

Development of numerical modelling strategies to perform complex structural analyses and to simulate sintering processes

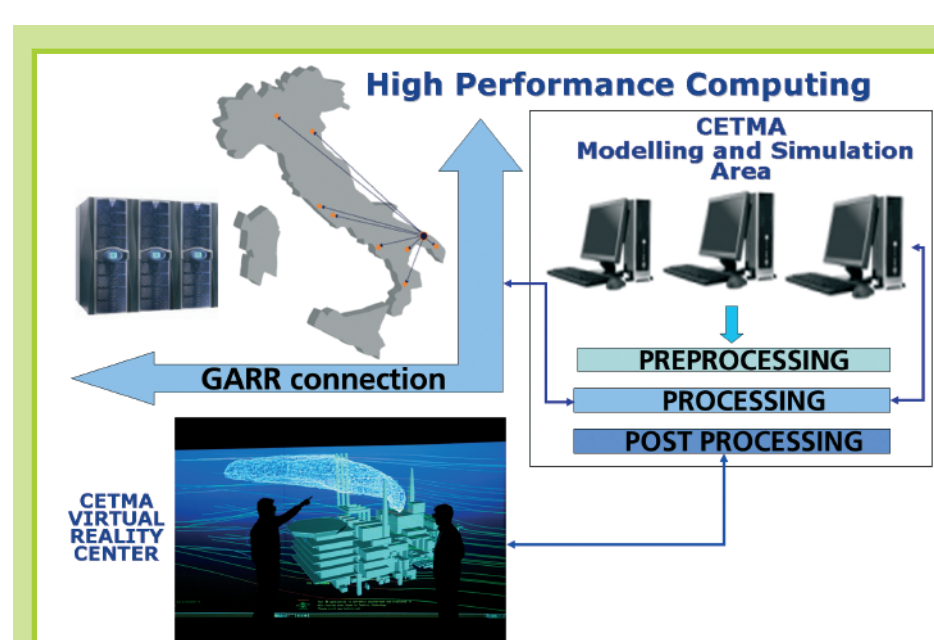
CRESCO - S.P.II.4

The aims of the research work are:

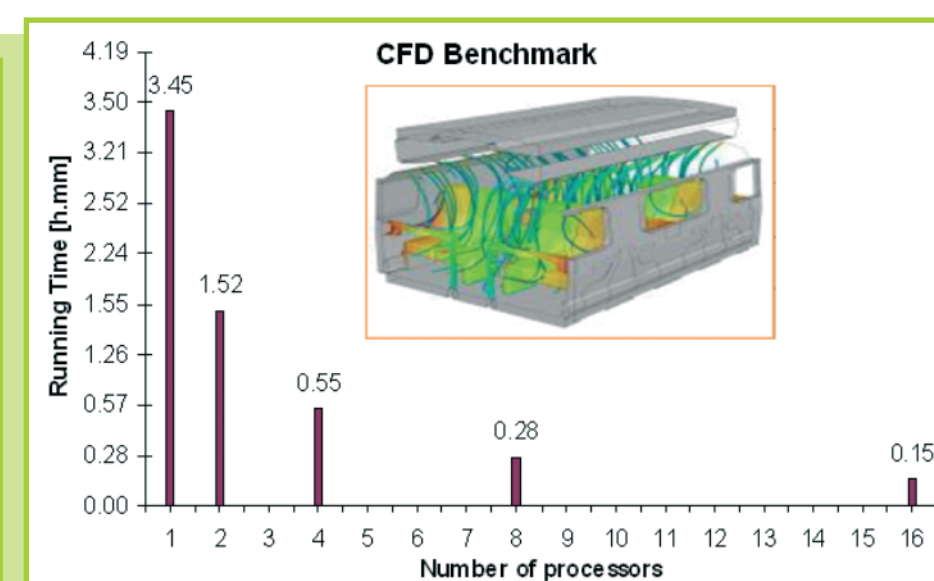
- to achieve the porting between the CETMA Virtual Reality Center (CVRC) in Brindisi and the Italian distributed ENEA-GRID infrastructure
- to study the structural behaviour of composite materials built by using Shape Memory Alloys (SMA)
- to understand and simulate the mechanical behaviour of ceramics components during the sintering processes

