acting shall be investigated. Additional load cases for special conditions not included in Table KD-230.4 shall be considered, as applicable.

**Step 5.** Perform an elastic–plastic analysis for each of the load cases defined in **Step 4**. If convergence is achieved, the component is stable under the applied loads for this load case. Otherwise, the component configuration (i.e., thickness) shall be modified or applied loads reduced and the analysis repeated.

(a) Each analysis used with respect to KD-232.1 shall use the elastic–plastic stress–strain model in KD-231.4. Nonlinear geometry shall be used in the analysis.

(b) The following evaluation shall be performed using two independent elastic–plastic analyses for the following loading conditions:

1. all loads listed as local criteria in Table KD-230.4.
2. a series of applied loads as described in KD-234. The same loading histogram needed to demonstrate compliance with KD-234 shall be used in this analysis. KD-350 contains guidance in development of that loading histogram.

(c) Loads from fabrication operations such as pressure testing, autofrettage, shrink fitting, and wire winding shall be included if they produce plastic deformation. These loads shall not be included in the evaluation of cold-forming damage, \(D_{\text{eff}}\).

(d) For a location in the component subject to evaluation, determine the principal stresses, \(\sigma_1\), \(\sigma_2\), \(\sigma_3\), the equivalent stress, \(\sigma_{eq}\), using eq. (KD-232.1) below, and the total equivalent plastic strain, \(\epsilon_{peq}\).

### KD-232 Protection Against Local Failure

In addition to demonstrating protection against plastic collapse as defined in KD-231, the local failure criteria below shall be satisfied.

#### KD-232.1 Elastic–Plastic Analysis Procedure

The following procedure shall be used to evaluate protection against local failure.

- (a) Each analysis used with respect to KD-232.1 shall use the elastic–plastic stress–strain model in KD-231.4. Nonlinear geometry shall be used in the analysis.
- (b) The following evaluation shall be performed using two independent elastic–plastic analyses for the following loading conditions:
  1. all loads listed as local criteria in Table KD-230.4.
  2. a series of applied loads as described in KD-234. The same loading histogram needed to demonstrate compliance with KD-234 shall be used in this analysis. KD-350 contains guidance in development of that loading histogram.
- (c) Loads from fabrication operations such as pressure testing, autofrettage, shrink fitting, and wire winding shall be included if they produce plastic deformation. These loads shall not be included in the evaluation of cold-forming damage, \(D_{\text{eff}}\).
- (d) For a location in the component subject to evaluation, determine the principal stresses, \(\sigma_1\), \(\sigma_2\), \(\sigma_3\), the equivalent stress, \(\sigma_{eq}\), using eq. (KD-232.1) below, and the total equivalent plastic strain, \(\epsilon_{peq}\).

#### Table KD-230.4 Load Combinations and Load Factors for an Elastic–Plastic Analysis

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Load Combinations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design Conditions</strong></td>
<td></td>
</tr>
<tr>
<td>Global criteria</td>
<td>(1) (1.80(P_D + P_S + D))</td>
</tr>
<tr>
<td></td>
<td>(2) (1.58(P_D + P_S + D + T) + 2.03L + 2.03L_{A} + 0.65S)</td>
</tr>
<tr>
<td></td>
<td>(3) (1.58(P_D + P_S + D) + 2.03S_{A} + \max. [1.28L + 1.28L_{A}, 0.65W])</td>
</tr>
<tr>
<td></td>
<td>(4) (1.58(P_D + P_S + D) + 1.28W + 1.28L + 1.28L_{A} + 0.65S)</td>
</tr>
<tr>
<td></td>
<td>(5) (1.58(P_D + P_S + D) + 1.28E + 1.28L + 1.28L_{A} + 0.65S)</td>
</tr>
<tr>
<td>Local criteria</td>
<td>(1.28(P_D + P_S + D) + 1.00W_{A})</td>
</tr>
<tr>
<td>Serviceability criteria</td>
<td>According to User’s Design Specification, if applicable. See KD-231.2(b).</td>
</tr>
<tr>
<td><strong>Hydrostatic Test Conditions</strong></td>
<td></td>
</tr>
<tr>
<td>Global criteria</td>
<td>((1/K_{\text{ut}})P + P_S + D + 0.6W_{\text{pt}}) (see KD-236)</td>
</tr>
<tr>
<td>Serviceability criteria</td>
<td>According to User’s Design Specification, if applicable. See KG-311.</td>
</tr>
</tbody>
</table>

GENERAL NOTES:

(a) The parameters used in the Load Combinations column are defined in Table KD-230.2.

(b) See KD-231.2 for descriptions of global and serviceability criteria.

(c) If the layered construction is applied, \(K_{\text{ut eq}}\) instead of \(K_{\text{ut}}\) shall be used.

\[
K_{\text{ut eq}} = \left( \sum_{j=1}^{n} \left( \frac{K_{\text{ut eqj}}}{t_j} \right) \right) / \sum_{j=1}^{n} t_j
\]

where

- \(K_{\text{ut}}\) = factor of upper limit for hydrostatic test pressure (see KT-312)
- \(K_{\text{ut eq}}\) = equivalent factor of upper limit for hydrostatic test pressure for layered construction
- \(t_j\) = thickness of each layer

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