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RamSeries - Validation Case 25

Flying Spaghetti

Version
15.1.0

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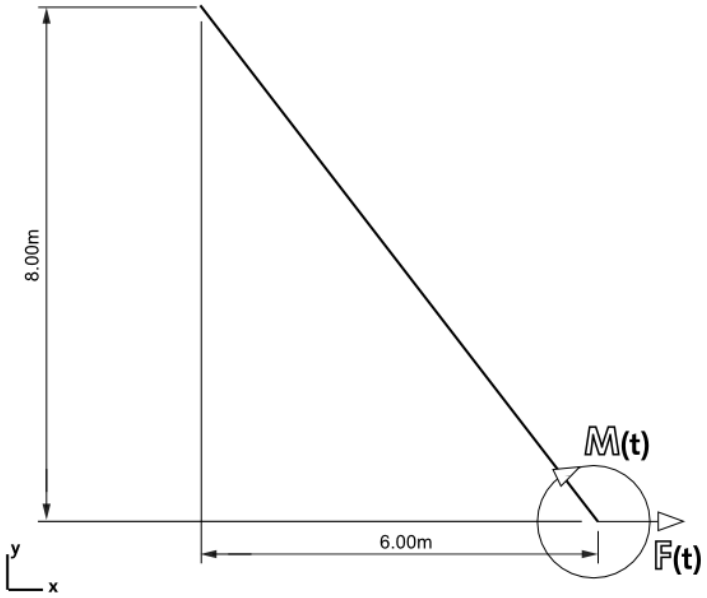
1 Validation Case 25 - Flying spaghetti

Model Description

This test case is based on the example "The flying spaghetti" described in Ref. [1] and Ref. [2].

A flexible rod with free ends, initially placed in an inclined position, is subjected to a torque and force applied simultaneously at one end. The external force and moment are removed at the same time t=2.5 s, and consequently, a free flight occurs inmediately after. The following image shows the geometry:



Load time history:

M(t) =

80 N.m (0≤t≤2.5)

0 N.m (t>0)

F(t) = M(t)/10.0

The pendulum section has the following properties (the material is assumed to be linear elastic):

$E \cdot A = \kappa \cdot G \cdot A = 1.0e4N$

$E \cdot I = 100\ N \cdot m^2$

$A_\rho = 1\ kg/m$

$I_\rho = 10\ kg \cdot m$

Results

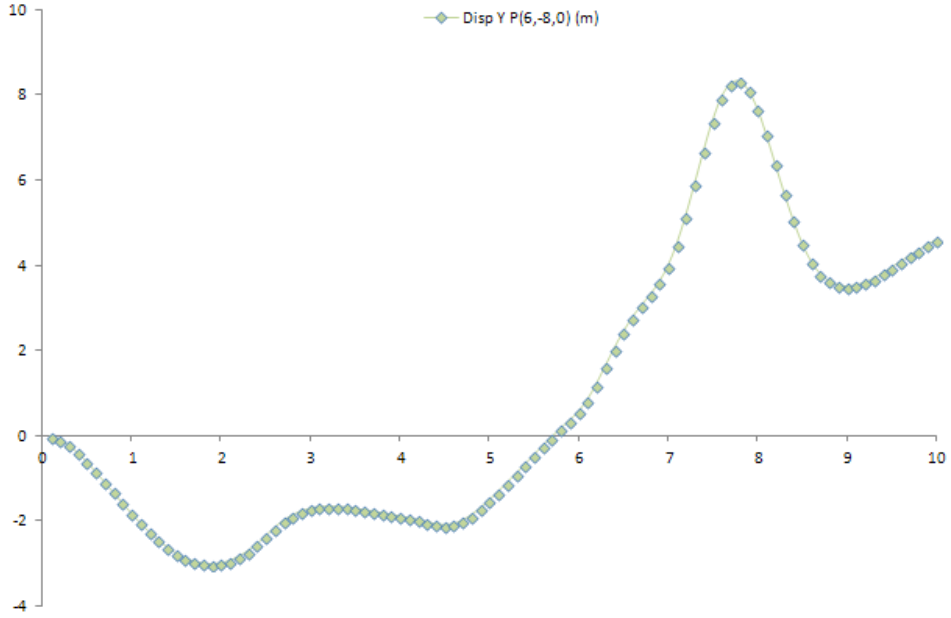
For the sake of validation, a simulation was run using the properties described in the previous section, using a 20 linear beam element (21 nodes) mesh.

The total time of the simulation is T=10 s, with a time step of Δt = 0.1 s.

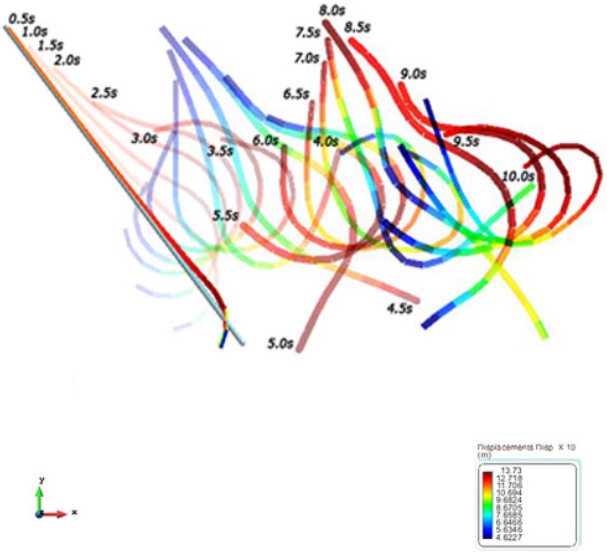
An implicit energy-conserving scheme is used.