Porting CVRC-GRID

The aim of this activity is to connect the grid infrastructure to the single design work stations and to the CVRC located at CETMA site. The connection is possible through the software Citrix that allows the users to interface with the single machines and to run simulations using the finite element packages available (Ansys, Abaqus, Fluent, etc...) and AFS that allows the data transfer between different machines. Post processing and full understanding of the results is allowed through the capabilities of the virtual reality environment provided by the CVRC while reduction of running time is obtained through the parallel computing environment provided by the Grid.



Layout of the various phases of the porting CVRC-Grid



Reduction of running time for a 3D CFD model when the number of processors increase (from 1 to 16)

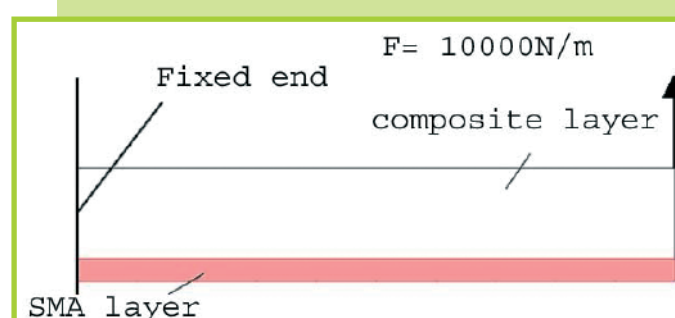
Structural analysis of composite materials hybridized with shape memory alloy (SMA)

Hybrid composites are characterized by a complex behaviour related to the martensitic transformation of the SMA, which is generally dependent on stress, temperature and load history. For this reason several models have been developed, but not all can be implemented in a finite element software because their complexity.

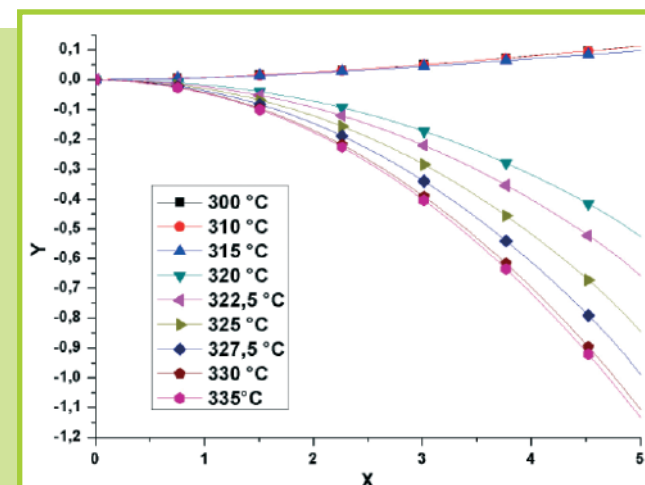
The main activities of our work are:

- the study of the main models developed and the identification of those that can be implemented in FE software;
- first simulations of simple hybrid prototypes by means of the identified models;
- the realization of simple hybrid prototypes and their experimental characterization to collect data for the verification of the first simulations;
- simulations of complex hybrid structures.

FE Analysis of the actuator and Experimental Characterization



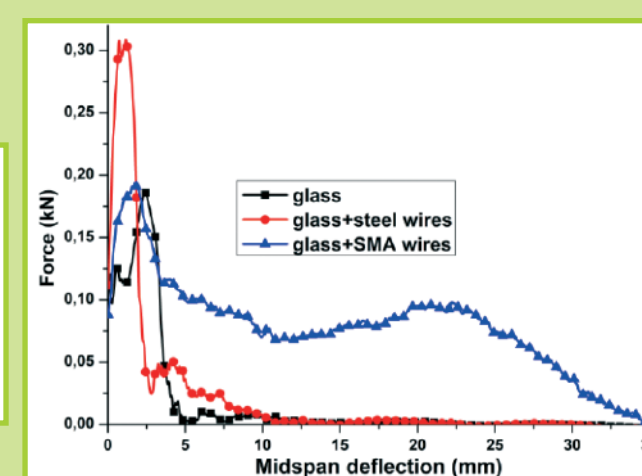
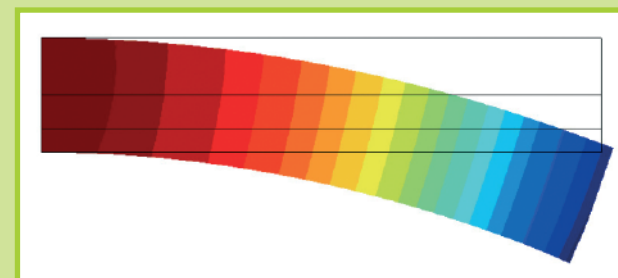
Load scheme



