

RamSeries - Validation Case 24

Flexible pendulum



RamSeries

Version
15.1.0

Table of Contents

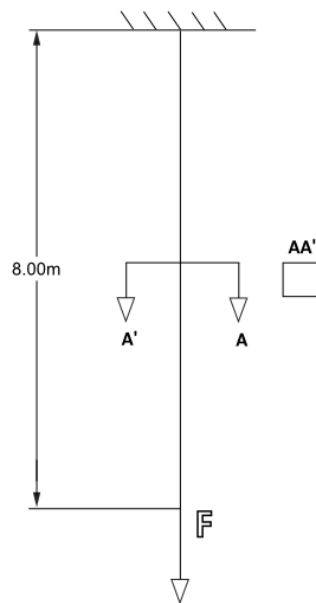
Chapters	Pag.
Validation Case 24 - Flexible pendulum	1
Model Description	1
Results	2
References	5
Validation Summary	6

1 Validation Case 24 - Flexible pendulum

Model Description

This test case is based on the example "A flexible pendulum" described in Ref. [1] and Ref. [2].

A simple beam is placed initially in vertical position, and an angular velocity $\omega_0 = 2 \text{ rad/s}$ is consistently applied to all nodes. The pendulum's tip is subjected to a constant force $F = 8 \text{ N}$, and no body forces are considered. The following image shows the geometry:



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

$$E \cdot A = 50.68 \text{e}5 \text{ N}$$

$$\kappa \cdot G \cdot A = 25.34 \text{e}5 \text{ N}$$

$$E \cdot I = 570.37 \text{ N} \cdot \text{m}^2$$

$$A_p = 20.34 \text{e}-2 \text{ kg/m}$$

$$I_p = 22.89 \text{e}-6 \text{ kg} \cdot \text{m}$$

Results

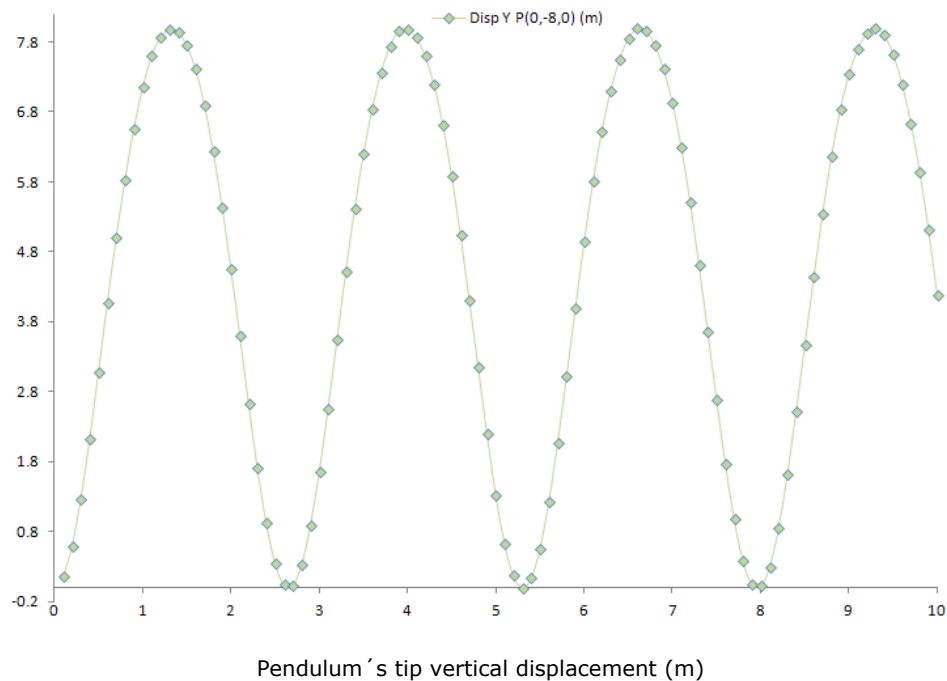
For the sake of validation, a simulation was run using the properties described in the previous section, using a four linear beam element (5 nodes) mesh.

The total time of the simulation is $T=10$ s, with a time step of $\Delta t = 0.1$ s.

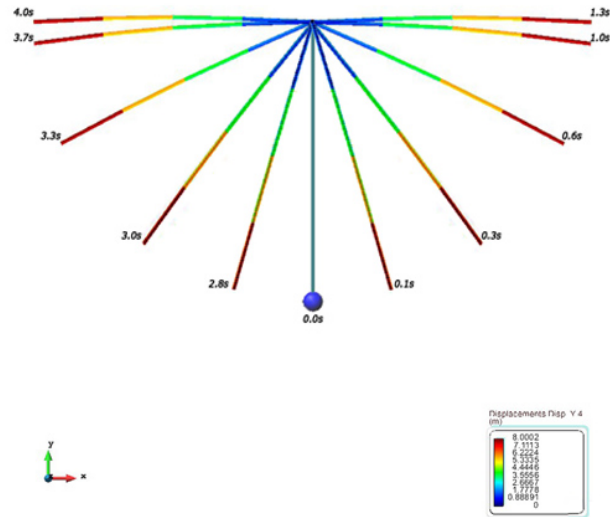
An implicit energy-conserving scheme is used.

Displacements results:

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

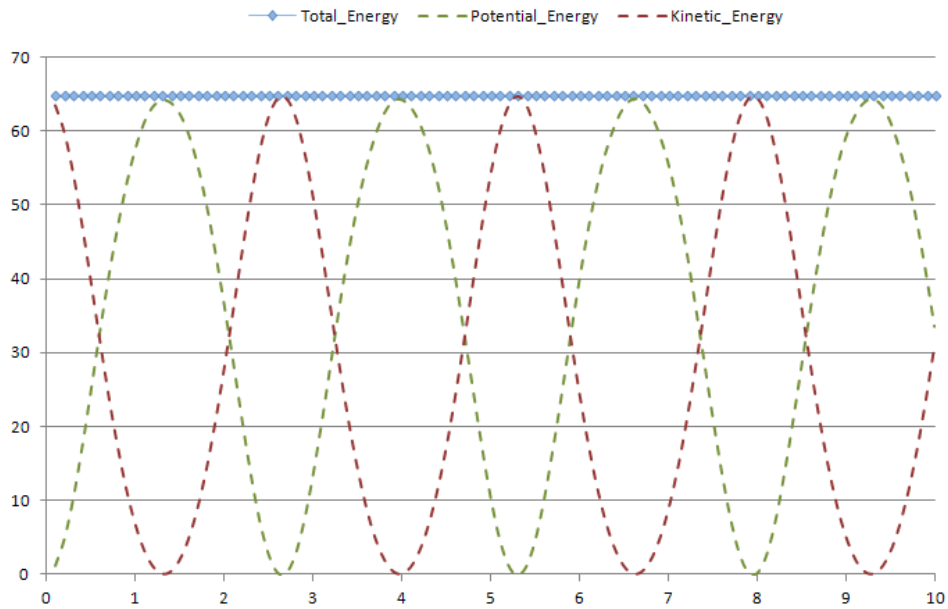


The position of the pendulum in different stages of the analysis is shown in the next image:



Energy conserving results:

The following graphs show the evolution of the pendulum's energy: potential, kinetic, and total. As can be observed, the total energy of the system remains constant:



System energy evolution

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] N. Stander and E. Stain. An energy-conserving planar finite element beam element for dynamics of flexible mechanism. Engng. Comput., 16:60-85. (1996).

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