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DETERMINATION OF THE DYNAMIC MECHANICAL PROPERTIES OF MATERIALS AT DIFFERENT STRAIN RATES AND TEMPERATURES

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Abstract

The dynamic mechanical properties of most materials can be relatively easily determined up to ~10^4 s^{-1} at room temperature with the Hopkinson Split Bar techniques. The strain rate sensitivity of the material is then usually taken as the change in the flow stress corresponding to a certain constant strain measured at different constant strain rates. This apparent strain rate sensitivity, however, does not take into account the strain rate dependent strain hardening of the material, i.e., the possible variations in the microstructure. To obtain the instantaneous strain rate sensitivity of the material for a constant microstructure, a strain rate jump test can be done, where the strain rate is suddenly either increased or decreased during the test. Various techniques to accomplish the strain rate jump can be employed, depending on the jump magnitude and the strain rate range in question. In many cases it is also important to know the dynamic properties of the material at elevated and/or subzero temperatures. In compression the test can be accomplished for example by heating the bars or short sections of them together with the specimen, or by heating only the specimen and manipulating the bars and the specimen mechanically to enable the testing. In tension and torsion the latter technique cannot normally be used because the specimen has to be mechanically fixed to the bars. Also, if heating of the specimen up to the test temperature lasts too long, the microstructure of the specimen may undergo significant changes, and therefore rapid heating of the specimen may be required. At subzero temperatures, testing is usually not as challenging because the temperature difference to RT is not too large and permanent microstructural changes seldom occur. In this paper, different techniques that are used at TUT for high and low temperature dynamic tests as well as for strain rate jump tests in compression and tension are presented and discussed. Also several examples of test results obtained with these techniques, especially for materials that are thermally or mechanically metastable, are presented and discussed.

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