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KR-Curve Determination and Verification

Introduction

To predict the crack propagation and the critical crack length in an aluminium skeleton structure under a prevailing load, material parameters such as fracture toughness *Klc* and the crack growth resistance KR-curve are used. The use of the KR-curve to determine the critical crack length in a damage tolerance evaluation is less conservative than the use of fracture toughness *Klc.* That is why on the one hand the application of the KR-curves can lead to cost savings when calculating inspection interval times on an aluminium skeleton structure. On the other hand, these findings can also be applied to weight optimizations. This thesis aims to develop a strategy for generating of such curves of aluminium 2024 alloy sheets.

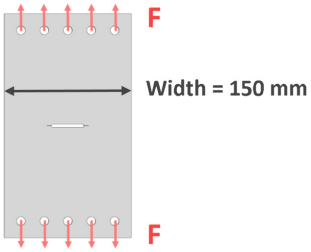

Fig. 1: Middle Cracked Tension M(T) Specimen

Procedure

Based on experimental tests and theoretical investigations on the provided ASTM test standard, the best test method is determined. Tools such as CAD, Finite Element Method, and hand calculations are used for solution finding. The resulting crack resistance tests are performed at the materials laboratory of the Lucerne University of Applied Sciences (HSLU). Middle Cracked Tension M(T) Specimens are loaded under static tensile force on the Zwick-Roell materials testing machine. Through the observation of the crack growth in the specimen and the recorded force, the KR-curve is deduced mathematically. This is done based on the methods given by the international standard ASTM E561 for the determination of KR-curves.

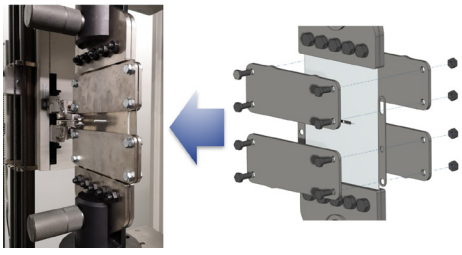

Fig. 2: Specimen Test Setup

Results

In total, seven specimens have been tested. With the load cell in the displacement mode, the following force vs. crack mouth opening displacement (CMOD) curves were generated. Buckling prevention, precise alignment, artificial notch resp. crack and proper calibration of the generated data was found to be of significance to generate adequate KR-Curves. The verification of the produced KR-curves with data from open literature has shown that the generated material data are precise. They are usable for critical crack length calculation. However, the peak KR value could not be attained with the existing equipment. As a conclusion it was found, that this would require M(T)-Specimens with a width of 500 mm and a testing apparatus with higher maximum tensile load of minimum 200 kN compared to the existing capacity of 150 kN.

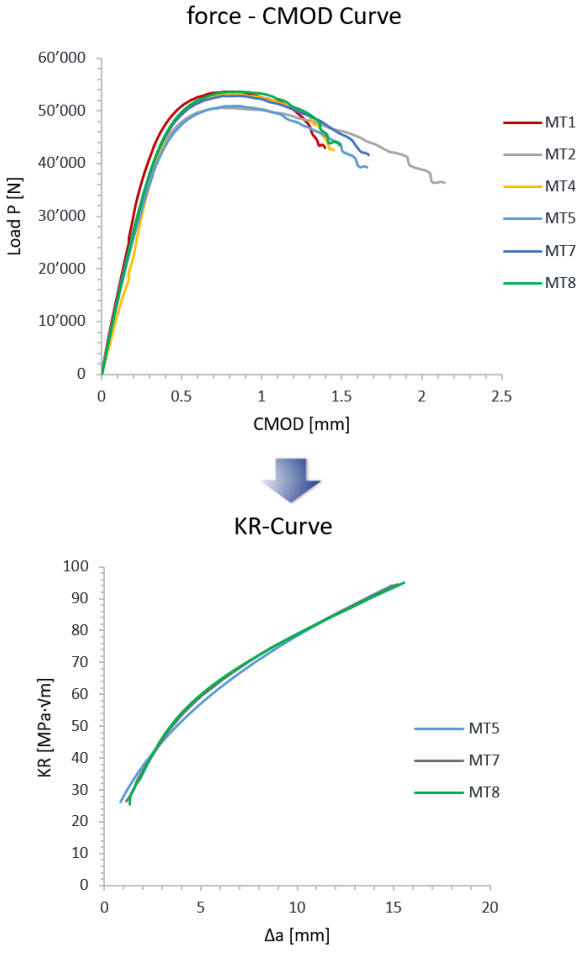

Fig. 3: Measured force-CMOD Curves converted into KR vs. crack length (a)-Curves