This data sheet interacts with

HDS2 Catalogue

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HepcoMotion®

No. 2 HDS2 Beam Deflection Calculations

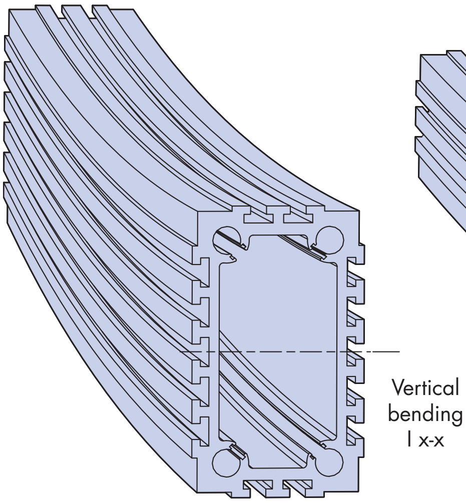
When designing a system using a Hepco construction beam, which has a section that is unsupported, the amount of deflection should be considered. The beam deflections can be calculated using simple theory which is comprehensively covered in many engineering text and reference books, however the following data sheet covers calculations for common applications.

The magnitude of the deflection will depend on a number of factors, namely, the amount of load acting on the system, and method of beam support, and the distance that the beam is spanning.

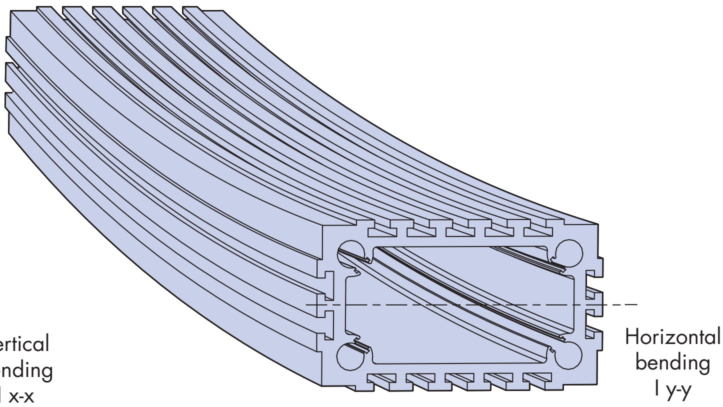
Parameters required for beam deflection calculations can be found in the table below.

Parameter			HB25C	HB25	HB33
Beam second moment of inertia	I x-x	mm^4	$2.8x10^6$	$4.7x10^7$	$16.9x10^7$
	I y-y		$10.2x10^6$	$1.8x10^7$	$8.4x10^7$
Dimension Y	Vertical bending	mm	38	110	150
	Horizontal bending		70	65	100
Mass of beam	Q	kg/m	11.3	24	37.5
Young's Modulus	E	N/mm^2	66 000		
Maximum allowable bending stress	σ	N/mm^2	90		

The figures quoted for Ix-x are to be used when calculating deflections of beams subject to vertical loading and Iy-y is to be used when calculating deflections of beams subject to horizontal bending - see diagrams below and on the next page.



Vertical bending



Horizontal bending

Note: In all calculations lengths are in mm and forces in N (newtons).

