SBD Beam Deflection Calculations

Calculation of System Deflection

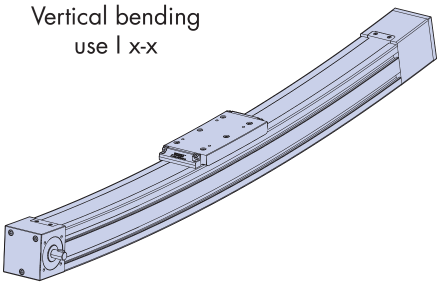
An SBD system which has a portion of unsupported beam will be subject to beam deflection. The magnitude of this deflection will depend on two factors; namely, the amount of load acting on the system and the distance that the beam is spanning.

The beam deflection is accurately modelled by simple beam bending equations. The most common application is for an SBD beam supported at two points separated by a distance L (mm), subjected to a load acting at the midpoint of the span. The deflection d (mm) due to the applied load W (N) is measured adjacent to the point of loading. This is the worst case.

$$d = \frac{WL^3}{48EI}$$

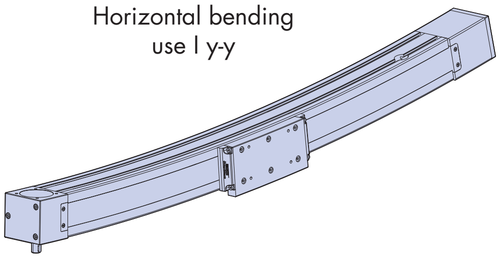
Equation 1

Vertical bending
use I x-x



Where: E is the Young's Modulus of the aluminium material of the beam (=68,000N/mm^2); I is the moment of inertia of the beam section, which can be found in the table below. The figure quoted for Ix-x is to be used when calculating deflections of beams subject to vertical bending and Iy-y is to be used when calculating deflections of beams subject to horizontal bending – see diagrams to the left and right.

Horizontal bending
use I y-y



Parameter			SBD20-80		SBD30-100	
			Standard	Cleanroom	Standard	Cleanroom
Beam moment of inertia	I x-x	mm^4	1500000		3700000	
	I y-y		1800000		4600000	
Mass of SBD unit	Q	kg/m	9.7 x L + 6.0	9.7 x L + 6.2	15.7 x L + 12.2	15.7 x L + 12.5

In many cases, particularly those with long unsupported spans, the deflection of the beam under its own weight will be significant. In the case of a beam of length L supported at its ends, the deflection at its centre due to its own weight will be as given in equation 2 below:

$$d = \frac{5L^3}{384EI} \times \frac{LQg}{1000}$$

Equation 2

Where Q is the mass of the SBD unit in kg/m, g = acceleration due to gravity (=9.81m/s^2) and the other quantities are as per Equation 1 above.

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The beam deflection of an SBD unit, mounted as a cantilever axes, can be calculated by similar methods. If a load W is applied at the end of the axis, and the distance from the point of load application to the centre line of the carriage is L, then the beam deflection at the load is given by Equation 3 below:

$$d = \frac{WL^3}{3EI} \qquad \text{Equation 3}$$

The beam deflection at the end of a cantilever axis under the action of its own weight will be given by Equation 4 below (note that the meaning of the symbols in Equations 3 & 4 are the same as in Equations 1 & 2):

$$d = \frac{L^3}{8EI} \times \frac{LQg}{1000} \qquad \text{Equation 4}$$

There are many other bending and torsion deflection models which may be applicable to an SBD system, if these are relevant in a particular application, an appropriate engineering text should be consulted. The data herein will allow such calculations to be completed.

Example

An SBD 30-100 standard unit carrying 100kg, is simply supported between two mounting points, located at each end of the beam. The beam is orientated so that the carriage is on the top, and the beam is 2000mm long. To determine the amount of deflection that will be present at the centre of the beam when the load passes that point, Equations 1 & 2 can be used.

$$d = \frac{WL^3}{48EI} \qquad \text{Equation 1}$$

Where; $W = 100\text{kg} \times 9.81\text{m/s}^2 = 981\text{N}$

I x-x $= 3700000\ \text{mm}^4$ $E = 68000\text{N/mm}^2$ $L = 2000\text{mm}$

$$d = \frac{981 \times 2000^3}{48 \times 68000 \times 3700000} = 0.65\text{mm}$$

To determine the deflection of the beam due to its own weight Equation 2 can be used.

$$d = \frac{5L^3}{384EI} \times \frac{LQg}{1000} \qquad \text{Equation 2}$$

Where; $Q = 15.7\text{kg} \times 2 + 12.2 = 43.6\text{kg}$

$$d = \frac{5 \times 2000^3}{384 \times 68000 \times 3700000} \times \frac{2000 \times 43.6 \times 9.81}{1000} = 0.35\text{mm}$$

Therefore, the total deflection at the centre of the beam, of a 2000mm long SBD 30-100 unit with a 100kg load, is;

0.65mm + 0.35mm = 1mm.

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