# 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 $\theta = 30\,\text{deg}$.

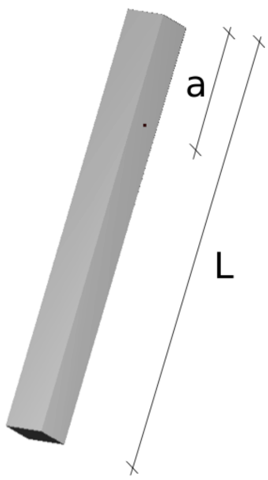


Figure 1: The pinned bar in the initial configuration.

## 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 |