

CIVIL AND ENVIRONMENTAL ENGINEERING

DISEG/DISAT/UniTrento - Design and optimization of metamaterials for underwater acoustic applications in the presence of fluid–structure interaction

Funded By	Dipartimento DISAT UNIVERSITA' STUDI TRENTO [P.iva/CF:00340520220] Dipartimento DISEG
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Context of the research activity	Structural Mechanics, Fluid–Structure Interaction.
Objectives	<p>Metamaterials represent a class of engineered systems in which physical properties emerge primarily from geometric configuration and structural organization, rather than from the intrinsic nature of the constituent materials alone. In recent years, these concepts have found increasing application in the control of elastic and acoustic wave propagation, opening new perspectives for devices and structures operating in complex environments, including underwater settings.</p> <p>The underwater environment introduces specific challenges related to the strong interaction between the fluid medium and the solid structure, particularly due to the high density and relative incompressibility of the fluid. This fluid–structure interaction significantly alters the dynamic response of the system, affecting wave transmission, resonance mechanisms, and the effectiveness of acoustic attenuation strategies. Understanding and exploiting these effects is therefore essential for the design of functional metamaterials in underwater acoustics.</p> <p>Within this context, the present PhD research aims to develop and analyze metamaterials coupled with heavy fluids, with a particular focus on the control and optimization of acoustic performance. The research will involve the modeling and optimization of periodic and/or complex structures in order to modulate the propagation of acoustic and elastodynamic waves through mechanisms such as band gaps, local resonances, and fluid–structure coupling. The ultimate goal is to provide general design criteria and analytical tools for metamaterials operating in underwater environments, contributing to the development of advanced solutions for noise control, vibro-acoustic isolation, and wave management in immersed systems.</p>

Skills and competencies for the development of the activity

- Structural Mechanics
- Fluid–Structure Interaction
- Topological Optimization
- Periodic Structures and Wave Propagation