



Enhanced manufacturing processes

New Welding Processes

Periodic Report

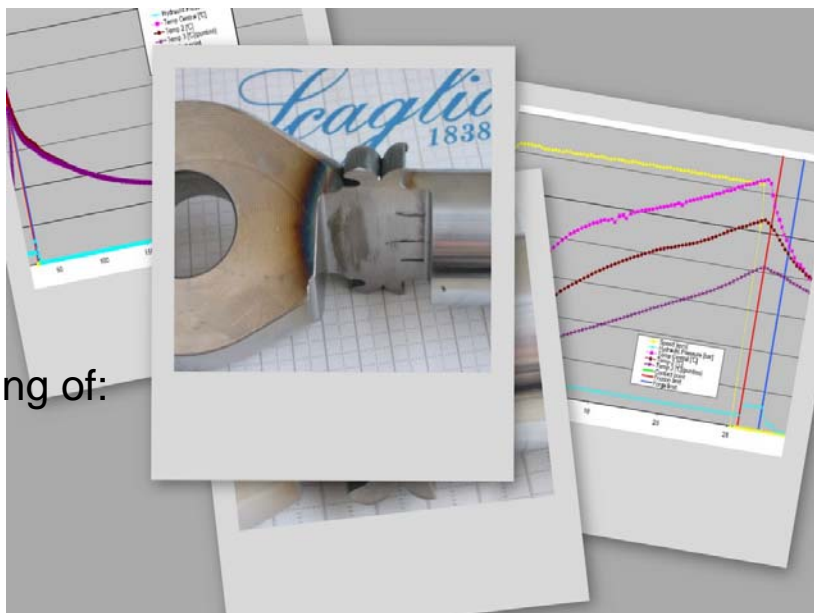
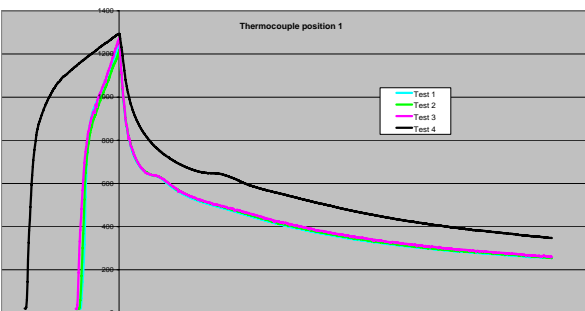
*General meeting at Vic
26th-27th May 2008*



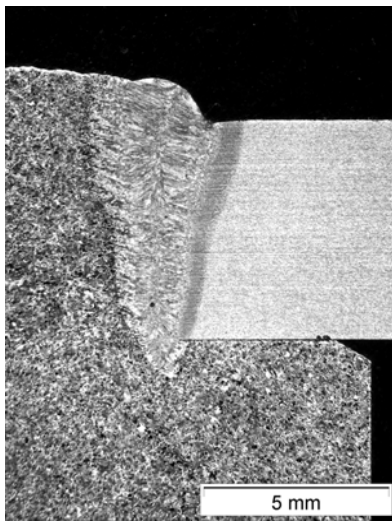


Objectives for the 4th reporting period

- Conclusion of welding trials and analysis (microstructural and mechanical) of the following welding processes:
Friction, Laser, Electron Beam, Hybrid (Laser+MAG) and Stud
- Technical and economical evaluation of the different welding processes;
- Production of Friction welding samples on: *rods* [cast Iron (rod end) and chromed bar (rod bar)]; *cylinders* [cast Iron (tube) and steel (caps end)] - different components made by dissimilar combination of materials;
- Development of a thermo-mechanical FE model for the prediction of residual stresses and distortions after a fusion welding process;
- Production of prototypes.



- **Setting-of** the friction welding process for the joining of:
 - cast iron / steel
 - steel / steel
- **Analysis** of the temperature evolution during:
 - friction and forge and cooling phases;
 - process parameters variation;
- **Determination** of the energy absorbed during the process;
- **Characterization** of the “flash” geometry produced during the process;
- **Production** of samples for partners analysis and testing; **production** of prototypes;
- **Analysis** of the capability of the friction welding process for joining:
 - commercial cast iron;
 - cylinders and rods made of modified cast iron produced by Roda;
 - rods produced by a cladding process by ISQ;
 - rods produced by an insert method (casting process) by Roda.
- **Collection of data** for an analysis of the friction welding cost.



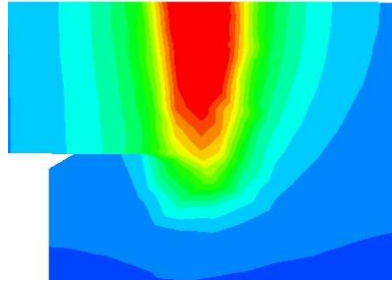
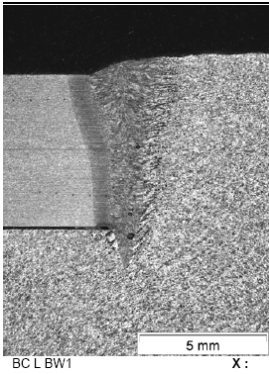
Research/work performed - ISQ



