THE ROLE OF BOUNDARY CONDITIONS IN THE INSTABILITY OF ONE DIMENSIONAL FLUID-STRUCTURE INTERACTION SYSTEMS

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The instability properties of one-dimensionnal fluid-structure interaction systems are investigated. These systems are described by a local wave equation, a finite length and boundary conditions. Local stability refers to the stability of waves propagating in infinite length media while global stability refers to the stability of finite length systems. Unstable waves are often the main reason of the instability of finite length systems, but recently, it has been shown that global instability is possible despite local stability [1]. The phenomenon has been attributed to over-reflecting boundary conditions. The understand the role of wave reflections at boundary conditions in the global instability, we introduce a gain matrix,

$$G = R^{+}P^{+}R^{-}P^{-}. \tag{1}$$

This matrix allows to write the amplification process of waves at a given frequency as a back and forth travel involving propagations(P) and reflections(R) upstream(-) and downstream(+). The analysis of the eigenvalues and eigenvectors of this matrix allows to compute the eigenmodes and eigenfrequencies of any system. It is then possibile to determine the driver of the instability, wave propagations or wave reflections. Different systems that exhibit different behaviors are then presented.

References

[1] O. Doaré and E. de Langre, Local and global instability of fluid-conveying pipes on elastic foundations, Journal of Fluids and Structures, 16(1), 1-14.
[2] O. Doaré and E. de Langre, The role of boundary conditions in the instability of one-dimensional systems, European Journal of Mechanics B/Fluids, in press.