MECHANICAL ENGINEERING

MUR DM 117/Mollebalestra - Smart adaptive leaf springs for advanced digital vehicles

Funded By	MOLLEBALESTRA S.p.A. [P.iva/CF:07524810012] MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Politecnico di TORINO [P.iva/CF:00518460019]
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Context of the research activity	"Smart adaptive leaf springs for advanced digital vehicles" is an innovative project to improve the vehicle suspension system. By combining hybrid steel-composite leaf springs with embedded sensors and variable stiffness capabilities, it aims to enhance vehicle performance and safety. This breakthrough solution leverages advanced materials, data-driven insights, and cutting-edge technologies to provide superior load support, improved ride comfort, and reduced environmental impact. Progetto finanziato nell'ambito del PNRR - MUR DM 117/2023 - CUP E14D23002030004
	Research Field: The research field for this PhD position encompasses a unique blend of automotive engineering, materials science, and data-driven technologies. The project focuses on exploring the integration of hybrid steel-composite leaf springs with embedded sensors and variable stiffness capabilities. This multidisciplinary research field provides an excellent platform to investigate the interplay between advanced materials, intelligent systems, and sustainable transportation solutions. Research Objectives: The PhD candidate will work on cutting-edge research to achieve the following objectives: 1) Material Development: The successful candidate will conduct in-depth investigations into the mechanical properties and behavior of hybrid steel-composite leaf springs. This research aims to optimize the combination of materials to achieve a balance between durability, lightweight design, and enhanced load support characteristics. Through experimental testing and

Objectives	numerical simulations, novel composite materials will be developed to meet the demanding requirements of vehicle suspensions, including electric vehicles. 2) Sensor Integration: The PhD candidate will explore innovative techniques for embedding sensors within the composite leaf springs. This integration will enable real-time monitoring of performance parameters, such as strain, stress, and fatigue. By strategically placing sensors and developing robust calibration methods, the candidate will ensure accurate and reliable measurement of critical data, facilitating early detection of potential issues and supporting condition-based maintenance strategies. 3) Variable Stiffness Control: The project will investigate the integration of piezoelectric materials and shape memory alloys to introduce variable stiffness capabilities to the leaf springs. The candidate will explore the potential of these smart materials to dynamically adapt the suspension's stiffness in response to varying road conditions and vehicle dynamics. Through advanced control algorithms and system optimization, the objective is to enhance vehicle stability, ride comfort, and safety. 4) Data Analysis and Modeling: Data-driven methodologies will play a crucial role in this research. The candidate will leverage advanced data analysis techniques and develop mathematical models to interpret sensor data, identify patterns, and extract valuable insights. By combining experimental data with computational simulations, the candidate will gain a comprehensive understanding of the leaf springs' behavior and predict their performance under various operating conditions. Collaboration with Mollebalestra: The selected PhD candidate will have a unique opportunity to collaborate closely with Mollebalestra, a renowned suspension, leaf spring, and shock absorber manufacturer. This collaboration will offer invaluable industry insights, access to state-of-the-art facilities, and practical validation of the developed technologies. The candidate will have the privilege of working alongside experienced professionals from Mollebalestra, who will provide guidance, expertise, and real-world perspectives throughout the research journey. The collaboration with Mollebalestra will foster a deep understanding of the practical aspects of suspension system design, manufacturing processes, and market requirements. The candidate will have the chance to contribute directly to the development of innovative suspension solutions, aligning their research objectives with the industry's needs. This collaboration will not only enhance the candidate's academic experience but also provide a solid foundation for future career opportunities in the automotive industry. The PhD candidate will be enrolled in the prestigious research program of Politecnico di Torino, renowned for its excellence in engineering research and education. They will have access to outstanding research facilities, a supportive academic community, and a vibrant research environment. The candidate will work under the supervision of experienced researchers and have the opportunity to present their findings at international conferences and publish in high-impact scientific journals.

Skills and competencies for the development of the activity	Candidates with a strong academic background in mechanical/aerospace engineering, materials science, or a related field are preferred. Knowledge and experience in composite materials, sensors, control systems, and data analysis will be advantageous. The candidate should demonstrate excellent analytical and problem-solving skills, a passion for research, and the ability to work both independently and collaboratively.