

Stress Corrosion Testing

Structural materials—for example, the metals used in aircraft, bridges or storage tanks—may develop flaws during their service lifetimes that can affect the structural integrity of a component. Thus, it is important to know the fracture toughness of a material, or its ability to resist cracks.

NASA has had long experience in developing tests to determine the fracture toughness of materials used in aerospace hardware. Lewis Research Center and Langley Research Center, working closely with the American Society for Testing and Materials (ASTM), have made a number of important contributions to the science of predicting materials behavior. Advanced

test procedures developed by the two NASA centers and their contractors have been accepted and recommended by ASTM, to the benefit of the entire materials and structure evaluation industry.

A recent effort in this area is a study conducted by Aluminum Company of America, Alcoa Center, Pennsylvania. Under contract to Langley, Alcoa Laboratories researched state-of-the-art methods for evaluating stress corrosion cracking, a process involving the interaction—over time—of tension stress and a corroding substance at a metal surface. Dealing with stress corrosion cracking problems is a costly matter to industry; proper selection of engineering material is an important first step in avoiding stress corrosion failures.

After three years of research concluded last year, the study recommended as the optimum test procedure a technique known as the “breaking load” method. Developed by Alcoa, this new method determines fracture strengths by loading cylindrical test bars until they fail, after the bars have been exposed to a corrosive environment in the presence of a sustained stress. In the Alcoa procedure, a test specimen—mounted in a self-stressing frame—is placed on a movable rack that is periodically lowered into a tank containing sodium chloride solution (left). After exposure to this corrosive environment for a period of four to 10 days, the specimen is removed and tension-tested to failure by the apparatus shown at left below. The photo below shows a closeup of the fracture surface of a failed specimen, with the boundaries of the stress corrosion flaws outlined for clarity. The degree of degradation due to the environmental attack is measured by comparing the specimen's post-exposure strength with the original tensile strength of the material. Such characterization is useful in determining structural designs and selecting materials to avoid stress corrosion problems.

In comparison with present industry standards, the breaking load test provides more information with fewer specimens and shorter exposure times; additionally, it is more discriminating of stress corrosion resistances among materials. Alcoa and Langley plan to submit the procedure to ASTM for consideration as a new standard method of test.

