PERF009 – Elastic design of the pump LAUGH

Summarized:

The purpose of this benchmark is to measure the performances of an elastic design of a pump LAUGH subjected to a constant interior pressure.

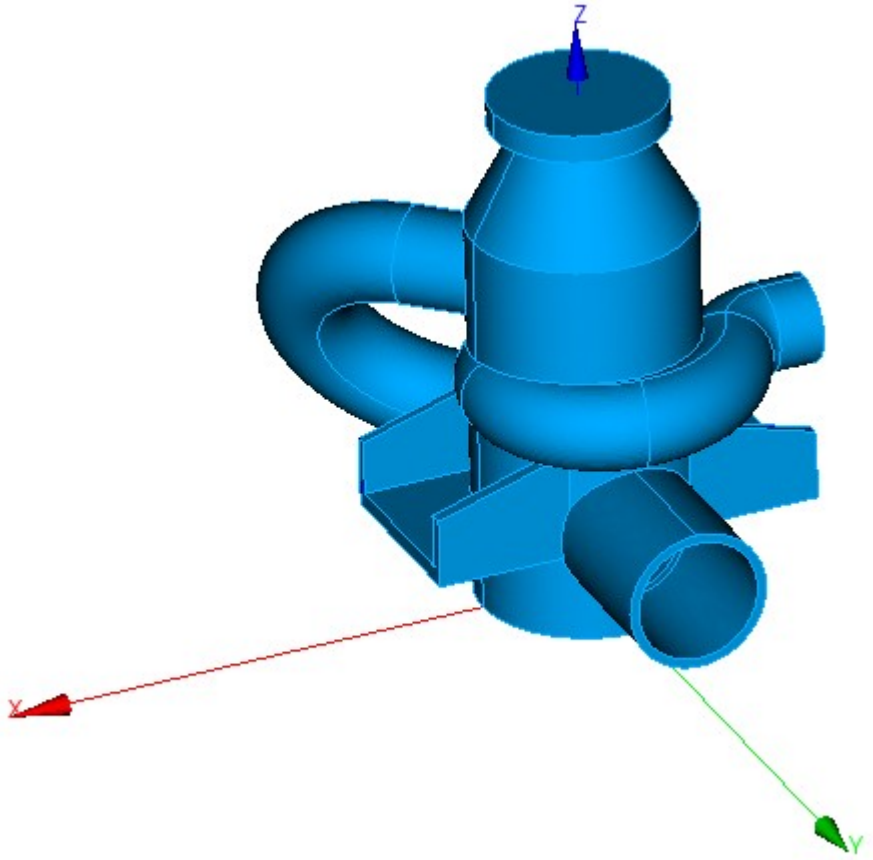
This case test is declined in 7 modelizations which are identical. The differences are related on the change of solver and the number of processors,

1) Modelization a: solver MULT_FRONT on 1 processor,
2) Modelization b: solver MULT_FRONT on 2 processors,
3) Modelization C: solver MULT_FRONT on 4 processors,
4) Modelization D: solver MUMPS on 2 processors,
5) Modelization E: solver MUMPS on 4 processors,
6) Modelization F: solver MUMPS on 8 processors,
7) Modelization G: solver MUMPS on 16 processors,

1 Problem of reference

1.1 Geometry

the geometry of the pump is the following one:



1.2 Properties of the material

- $E = 2.10^5 \text{ MPa}$
- $\nu = 0.3$

1.3 Boundary conditions and loadings

imposed Displacement:

Lower face : $DX = DY = DZ = 0.$

Imposed interior pressure:

$$P = 100 \text{ MPa}$$

2 Reference solution

2.1 Méthode de calcul

result of reference was obtained by calculating the average of displacements in all the directions on the upper face of the pump with the solver "MUMPS".

2.2 Uncertainties

numerical Solution (NON-regression).

