

A NEW PROCEDURE FOR THE EVALUATION OF RESIDUAL STRESSES BY THE HOLE DRILLING METHOD BASED ON NEWTON-RAPHSON TECHNIQUE

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In the hole drilling method, the non-uniform residual stresses can be determined from the measured relaxed strains using several techniques, the most used of which are the power series method and the integral method. The relationship between relaxed strains and stresses is

$$\varepsilon(z) = \int_0^z F(Z, z) \sigma(Z) dZ; \quad Z \leq z; \quad (1)$$

being z the depth of the hole, Z the distance from the surface along the hole axis, $\sigma(Z)$ a combination of the unknown residual stresses, $F(Z, z)$ is the influence function determined by numerical analysis, $\varepsilon(z)$ the relaxed strains measured at the surface.

In the method proposed in this paper $\sigma(Z)$ is approximated by a $\sigma'(Z)$ function given by a set of n polynomials $\sigma_j(Z)$ of i_M degree, each one representing $\sigma(Z)$ in a limited field $z_{j-1} < Z < z_j$, being $j=1 \div n$:

$$\sigma_j(Z) = \sum_{i=0}^{i_M} a_{ij} Z^i, \quad z_{j-1} \leq Z \leq z_j, \quad j = 1 \div n \quad (2)$$

In this case eq. (1) becomes

$$\varepsilon'(z) = \sum_{k=1}^n \sum_{i=0}^{i_M} a_{ik} \int_{z_{k-1}}^{z_k} F(Z, z) Z^i dZ \quad (3)$$

The a_{ij} coefficients in eq.(3) are the only unknowns of the problem described by eq.(1) and their determination is effected by successive approximations by the *Newton-Raphson* method, minimizing a least square difference between the $\varepsilon(z)$ values and the $\varepsilon'(z)$ function.

It is interesting to note that using $n=1$, the proposed method reduces to the power series method, while considering $i_M=0$, the proposed method becomes a sort of *optimized* integral method. The application of the method is very simple and allows to obtain more precise results than the most used existing techniques.