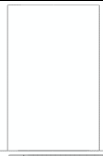
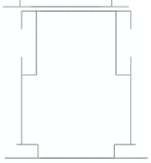
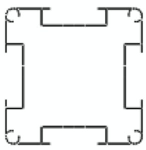
DETERMINATION OF THE MAXIMUM LOAD RESISTANCE OF ALUMINIUM PROFILES

1. INTRODUCTION

Four different aluminium sections were provided by beMatrix with the request to determine their maximum load bearing capacity in bending. These four sections are illustrated in the table below. For each of these sections the maximum distributed load and point load (in the middle of the beam) were determined via finite element models. This was done on a 4 m long beam. Rescaling the results to other lengths is simply done using beam formulas.

Table 1 – Sections

Section	Name	
1	DMK	
2	b62	
3	DMHL	
4	SQ62	

2. DESCRIPTION OF THE FINITE ELEMENT MODEL

For each section a finite element model was created with the following features:

- Modelled as shell
- A length of 2 m with symmetry conditions applied to one side, resulting in a total length of 4 m
- The other side is assumed fully fixed (encastred)

An example of a model is illustrated in Figure 1. The purpose of the calculations is to identify the maximum allowable load for different load cases:

- LC-1a: Point load (in the middle) pointed in the strong direction of beam
- LC-1b: Distributed load pointed in the strong direction of beam
- LC-2a: Point load (in the middle) pointed in the weak direction of beam
- LC-2b: Distributed load pointed in the weak direction of beam

Note that LC-2a en LC-2b were only checked for sections 1 and 2 (DMK sections), since the other beams are only used in the strong direction. The maximum load for other lengths can be calculated by scaling the results, depending on the considered load case:

- For point loads: scaling is done linearly with the length: $x = \frac{F_4 \cdot 4}{l_x}$, with F_4 the maximum point load calculated by the finite element model for the 4 m beam and l_x the considered length.
- For distributed loads: scaling is done quadratically with the length: $q_x = \frac{q_4 \cdot 16}{l_x^2}$, with q_4 the maximum distributed load calculated by the finite element model for the 4 m beam and l_x the considered length.

