FDLV104 - Computation of added mass on modele generalized 3D

Summarized:

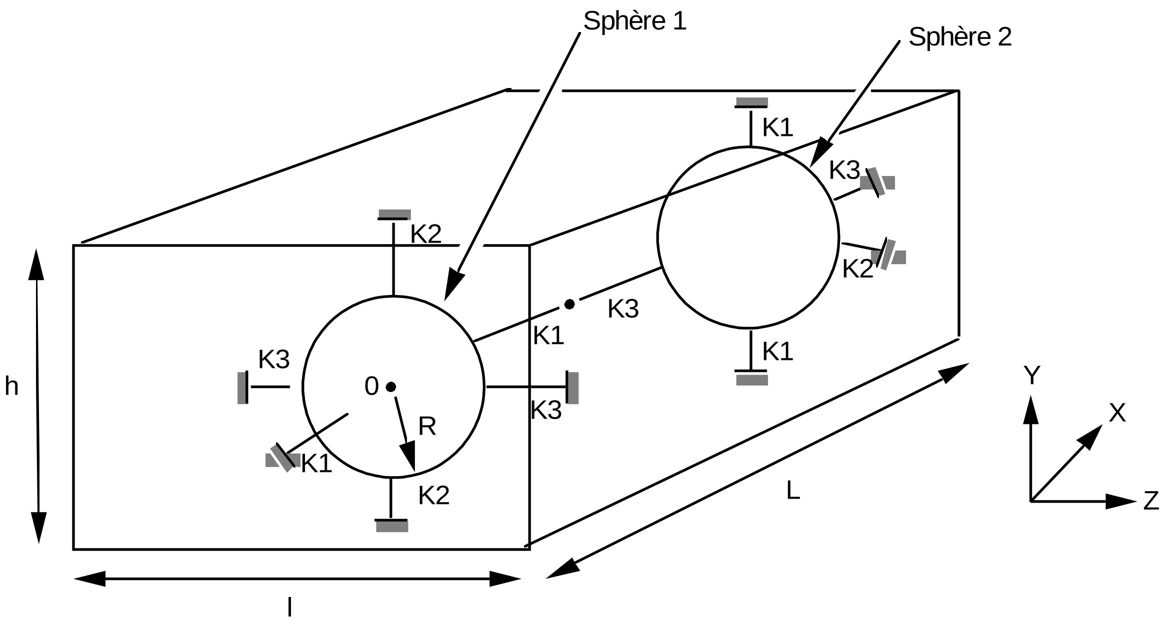
This test of the field of the fluids (fluid coupling/structure) 3D validates the computation of added mass on one modele generalized of type, namely two spheres coupled by an incompressible fluid.

By a modal analysis carried out by dynamic substructuring, one obtains the coupled modes of the two spheres because of the presence of the fluid. The eigenfrequencies are compared with those determined by a direct computation.

One obtains the eigenfrequencies with a margin of less than 3%.

1 Problem of reference

1.1 Geometry



Length:	$L=4\,m$
width:	$l=2\,m$
height:	$h=2\,m$
Thickness of the shells:	$e=10^{-3}\,m$
Radius of the spheres:	$R=0.5\,m$

1.2 Properties of the materials

Structure: steel - elastic material

$E=2.10^{11}\,Pa$
$\nu=0.3$
$\rho_s=7800\,kg/m^3$

springs have as a respective stiffness:

$K1=10^6\,N/m$ $K2=10^5\,N/m$ $K3=10^7\,N/m$

Fluid: water - thermal material are equivalent

$\lambda=1.$
the specific heat plays the part of density of the fluid: $\rho_f=1000\,kg/m^3$

1.3 Boundary conditions and loadings

Side structure: the degrees of freedom of rotation DRX DRY, DRZ sphere 1 are blocked:

```
DRX: 0.0DRY      : 0.0DRZ     : 0.0
```

fluid Side: one null imposes a pressure (i.e temperature) in a node of the fluid mesh. Reference solution

2 Method of calculating

2.1 used for the reference solution One

uses a direct modal computation to obtain the eigenfrequencies modified by the fluid around the spheres.

The two spheres result by a translation from vector from components and $(2,0.,0.)$ for a rotation from nautical analyses what $(90.,0.,90.)$ makes it possible to plan to build one modele generalized on the 1st sphere. One will be able to carry out same modal computation with fluid coupling/structure by means of the dynamic substructuring. The computation direct **with** taking into account of added mass led to the following eigenfrequencies of the immersed system: Results

$$
\begin{aligned}
f_1 &= 3.1172\,Hz\\
f_2 &= 3.1183\,Hz\\
f_3 &= 9.2727\,Hz\\
f_4 &= 9.8267\,Hz\\
f_5 &= 22.4400\,Hz\\
f_6 &= 30.3295\,Hz
\end{aligned}
$$

2.2 of reference direct

Modal computation by Code_Aster . *Uncertainty*

2.3 on the solution

uncertainties on the solution are related on the discretization of the fluid interface/structure and to invariance of the mesh by rotation of nautical angles. $(90°,0°,90°)$ Modelization

3 A Characteristic

3.1 of the modelization The modelization

understands: side

structure: 336

shell elements DKT `modelling` the sphere 1,6
discrete elements of the type K_TR_L `(modelization` DIS_TR `) modelling` six springs connecting sphere 1 to the solid mass, fluid

side: 672

THER `_FACE3 elements` thermal modelling the fluid interface/structure, 39.445
THER `_TETRA4 elements` thermal modelling the fluid. Characteristics

3.2 of the mesh Number of meshes

and types: 672 meshes TRIA3, 39.445 TETRA4, 6 SEG2 Values

3.3 tested Identification

Reference	Hz **Mode**
n°1 3.1172	Mode
n°2 3.1183	Mode
n°3 9.2727	Mode
n°4 9.8267	Mode
n°5 22.4400	Mode
n°6 30.3295	Remarks

3.4

the variation on the two last eigenfrequencies is explained by a NON-symmetry of the mesh of the fluid interface/structure (thermal) compared to that of the first. The mesh **from** the fluid interface/structure (thermal elements) of the second sphere does not result exactly from that from the first by rotation from nautical angles from. $90°, 0°, 90°$ Summary

4 of the results

the results got by computation by dynamic substructuring show a perfect agreement with direct computation. Nevertheless, to have this agreement, it should be taken care that the meshes of the interfaces fluid/structure (thermal elements) of the substructures which are repeated inside the fluid mesh deduce perfectly by rotations of nautical angle defined in DEFI `_MODELE_GENE.`