3 Modelization A

3.1 Characteristic of the modelization A

Number of processor: 1

Modelization 3D:

Many nodes	261.520		
Number of meshes	218.832	Are:	
		SEG3	3.600
		TRIA6	77.544
		TETRA10	137.688

3.2 Functionalities tested

Command	Option
AFFE_MODELE	MODELISATION 3D
AFFE_CHAR_MECA	FACE_IMPO
	PRES_REP
MECA_STATIQUE	
solver	MULT_FRONT

3.3 Results

Quantity	Reference	Code_Aster	relative Error (%)
DEPL MOY DX	3.83679	3.83679086	2.2E-05
DEPL MOY DY	-7.41447	-7.4144716	2.2E-05
DEPL MOY DZ	2.87533	2.8753262	1.3E-04

3.4 Environment of execution

Machine	Version	(Mo) Memory		Number DDL	Time execution (MECA_STATIQUE) (dry)			
		Allocated	Used		USER	SYSTEM	USER+ SYS	ELAPSED
Linux 64 bits (ia64) “Bulls”	10.1.12	4.000	3.975.803	352	278.72	17.79	296.51	297.15

4 Modelization B

4.1 Characteristic of the modelization B

Number of processor: 2

Modelization 3D:

Many nodes	261.520		
Number of meshes	218.832	Are:	
		SEG3	3.600
		TRIA6	77.544
		TETRA10	137.688

4.2 Functionalities tested

Command	Option
AFFE_MODELE	MODELISATION 3D
AFFE_CHAR_MECA	FACE_IMPO
	PRES_REP
MECA_STATIQUE	
solver	MULT_FRONT

4.3 Results

Quantity	Reference	Code_Aster	relative Error (%)
DEPL MOY DX	3.83679	3.83679086	2.2E-05
DEPL MOY DY	-7.41447	-7.4144716	2.2E-05
DEPL MOY DZ	2.87533	2.8753262	1.3E-04

4.4 Environment of execution

Machine	Version	(Mo) Memory		Number DDL	Time execution (MECA_STATIQUE) (dry)			
		Allocated	Used		USER	SYSTEM	USER+ SYS	ELAPSED
Linux 64 bits (ia64) “Bulls”	10.1.12	4.000	3.975.803	352	300.73	16.79	317.52	232.68

5 Modelization C

5.1 Characteristic of the modelization C

Number of processor: 3

Modelization 3D:

Many nodes	261.520			
Number of meshes	218.832	Are:		
			SEG3	3.600
			TRIA6	77.544
			TETRA10	137.688

5.2 Functionalities tested

Command	Option
AFFE_MODELE	MODELISATION 3D
AFFE_CHAR_MECA	FACE_IMPO
	PRES_REP
MECA_STATIQUE	
solver	MULT_FRONT

5.3 Results

Quantity	Reference	Code_Aster	relative Error (%)
DEPL MOY DX	3.83679	3.83679086	2.2E-05
DEPL MOY DY	-7.41447	-7.4144716	2.2E-05
DEPL MOY DZ	2.87533	2.8753262	1.3E-04

5.4 Environment of execution

Machine	Version	(Mo) Memory		Number DDL	Time execution (MECA_STATIQUE) (dry)			
		Allocated	Used		USER	SYSTEM	USER+ SYS	ELAPSED
Linux 64 bits (ia64) “Bulls”	10.1.12	4.000	3.975.803	352	388.16	17.25	405.41	212.47

6 Modelization D

6.1 Characteristic of the modelization D

Number of processor: 2

Modelization 3D:

Many nodes	261.520			
Number of meshes	218.832	Are:		
			SEG3	3.600
			TRIA6	77.544
			TETRA10	137.688

6.2 Functionalities tested

Command	Option
AFFE_MODELE	MODELISATION 3D
AFFE_CHAR_MECA	FACE_IMPO
	PRES_REP
MECA_STATIQUE	
solver	MUMPS

6.3 Results

Quantity	Reference	Code_Aster	relative Error (%)
DEPL MOY DX	3.83679	3.83679086	2.2E-05
DEPL MOY DY	-7.41447	-7.4144716	2.2E-05
DEPL MOY DZ	2.87533	2.8753262	1.3E-04

6.4 Environment of execution

Machine	Version	(Mo) Memory		Number DDL	Time execution (MECA_STATIQUE) (dry)			
		Allocated	Used		USER	SYSTEM	USER+ SYS	ELAPSED
Linux 64 bits (ia64) “Bulls”	10.1.15	2.200.888		803.352	149.31	7.11	156.42	166.46

7 Modelization E

7.1 Characteristic of the modelization E

Number of processor: 4

Modelization 3D:

Many nodes	261.520		
Number of meshes	218.832	Are:	
		SEG3	3.600
		TRIA6	77.544
		TETRA10	137.688

