Delivery Van's Battery Rack Design for Crash Safety, in Thermoplastic with Embedded Sort Fiberglass.

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To improve the performance of existing electric vehicles, research and development of new components is necessary, but not only limited to the issue of energy storage cells; the set of mechanical, electrical and electronic elements to be integrated also should be considered.

The OPerating RAck for Full Electric Vehicle Project - OPERA4FEV- is part of the Seventh Framework Programme of the European Commission and aims is the innovation in the design of a battery rack in plastic material, cheap, lightweight and versatile, able to achieve a easy integration between rigid prismatic batteries with power control components, the cooling system and the structure of the vehicle; becoming an alternative to current technology makes use of metallic materials. The OPERA4FEV project gives importance to the security conditions required for the on board batteries, rack evaluating conditions for the occurrence of crash situations and analyzing the potential risks for the vehicle and its occupants in the event of failure (breakage, explosion) of one or more batteries.

The Instituto Universitario de Investigación del Automóvil - INSIA, belonging to the Universidad Politécnica de Madrid, participated in the design tasks of the plastic components that are part of the battery rack and evaluated their resistance to mechanical stresses induced by acceleration and deceleration forces that occur in crash cases. It began with a prior design proposed by the French company MECAPLAST, project leader, from which a finite element model was created. For the material characterization, the data obtained in the tensile test specimens of thermoplastic pultruded fibreglass material, made by the Spanish group REPOL, were collected. Subsequently, the mathematical model for the material using the law of viscoelastic behavior of Johnson-Cook was formulated. EF model will acceleration forces applied to simulate crash conditions in three directions (x, y, z), following the guidelines of Regulation 100 r2 Annex 8C concerning mechanical impact tests for vehicle components with electric drive train (fig1).

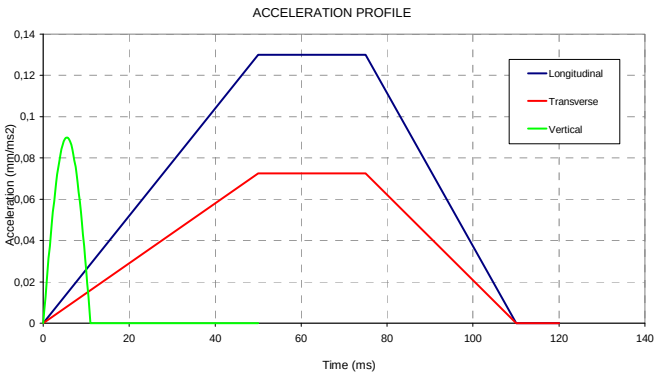
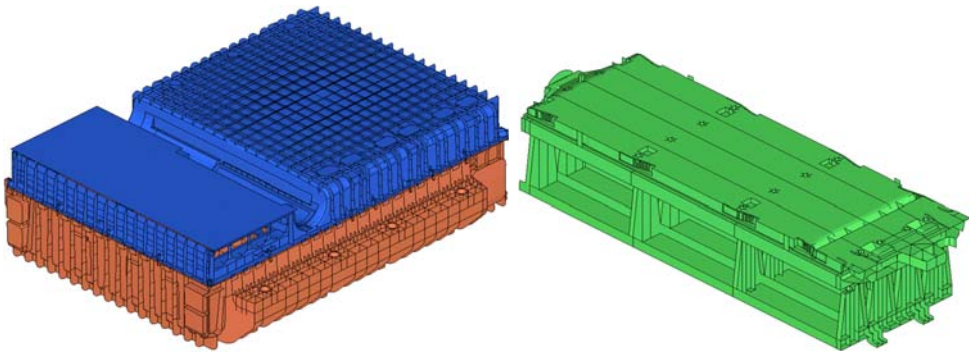


Figure 1 Crash test pulses.

The work results are more of 200 virtual testing, simulating the conditions of crash on a battery rack designed in a thermoplastic material reinforced with fiberglass, making a final finite element model corresponding to the OPERA4FEV project objectives. With the material under study, a 25% reduction in the battery rack weight relative to current technology, without affecting safety is achieved. Moreover, results were obtained that demonstrate the temperature influence on the mechanical behaviour of the rack, to decrease its maximum strength on 46% in longitudinal acceleration, and 26% in transverse case, when passing from a temperature of 20 ºC to 60 ºC. This is a relevant factor due to heating that occurs in the battery during operation.

As simulation results were obtained a process of iterative design was developed to searching a final product that achieved to accomplish the objectives of the project and ensure the safety condition to maintain confined the batteries inside the rack in case of a crash or fault occurs in one or more of them (Fig 2).



The crash tests are currently being prepared in the laboratory for testing real prototypes of the proposed rack, in order to perform validation of the finite element model created. It achieved validate the model, serial production of this type of rack is viable, and to be assembled into vehicles of category N2; and it gives the possibility to reduce approval times in plastic components of medium and large size, developed for electric vehicles in thermoplastic material with embedded fiberglass.