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Angular spectrum modelling of longitudinal guided wave propagation in a embedded cylinder - Application to the non-destructive evaluation of grouted tendons

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Steel members of civil engineering structures undergo degradations due to corrosion and mechanical fatigue mainly, which can lead to its ruin in a long term. Hence, non-destructive inspection techniques are needed to monitor these structures. In this study, we are more particularly interested in non-destructive evaluation of bridge post-tensioned tendons using longitudinal mechanical guided waves. As by construction, the tendons have a single access to their ends (tendons are embedded over their whole lengths), the use of the guided propagation can have some advantages to inspect a given length from this single point (reflectometry technique). Nevertheless, the conditions of propagation in a waveguide (the tendon) are strongly influenced by its geometry and the embedding material. In order to propose an adapted non-destructive evaluation methodology, a model of propagation is studied. This work is focused on the determination of the exact solution of a cylindrical waves beam propagation, limited in time and space, inside a solid concentric cylinder embedded in a vacuum, liquid or solid (the steel tendon will be considered as a cylinder of same diameter). The model is based on the angular spectrum method and a Fourier-Bessel analysis to predict the spatio-temporal elastodynamic fields. Two types of approaches are then possible. A local analysis which describes the solutions as a partial waves series (Debye's series expansion) for the reflection/refraction of cylindrical waves at the steel/grout interface and thus allows an immediate physical interpretation. A global resolution which presents a condensed mathematical form of the above-mentioned local analysis.

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