EWI Forming Center

Hot and Warm Forming of Selected Sheet Materials

April 17, 2013

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Background

- **Hot forming is becoming more common to produce net-shape structural components of aerospace, automotive, heavy manufacturing and defense applications**
- **Warm forming of aluminum 5xxx-7xxx recently gains more interests for automotive and aerospace applications**
- **The driving factors are light weighting and excellent structural performance**
- **Industry looks for:**
  - practical knowledge of tooling design and production technology
  - scientific knowledge of reliable material models that can help to predict the forming limit and the failures of the part
  - innovative solutions to reduce the manufacturing cost

Background of EWI-FC and OSU-CPF on Hot/Warm Forming

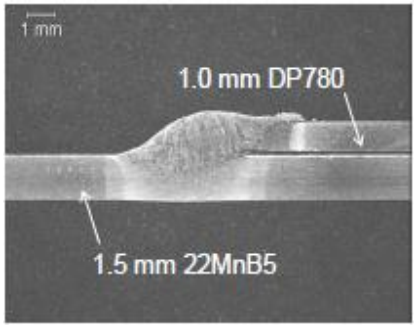
- EWI recently conducted several industry-sponsored projects related to hot forming various materials in aerospace, automotive and heavy manufacturing structures applications
- OSU-CPF has been conducting multiple projects in process simulations on both hot forming AHSS and warm forming of aluminum alloys
- EWI and OSU-CPF have been collaborating to develop proposals to government agencies (DoE, State of Ohio and DoD) on a hot forming topic
- Networking with more than 18 organizations on hot forming

Research Goal

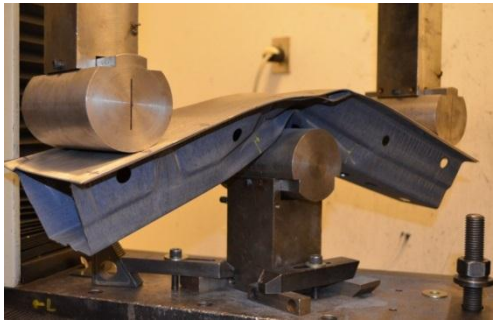
Develop process knowledge on:

- **Forming** the materials at elevated temperatures (formability of Manganese-Boron steel, TWB &TRB, Al, Ti and Nickel alloys)
- **Welding** the hot / warm formed part (for weld failure analysis)
- **Evaluating** the performance of hot-formed and welded structures using quasi-static and dynamic destructive testing

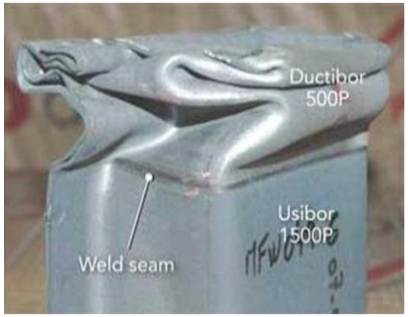
Example hot forming test
[Courtesy of POSCO]



Fatigue crack on a GMAW between DP780 and 22MnB5 [Koganti 2007]



Bend test of PHS part at EWI

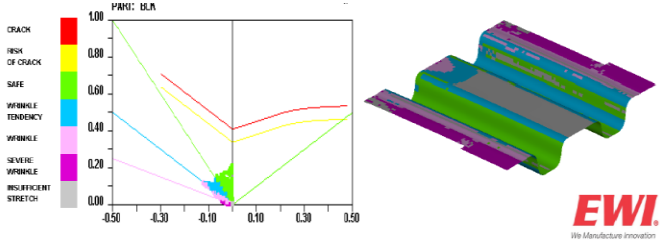


Example of dynamic crush testing of TWB

Available Resources for Hot/Warm Forming Research

- **GRESS Electric furnace available (28” x 16” x 8” size heating chamber up to 2250 °F)**
- **Various welding equipment**
- **Only Forming Test Tooling is required.**

Electric furnace



Hot forming process modeling

160-Ton hydraulic press

Destructive testing equipment

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Recommended Scope of Work

- **Task 1 – State of the Art (SOA) review**
  - The SOA review on hot stamping for automotive applications was conducted by OSU-CPF
  - The SOA review on warm forming aluminum and other materials will be conducted in this project
- **Task 2 - Characterization of material properties**
  - Tensile tests at elevated temperatures with the controlled cooling rates will be conducted
  - The material constitutive model will be determined
- **Task 3 – Design and manufacturing the test tooling**
  - Tooling design with FEM simulations and manufacturing

Recommended Scope of Work

- **Task 4 – Hot / warm forming tests**
  - Testing at a 160-TON hydraulic press
- **Task 5 – Welding test / fabricating the part**
  - Resistance, laser and arc welding of the hot / warm formed part
- **Task 6 – Destructive testing with the fabricated part**
  - Quasi-static bend and dynamic (up to 19-mph) crash tests

Deliverables & Performance Period

- **Deliverables:**
  - Reporting (monthly basis, at the end of each task and a final)
  - Material properties, Tooling design
  - Process modeling results
  - Experimental data of hot / warm forming and welding
  - Destructive test results
- **Performance period: 12 months**
- **The final project scope including budget and materials will be determined with the inputs of industry partners.**

If you want to know more about the detailed project plan of the project topic, please free to contact Hyunok Kim (hkim@ewi.org / 614.688.5239).

Questions & Contact

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