to be rejected from the useful AE data. A leakage in turn is a continuous not a sporadic process, which is traditionally controlled by an acoustic leakage detection method.

The goal of the paper is to demonstrate the abilities and perspectives of AE technique for monitoring all mentioned sources related to dangerous damages regardless of the nature and spectral features of these sources. The paper sums up numerous results obtained by authors in the fields of acoustic emission phenomena, fracture mechanics and nondestructive testing. The research includes the development of different analytical, numerical and experimental methods for specifying types and parameters of examined AE sources.

In the first part of the paper the results of mechanical static and cyclic testing of metal specimens are performed. The quantitative relations between the fracture mechanic characteristics and the parameters of flow of AE events are obtained. AE amplitude distributions refer to different fracture mechanisms are performed and a dynamic range of AE corresponding to cracking is discussed.

The problem of AE testing of impacts is studied in the second part of the paper. A force-deformation relation obtained in Hertz's theory of impact is used to estimate the parameters of impact of metal sphere upon a thick plate. The results of calculation agree well with experimental data. Quantitative relationship between AE waveform features and impact parameters, such as maximum indentation, contact duration, impact force, etc., determined in the study enables one to estimate physical characteristics of impact, thus impact hazardous, using AE data. .It is shown that AE technique allows identifying and interpreting impact sources both close to and far from the source.

It is shown that normal impact of metal sphere against a plate (a surface of the controlled object) may serve as a calibrated acoustic source with known parameters along with AE imitators generally used in AE testing, such as breaking of pencil or glass capillary. The repeatability of acoustic emission amplitude from impacts obtained during experiments turned out to be very high: internal scatter less than 1 dB.

The problem of AE detection of leakage in pipelines is analyzed in the third part of the paper. The results of in-field testing of pipelines are performed, showing the abilities of AE leakage monitoring. An efficiency of correlation algorithm of location as applied to the discrete flow of AE hits related to leakage is demonstrated and the advantage of this technique over the standard "linear" algorithm of location is discussed.

Summarizing the results obtained we conclude that monitoring of the analyzed dynamic sources of damaging, traditionally carried out in different frequency ranges by special acoustic techniques may be successfully realized by means of the unique AE method. Practical significance of these findings for evaluation of construction integrity is discussed.