Investigation of the influence of temperature on the fatigue behaviour of C45E steel

Temperature can have a significant influence on the cyclic deformation and fatigue behaviour of metallic materials. In unalloyed and low-alloy steels in particular, temperature-dependent interactions between dissolved atoms and dislocations can occur, which influence the material's behaviour during cyclic loading. One relevant mechanism here is dynamic strain ageing, which, within a characteristic temperature range, can lead to changes in the material response and thus also in its fatigue behaviour.
The aim of this work is to experimentally investigate the influence of temperature on the fatigue behaviour of a C45E steel in the normalised condition. In particular, the study aims to analyse how different temperature levels affect the cyclic deformation behaviour and the resulting fatigue life. Particular focus is placed on identifying and characterising temperature ranges before, during and after the occurrence of dynamic strain ageing.
The first step involves familiarising oneself with the fundamentals of fatigue testing and the temperature-dependent deformation mechanisms for the test material. Subsequently, suitable test parameters and temperature levels are defined for the experimental investigations. An existing database for the material can be utilised for this purpose. To systematically investigate the influence of temperature, temperature-ramp tests are first carried out. The fatigue tests begin at room temperature and under a constant stress level. After a defined number of cycles, the specimen temperature is increased in stages. The aim is to record changes in the cyclic deformation behaviour as a function of temperature within a single test and to identify characteristic temperature ranges. Based on the results, selected temperature levels are then defined and investigated in separate fatigue tests. In particular, temperatures below, within and above the dynamic strain ageing field are to be considered. In contrast to the temperature-rising tests, the temperature is maintained at a constant level during these tests. This allows the influence of temperature on the material response and fatigue life to be examined in isolation.
The fatigue tests will be instrumented using suitable measurement techniques so that relevant material responses can be continuously recorded during cyclic loading. The test results will then be evaluated and compared with regard to temperature-dependent material responses and fatigue life. The results are to be discussed, in particular with regard to the underlying temperature-dependent deformation mechanisms and the possible influence of dynamic strain ageing. The test results and their discussion are to be documented in the form of a report (including a presentation).

Prerequisites:

- An interest in materials science, materials testing and fatigue
- (Basic) knowledge in the field of experimental testing and measurement techniques

Type of opportunity:

- **Practical placement and Bachelor's thesis (30 ECTS) at the WWHK**
- **Research and development module (10, 20 or 30 ECTS) at the WWHK**
- **Master's thesis (30 ECTS) at the WWHK**

Duration and extent depend on the study regulations and the nature of the student's work

WWHK
Materials Science & Materials Testing

Start date: immediately

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