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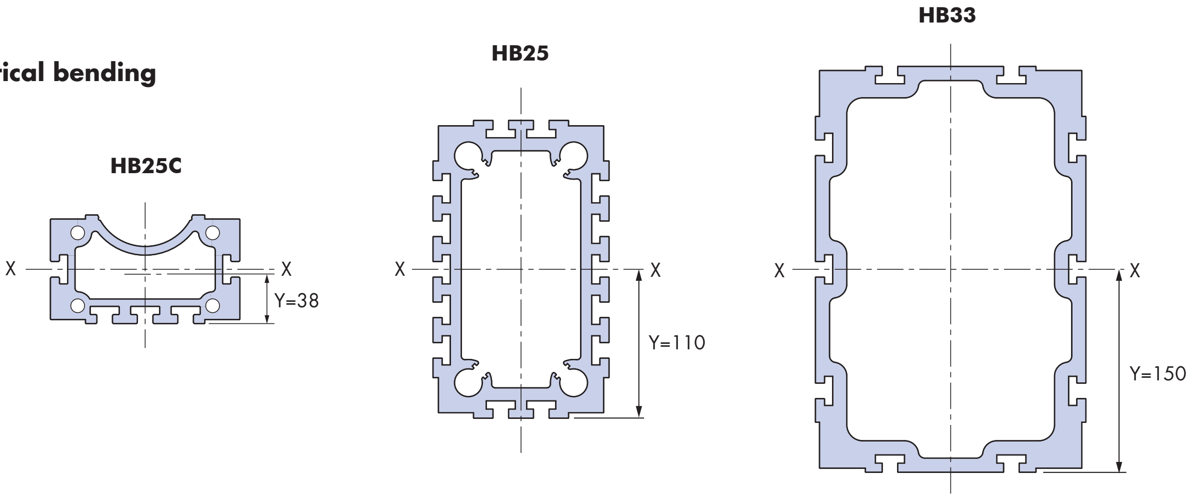
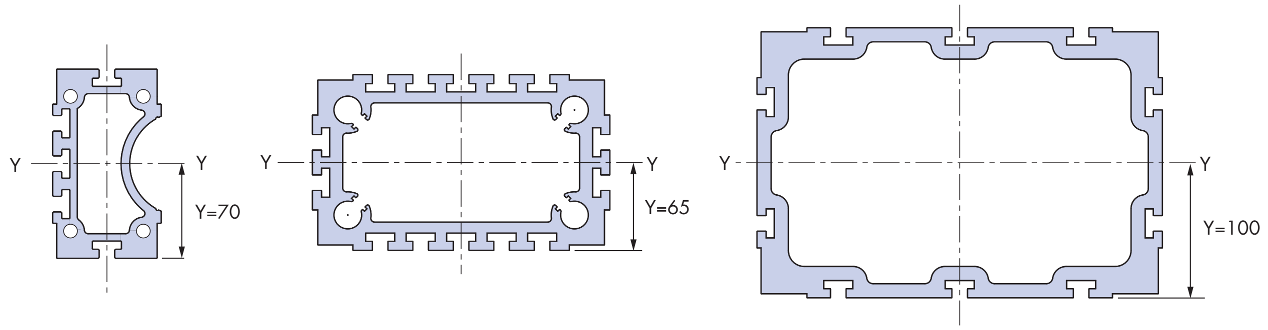
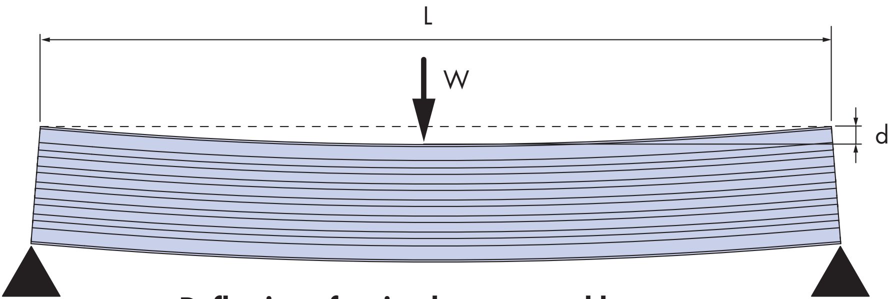
Vertical bending



Horizontal bending



The beam deflection is accurately modelled by simple beam bending equations. The most common application is for a HDS2 construction 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.



Deflection of a simply supported beam

$$d = \frac{W \times L^3}{48 \times E \times I} \qquad \text{equation 1}$$

Where: E = Young's Modulus of the aluminium material of the beams see table on 📖1;
I = Moment of inertia of the beam section, which can be found in the table on 📖1;

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 beam of length L supported at it ends, the deflection at its centre due to its own weight will be as given in equation 2 below.

$$d = \frac{5 \times L^3}{384 \times E \times I} \times \frac{L \times Q \times g}{1000} \qquad \text{equation 2}$$

Where Q is the mass of the beam in kg/m, g = acceleration due to gravity (= 9.81m/s²) and the other quantities are as per equation 1.

