

# Analysis of Air Spring

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Both the linear motor and the linear encoder have very small tolerances, on the order of .005". We are planning on constraining them with a linear guide system constructed with linear bearings and steel or aluminum shafting.

We considered a model with a beam simply supported on both ends with a force applied at the midpoint of the beam. This was used to determine if the flex in our guide system was on the order of our tolerances, or if it would be a limited element.

We assume a max horizontal force of 2000N and 1m long, 2.54cm diameter steel shafting.

$$\begin{aligned}\text{Max Deflection} &= \frac{P * L^3}{48 * E * I} \\ &= \frac{2000 * 1^3}{48 * 200 * 10^9 * .0254^3} \\ &= 1.53 * 10^{-4} \text{ m}\end{aligned}$$

This works out to be approximately .006". While this is higher than our allowed tolerances, we have a large safety factor in our horizontal force estimate. Considering that the order is correct, we should be able to deal with the flexing of the steel rod. At worst, we can move to a continuously supported shaft and  $\frac{3}{4}$  bearings.