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# ISCM2019-Keynote Lectures

## Effects of attached blade cavitation on the natural frequencies of a Francis runner

## (invited lecture)

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**ABSTRACT**

To have a safe structural design, the natural frequencies of the runner considering the added mass effects of surrounding water must be correctly predicted during design phase. This is necessary to avoid resonance conditions excited by the unsteady flow conditions. The pressure fluctuations can provoke a catastrophic failure if they are tuned with a runner natural frequency or they can accelerate the fatigue damage if they are close to a natural frequency with low damping. However, it is very probable that large-scale forms of attached cavitation appear on the runner blades with different dimensions and locations specially at off-design operation. Consequently, it is expected that the presence of vapor pockets surrounding the runner may change the predicted added mass effects if only a fully liquid domain has been considered. To elucidated such hypothesis, a numerical investigation of the modal response of a Francis runner has been carried out taking into account the presence of different types of suction side runner blade cavitation. This fluid-structure interaction (FSI) problem has been modelled with acoustic-structural coupling. The calculated added mass effects for both leading edge and trailing edge cavitation forms have been compared with those corresponding to the pure water condition without cavitation. Firstly, a single blade has been investigated and the influence of cavitation on the natural frequencies has been demonstrated and evaluated. Based on these results, the entire runner geometry has been considered with similar cavity shapes and locations. The results show that the natural frequencies of the runner's first modes of vibration are increased when cavitation exists. Moreover, the frequency increase depends on the cavity size, its location and the particular mode shape of the runner being affected.