Tanaka constitutive law for SMA materials

$$\xi = \begin{cases} 1 & \text{for } T \leq A_s + \frac{|\sigma|}{C_A} \\ 1 - \frac{T - A_s + \frac{|\sigma|}{C_A}}{A_f - A_s + \frac{|\sigma|}{C_A}} & \text{for } A_s + \frac{|\sigma|}{C_A} < T < A_f + \frac{|\sigma|}{C_A} \\ 0 & \text{for } T \geq A_f + \frac{|\sigma|}{C_A} \end{cases}$$

Deformation of the actuator



Charpy flexural characterization of hybrid specimens

Development of numerical models for the simulation of ceramic components during sintering

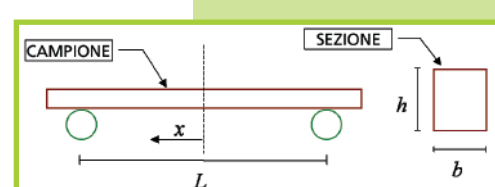
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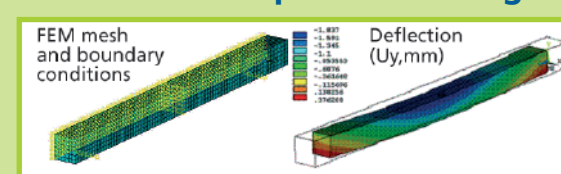
FE solver was used to simulate and visualize the system deformations during sintering. Some tools were developed to achieve better results: user subroutines to correctly represent the constitutive material law and macro to allow post-processing for mould design.

Perspectives

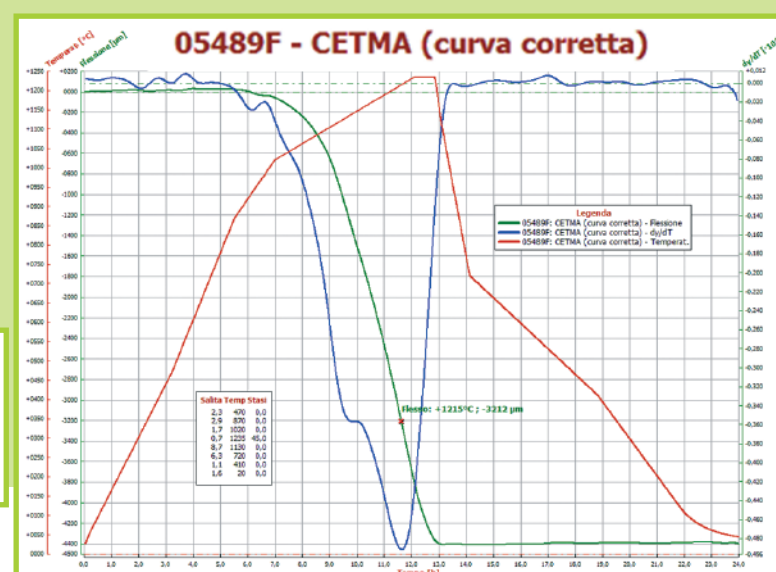
The next challenge is the integration of the Enea Grid Infrastructure with the CVRC using new FEM procedures allowing to achieve the scalability of our simulations on numerous processors.



Numerical model of the two points bending creep test



Experimental Characterization



Design of new ceramic shapes (washbasin) through numerical simulation