Displacements results:

The next image shows the vertical displacement evolution of the lowest point of the spaghetti:

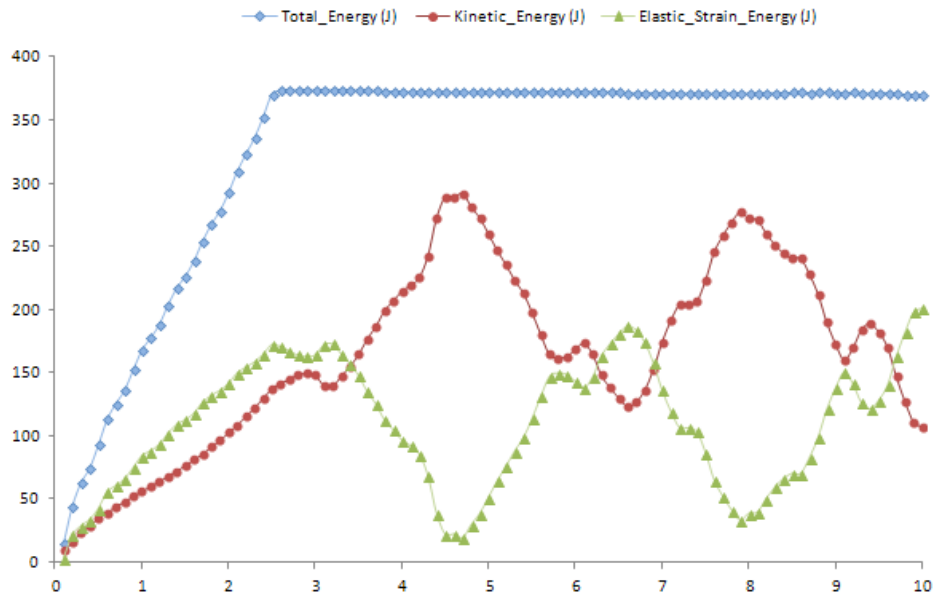


The position of the spaghetti at different stages of the analysis is shown in the next image:

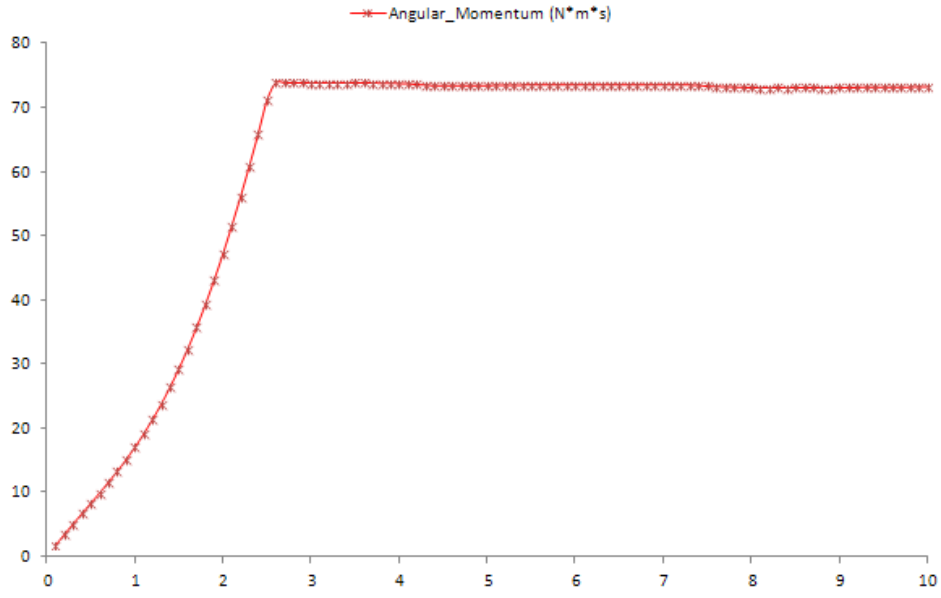

0.5s
1.0s
1.5s
2.0s
2.5s
3.0s
3.5s
4.0s
4.5s
5.0s
5.5s
6.0s
6.5s
7.0s
7.5s
8.0s
8.5s
9.0s
9.5s
10.0s
y
x

Energy conserving results:

The following graphs show the evolution of the spaghetti´s kinetic, elastic and total energy, and the angular momentum. As can be observed, the total energy and the momentum of the spaghetti remain constant from the moment it begins the free flight (t=2.5 s):



System energy evolution



System angular momentum evolution

Validation Summary

CompassFEM version	15.1.0
Tdyn solver version	15.1.0
RamSeries solver version	15.1.0
Benchmark status	Successfull
Last validation date	27/11/2018

References

[1] Alberto P. Sibileau. Conservative time integration on beams under contact constraints using B-Spline interpolation. Master Thesis, Universitat Politècnica de Catalunya (2011).

[2] J.C. Simo and L. Vu-Quoc. On the Dynamics of Flexible Beams Under Overall Motions - The Plane Case: Part II.ASME J. of Appl. Mech., 53:855-863 (1986).