x = 0 for which the deformations in region I are elastic. We see from inequality (13), however, that the greater the jump in deformation at the initial instant the more rapidly should the thermal load tend to zero.

LITERATURE CITED


DEFECT COORDINATES ON THE SURFACE OF SPHERICAL PARTS BY THE ACOUSTIC EMISSION METHOD

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Recently, the attention of investigators has been attracted to the acoustic emission method (AEM), which allows one to observe the origin or development of existing micro- and macrocrack-type defects [1-3]. The physical essence of the method is that as a result of the discrete development of plastic deformation or a breakdown in continuity in the material, oscillations — caused by the relaxation of elastic energy in individual microravolumes — are excited. By recording these oscillations, it is possible to determine the moment of the defect origin and location. At present, attempts are being made to use this method in various stages of production and use of the most critical parts of various types of structures.

This article is devoted to determining the defect coordinates revealed on spherical parts with the use of the AEM.

Let n sensors be placed on the surface of a uniform isotropic spherical vessel. These sensors transform the acoustic-wave mechanical energy into an electrical potential, which is amplified and recorded by special apparatus. In the wave propagation of stresses, the order of tripping the sensors will be in direct relation to their distance from the disturbance source. Since the location and moment of origin of the defect are variable values, counting the information arrival time from the defect must be done from the moment of wave arrival at the closest sensor. The signals from the remaining sensors arrive with a delay by the time

\[ t_{k} = t_{k} - t_{1}, \]

where \( t_{k} \) is the signal arrival time at the k-th sensor. Having designated by \( S_{k} \) the distance from the defect to the k-th sensor, we write the delay equation:

\[ S_{k} - S_{1} = V t_{k}, \]

where \( V \) is the rate of wave propagation. In the case of n sensors of similar equations we write \( n - 1 \). The distance \( S_{k} \) is a function of the defect coordinates dependent on the defect location. Consequently, Eq. (2) may be presented in the form

\[ S_{k}(\varphi, \theta, \alpha_{1}, ..., \alpha_{m}) - S_{1}(\varphi, \theta, \alpha_{1}, ..., \alpha_{m}) = V t_{k}, \]

where \( k = 2, 3, 4, ..., n \), \( \varphi \) and \( \theta \) are the spherical coordinates, and \( \alpha_{1}, ..., \alpha_{m} \) are parameters set by the location of the sensors. The radius of the sphere is not included in this equation since we assumed that it is a constant.

Let us join the closest points at which sensors are located by the geodesic arcs of a great circle. In this case the surface of the sphere is divided into spherical triangles. To determine the location of a defect
found in any triangle, it is sufficient to use the equations

\[ S_1(\psi, \theta, \alpha_1 \ldots \alpha_4) - S_1(\psi, 0, \alpha_1 \ldots \alpha_4) = V_1 ; \]

\[ S_2(\psi, \theta, \alpha_1 \ldots \alpha_4) - S_1(\psi, \theta, \alpha_1 \ldots \alpha_4) = V_1 ; \]

\[ \text{i.e., three sensors located at the apexes of the triangle are sufficient. The wave generated by the defect propagates along the geodesic arc. Consequently, the values } S_1, S_2, \text{ and } S_3 \text{ are integrals along the geodesic arc. However, to calculate their value is not possible since one of the limits of integration — the coordinates of the defect — is not known. Therefore, it is necessary to introduce a system of coordinates in which these functions would have a simpler form.} \]

Let us draw through the point where the first sensor* is located the axis \( z_1 \) of the system of coordinates the origin of which coincides with the sphere center. Through the point at which the second sensor is located and the axis \( z_1 \) we draw the plane \( L \). In this plane we draw the axis \( y_1 \) perpendicular to the axis \( z_1 \). We draw the axis \( x_1 \) through the sphere center along a normal to the plane \( L \). We draw the second system similarly to the first using as the axis \( z_2 \) the axis passing through the sphere center and the point of location of the second sensor. The axis \( y_2 \) lies in the plane \( L \) perpendicular to the axis \( z_2 \) and the axis \( x_2 \) coincides with the axis \( x_1 \). As the origin of the system of coordinates corresponding to the third sensor we use the sphere center and we draw the axis \( z_3 \) through the point of location of the third sensor. The axes \( y_3 \) and \( x_3 \) are located in the plane \( M \), which is normal to the axis \( z_2 \) and passes through the sphere center. In these systems the corresponding distance is described by the equation

\[ S_k = R \theta_k \quad (k = 1, 2, 3), \]

where \( \theta \) is the angle between the radius vector of the defect and the axis \( z_k \) and \( R \) is the sphere radius.

To solve the system of equations (4) it is necessary to express Eq. (5) in a single system of coordinates and to substitute the result in Eq. (4). As such a system, use was made of the system of coordinates related to the sensor tripped first. The plane \( L \) intersects the sphere on the arc of a great circle (geodesic) on which lie the points of location of the first and second sensors. The arc value connecting these points is designated as \( \theta_0 \) and it is determined by the location of the sensors. The position of the system related to the third sensor relative to the system related to the second sensor is specified by the angles \( \phi' \) and \( \theta' \), which are also specified by the location of the sensors.

The transition from the system related to the second sensor to the system related to the first may be presented as rotation around the axis \( x(x_2) \) by the angle \( \theta_0 \). Consequently:

\[ x_1 = x_1 ; \]

\[ y_2 = y_1 \cos \theta_0 - z_1 \sin \theta_0 ; \]

\[ z_2 = y_1 \sin \theta_0 + z_1 \cos \theta_0 . \]

The transition from the system related to the third sensor to the system related to the first is done in two stages, from the third to the second and from the second to the first, as a result of which

*Here and in the future the sensor tripped first and similarly, the second, third, etc.