PERF014 – Contact between two plates in parallel

Summary:

The objective of this CAS-test is to measure the parallel performances of a calculation with a large number of degrees of freedom of contact. It consists of two plates making contact with a rigid foundation.

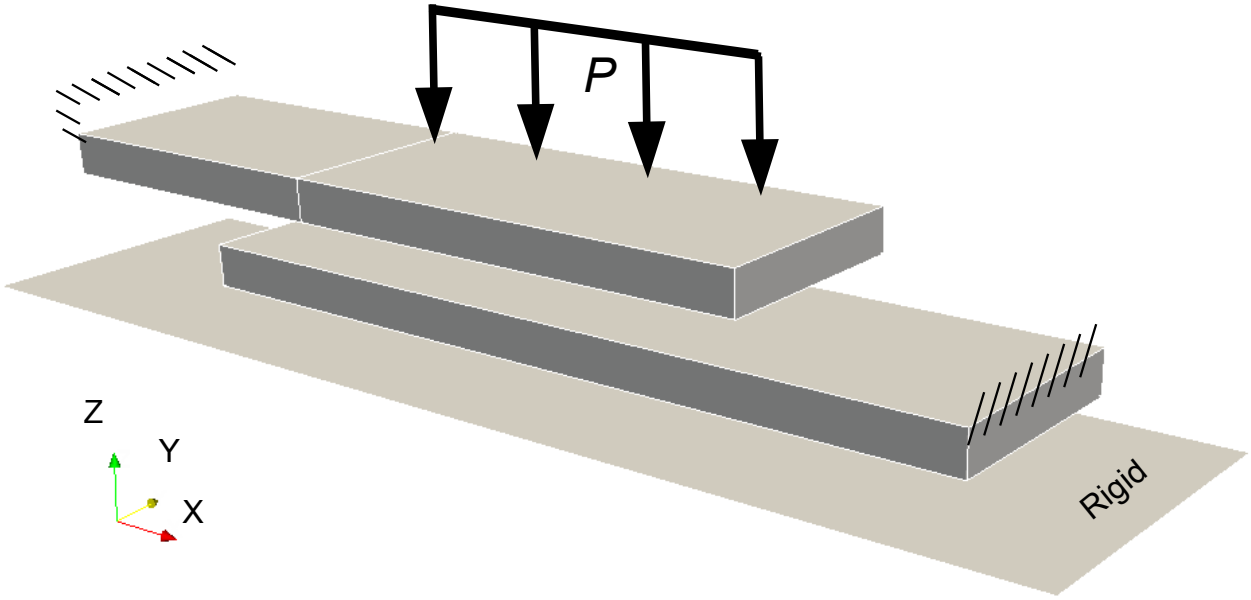
This case test is declined in 3 quasi-identical modelings. The differences are related to the smoothness of the grids used like with the number of processors:

1) Modeling a: 8900 elements out of 1 processor,
2) Modeling b: 40000 elements out of 4 processors,
3) Modeling 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 material

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

1.3 Boundary conditions and loadings

Imposed displacement:

Side faces : $DX = DY = DZ = 0.$

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

Pressure imposed on the higher face:

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

2 Reference solution

2.1 Method of calculating

The results of reference are of standard not-regression.

2.2 Sizes and results of reference

Resultant of the efforts according to DZ with embedding.

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

2.3 Uncertainties on the solution

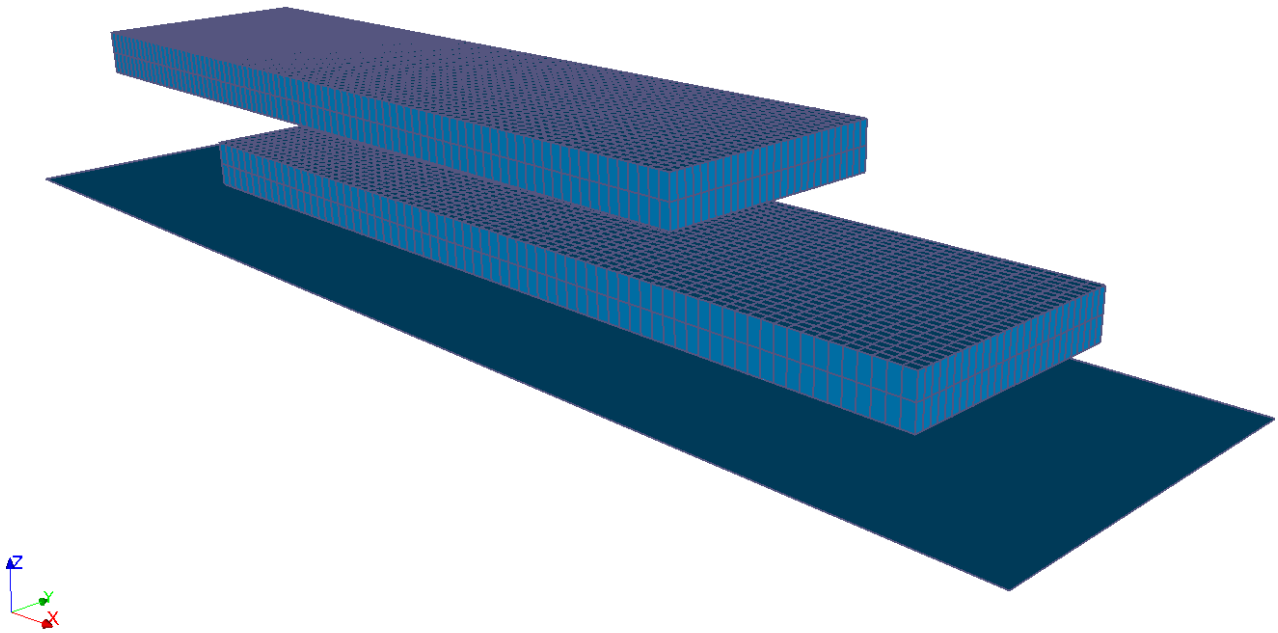
Solution of not-regression.

