Constrained Layer Damping (CLD) Treatments for Underwater Noise Reduction of Ship Structures

F Cui[1], C Cai[2], *H Zheng[3]

[1]Institute of High Performance Computing, A*STAR, Singapore
[2]BW Offshore Singapore Pte Ltd, Singapore
[3]Institute of Vibration, Shock & Noise, School of Mechanical Engineering
State Key Laboratory of Mechanical System and Vibration, Shanghai Jiaotong University

*Corresponding author: huizheng@sjtu.edu.cn

The optimization of passive/active constrained layer damping (CLD) treatments are performed for ship structures with the aim of reducing the acoustic radiation from underwater structures at a cost of the lowest additive weight to the host structure and the most economical control effort required by the active constraining layer. An efficient modeling and simulation methodology is developed for the structures with frequency-dependent CLD patches using existing finite element methods for uncoupled structural vibration analysis and the boundary element analysis for vibro-acoustics calculations. The optimal passive CLD configurations are then searched using modern optimization algorithms for maximizing the modal loss factors of the CLD-treated structure. The control voltages to be applied to the PZT constraining layer of the corresponding active CLD patches are minimized under different dynamical loads applied onto the structure with consideration of the power consumptions owing to the active control. The technical challenges in implementing the CLD patch optimization for optimal noise reduction of underwater structures, such as the finite element modeling of passive/active CLD patches, maximizing the modal loss factors of multiple modes, optimal sensor locations for observing the acoustic radiation from the structure, etc., are discussed in detail,

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