Modelling the Impact of Defects in Noise Reduction Treatments Applied to Underwater Structures

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Abstract:
Acoustically compliant materials can be used to reduce the noise radiated by underwater structures, by decoupling vibrating surfaces from the surrounding fluid. Such materials are characterised by their mechanical decoupling factor, which gives the reduction in normal surface vibration across the material when it is fluid-loaded. Whilst this parameter provides a means of comparing the performance of different materials, it can be misleading to assume that the radiated noise levels of a real structure will be reduced by the same amount, as it is often impossible to cover them completely. Exposed vibrating surfaces may radiate more strongly than the surrounding acoustically coated regions and could contribute significantly to overall noise levels, particularly if the mechanical decoupling factor of the coating is high. Defects in noise reduction treatments could arise if for example the acoustic coating is applied in tile form, when there will be gaps between the tiles, or if there are constraints that prevent treatments being applied to some areas of the structure leading to exposed surfaces. The impact of such cladding defects is dependent upon their acoustic size, the local impedance of the surrounding area, and the effectiveness of the acoustic coating. Here a theoretical model is presented for a first order approximation to estimating the impact of such defects. By way of example, an infinite elastic layer is considered which is subject to mechanical forcing. Bonded to this layer is a compliant acoustic coating whose outermost surface is exposed to an unbounded fluid medium. The far-field radiated noise is calculated for an entirely clad system and for one in which an acoustically small region of the forced layer is exposed to the fluid. In calculating the impact of the exposed region, it is assumed that the vibration level is prescribed, that is, it is unchanged by exposure to the fluid. The change in radiated noise level is calculated for two extreme local boundary conditions: a fluid filled cavity within a pressure release material, and a fluid filled cavity within a rigid material. In both case the base of the cavity vibrates at the prescribed level.