ANALYSIS OF STRESS-STRAIN RELATIONSHIPS IN SILICON RIBBON

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Stress vs Strain for Si (Temperatures in °C)

![Graph of Stress vs Strain for Si](https://ntrs.nasa.gov/search.jsp?R=19850024125)

**Note:**

- The graph shows stress vs strain for silicon at different temperatures (1000°C, 1200°C, 1350°C).
- Key points:
  - At 1000°C, stress is approximately 3 MPa at a strain of 0.03.
  - At 1200°C, stress is approximately 2 MPa at a strain of 0.07.
  - At 1350°C, stress is approximately 1 MPa at a strain of 0.1.

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**Page Number:** 517
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TEMPERATURE (°C)

Y, J STRESS

USED IN MODEL

0 200 400 600 800 1000 1200 1400

1000 2000 3000 4000
Approaches

(1) CONVENTIONAL APPROACH

A SERIES OF MODELS TO PRESENT EACH INTERMEDIATE STAGE
(QUASI-STATIC ANALYSIS)

ADVANTAGE: SMALL MODEL IN EARLY STAGES

DISADVANTAGE: 1. A SERIES OF MODELS (LABOR INTENSIVE)
2. POST-STRESS HISTORY IGNORED

(2) RECOMMENDED APPROACH

A MODEL TO PRESENT ENTIRE PROCESS (DYNAMICAL TRANSIT ANALYSIS)

ADVANTAGE: 1. ONE MODEL ONLY
2. ALL POST-DEFORMATION INCLUDED

DISADVANTAGE: COSTLY AT EARLY STAGE ANALYSIS
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Model
Deformed Shapes by Steps

STEP 1
\[ a_1 = 0.1271 \times 10^{-2} \]
\[ h_x = -0.5005 \times 10^{-3} \]

STEP 5
\[ a_2 = 0.1129 \times 10^{-2} \]
\[ h_x = -0.2301 \times 10^{-2} \]

STEP 10
\[ a_3 = 0.5279 \times 10^{-3} \]
\[ h_x = -0.2979 \times 10^{-2} \]

STEP 15
\[ a_4 = 0.2150 \times 10^{-3} \]
\[ h_x = -0.3134 \times 10^{-2} \]

STEP 20
\[ a_5 = 0.9547 \times 10^{-4} \]
\[ h_x = -0.3202 \times 10^{-2} \]

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Stress Contours of $\sigma_y$ by Steps

$\varepsilon = \text{max} = 149$

$\varepsilon = \text{min} = -117$

PSI

$\varepsilon = \text{max} = 128$

$\varepsilon = \text{min} = -159$

$\varepsilon = \text{max} = 869$

$\varepsilon = \text{min} = -469$

$\varepsilon = \text{max} = 1012$

$\varepsilon = \text{min} = -1122$

ORIGINAL PAGE: IS
OF POOR QUALITY
Stress Contours of $\sigma_x$ by Steps

<table>
<thead>
<tr>
<th>Step</th>
<th>Contour Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>$\Delta = \text{max} = .05$, $0 = \text{min} = -.02$</td>
</tr>
<tr>
<td>Step 5</td>
<td>$\text{max} = 374$, $\text{min} = -657$</td>
</tr>
<tr>
<td>Step 10</td>
<td>$\text{max} = 782$, $\text{min} = -314$</td>
</tr>
<tr>
<td>Step 15</td>
<td>$\text{max} = 1293$, $\text{min} = -1159$</td>
</tr>
<tr>
<td>Step 20</td>
<td>$\text{max} = 1885$, $\text{min} = -858$</td>
</tr>
</tbody>
</table>

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Stress Contours of $\tau_{xy}$ by Steps

\begin{align*}
\text{STEP 5:} & \quad \Delta = \max = 91 \\
\text{STEP 10:} & \quad \max = 180 \\
\text{STEP 15:} & \quad \max = 556 \\
\text{STEP 20:} & \quad \tau_{xy} \max = 712 \\
\end{align*}

\begin{align*}
\Delta = \max = 91 \\
\max = 180 \\
\max = 556 \\
\tau_{xy} \max = 712 \\
\min = -167 \\
\min = -209 \\
\min = -337 \\
\tau_{xy} \min = -416
\end{align*}

Conclusion

- DYNAMICAL TRANSIT APPROACH WORKS
- PAST-STRAIN HISTORY IS SIGNIFICANT