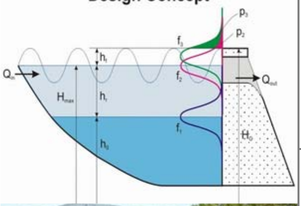
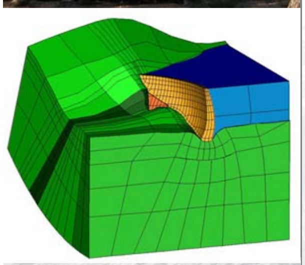
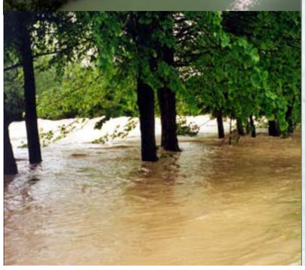
Design Concept







Master Thesis

Large-eddy simulation of turbulent pipe flow with Runge-kutta Projection Method

Turbulence modeling is one of the main challenges in Computational Fluid Dynamics (CFD). The governing equation of fluid flow or Navier-Stokes equations can be solved numerically without any turbulence modelling. However, the computational costs of these type of simulations are significantly large due to the large number of elements numbers and small time steps. Therefore it is necessary to model the effects of turbulence on the flow instead of resolving the whole range of spatial and temporal scales of the turbulence.

In the past, turbulence models based on Reynolds-Averaged Navier-Stokes (RANS) equations were used, however, due to significant increase of computational power, Large-Eddy simulations (LES) are gaining attention in the hydraulic research community. The idea behind this type of modelling is to resolve eddies larger than the grid size and model the smaller, isotopic ones with subgrid models.

In LES, the minimum order of accuracy in time and space is second-order. However, in a LES simulation, it is desirable to employ a numerical schemes with higher accuracy particularly for temporal discretization. In a standard OpenFOAM package, higher order time discretization is not available. On the other hand, for an accurate LES, this type of numerical algorithm seems necessary.

The aim of the Thesis is to implement fourth-order Runge-Kutta (RK4) technique along with Chorin's Projection Method to improve the current incompressible solvers in OpenFOAM. Student will implement RK4 along with Projection method in OpenFOAM. Then the implemented algorithm will be compared with the standard OpenFOAM solvers (e.g. PISO) as well as Direct Numerical Simulation (DNS) data for different Reynolds Numbers (Re=44000, 24580 and 5300).

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