NASA TECH BRIEF

Torsion System for Creep Testing with Multiple Stress Reversals

A torsion system has been devised and operated to provide exploratory data on accelerated creep due to multiple stress reversals. These data should be of interest to metallurgists engaged in the development of construction materials since conventional creep and relaxation testing is static and offers little information on the cyclic creep behavior of metals. A constant-torque pulley and dead weight system, used to repeatedly reverse shear stress on tubular specimens, proved to be slow and complex. Push–pull equipment has also been used but was inherently limited to small strains due to such deformational instabilities as necking and buckling.

Torsional testing of tubular specimens appears best suited for reversed stress creep tests since large strains are obtainable while maintaining specimen geometry. Although truly uniform stress distribution is sacrificed, the necking, subsequent instability, and the nonuniformities in stress and strain encountered in other tests are reduced.

In this test system, torsional loads are measured by using the elastic response of a shaft. The amount of windup, directly proportional to the torque, is measured by a pair of linear variable differential transformers (LVDT's) mounted in a holding fixture. Electronic functions are provided by a load controller. Torque is applied by a hydraulic rotary actuator connected to a torque cell and mounted in a load frame. Fluid flow to the actuator chambers is controlled by a servovalve, and pressure variations at the valve manifold are minimized by an accumulator. By measuring the relative angle of rotation of two specimen cross sections, a measure of the shearing strain is obtained. The operation involves two collars, clamped around the specimen, which fasten arms to the specimen sections of interest. These arms are connected to two coaxial cylinders that are free to rotate and translate about and along each other and the bearing race on the torque cell. Relative rotation of the two section clamps is translated into a one-to-one relative rotation of the coaxial cylinders. Such displacement is measured with a rotary variable differential transformer (RVDT), while transducer excitation and readout are performed by an amplifier–demodulator.

Either stress in terms of torque, or strain in terms of relative angle of twist may be controlled in a closed-loop mode. The load controller generates a current that drives the servovalve to force the load or relative angle of twist to assume values dictated by a command signal. Feedback signals generated by the torque cell and relative angle of twist device are scaled and fed into a controller for comparison with the command signals.

For elevated-temperature tests, the specimen is heated by a three-zone radiant heater in conjunction with three chromel-alumel thermocouples which sense, respectively, temperatures at the specimen center and its outer extremities within the heater. Two differential transducers measure the temperature differences between the center and outer portions of the specimen. Independent control of each of the three heater zones affords some control over axial thermal gradients.

Note:

Documentation is available from:

Clearinghouse for Federal Scientific and Technical Information
Springfield, Virginia 22151
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(continued overleaf)

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No patent action is contemplated by NASA.

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