

Linul

Program: Visiting Professor Program 2016-2017

Place: Dipartimento di Ingegneria Meccanica, Chimica e dei Materiali, University of Cagliari, Italy.

Period: 01.06.2017 – 01.07.2017

Visiting professor: Prof. Emanoil LINUL – Politehnica University of Timișoara, Faculty of Mechanical Engineering, Department of Mechanics and Strength of Materials, Timișoara, Romania

Project title: Vibration-based and Acoustic Techniques for Structural Damage Detection

Final Report

The visit was carried out in the framework of the **Visiting Professor Program 2016-2017 (long visit)** supported by **REGIONE SARDEGNA**. A brief report of the main activities performed during the visit is given in the following sections.

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Prof. Linul started his activity at the University of Cagliari on the 1st of June 2017. The first days were, however, dedicated to some bureaucratic issues as well as to give him a desk, keys, internet access, canteen card and so on.

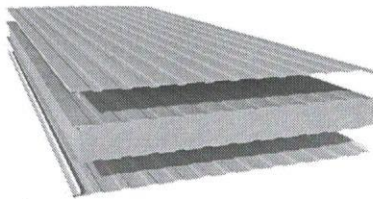
1. Research activities

Two preliminary meetings were held to illustrate the main research activities which are currently carried out at the Department of Mechanical, Chemical and Materials Engineering by prof. Maria Cristina Porcu and by Prof. Franco Aymerich. In particular, research activities on damage detection in composite materials and sandwich panels, health monitoring of structures, vibration-based and acoustic techniques for damage detection, seismic behavior of structures and seismic damage prevention were discussed. During following meetings the VP presented his research activity and the experimental tests that he is carrying out with Prof. Marsavina at the Politehnica University of Timisoara. The main topics of his researches are devoted to mechanical characterization of both cellular materials (such as metallic and polymeric foams) and advances lightweight composite sandwich beams with cellular material core. His work is focused also on different damage detection in sandwich specimens (face failure, core shear, indentation), and to construct the failure mode maps for each sandwich

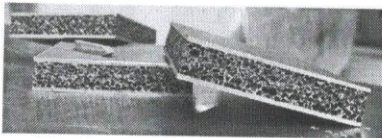
type. Fracture and failure, prediction of progressive damage evolution, debonding and failure/collapse including thermal effects were investigated also by Prof. Linul.

Damage detection is of primary importance for monitoring the behavior of structures. Mechanical properties, in fact, may degrade severely in presence of damage. In particular, strength and stiffness of composite materials may be strongly reduced in presence of matrix cracking, fiber breakage, fiber-matrix debonding or delamination. Health monitoring techniques for composite structures becomes, therefore, often essential. Both finite element analysis methods and experimental detection tools are usually adopted for this purpose. They are based on comparing dynamic response of damaged and undamaged structures.

On the other hand, the use of cellular materials (often inserted as core in sandwich structures), is increasing both in Mechanical and in Civil Engineering applications (see Figs. 1a and 1b). This is due to the good mechanical properties that cellular materials, such as metallic and polyurethane foams, may exhibit at low weight.



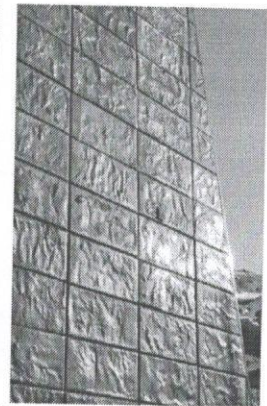
a) polyurethane foam panel



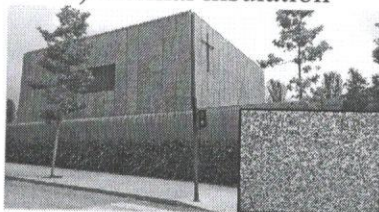
b) aluminum foam panel



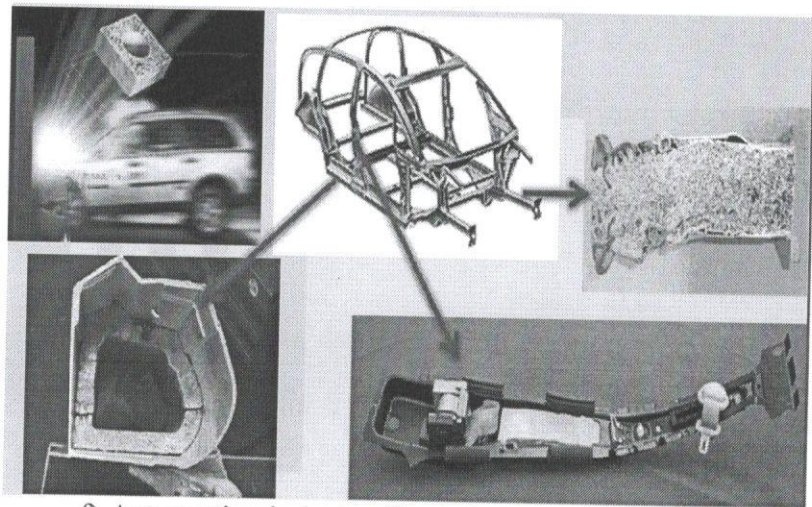
c) Facade protection using metallic foams



d) thermal insulation



e) thermal insulation



f) Automotive industry (foam impact applications)

