EXTENSION OF A 3D FINITE ELEMENT / SPECTRAL UNSTEADY INCOMPRESSIBLE NAVIER-STOKES SOLVER FOR LES APPLICATIONS

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An extension of the FEM/spectral code for unsteady incompressible viscous flow developed by D. Snyder has been performed. The new code's features consist in the capability to handle arbitrary axisymmetric geometries.

The code is based upon finite element discretization of the unsteady Navier-Stokes equations with a LES model for turbulence.

The development of the code has been achieved in two steps:

1. an extension of the 2D solver from cartesian coordinates to cylindrical coordinates. In order to get familiar with the cylindrical coordinates facing a simpler problem, the work on the code started from the 2D solver.
2. a fitting of blocks and subroutines written for the 2D solver into the 3D code. An adjustment of some parts of the code to the new kind of coordinates was necessary.

The equations are descritized using a Petrov/Galerkin FEM. A SUPG stabilizing technique is applied in order to eliminate the spurious oscillations in the case of convection-dominated flows, and a PSPG technique is used to allow to the solution to be free from the pressure spurious oscillations that arises due to the fact that same order functions of representation are used for the velocity and the pressure.

Two formulations of Navier-Stokes equations has been implemented:

- **conservative** formulation
- **non-conservative** formulation

Since, it has been made prevision for to code a skew symmetric formulation, more suitable for LES applications.