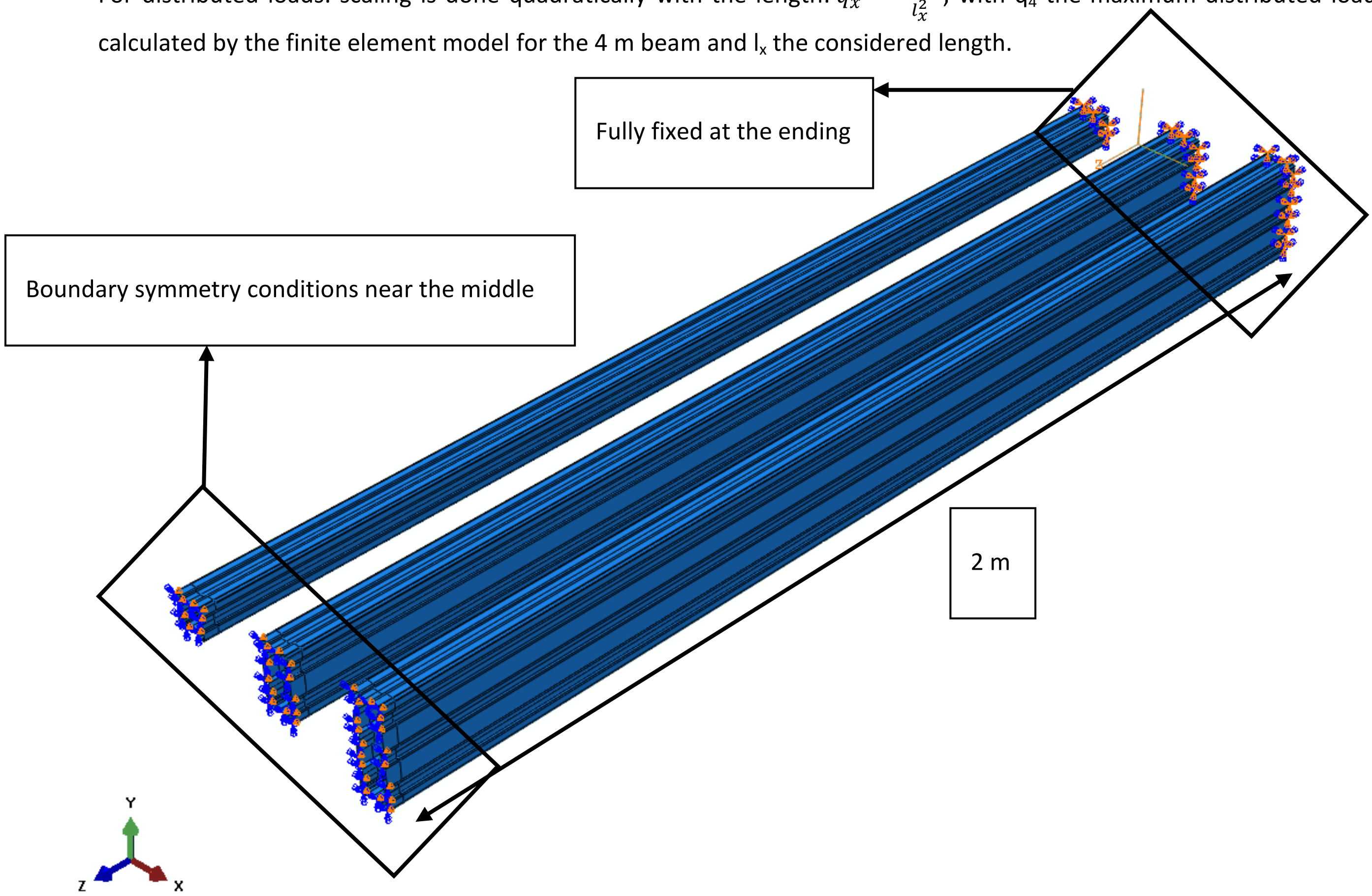


Figure 1 - Example of a model (SQ sections)

Note that gravity was included and that the necessary load factor was applied, i.e. 1.35. To avoid unphysical local stresses near the point loading, the load was distributed near the middle of the beam; see Figure 2 to Figure 5 for the area on which the point load was applied.

