HYDRODYNAMIC INTERACTIONS OF THE TRUNCATED POROUS VERTICAL CIRCULAR CYLINDER WITH WATER WAVES

Charaf Ouled Housseine
Research Department
Bureau Veritas Marine and Offshore
8, Cours du Triangle
Paris La Defense, France

Sime Malenica
Research Department
Bureau Veritas Marine and Offshore
8, Cours du Triangle
Paris La Defense, France

Guillaume De Hauteclocque
Research Department
Bureau Veritas Marine and Offshore
8, Cours du Triangle
Paris La Defense, France

Xiao-Bo Chen
Deepwater Technology Research Centre
Bureau Veritas
Singapore

ABSTRACT
Wave diffraction-radiation by a porous body is investigated here. Linear potential flow theory is used and the associated Boundary Value Problem (BVP) is formulated in frequency domain within a linear porosity condition. First, a semi-analytical solution for a truncated porous circular cylinder is developed using the dedicated eigenfunction expansion method. Then the general case of wave diffraction-radiation by a porous body with an arbitrary shape is discussed and solved through Boundary Integral Equation Method (BIEM).

The main goal of these developments is to adapt the existing diffraction-radiation code (HYDROSTAR) for that type of applications. Thus the present study of the porous cylinder consists a validation work of (BIEM) numerical implementation. Excellent agreement between analytical and numerical results is observed. Porosity influence on wave exciting forces, added mass and damping is also investigated.

NOMENCLATURE
For mathematical consistency, vectors are noted in bold characters, matrix between \([\ ]\) and modal coefficient vectors between \(\{\}\).\(T\) denotes the matrix/vector transpose, \(\Re\) the real part and \(\Im\) the imaginary part. \((\mathbf{e}_x, \mathbf{e}_y, \mathbf{e}_z)\) is the Cartesian coordinate system and \((\mathbf{e}_r, \mathbf{e}_\theta, \mathbf{e}_z)\) the cylindrical one.

\(g\) is the gravity, \(h\) the water depth, \(\rho\) the fluid density, \(\omega\) the wave frequency, \(\nu = \frac{\omega^2}{g}\) the infinite-depth wave number and \(\mathbf{n}\) the normal vector pointing out of the fluid domain. The subscript \(n\) is used for normal derivative. \((\mathcal{D})\) denotes the fluid domain, \((S)\) the body surface, \((S_F)\) the free surface and \((S_H)\) the seabed.

Finally, assuming time periodic variation, the complex notation is used with the following convention: for a harmonic function \(f\) whose the time domain variation is described by \(f(t) = F_0 \cos(\omega t - \alpha)\), we note: \(f(t) = \Re(F_0 e^{-i\omega t})\) with \(F = F_0 e^{i\alpha}\).

INTRODUCTION
It happens quite often in practice that the parts of the floating bodies are partially transparent or porous (locally porous}