Pinned bar

Reference: W. G. McLean, E. W. Nelson, C. L. Best, Schaum's Outline of Theory and Problems Reference: of Engineering Mechanics, Statics and Dynamics, McGraw-Hill Book Co., Inc., New York, NY, 1978, p. 336.

Analysis: Explicit dynamics, bilaterally constrained motion.

Purpose: Examine the accuracy of an analysis involving spherical joints.

Summary: A homogeneous bar, pinned at a distance a from one end, with total length L, is subjected to gravity loading and released from rest at an angle $\theta = 30\,\text{deg}$ from the vertical. The rotational speed when it passes through $\theta = 0\,\text{deg}$ is calculated and compared to an analytical expression.

The length of the spatial angular velocity vector at $\theta = 0\,\text{deg}$ reads

$$|\omega| = \sqrt{\frac{0.402 g_3 \left(L - 2a\right)}{L^2 - 3La + 3a^2}}$$

provided the bar was released at $\theta = 30\,\text{deg}$.

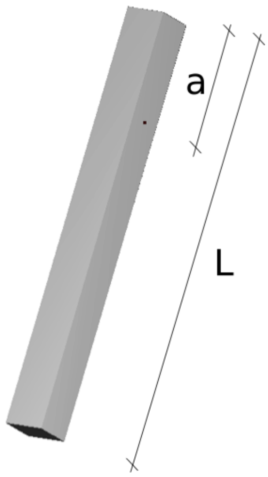

Figure 0.1: The pinned bar in the initial configuration.

Input parameters

Density (kg/m^3)	$\rho = 1$
Square cross-section (m^2)	$b \times b = 0.1 \times 0.1$
Length (m)	$L = 1$
Distance to joints (m)	$a = 0.25$
Gravity acceleration (m/s^2)	$\mathbf{g} = [0, 0, -9.8]$

Results

The time step used in the analysis is $h = 2^{-8}$. The hinge is modeled by a pair of spherical joints. The computations are terminated for the first n such that $\theta\,(nh) \leq 0$ (interpolation of the results to the exact point $\theta\,(t) = 0$ is omitted). The table below summarizes the results

	Target	*Solfec*	Ratio
Length of angular velocity when $\theta = 0\,\text{deg}$ (rad/s)	2.121	2.116	0.997