Modelling cavitation erosion using Smoothed Particle Hydrodynamics

Shrey Joshi

Supervisors: Marc Fivel, Jean-Pierre FRANC, Giovanni GHIGLIOTTI

Friday, November 9th November, 10:00 am
Amphi K 118, LEGI, 1209 Rue de la Piscine (campus universitaire).

The jury is comprised of:
Monsieur Arjen ROOS, Ingénieur de Recherche HDR, Safran Tec, Rapporteur
Monsieur Stéphane AUBERT, Professeur des Universités, École Centrale de Lyon, Rapporteur
Monsieur Rickard BENSOW, Professeur des Universités, Chalmers University, examinateur
Madame Magdalena NEUHAUSER, Ingénieure, Andritz Hydro AG, Examinateur

Abstract: The thesis is focused on development of a Smoothed Particle Hydrodynamics (SPH) Fluid-Structure Interaction (FSI) cavitation solver to investigate the phenomenon of material deformation under cavitation load. The fluid model is developed using an open source SPH code SPHYSICS_2D and the code is changed from 2D to 2D axisymmetric. The solid SPH model is developed in-house in 2D axisymmetric with a novel scheme to solve typical issues near symmetry axis. The solid model has the capability to solve for non-linear isotropic hardening with strain rate effects (commonly known as Johnson-Cook plasticity model). Various cases for detached and attached cavities are simulated using the FSI solver, the results indicate the ability of detached cavity to cause more damage compared to the attached cavities. An important and novel finding in the present study is the response of the material for a detached cavity where plastic deformation does not occur at the center of collapse but at an offset from the center, an in depth analysis has been presented in the thesis which shows that the offset occurs due to inertial effects in the material. An over prediction of the magnitude of plastic strain of around 60% for detached cavities is observed and around 200% for attached cavities observed when not using strain rate sensitive models for the solid, this indicates that importance of strain rate sensitivity in cavitation simulations.