EXPERIMENTAL STUDIES ON THE EFFECT OF OVERLOAD
ON FATIGUE CRACK GROWTH

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ABSTRACT: The fatigue crack growth behavior resulting from a single overload is investigated. In order to clarify the mechanism of overload on fatigue crack growth, the processes of crack closure and opening and their stress levels are monitored by strain gages placed on the back surface of specimens, and the fracture surface morphologies are examined by the microfractography. Experimental results may be used to explain quantitatively the mechanisms of retardation and delayed retardation after a single overload.

KEY WORDS: overload, retardation, fracture surface morphology, microfractography, void, dimple, striation, quasi-cleavage, effective stress intensity factor range.

I. INTRODUCTION

An overload applied to a constant cyclic loading results in significantly decreased fatigue crack growth rate. The delayed retardation phenomena mean that the crack first propagates at a decreasing rate until a point of the maximum retardation, is reached, then the crack growth rate increases gradually until the increment of crack length equals about the plastic zone size induced by the overload, at which point the crack growth rate recovers its original growth rate before the application of overload. Many analytical studies on the overload effect have been carried out, but experimental quantitative investigations on the mechanisms of overload effect are still lacking.

The subject of this paper is to clarify the mechanisms of overload effect through a number of experiments, so that we can propose a more rational analytical model and predict crack growth life under spectrum loading more accurately.

II. EXPERIMENTAL PROCEDURE

1. Test specimens

The material used is 7075-T6 aluminum alloy. The chemical compositions and mechanical properties of the material are shown in Tables 1 and 2, respectively. Compact tension specimens are used. The configuration and size are determined according to ASTM E-647, as shown in Fig. 1. The specimen thickness is 10mm.

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Table 1
Chemical compositions (wt %)

<table>
<thead>
<tr>
<th></th>
<th>Si</th>
<th>Fe</th>
<th>Cu</th>
<th>Ti</th>
<th>Mn</th>
<th>Cr</th>
<th>Zn</th>
<th>Mg</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>0.15</td>
<td>0.21</td>
<td>1.50</td>
<td>0.67</td>
<td>0.00</td>
<td>0.21</td>
<td>5.50</td>
<td>2.60</td>
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Table 2
Mechanical properties

<table>
<thead>
<tr>
<th>$\sigma_y$ (MPa)</th>
<th>$\sigma_u$ (MPa)</th>
<th>$E$ (GPa)</th>
<th>T.E. (%)</th>
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<tbody>
<tr>
<td>375.3</td>
<td>463.5</td>
<td>71.8</td>
<td>14</td>
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Fig. 1 Specimen geometry

Fig. 2 Schematic representation of test spectrum