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SQUEEZE UNDER IMPACT IN EXPOROHYDRODYNAMIC CONDITIONS FOR A FINITE WIDTH CIRCULAR DAMPER

BY

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Abstract: Squeeze film dampers are widely used technical components for turbomachinery as a means to cut down the amplitude of rotor vibration. The present paper proposes a different type of circular dampers using highly compressible porous layers (HCPL) imbibed with Newtonian liquids. The bearing characteristics are obtained by solving numerically the thin film equations adapted to porous layers using the finite volume method. In the particular case of a short circular damper, the numerical results are in good agreement with a combined analytical and numerical solution.

Keywords: hydrodymanic lubrication, exporohydrodynamic lubrication, circular damper, numerical methods, squeeze effect

1. Introduction

Squeeze film dampers are widely used technical components for turbomachinery as a means to cut down the amplitude of rotor vibration [1]. However, during the last 10–15 years, a new lubrication mechanism applicable to highly compressible porous layers imbibed with fluids (HCPL) acting as self-sustained films has been developed [2–6]. This new type of lubrication requires that the normal forces generated by elastic compression of the fibres comprising the solid phase are negligible compared to the pressure forces generated in the imbibed fluid, within the porous layer.

This paper proposes a different type of circular dampers using highly compressible porous layers (HCPL) imbibed with Newtonian liquids. A related recent study of impact process in ex-poro-hydrodynamic (XPHD) conditions was performed for narrow squeeze film dampers [7].

2. Theoretical model

A schematic of the XPHD squeeze film damper is presented in Figure 1.

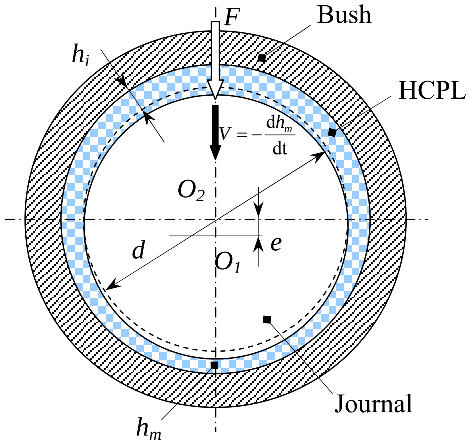

Figure 1. Schematic of the XPHD squeeze film damper

Assumptions applied in previous papers will be considered for the present study:

1. The liquid is Newtonian and the flow in the porous layer is laminar and isothermal/isoviscous.
2. The elastic forces of HCPL are negligible compared to the generated hydrodynamic forces.
3. The pressure across the HCPL thickness is constant.
4. The local deformation is present only on the normal direction of the porous layer. The solid mass is conserved throughout the process of layer deformation. For the sake of clarity the term of *local compacticity*, σ, is introduced, i.e. the instantaneous solid fraction. Consequently, the compacticity is related to porosity, ε, $\sigma = 1 - \varepsilon$. This assumption was accepted in all the papers on XPHD lubrication:

$$\sigma h = \sigma_i h_i = \sigma_0 h_0 \tag{1}$$

where σ_0 and h_0 are the uncompressed compacticity (solid fraction) and layer thickness.