Steel Processing Properties and their Effect on Impact Deformation of Lightweight Structures

Quarterly Report 10/19/1999

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http://www-explorer.ornl.gov
Activities Since Last Quarterly Report

- Prepared WWW interface for SOW modification
  - AISI members can log into Web page to comment and review the project’s SOW
- Strain Rate Sensitivity Study of ULSAB
  - Analyzed Auto/Steel Partnership project data and reports on strain rate sensitivity
  - Prepared data for constitutive material models for crash simulations
  - Performed ULSAB crash simulations using strain rate data
  - Developed WWW report for the study
1. Go to: http://www-explorer.ornl.gov
2. Click on 'Collaboration'
3. On 'Collaboration' page, scroll down to 'Ongoing Initiatives'
4. Click on 'Steel Processing Properties and Their Effect on Impact Deformation of Lightweight Structures'
5. When prompted, provide (case sensitive):
   - user: aisi
   - password: Steel1
6. Add/Review comments, print commented document, etc.
Strain Rate Sensitivity Study of ULSAB
Strain Rate Sensitivity Study - Overview

• Objective
  – Perform preliminary study of strain rate effects in ULSAB

• Approach
  – Combine ULSAB computational models and Auto/Steel Partnership data on steel strain rate sensitivity

• Expected Benefits
  – Develop data for FEM computational modeling of steel impact problems
  – Determine feasibility of strain rate dependent constitutive models for ULSAB computational models
A/SP Materials

- Phase 1
  - DQSK
  - HSLA 340
  - IF
  - M-190
- Phase 2
  - AKDQ
  - HSLA 410
  - DP
<table>
<thead>
<tr>
<th>ULSAB Material ID</th>
<th>Yield Stress [MPa]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>350</td>
</tr>
<tr>
<td>5</td>
<td>210</td>
</tr>
<tr>
<td>8</td>
<td>140 (195)</td>
</tr>
<tr>
<td>31</td>
<td>600</td>
</tr>
<tr>
<td>49</td>
<td>420</td>
</tr>
<tr>
<td>203</td>
<td>276</td>
</tr>
<tr>
<td>209</td>
<td>872</td>
</tr>
</tbody>
</table>
A/SP - ULSAB Materials Correlation

Quasi-Static Material Data for ULSAB

Dyna Material ID
1 - HSLA 340 (1)
5 - DQSK
8 - AKDQ
31 - DP
49 - HSLA 410 (2)
203 - DP
209 - M-190
HSLA Steel - Phase 1

Legend
- 0.001 [1/s]
- 0.1 [1/s]
- 50 [1/s]
- 4000 [1/s]
- ULSAB Material 1
M-190 Steel

Legend
- 0.001 [1/s]
- 40 [1/s]
- 2000 [1/s]
- ULSAB Material 209
HSLA Steel - Phase 2

Legend
- 0.001 [1/s]
- 1 [1/s]
- 65 [1/s]
- 2200 [1/s]
- ULSAB Material 49
**True Plastic Strain**

**Stress [MPa]**

**Dual Phase Steel**

Legend:
- 0.001 [1/s]
- 1 [1/s]
- 72 [1/s]
- 2500 [1/s]
- ULSAB Material 31
Bringing Science to Life

**Constitutive Models**
- **Quasi-Static**
- **Lookup Table**
- **Johnson-Cook**

Graph showing NCAP Test results with time in seconds on the x-axis and barrier force in Newtons on the y-axis. The graph compares different constitutive models: Quasi-Static, Lookup Table, and Johnson-Cook.
NCAP - Node 17

Models
- Quasi-Static
- Lookup Table

Acceleration [g]

Time

0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1
NCAP - Node 21

Models
- Quasi-Static
- Lookup Table

Time [s]

Acceleration [g]
NCAP - Node 46

Models
- Quasi-Static
- Lookup Table
Offset Impact - Node 17

Models
- Quasi-Static
- Lookup Table

Time [s]
0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1

Acceleration [g]
-200 -150 -100 -50 0 50 100 150 200 250
Offset Impact - Node 46

Models
- Quasi-Static
- Lookup Table

Time [s]

Acceleration [g]
Conclusions

• All results not in yet

• Initial simulations indicate modest influence of strain rate effects on ULSAB model
  – main load path is HSLA 340 material with relatively low strain rate sensitivity
  – **modeling can make a big role!**
  – new research project has been initiated with A/SP on modeling impact collapse of steel structures

• Final results available by 11/8/1999 on project Web page
Next Steps

• Define modifications to SOW
  – Further pursue strain rate analysis?
  – Develop forming and processing data?

• Determine activities for the next quarter