Fig.1 Cellular Materials applications

They also have good acoustic or/and thermic isolation properties, as shown by Fig. 1c (aluminum foams as thermal protection), Fig. 1d (polyurethane foams as thermal isolator) and Fig. 1e (aluminum foams as thermal isolator). In addition they can exhibit high capacity of dissipate energy, see Fig. 1f (automotive industry).

Workshops and meetings were held with Prof. Linul during his visit to define a common research project to be developed in cooperation between the University of Cagliari and the Politehnica University of Timișoara. The following research aspects were examined:

- Damage detection in composite materials: methods and techniques
- Impact tests on sandwiches and composite materials
- Manufacturing of composite materials, sandwich materials (tubes filled with foams)
- Possibilities to measure the interface fracture in sandwich composites with foam cores
- Dynamic tests to determine some properties of materials (ductile behavior and dissipation of energy)
- Numerical models to assess the dissipative effects of the insertion of foam filled tubes into structures subjected to earthquakes, impact loads or blast actions.

2. Transfer of knowledge activities

A seminar was presented by Prof. Linul on 27th June 2017 devoted to Master and PhD students in Mechanical and Civil Engineering, to researchers and teaching staff. The Seminar was publicized in the "convegni" mailing list of UNICA and all the students of the courses of Dynamic of Structures and Seismic Dynamic of Structures taught by Prof. M. Cristina Porcu were also invited. The title of the Seminar was:

"Cellular materials in Mechanical and Civil Engineering: practical applications and experimental characterization".

At the end of the seminary, a workshop was done with students and teachers. The students were also informed about the Erasmus Agreement with the University of Timisoara and about the possibilities of developing their thesis work on the topics presented, by exploiting also the opportunity of applying for an Erasmus scholarship.

On the 28th of June a meeting with Prof. Maria Cristina Porcu, Prof Francesco Aymerich and the student Claudio Ghiani was organised. The student Claudio Ghiani is a Master Degree Student who has been assigned an Erasmus scholarship to spend two months in Timisoara. According to his supervisor Prof. M. Cristina Porcu, he is planning to go to

Timisoara to develop his Master Thesis working in the research group of Prof. Marsavina and Prof. Linul. The main features to be addressed in his thesis were discussed during the workshop.

3. Other activities

On the 6th of June, Prof. Linul was accompanied by Prof. Porcu to visit the Laboratories of the Department of Mechanical, Chemical and Material Engineering located in Monserrato. Under the guidance of Prof. Aymerich, Prof. Linul visited the Experimental Stress Analysis laboratory, Strength and Fatigue laboratory and the Composite Manufacturing and Testing laboratory in Monserrato. A workshop followed the visit.

On the 12th of June Prof. Porcu showed to Prof. Linul the Structural Dynamic Laboratory in piazza D'Armi. The activities of a Master Thesis student (William Sunda) who is currently developing his experimental thesis in the same laboratory were also presented.

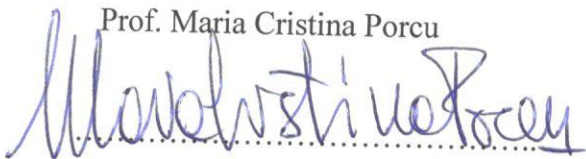
4. Future cooperation

During the visit, the future cooperation in teaching and research activities between the University of Cagliari and the Politecnica University of Timisoara was evaluated by Prof. Linul, Prof. Francesco Aymerich and Prof. Maria Cristina Porcu. For the teaching activities it was agreed to continue the Erasmus-Socrates exchange program which has been running for many years between the two universities. With the purpose of starting a stable program of research cooperation, an application for a FP7 Marie Curie IEF will be prepared by choosing the University of Cagliari as host for the research. The topic of the research proposal can be on the design and investigation of new advanced lightweight AFFT (aluminum foam filled tubes) damper for optimal seismic performance. The M-ERA.NET will be also evaluated as an alternative program for starting cooperation between University of Cagliari and Politecnica University of Timisoara.

Cagliari, 30.06.2017

For confirmation

Prof. Maria Cristina Porcu



Prof. Dr. Eng. Emanoil LINUL

POLITEHNICA University of Timisoara