3 Modeling A

3.1 Characteristics of modeling

Modeling is 3D, the formulation of the contact is CONTINUOUS (without friction). The non-linear solvor is NEWTON_KRYLOV associated to the iterative linear solvor PETSC.

3.2 Characteristics of the grid



Many nodes	14,011			
Many meshs	19,665	That is to say:	SEG2	940
			QUAD4	9,821
			HEXA8	8,904

3.3 Sizes tested and results

Not-regression.

3.4 Environment of execution

Many processors: 1

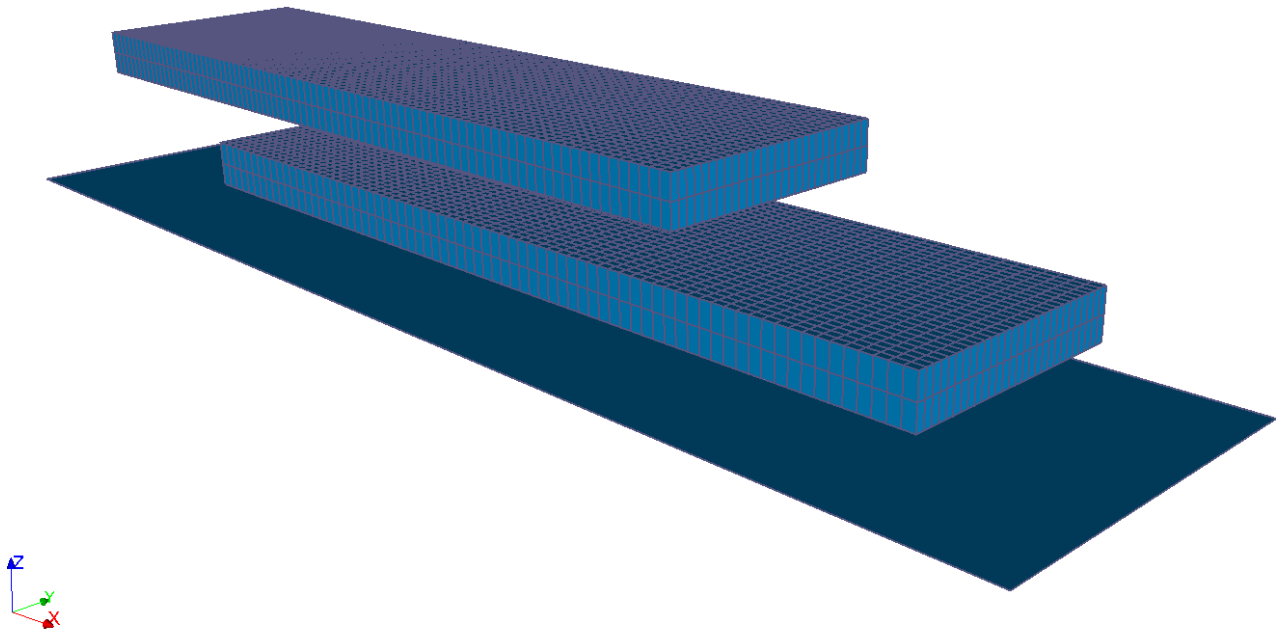
Machine	Version	Memory (Mo)		Many degrees of freedom	Time execution (STAT_NON_LINE) (dryness)			
		Allocated	Used		TO USE	SYSTEM	TO USE +SYS	ELAPSED
Aster4	11.3.4	512	620	46,325	85.59	3.23	88.82	88.95

4 Modeling B

4.1 Characteristics of modeling

Modeling is 3D, the formulation of the contact is CONTINUOUS (without friction). The non-linear solvor is NEWTON_KRYLOV associated to the iterative linear solvor PETSC.

