

STRAIN GAGE HOLE DRILLING METHOD

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Basis of the Method - Strain released by drilling a hole in a specimen is recorded by strain gages distributed around the drilled hole of the surface of the specimen. The recorded strains are converted to stress using equations that have calibration coefficients determined by test. E 837-99 (1) was a significant change from E 837-95. Stresses in E 837-95 were calculated from the strains measured at the final hole depth. Strains at other depths did not influence the calculated stresses. Stresses in E 837-99 are calculated from a best fit of the strains at incremental depths. In this case, all measured strains influence the stress magnitude. Changes between E 837-99 and E 837-01 were editorial in nature.

Procedure (2)

- a. Install a special three to six strain gage rosette at the point where stresses are to be measured.
- b. Wire the strain gages to a static strain indicator.
- c. Attach and accurately position a drilling device over the target of the rosette.
- d. Balance the gage circuits.
- e. Drill hole in increments, being careful not to generate heat that would induce residual stresses.
- f. Record strains after the strain indicator has stabilized.
- g. Calculate stresses using strain data averaging (3).

Results - Each hole drill provides the principal stresses and the angle to the principal stresses in the plane of the specimen surface at the hole drilling location. The stresses calculated per the ASTM E 837-01 equations represent the average stress over about half the whole depth and across the hole diameter. Stress with depth variations can be determined from (4).

Equipment - Strain gage rosettes, strain indicator, rosette installation supplies, A precision milling device including a microscope for positioning the drill and measuring the final hole diameter. Drilling has been successfully performed using air turbines and air abrasive methods. As an alternative to strain gage rosettes, relieved strains can be determined using a laser light source and holography.

Assumptions - Isotropic linearly-elastic material, stresses less than one half yield, stresses do not vary significantly with depth, and stresses uniform over the area of the drilled hole.

Limitations - Near room temperature measurement, need smooth surface suitable for strain gage application, and near surface measurement (0.040 inch for a medium size rosette).

References

1. ASTM E 837-01, Standard Test Method for Determining Residual Stresses by the Hole-Drilling Strain-Gage Method.
2. Measurement of Residual Stresses by the Hole-Drilling Strain Gage Method, Tech Note TN-503-4, Measurements Group, Raleigh, North Carolina.
3. Schajer, G. S., "Strain Data Averaging for Hole-Drilling Method," Experimental Techniques, vol. 15, No. 2, 1991, pp. 25-28.
4. Schajer, G. S. "Measurements of Non-Uniform Residual Stresses Using the Hole Drilling Method," Journal of Engineering Material and Technology, vol. 110, no. 4, 1988, Part I: pp. 338-343, Part II: pp. 344-349.