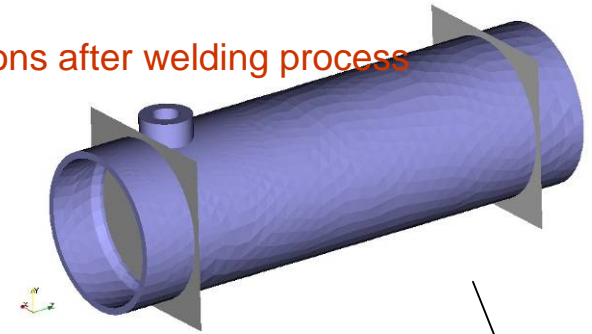
- **Metallographic analysis** of the weld samples produced by:
 - ISQ in carbon steel with alternative processes
 - SCAGLIA in cast iron, carbon steel, modified cast iron and inserts
- **Design** of parameter's sets to be used by SCAGLIA to avoid cracks in cast iron rod ends;
- **Cross comparison** of modelling results (CENAERO) with real trial results (SCAGLIA) and literature data for friction welding;
- **Design** of bevels for all the components to be joined by the alternative welding processes;
- **Welding trials** with Laser, EB, Hybrid and Stud processes;
- **Design of a new technique** to friction weld cast iron by cladding;
- **Production** of samples and prototypes on alternative processes;
- **Comparative analysis** of the studied different processes.



Research/work performed - CENEARO

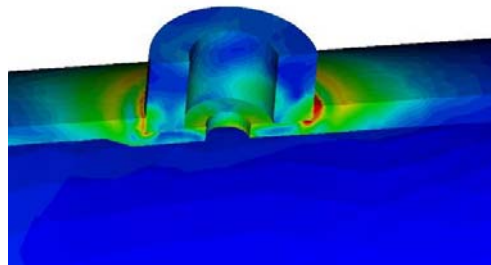
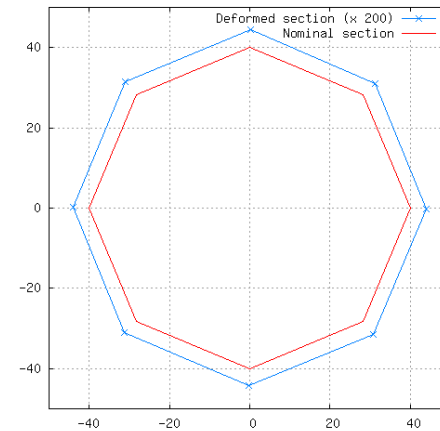
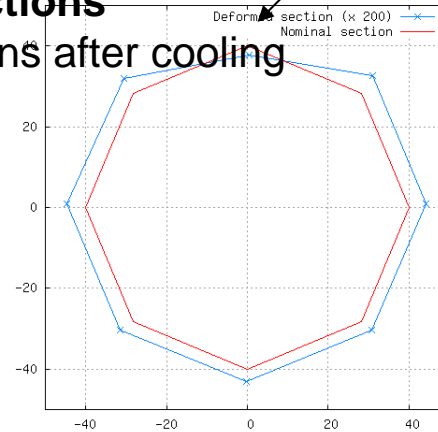
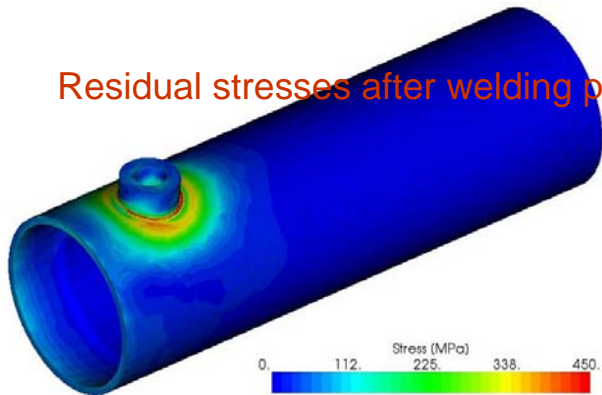


Distortions after welding process



- **Laser welding simulation** performed on 2230 Cylinder (using industrial parameters) :
 - oil port on cylinder and end cap on cylinder welding
- **Thermo-mechanical model** implemented in Morfeo
- **Heat flux parameters** derived from **macro sections**
- **Computation** of residual stresses and distortions after cooling

Residual stresses after welding process



General meeting at Vic
26th-27th May 2008





Alternative processes demonstrated higher performance for joining hydraulic cylinder components (lower welding times and heat inputs)

Application Welding process	Oil Port	Shell/Cap	Rod/Eye
MAG (reference process)	Weld time 30 s Heat input 33 Wh	Weld time 74 s Heat input 101 Wh	Weld time 87 s Heat input 113 Wh
FRICTION	Not feasible	Weld time 22 s Heat input 60 Wh	Weld time 20 s Heat input 50 Wh
LASER	Weld time 8 s Heat input 6 Wh	Weld time 22 s Heat input 31 Wh	Cracks
EBW	Weld time 12 s Heat input 13 Wh	Weld time 71 s Heat input 52 Wh	Weld time 27 s Heat input 23 Wh
HYBRID	Not feasible	Weld time 20 s Heat input 35 Wh	Cracks
STUD	Weld time 0.75 s Heat input 12 Wh	Not feasible	Not feasible

- **Novel process** for welding cast iron components *developed*;
- **Determination of real friction** welding temperatures and energies involved *achieved*;
- **Good agreement** between **simulation and experimental data** for distortions *attained*.
- **Production** of prototypes from the main research results *achieved*.

