Fluid-conveying pipes have a rich history in the study of dynamics. Everyday experiences, such as holding a fire hose or observing the snaking motions of a garden hose, demonstrate phenomena related to pipe dynamics. These phenomena, known as fire-hose instability and garden-hose instability, respectively, are widely recognized. However, the study of pipe dynamics has expanded beyond these specific instabilities and has become a prominent model problem in the field of structural dynamics and stability. This is primarily due to the widespread industrial utilization of pipe systems.

(a) *(b)*

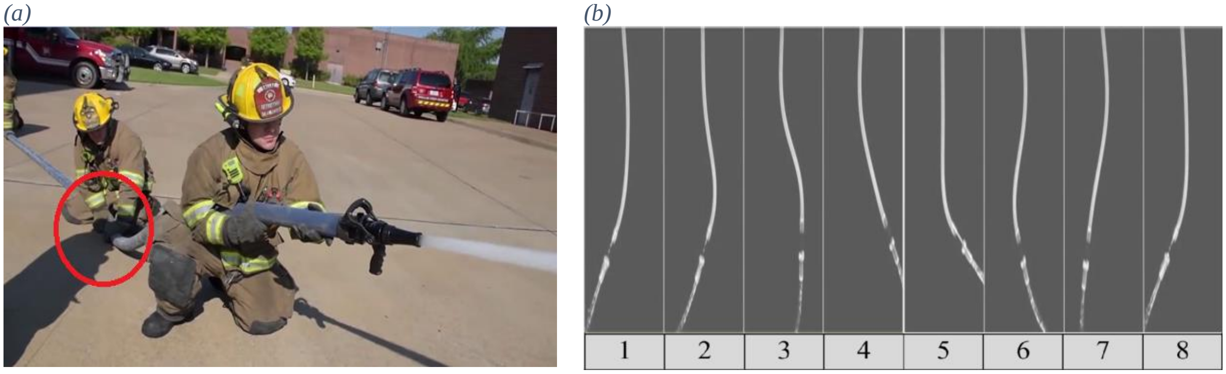

Fig. 1. buckling instability of a pipe (a); flutter instability of a cantilevered pipe (b)

The study of rotordynamics has a long history, dating back to Rankine's exploration of whirling motions in a rotor in 1869. Critical speeds, which induce resonance responses, are significant in rotordynamics. These speeds cause substantial transverse amplitude motion in the rotor when the excitation frequency aligns with a natural frequency. Fig. 2 provides a visualization of the critical speeds for the first and second modes. Researchers and designers strive to accurately predict these critical speeds, as they are crucial in rotor analysis. Furthermore, rotors can exhibit complex dynamics, including multi-periodic or aperiodic motion, which results in high vibration loads and fatigue risks for the components. Consequently, there has been significant research interest in studying rotor dynamics.

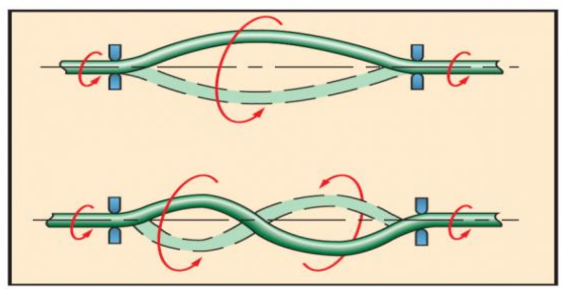

Fig 2. the critical speeds for the first and second modes

Specific techniques are employed in the analysis of flow-induced vibrations in pipes, specifically tailored for this area of study. These traditional technique primarily concentrate on examining the vibration behavior of pipes influenced by fluid flow velocity excitation. However, in the case of spinning pipes, additional forces such as the gyroscopic effect and rotary inertia become crucial factors that interact with the effects induced by fluid flow. These additional forces introduce complexity into the system's dynamics, requiring specialized techniques to accurately comprehend and analyze the interaction between the effects induced by the fluid and the rotational motion of the pipe.

The project aims to analyze rotating pipes using principles from fluid-structure interaction (FSI) and rotordynamics. This interdisciplinary approach uncovers complex dynamics and offers valuable insights. By developing a mathematical model, the study investigates how fluid flow and rotation impact pipe stability and dynamics.

The rotating pipe carrying fluid is a unique configuration combining fluid flow and pipe rotation. This interaction adds complexity and leads to interesting dynamic behaviors. Studying these dynamics provides valuable insights into the system's characteristics.