PERF014 – Contact between two plates in parallel

Summarized:

The purpose of this benchmark is to measure the parallel performances of a computation with a large number of degrees of freedom of contact. It consists of two plates making contact with a rigid foundation.

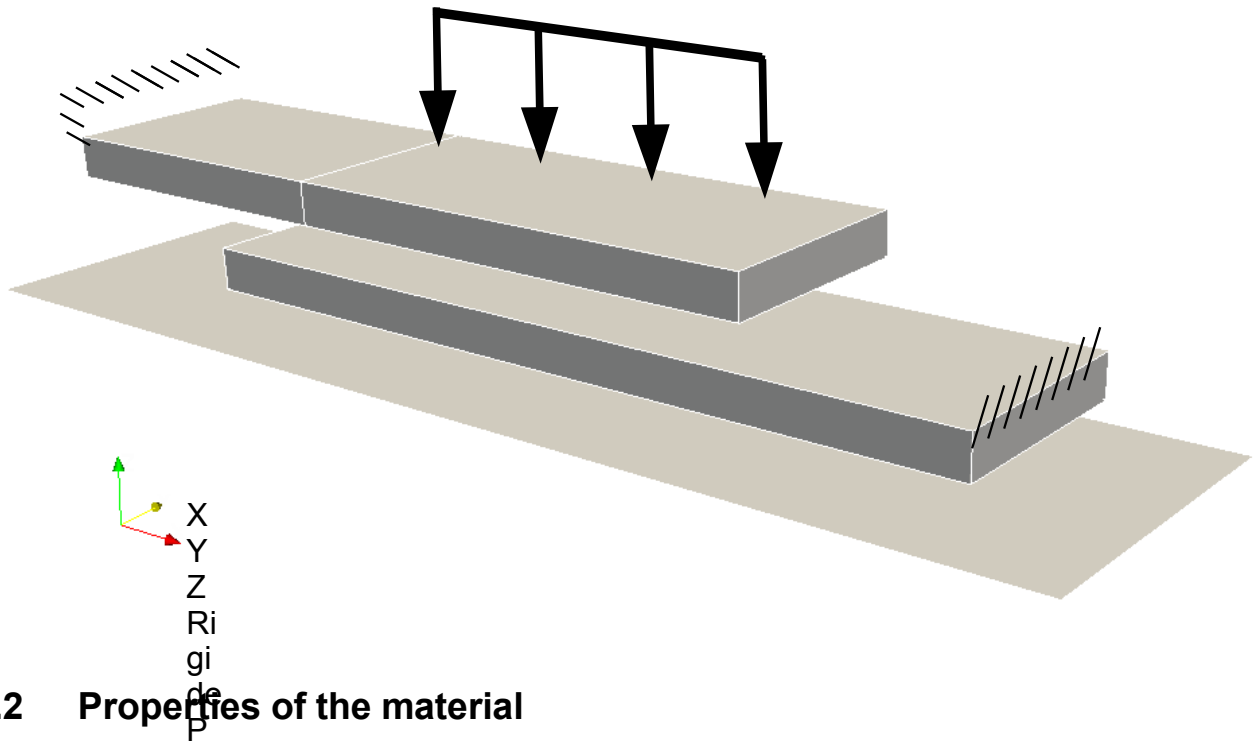
This case test is declined in 3 quasi-identical modelizations. The differences are related to the smoothness of the meshes used like with the number of processors:

1) Modelization a: 8900 elements out of 1 processor,
2) Modelization b: 40000 elements out of 4 processors,
3) Modelization C: 63000 elements out of 8 processors.

1 Problem of reference

1.1 Geometry

the geometry of the problem of contact is the following one:



1.2 Properties of the material

- $E = 2{,}1 \times 10^5 \,\mathrm{MPa}$
- $\nu = 0.3$

1.3 Boundary conditions and loadings

imposed Displacement:

Side sides	:	$DX = DY = DZ = 0.$
Foundation	:	$DX = DY = DZ = 0.$

Pressure imposed on the upper face:

$$P = 100 \,\mathrm{MPa}$$

2 Reference solution

2.1 Method of calculating

the results of reference are of standard NON-regression.

2.2 Quantities and results of reference

Resulting from the forces following DZ to the fixed support.

Maximum displacement on the enforcement zone of the force of pressure.

