New launchers for analyzing resistance to impacts and improving armor plating

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New pneumatic launchers at the Impact on Aeronautical Structures

Laboratory, located at the Universidad Carlos III de Madrid Science Park, make it possible to carry out a wide range of studies on problems of impact that arise in the aeronautics industry and on optimum armor plating in other sectors.

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"Our goal is to design armor plating whose protective behavior is optimum," explains José Antonio Loya, head of the laboratory and researcher in the UC3M Department of Continuum Mechanics and Structural Analysis. "If an element is well designed, a collision should not produce any catastrophic damage, but if not, the impact of a piece could go through it like a knife through butter," he comments.

Models and Impact Tests

The studies that the researchers carry out help them better understand how structures respond to different kinds of impacts. At present, these studies entail reproducing computer models of the structures and analyzing what happens with certain impacts by using computer simulations. To validate the numerical models developed, it is necessary to produce impacts against real structural elements in the laboratory, under conditions similar to those when the elements are in use. Here is where the pneumatic launchers and high-speed cameras of the laboratory come into play, as they make it possible to examine every detail of the consequences that, for example, the collision of a slab of ice against a

piece of carbon fiber from an airplane fuselage has.

The laboratory has three launchers of different calibers. Of these, the smallest-caliber launcher can reach impact speeds of up to 1000 meters per second, which is 3,600 kilometers per hour, almost three times the speed of sound. The last launcher installed was built jointly with the company VTI (designated in Spanish as a " pyme," the initials which stand for the category of small or medium firm), located at the UC3M "Leganés Tecnológico" Science Park. This launcher has a caliber of 60mm and can fire objects up to 900 kilometers per hour, around the speed at which airliners make trans-Atlantic flights. The projectiles normally fired by this kind of device are spherical or cylindrical. This new system makes it possible to launch other kinds of geometrical objects: anything that weighs less than 250 grams and has a diameter that is smaller than the machine caliber can be used as a projectile. "What we do in those cases is to encapsulate our projectile with something the launching tube can be sealed with so that the gas propels it properly," explains Loya. This has allowed the launching of ice projectiles with prismatic geometry to simulate the impact of ice that has come off the blade of a propeller or the leading edge of a wing against the fuselage of an airplane.

This kind of work has numerous practical applications because there are many components that can be subjected to impacts, from the casing of a mobile telephone, which should resist blows when it falls to the ground, to solar panels, susceptible to the impact of hail. "There are industrial sectors which are interested in analyzing the energy that a structure is capable of absorbing during a collision, while in others, the focus is on how much an impacting fragment penetrates," explain the researchers. Their work can be applied to the transportation sector, as it can improve the features of motorcycle helmets, automobile windshields and fuselages of airplanes and trains, where speed converts any object into a projectile capable of perforation.

In addition to high-speed pneumatic launchers, the laboratory has other equipment that enables researchers to make a complete mechanical description of structural elements, at both low and high temperatures. The laboratory is concentrated on the study of light structures built mainly from compound materials, like those used in the aeronautics and aerospace industries. In studies recently published in the journals Composites: Part A and Composite Structures, for example, researchers from the laboratory have created analytical models that identify different mechanisms of energy absorption after an impact on carbon/epoxy laminations and sandwich-type materials, respectively, and which have satisfactorily reproduced the experimental results obtained.

R&D&I in Problems of Impact

Scientists use the laboratory facilities to carry out their research within the framework of national or international programs. Different researchers from the department produce their doctoral theses there. Moreover, a regular client is the aeronautics sector, where there are numerous companies that want to improve their designs to make them lighter and more resistant at a lower cost. An impossible goal? With R&D, they can find innovative solutions in this and other contexts. The fact that the laboratory is located in the business environment of the UC3M Science Park helps it meet the demands of several industrial sectors in addition to the aeronautics sector, where it enjoys prestige. In this regard, note the scientists, they can work as technical consultants for any company interested in analyzing different problems related to the mechanics of solids or impact resistance.

This new facility joins the group of applied R&D&I laboratories that have been established at the UC3M Science Park in recent years in the area of safety and for the aerospace sector, thanks to the boost from different competitive public tenders. With the goal of contributing to the improvement of the competitiveness of production and to social welfare,

the laboratories respond to the previous identification of the needs of different sectors and areas of innovation.

More information: Experimental analysis of normal and oblique high velocity impacts on carbon/epoxy tape laminates. Authors: Pernas-Sánchez, J. Artero-Guerrero, JA.; Varas, D. López-Puente, J. Journal: COMPOSITES PART A-APPLIED SCIENCE AND MANUFACTURING. Volume: 60. Pages: 24-3. May 2014. DOI: 10.1016/j.compositesa.2014.01.006

Analytical study of the low-velocity impact response of composite sandwich beams. Authors: Ivañez, I., Barbero, E., Sanchez-Saez, S. Journal: COMPOSITE STRUCTURES, Volume: 111. Pages: 459-467. May 2014.

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