4.2 Characteristics of the grid



Many nodes	61,510			
Many meshs	84,225	That is to say:		
			SEG2	2,124
			QUAD4	42,101
			HEXA8	40,000

4.3 Sizes tested and results

Not-regression.

4.4 Environment of execution

Many processors: 4

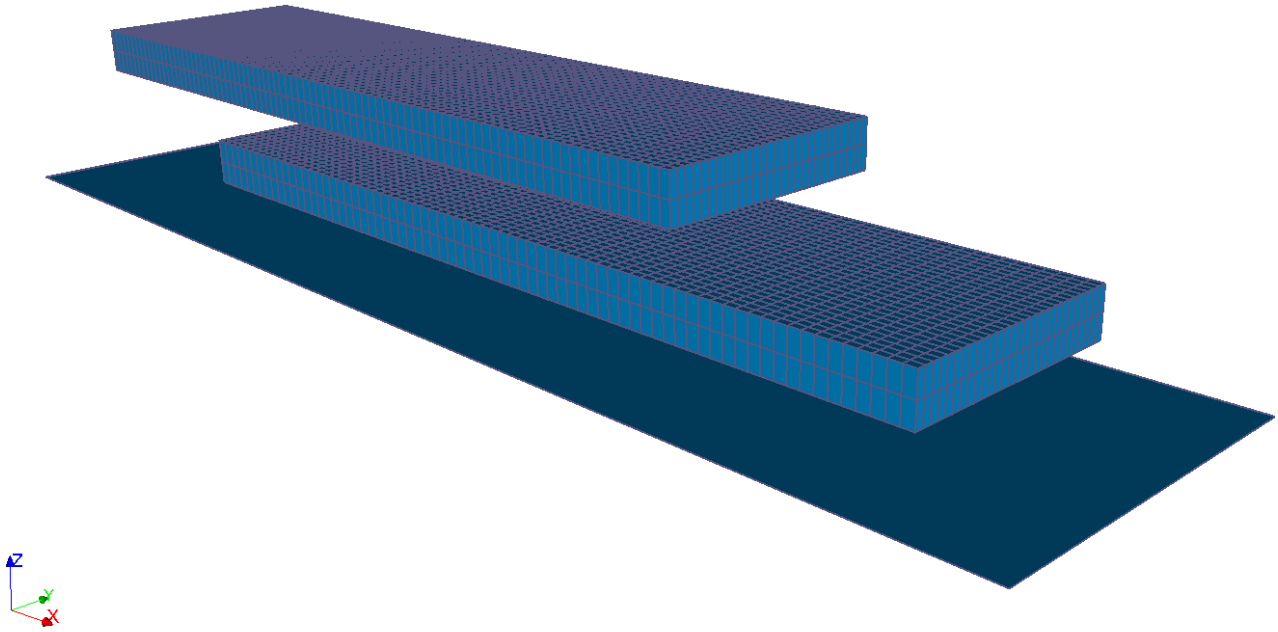
Machine	Version	Memory (Mo)		Number DDL	Time execution (STAT_NON_LINE) (dryness)			
		Allocated	Used		TO USE	SYSTEM	TO USE +SYS	ELAPSED
Aster4	11.3.4	2048	1320	205,032	338.34	15.76	354.10	379.00

5 Modeling C

5.1 Characteristics of modeling

Modeling is 3D, the formulation of the contact is CONTINUOUS (without friction). The non-linear solvor is NEWTON_KRYLOV associated to the iterative linear solvor PETSC.

5.2 Characteristics of the grid



Many nodes	96,388			
Many meshs	131,285	That is to say:		
			SEG2	2,654
			QUAD4	65,631
			HEXA8	63,000

5.3 Sizes tested and results

Not-regression.

5.4 Environment of execution

Many processors: 8

Machine	Version	Memory (Mo)		Many degrees of freedom	Time execution (STAT_NON_LINE) (dryness)			
		Allocated	Used		TO USE	SYSTEM	TO USE +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 calculation 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 mechanics of the structures.
One shows through 3 modelings the interest of parallel calculation for this kind of problem. Parallelism is made possible for two reasons:

- on the one hand thanks to the elementary approach of the formulation `CONTINUOUS` and distribution of resulting calculations,
- in addition thanks to the non-linear solvor `NEWTON_KRYLOV` coupled to a robust parallel iterative solvor.