

International Research and Education in Engineering (IREE)

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ABSTRACT: The report will present the exchange of ideas and information between the University of South Carolina and two Universities in Italy. Both universities are active in the modeling of complex structures made of composite materials. The aim of the visit was to get acquainted with the research activities of these two laboratories and find space for future collaboration.

INTRODUCTION

The mechanical engineering department of the University of South Carolina has been awarded with the current NSF award. The laboratory of active material and smart structures (LAMSS) has studied the behavior of wave propagation in isotropic and anisotropic structures. The main focus of the research has been on understanding the interaction between the piezoelectric active wafer sensor (PWAS) installed on the structure and the host structure itself. In the case of composite structures the behavior of the wave excited is more complicated. The PWAS excites Lamb waves on the composite material that propagate with different phase velocities along different propagation directions. We have developed software able to predict the phase velocity of the wave excited on a composite plate. We have also studied the tuning frequencies of the transducer with the structure through normal mode expansion method.

Composite structures are used quite extensively on aircraft and aerospace structures. There is an increasing interest in the scientific community in the US and abroad to understand their behavior. The two major space agencies in the world (NASA and ESA) are funding universities for collaboration on this topic. By exchanging the outcomes of our researches we can improve our understanding of the complex behavior of composite structures.

Giola Santoni Bottai was hosted by the University of La Sapienza Rome and University of Pisa in Italy to present our recent development in this field and to learn about the research developed in these research centers. Her permanence was between June the 14th and August the 8th 2007.

RESEARCH ACTIVITIES AND ACCOMPLISHMENTS OF THE INTERNATIONAL COOPERATION

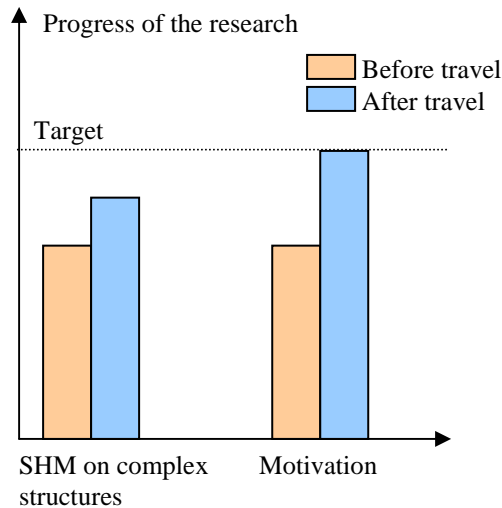
During the permanence in Italy, Bottai continued her research on wave propagation in composite structures and structural health monitoring (SHM) technique. The aim of the research was to gain deeper knowledge of the properties of composite structures and their modeling through exact solution and finite element modeling.

The laboratories visited in Italy have a deep knowledge of the composite structure behavior in fields that are related to the present research.

The university La Sapienza of Rome is developing finite element (FE) model of composite structures made of piezoelectric material and unidirectional laminate. The model is developed assuming the representative element a shell element with 9 nodes. The host laboratory had previous knowledge and experience on the integration of piezoelectric elements on a composite material structural for vibration control.

The research developed at the University of South Carolina is mainly on the theoretical behavior of the wave propagation. Through the cooperation between the two laboratories it is possible to derive a FE model of the wave propagation in anisotropic material with complex structures.

The university of Pisa research is focused on the structural behavior of the composite structure under static load or fatigue load. The aim of our research is to develop an integrated sensor system able to detect the presence of damage of a structure under different environmental and loading condition. In order to achieve this goal we must understand how the structures behave in these extreme conditions. The researchers at the University of Pisa have described their recent developments in the study of joint structures made of composite plates and metallic plates and we have discussed together the outcomes of their research.



BROADER IMPACTS OF THE INTERNATIONAL TRAVEL

The fundamental part of any kind of research is to let the research community know what your research is about and to shear with peer recent developments in the field of interest. It is important for a scholar to create connections in the scientific community for an easier exchange of ideas. In this way new collaboration among laboratories in different countries can be created.

The present project has given the possibility to get in contact the LAMSS laboratory in South Carolina with other two laboratories located in Italy. It has been possible not only to get involved in the research that was directly connected with the LAMSS research, but also to know what the other research interests of the host laboratories are.

During the visit to Italy, it was possible to get acquainted with a different teaching system and graduate study management. With the interaction with the students of the host structures it was possible to make comparison and discover way to improve the research activities both in the host structures and the laboratory in the USA. It has been also possible to experience how the interaction between the teacher and the student is different between the two countries.

The travel has given the opportunity to the University of South Carolina to be appreciated in a foreign country. Moreover, it has given the opportunity to seek future collaboration with the two laboratories in the composite material structural and acoustical behavior. The outcomes of the NSF project do not lies only in the single visit to the host structures, but more in ongoing interaction with the foreign laboratories and the creation of possible future collaboration with them.

DISCUSSION AND SUMMARY

The international research experience has given the possibility to broaden the knowledge of computational analysis of complex structures and to improve our knowledge on different kind of actuators and sensors that are currently under research in Italy. In particular the experience at La Sapienza has shown how the research on wave propagation on composite structure can benefit by the implementation of numerical solutions. Moreover, it has been possible to get acquainted with different codes such as ADINA and LS-DYNA not used in our laboratory.

ACKNOWLEDGEMENTS

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BRIEF BIOGRAPHIES OF RESEARCHERS

Giola Santoni Bottai is a US permanent resident. She received the B.S. degree in Aerospace Engineering at the University of Pisa, Italy, (5-year program), in 1999. She is a PhD candidate in the Dept. of Mechanical Engineering, University of South Carolina with research focus on fundamental studies of the Lamb-wave interaction between piezoelectric wafer active sensors and the host structure during structural health monitoring. After graduation, she worked in Italy for several Italian and US companies in the mechanical and aeronautical sectors, where she gained valuable and rewarding experience in applying the

skills developed during the undergraduate studies to solving real applications problems faced by engineers working in industry.