2.3 Uncertainties on the solution

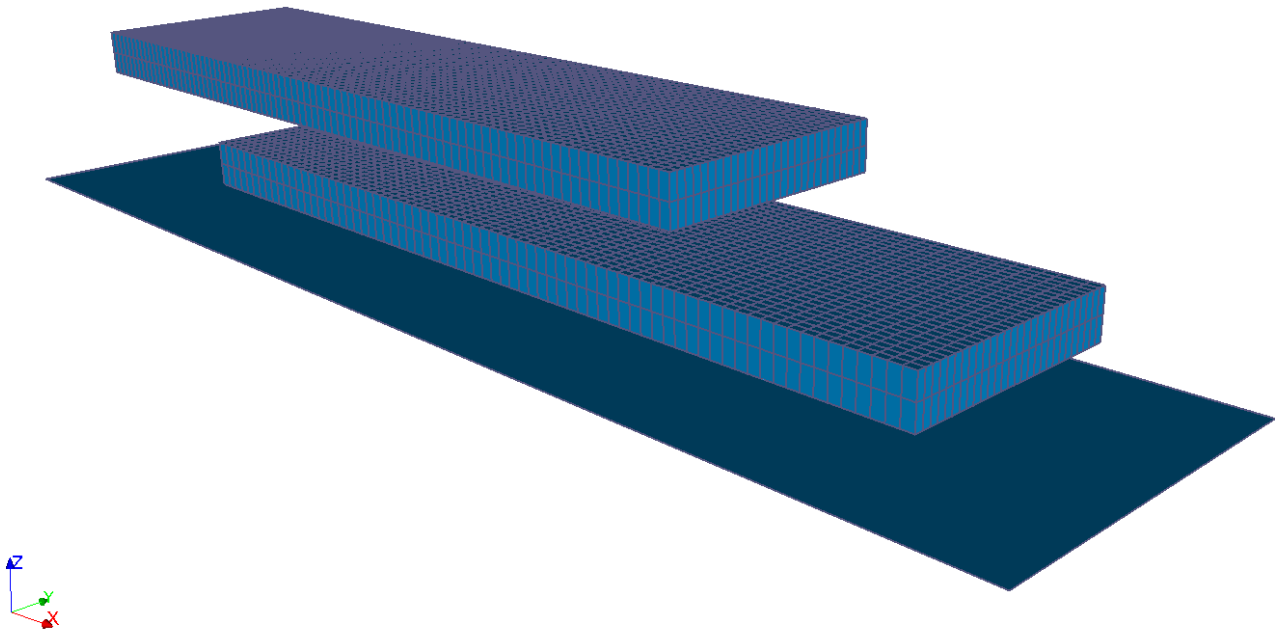
Solution of NON-regression.

3 Modelization A

3.1 Characteristic of the modelization

The modelization is 3D, the formulation of the contact is CONTINUE (without friction). The nonlinear solver is NEWTON_KRYLOV associated with iterative linear solver PETSC.

3.2 Characteristics of the mesh



Many nodes 14.011
Number of meshes 19.665 Is:

SEG2	940
QUAD4	9.821
HEXA8	8.904

3.3 Quantities tested and NON-regression

results.

3.4 Environment of execution

Many processors: 1

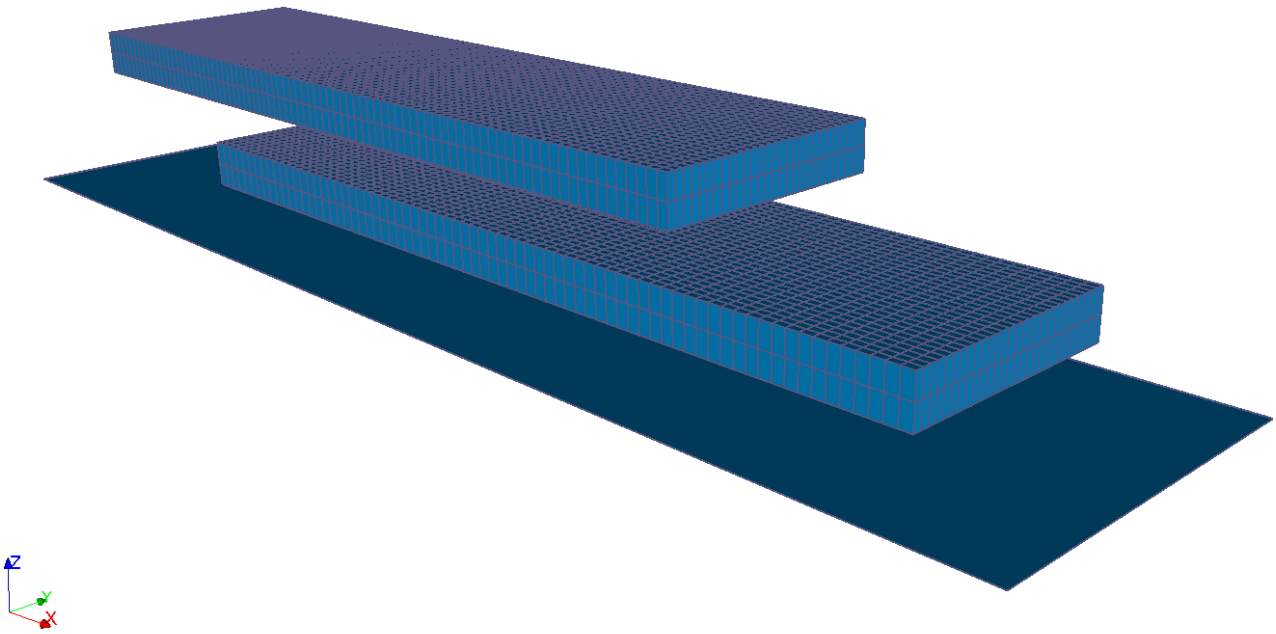
Machine	Version	(Mo) Memory		Many degrees of freedom	Time execution (STAT_NON_LINE) (dry)			
		Allocated	Used		USER	SYSTEMS	USER+SYS	ELAPSED
Aster4	11.3.4	512.620		46.325	85.59	3.23	88.82	88.95

4 Modelization B

4.1 Characteristic of the modelization

The modelization is 3D, the formulation of the contact is CONTINUE (without friction). The nonlinear solver is NEWTON_KRYLOV associated with iterative linear solver PETSC.

