AERO 214

Introduction to Aerospace Mechanics of Materials
Stress Concentration

Transmission input shafts with spiral fracture. Crack initiated at the root due to stress concentration.
Stress concentration

- Transition of cross sections → High stresses
- More abrupt transition → Higher stresses

Abrupt change
Stress “flow lines” crowd
High stress concentration

Smoothen transition
“Flow lines” less crowded
Lower stress concentration

Fillet
Stress Concentration Factors

\[ \sigma_{\text{Max}} = K_t \sigma_{\text{nom}} \]

Approximate formula
\[ K_t \approx B \left( \frac{r}{d} \right)^a \]

<table>
<thead>
<tr>
<th>( \frac{D}{d} )</th>
<th>( B )</th>
<th>( a )</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00</td>
<td>1.100</td>
<td>-0.321</td>
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<tr>
<td>1.50</td>
<td>1.077</td>
<td>-0.296</td>
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<tr>
<td>1.15</td>
<td>1.014</td>
<td>-0.239</td>
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<tr>
<td>1.05</td>
<td>0.998</td>
<td>-0.138</td>
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<tr>
<td>1.01</td>
<td>0.977</td>
<td>-0.107</td>
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</table>

**Figure C.1** Theoretical stress-concentration factor \( K_t \) for a filleted bar in axial tension [9 and 12, Chapter 3].
Figure C.7  Theoretical stress-concentration factor $K_t$ for a shaft with a shoulder fillet in axial tension [9 and 12, Chapter 3].

$$\sigma_{Max} = K_t \sigma_{nom}$$

Approximate formula

$$K_t \approx B \left( \frac{r}{d} \right)^a$$

<table>
<thead>
<tr>
<th>$D/d$</th>
<th>$B$</th>
<th>$a$</th>
</tr>
</thead>
<tbody>
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<td>2.00</td>
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</table>
Carbon fiber polymer matrix composites

Prepreg: fiber pre-coated with the matrix polymer
Fiber debonding and pull-out in composites

Hutchinson and Jensen, Mechanics of materials, 1990
Fracture surface of a Metal matrix composite showing fiber pull-out and breakage
Thermal Expansion
Allow for Thermal Expansion
Expansion Joints and Loops
Moisture Strain in Wood

bow  crook  kink  cup  twist