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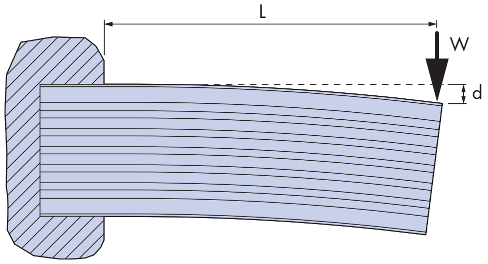
The deflection of a beam, mounted as a cantilever axis can be calculated by similar methods: If a load W is applied at the end of the beam, and the distance from the point of load application to the edge of the support is L, then the beam deflection d at the point of load is given by equation 3 below;



Deflection of a cantilever beam

$$d = \frac{W \times L^3}{3 \times E \times I} \qquad \text{equation 3}$$

The beam deflection at the end of a cantilever beam under the action of its own weight will be given by equation 4 below, where the symbols have the same meaning as for equations 1 & 2;

$$d = \frac{L^3}{8 \times E \times I} \times \frac{L \times Q \times g}{1000} \qquad \text{equation 4}$$

The maximum load which can be put onto a beam is determined by the maximum allowable bending stress for the material. This can be found in the table on 🕮1. The peak bending stress σ for a given load on a simply supported beam is shown on the previous page. Y is the distance from the centre of the beam to its extreme edge in the direction of the applied load, see the diagram on 🕮 1.

$$\text{peak stress } \sigma = \frac{W \times L \times y}{4 \times I}$$

Re-arranging the above formula to determine the load capacity of a simply supported beam at the maximum allowable bending stress.

$$\text{beam strength} = \frac{\sigma_{max} \times 4 \times I}{L \times y} \qquad \text{equation 5}$$

The maximum load capacities for a cantilever beam are given as.

$$\text{beam strength} = \frac{\sigma_{max} \times I}{L \times y} \qquad \text{equation 6}$$

The calculations in this data sheet refers to the deflection and load capacity of the construction beam sections without, back plates or slides fitted. The addition of any or all of these will increase the stiffness of the beam, however such compound beams do not always follow the simple equations laid out above. The amount of stiffness effect will depend, to some degree on the application.

The calculations also assume beams are “long” and may be slightly inaccurate for lengths much below 1m.

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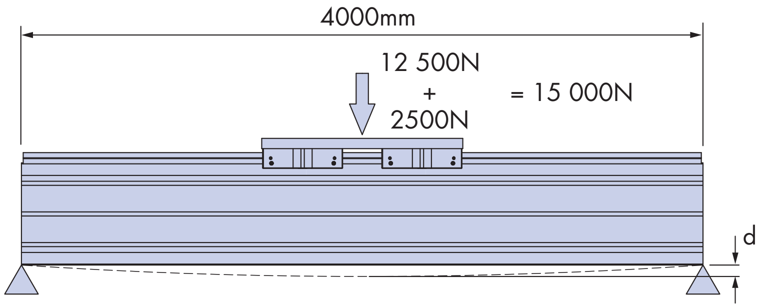
Example

A gantry system has a central span of 4000mm which is simply supported at its ends. The HB33 beam is fitted with 2 x HSS33 V slide as shown below. The carriage assembly weighs 2500N and there is an external load of 12 500N. 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.



$$d = \frac{W \times L^3}{48 \times E \times I}$$ equation 1

Where; W = 15 000N, L = 4 000mm, E = 66 000N/mm^2, I x-x = 16.9 x 10^{7}mm^4

$$d = \frac{15000 \times 4000^3}{48 \times 66000 \times 16.9x10^7} = 1.79\,mm$$

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

$$d = \frac{5 \times L^3}{384 \times E \times I} \times \frac{L \times Q \times g}{1000}$$ equation 2

Where; Q = 37.5 kg/mtr

$$d = \frac{5 \times 4000^3}{384 \times 66000 \times 16.9 \times 10^7} \times \frac{4000 \times 37.5 \times 9.81}{1000} = 0.11mm$$

Therefore the total deflection at the centre of a 4800mm long HB33 beam with a 1500kg load is;
1.79mm + 0.11mm = 1.9mm

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