4.2 Characteristics of the mesh



Many nodes 61.510
Number of meshes 84.225 Is:

SEG2	2.124
QUAD4	42.101
HEXA8	40.000

4.3 Quantities tested and NON-regression

results.

4.4 Environment of execution

Many processors: 4

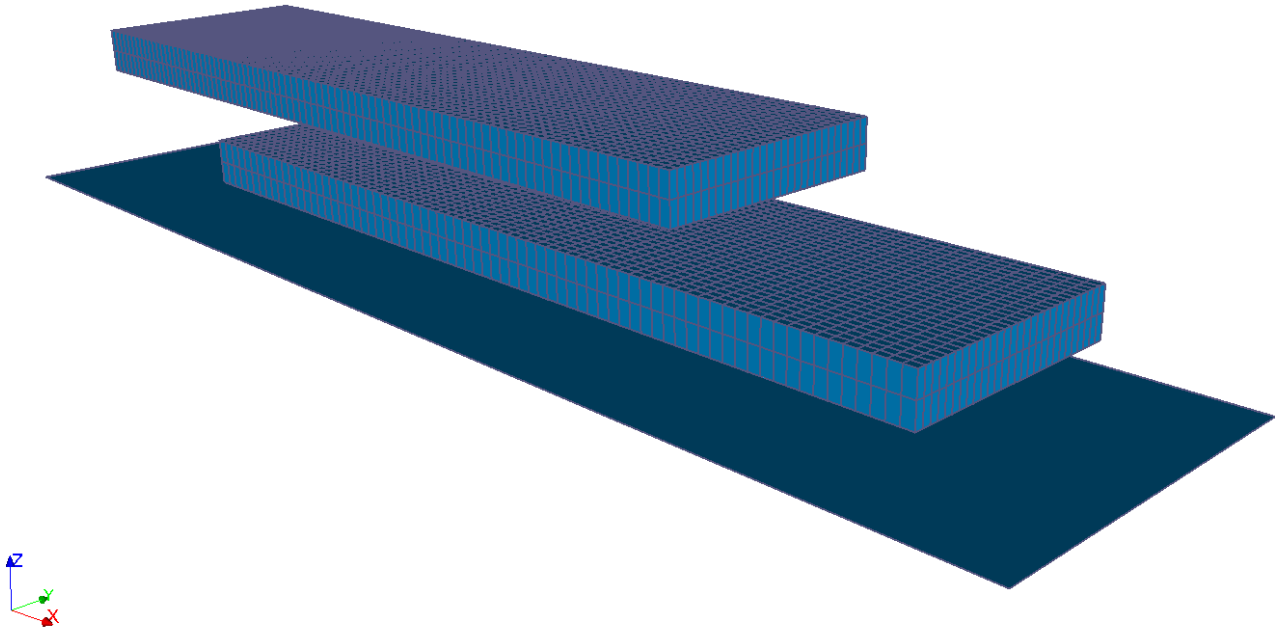
Machine	Version	(Mo) Memory		Number DDL	Time execution (STAT_NON_LINE) (dry)			
		Allocated	Used		USER	SYSTEMS	USER+SYS	ELAPSED
Aster4	11.3.4	2048	1320	205.032	338.34	15.76	354.10	379.00

5 Modelization C

5.1 Characteristic of the modelization

The modelization is 3D, the formulation of the contact is CONTINUE (without friction). The nonlinear solver is NEWTON_KRYLOV associated with iterative linear solver PETSC.

5.2 Characteristics of the mesh



Many nodes 96.388
Number of meshes 131.285 Is:

SEG2	2.654
QUAD4	65.631
HEXA8	63.000

5.3 Quantities tested and NON-regression

results.

5.4 Environment of execution

Many processors: 8

Machine	Version	(Mo) Memory		Many degrees of freedom	Time execution (STAT_NON_LINE) (dry)			
		Allocated	Used		USER	SYSTEM	USER+ SYS	ELAPSED
Aster4	11.3.4	4096	1714	321.292	489.01	21.09	510.10	551.75

6 Summary of the results

This benchmark implements a computation of contact of which the number of potential nodes of contact is approximately 10 % amongst degrees of freedom total. That represents a significant portion compared to what one usually meets in the studies in structural mechanics.
One shows through the 3 modelizations the interest of parallel computation for this kind of problem. Parallelism is made possible for two reasons:

- on the one hand thanks to the elementary approach of the formulation CONTINUE and the distribution of resulting computations,
- on the other hand thanks to nonlinear solver NEWTON_KRYLOV coupled to a robust parallel iterative solver.