Engineering and Innovation Research Studentship October 2020

Project title:	The Effect of Plastic Collapse on the Results of a Creep Rupture Test
Discipline	**Engineering, Residual stress**
Key words:	Creep fracture; creep rupture; plastic collapses;
Supervisory team:	**Hedieh Jazaeri, Salih Gungor, John Bouchard**
URL for lead supervisor's OU profile	**http://stem.open.ac.uk/people/hj997**

Project Highlights:

Fundamental engineering study underpinning modelling & lifetime assessment technology.

- Opportunity to apply full field measurement techniques in the OU's creep laboratory and neutron scattering at Central Facilities.
- A project co-sponsored by EDF Energy with opportunity for industrial placement.
- Rich collaboration with EDF Energy's High Temperature Centre academic partners.

Project Description:

All machines that operate at high temperature such as power plant (whether fossil, nuclear or solar thermal), gas turbines and reciprocating engines rely on the results of standardised mechanical tests for engineering calculations. These engineering calculations are the basis of the original design substantiation and any later justifications of fitness for service for all plant operating at high temperature. However, a significant assumption is made in all cases. This assumption is that the strengths that have been derived from standardised mechanical tests (such as tensile tests and creep rupture tests) which are conducted on round bar uniaxial specimens are relevant to a wide variety of different geometries.

It has long been known that the standardised round bar uniaxial specimen fails by necking, which occurs when the specimen plastically collapses under load (Considère 1885 and Hart 1967). However, it has always been assumed that plastic collapse leads to conservative strength values, which are therefore "safe" when used for design and fitness for service. This assumption is likely to be true, although it is also likely to be the cause for much of the scatter and uncertainty associated with the results of both tensile and creep tests. This scatter and uncertainty in the test results is then carried directly into the mechanical properties that are used for design and fitness for service calculations thereby leading to overly pessimistic calculations.

Furthermore, any attempts to study creep fracture by intergranular cavitation are likely to be obscured whenever the test specimen plastic collapses. Therefore, any research into creep cavitation would benefit from an improved understanding of plastic collapse.

This project is intended to study the effects of large strains during tensile and creep tests on the plastic collapse of the specimen. Thereby, giving improved understanding of the uncertainty and variability in the creep rupture results such as time to rupture and rupture elongation.

Research Methods:

This is an Engineering project proposed by EDF Energy. It will make good use of the "Walter+bai" dual station creep testing machine that is currently being commissioned in the School's E&I Creep Laboratories. It will use high temperature digital image correlation (DIC) to monitor spatially varying deformation and cavitation characterisation technologies developed at the Open University over the past 10 years. This new PhD project continues the OU's longstanding (25 year) collaboration with EDF Energy and its role in the EDF's High Temperature Centre.

Indication of project timeline:

Year 1: Become accustomed with high temperature testing, specimen and experiment design, digital image correlation, microscopy, damage characterisation and experiment simulation using finite element analysis. Literature review, development of research question and definition of research methodology.

Year 2: Industrial placement (3 months). Creep test programme, effect of geometry and localisation, in-situ monitoring, destructive characterisation, detailed modelling.

Year 3: Further develop experimental and analysis studies, critically evaluate the results. Present findings to experimental mechanics and high temperature scientific communities at conferences. Write journal papers and prepare PhD thesis.

Background reading:

M. Considère, Annales des Ponts et Chausées Vol. 9, p. 574, 1885.

E W Hart, Theory of the Tensile Test, Acta Metallurgica, Vol. 15, No. 2, pp. 351-355, 1967.

Candidate Applications:

An ideal candidate will hold a higher class 2 undergraduate degree in mechanical engineering or physics and have experience of testing at high temperature.

Applications should include:

- A 1000 word cover letter outlining why the project is of interest to you and how your skills match those required
- An academic CV containing contact details of three academic references
- Open University application form
- Applicants will need to demonstrate good competence in the English language. To be eligible for a full award, a student must have no restrictions on how long they can stay in the UK and have been ordinarily resident in the UK for at least 3 years prior to the start of the studentship.

Applications should be sent to **STEM-EI-PhD@open.ac.uk by 31.03.20**