Operator CALC_IFS_DNL

1 Goal

The object of this order is to allow the calculations fluid-structures coupled in non-linear transitory mode. For that, one comes to couple *Code_Aster*, for the structure part, with *Code_Saturne*, for the fluid field, *via* supervisor YACS of Salomé.

The method of coupling is of type partitionné Neuman-Dirichlet. To solve the problem structure, one bases oneself on the operator DYNA_NON_LINE, of which one very largely takes again syntax.

Contents

2 Syntax

Syntax specific to the YEWS:

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♦  PAS_INIT          =     pdtinit                [R]
♦  GROUP_MA_IFS      =    lgrmaifs,               [l_gr_maille]
♦  NOM_CMP_IFS       =    lcompifs,               [l_Kn]
◊  UNITE_NOEUD       =     /   ulnoeud,           [I]
                           /   81,                [DEFECT]
◊  UNITE_ELEM        =     /   ulelem,            [I]
                           /   82,                [DEFECT]

)
```

3 Principle of operation

The method of coupling is of type partitionné Neuman-Dirichlet. To solve the problem structure, one bases oneself on the operator DYNA_NON_LINE of *Code_Aster.* The fluid field will be solved with *Code_Saturne*. The grids with the interface not being obligatorily in conformity, it is necessary to use an operator of projection of fields: one has chooses to use PROJ_CHAMP. Who will manage all the stages of projection (*Code_Saturne* will have thus no projection to make in-house).

One can summarize the algorithm of coupling as follows:
with each step of time, *Code_Aster* send displacement and speed calculated to *Code_Saturne* , which from of deduced a deformation from the fluid grid and solves the fluid problem top (of description ALE). The efforts fluid with the walls are then sent towards *Code_Aster* who can then solve the new problem structure on a step.

In this simple form the algorithm is explicit and that imposes a step of small enough time for reasons of conditional stability [R5.05.05]. In practice it is not inevitably very penalizing because the resolution of the fluid problem often claims a step of rather small time.
It is possible to define a implicitée version of the method of coupling. It is enough, at each step of time to introduce an iterative process of type not fixes. That makes it possible to use a step of larger time, but with a overcost of calculation related to the iterations of fixed point.

All the data exchanged (they are scalar or vectorial) between the two computer codes pass by calls YACS. The use of the coupling YEWS thus passes obligatorily through Salomé who will control the two codes: *Code_Aster* and *Code_Saturne*. One cannot thus carry out this kind of calculation by classically using the interfaces of launching of *Code_Aster* : astk or as_run.
This documentation is restricted to describe the use with the direction *Code_Aster* only.

The resolution of the structure part is done thanks to the operator DYNA_NON_LINE, which explains why the syntax of CALC_IFS_DNL maybe in very great identical part. One thus re-examines with U4.53.01 documentation for all the keyword commun runs with DYNA_NON_LINE.

The only differences in syntax, which are detailed in this documentation, are related to:
- the management of time: the keyword factor is not used INCREMENT, because piloting in time is managed by the coupler itself
- the definition of the characteristics of the interface fluid-structure.

CALC_IFS_DNL product a concept of the type evol_noli usual.

4 Definition of the temporal discretization

Piloting in time is in fact off-set out of *Code_Aster*. More precisely, the coupler will evaluate at every moment calculation the current step and will provide it to the two codes which are *Code_Aster* and *Code_Saturne*. In practice, each one of these codes provides only one step of initial time which makes it possible the coupler to evaluate the first step of time.

In the same way, information of initial time and final time of study are defined in the level of the coupler itself and not in the command file.

Code_Aster will recover all this information (initial moment, final moment, not running) *via* YACS.

4.1 Keyword PAS_INIT

The step of initial time for the coupling YEWS defines, within the meaning of the step of relevant time for calculation structure alone. *Code_Saturne* in the same way its own step of initial time defines and the coupler then will return to the two codes the step of initial time which will be really used for the coupled resolution. In practice, this step of coupled time will be the minimum of the two steps of time coming from the codes, in order to observe and quality the stability conditions of the solution on each of the two fields.

If one uses a diagram in time clarifies in *Code_Aster*, then, obviously, the step of initial time will have to observe the condition of Current (or CFL, [U4.53.01] and [R5.05.05]).

5 Definition of the interface fluid-structure

The user must specify the interface fluid-structure. It is advisable to recall that with this interface, the fluid and solid grids are not inevitably in conformity. Moreover, *Code_Aster* managing all the stages of projection between the fluid and the solid, it is necessary to give him the information of the fluid grid.

5.1.1 Operand GROUP_MA_IFS

This operand makes it possible to define the group of meshs of the solid grid which is with the interface fluid-structure.

5.1.2 Operand NOM_CMP_IFS

One specifies which components of the effort will be transmitted to the interface fluid-structure, in the absolute reference mark.

For example:
NOM_CMP_IFS = ('FX', 'FY', 'FZ'),
To have complete transmission of the efforts in 3D.
If one wishes to transmit only certain components, it is enough to exclude the unutilised components. One can thus carry out conditions of slip to the wall.

5.1.3 Operands UNITE_NOEUD and UNITE_ELEM

These operands make it possible to define the unit logical of the files containing the grids corresponding to the interface fluid-structure resulting from the fluid grid. The resolution by Code_Saturne being done in finished volumes, it is necessary to define two grid distinct for projections from fields to be exchanged.

In the Neuman-Dirichlet coupling, the code structure provides to the fluid code displacements and speed with the interface. They are thus data with the nodes of the solid grid which one projects on the nodes of the fluid grid. The fluid grid of the interface is recovered of *Code_Saturne*, *via* YACS and will be written, with the format of grid Aster in the file having the logical unit UNITE_NOEUD (which is worth 81 by defaults). One can thus also recover this grid in postprocessing if need be.

The second phase of the coupling is done in the other direction: the fluid code provides to the code structure the efforts with the interface (according to the components given with NOM_CMP_IFS). More precisely, *Code_Saturne* being a code in finished volumes, the calculated surface efforts are constant by face and what *Code_Aster* recover is in fact the resultants by face of the elements, expressed with the nodes mediums. So that *Code_Aster* can project on the grid structure, it is thus necessary to have the grid of the nodes mediums of the fluid grid for the interface. This grid is also recovered via YACS and one writes it with the format Aster in the logical unit UNITE_ELEM (which is worth 82 by defaults).