7.2 Functionalities tested

Command	Option
AFFE_MODELE	MODELISATION 3D
AFFE_CHAR_MECA	FACE_IMPO
	PRES_REP
MECA_STATIQUE	
solver	MUMPS

7.3 Results

Quantity	Reference	Code_Aster	relative Error (%)
DEPL MOY DX	3.83679	3.83679086	2.2E-05
DEPL MOY DY	-7.41447	-7.4144716	2.2E-05
DEPL MOY DZ	2.87533	2.8753262	1.3E-04

7.4 Environment of execution

Machine	Version	(Mo) Memory		Number DDL	Time execution (MECA_STATIQUE) (dry)			
		Allocated	Used		USER	SYSTEM	USER+ SYS	ELAPSED
Linux 64 bits (ia64) “Bulls”	10.1.15	2.200.790		803.352	120.69	6.32	127.01	129.11

8 Modelization F

8.1 Characteristic of the modelization F

Number of processor: 8

Modelization 3D:

Many nodes	261.520		
Number of meshes	218.832	Are:	
		SEG3	3.600
		TRIA6	77.544
		TETRA10	137.688

8.2 Functionalities tested

Command	Option
AFFE_MODELE	MODELISATION 3D
AFFE_CHAR_MECA	FACE_IMPO
	PRES_REP
MECA_STATIQUE	
solver	MUMPS

8.3 Results

Quantity	Reference	Code_Aster	relative Error (%)
DEPL MOY DX	3.83679	3.83679086	2.2E-05
DEPL MOY DY	-7.41447	-7.4144716	2.2E-05
DEPL MOY DZ	2.87533	2.8753262	1.3E-04

8.4 Environment of execution

Machine	Version	(Mo) Memory		Number DDL	Time execution (MECA_STATIQUE) (dry)			
		Allocated	Used		USER	SYSTEM	USER+ SYS	ELAPSED
Linux 64 bits (ia64) “Bulls”	10.1.15	2.200.717		803.352	83.21	1.88	85.09	85.15

9 Modelization G

9.1 Characteristic of the modelization G

Number of processor: 16

Modelization 3D:

Many nodes	261.520			
Number of meshes	218.832	Are:		
			SEG3	3.600
			TRIA6	77.544
			TETRA10	137.688

9.2 Functionalities tested

Command	Option
AFFE_MODELE	MODELISATION 3D
AFFE_CHAR_MECA	FACE_IMPO
	PRES_REP
MECA_STATIQUE	
solver	MUMPS

9.3 Results

Quantity	Reference	Code_Aster	relative Error (%)
DEPL MOY DX	3.83679	3.83679086	2.2E-05
DEPL MOY DY	-7.41447	-7.4144716	2.2E-05
DEPL MOY DZ	2.87533	2.8753262	1.3E-04

9.4 Environment of execution

Machine	Version	(Mo) Memory		Number DDL	Time execution (MECA_STATIQUE) (dry)			
		Allocated	Used		USER	SYSTEM	USER+ SYS	ELAPSED
Linux 64 bits (ia64) “Bulls”	10.1.15	2.200.684		803.352	67.41	1.69	69.10	70.33

10 Summary of the results

Machine	Aster	MOD.	Nb DDL	Memory (Mo)		Time execution (MECA_STATIQUE) (dry)			
				Allocated	Used (*)	USER	SYSTEM	USER+SYS	ELAPSED
Linux 64 bits (ia64) “Bull”	10.1.12	A	803.352	4000	3.975	278.72	17.79	296.51	297.15
		B	803.352	4000	3.975	300.73	16.79	317.52	232.68
		C	803.352	4000	3.975	388.16	17.25	405.41	212.47
	10.1.15	D	803.352	2200	888	149.31	7.11	156.42	166.46
		E	803.352	2200	790	120.69	6.32	127.01	129.11
		F	803.352	2200	717	83.21	1.88	85.09	85.15
		G	803.352	2200	684	67.41	1.69	69.10	70.33

(*) for the modelizations with MUMPS (D, E, F, G), the memory used indicated is that of Aster, it does not include that necessary to MUMPS.

It is noted that one reaches a parallel effectiveness of 35% out of 4 processors with a parallelism OpenMP. This figure is to be compared with that obtained on benchmark PERF010 (60% of effectiveness out of 4 processors). This shows that this kind of parallelism brings performances which are dependant on the studied problem (geometry, blockings, etc…).
The same report can be made on parallelism MPI with correct parallel performances but in shrinkage compared to benchmark PERF010.