Thermo-mechanical fatigue characterization of metallic tubular structures fabricated by selective laser melting

Accurate prediction of the metallic material behaviour using numerical simulations is strongly desirable, in order to minimize the time and cost required to design tool geometry and optimize process conditions. To improve the predictive accuracy of simulations, it is necessary to use a material model capable of accurately reproducing the material's deformation behaviour. Applications such as pressure vessel, shafts and pipes are generally subjected to biaxial/multi-axial loading. Based on the application, there exists various stress ratios that act on the structures and based on the biaxial stress ratio specifications, the experimental methods may be categorized into two. One which uses two or more independent loading systems and the other which uses a single loading system. The examples for the first category testing process are tubular specimens under combination of internal pressure and torsion/tension/compression load, round solid or hollow bars subjected to bending and torsion and a cruciform specimen with independent in plane loading. For the second category anticlastic bending, bulge test and testing with special fixtures for disc and cruciform specimens and for all this set of testing cruciform subjected to individual loading and pipe subjected to internal pressure and torsion – tension are the only test procedures which could provide the stress ratio ranging from –1 to +1. The thin-wall tube allows to test with any steady load ratio to be performed. There have been many experimental studies of multiaxial testing of thin-walled tubular specimens loaded in combined tension-torsion or tension-internal pressure modes. However, few experimental studies have looked at the fatigue behaviour of metal 3D printed tubular specimens fabricated using selective laser melting (SLM) technology.

This project aims at introducing a thermo-mechanical fatigue characterization of SLM-printed tubular specimens under multiaxial/combined loading tests. The proportional and non-proportional cyclic tests as well as combination of monotonic tension and torsion-reverse-torsion cyclic tests will be conducted to investigate the effect of anisotropy on the fatigue behaviour of SLM-printed tubular specimens as well as developing the yield surface of the SLM-printed materials.

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