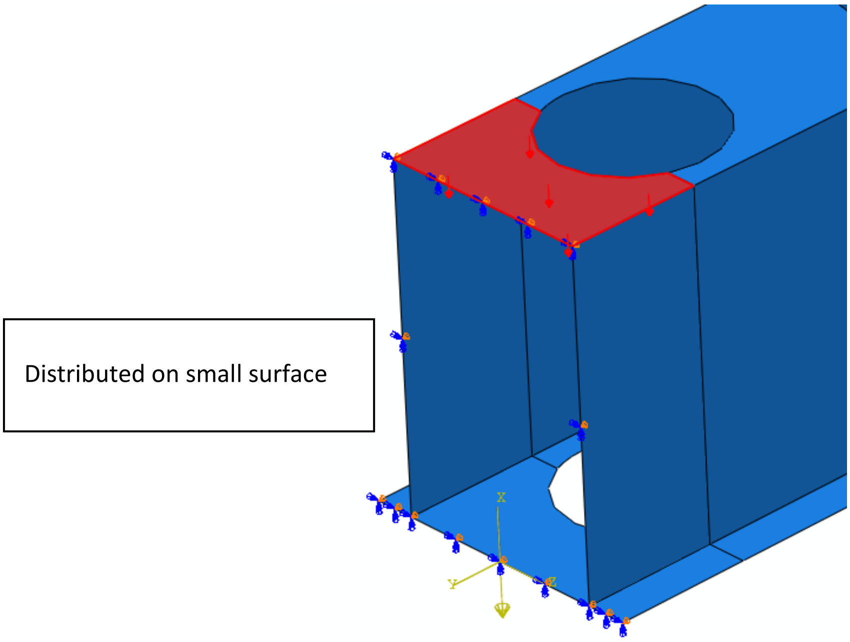


Figure 2 - Point load distribution, DMK section

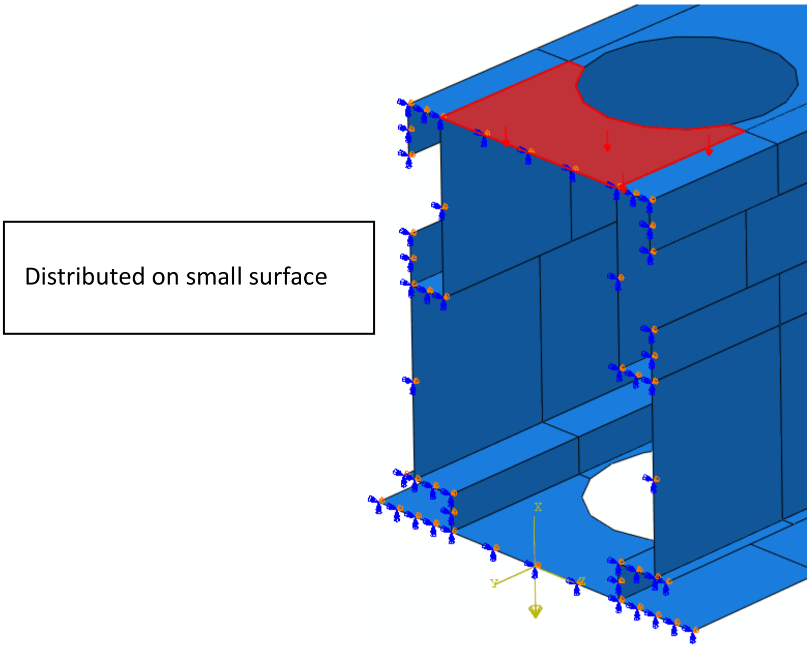


Figure 3 - Point load distribution, b62

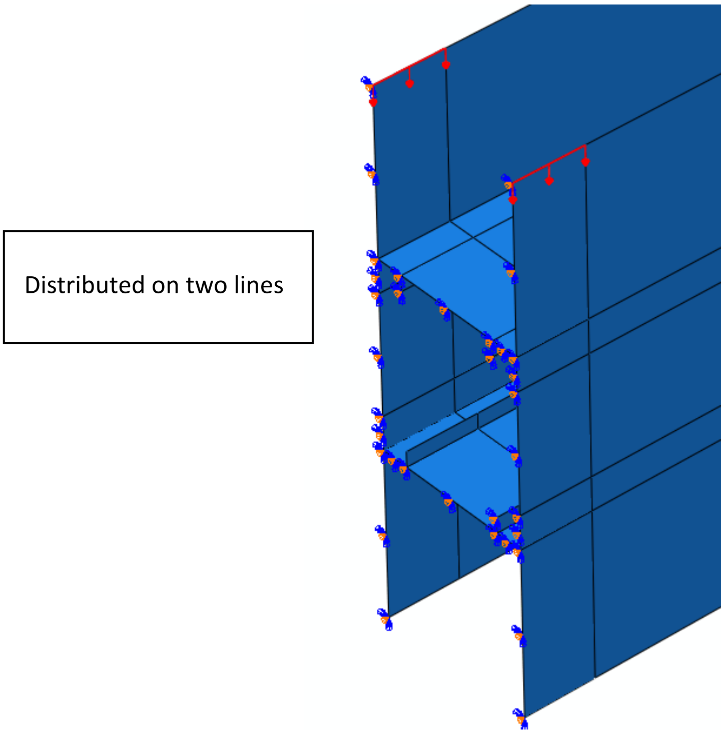


Figure 4 - Point load distribution, DMHL

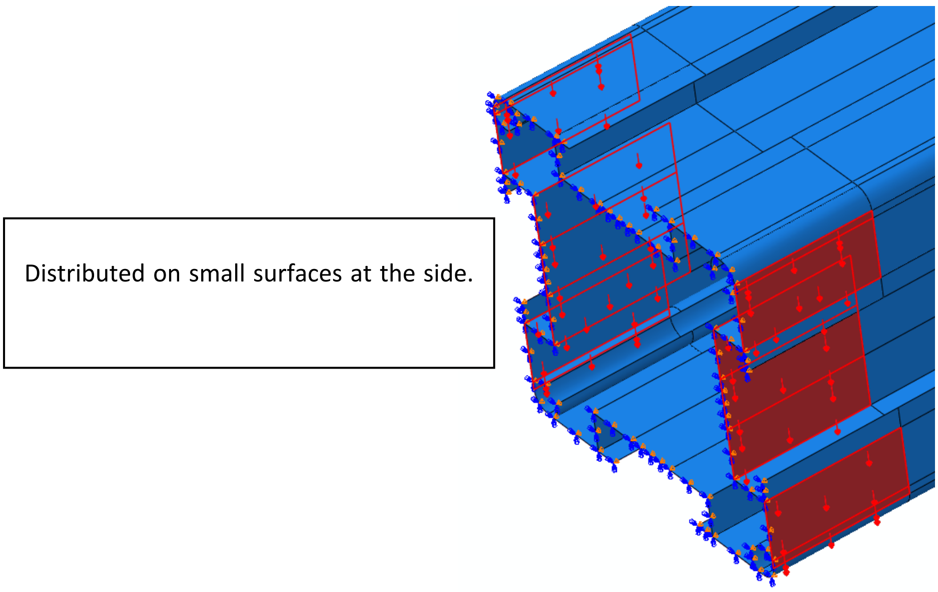


Figure 5 - Point load distribution, SQ 62

3. RESULTS

Showing the stress results for all the sections and for all the combinations would render the report long and difficult to read. Instead the maximum forces are given for each section in tables (determined based on the design resistance of EN AW 6060 T6: 127 MPa). Also, the moment of inertia is given in the same tables. Note that a safety factor was not taken into account in these tables. The maximum load according to EN1990 (i.e. including a suitable safety factor) is found by dividing the values in the table with 1.5.

1) DMK

Table 2 – Results DMK

LC	Max. load	Displacement [mm]	Displacement (gravity excluded) [mm]	Moment of inertia [mm^4]
1a – Point strong*	552 N	16.12	15.35	171242
1b – Distr. strong*	215 N/m	12.68	11.91	171924
2a – Point weak	960 N	31.97	30.98	147561
2b – Distr. weak	345 N/m	24.14	23.15	141932

*Because the section is not symmetrical the calculation was done for the load being applied on both sides. The values in the table are the lowest ones.

2) b62

Table 3 – Results b62

LC	Max. load	Displacement [mm]	Displacement (gravity excluded) [mm]	Moment of inertia [mm^4]
1a – Point strong*	897 N	18.57	18.04	236775
1b – Distr. Strong*	345 N/m	14.41	13.88	236723
2a – Point weak	1320 N	30.22	29.59	212427
2b – Distr. weak	484 N/m	22.80	22.17	207917

*Because the section is not symmetrical the calculation was done for the load being applied on both sides. The values in the table are the lowest ones.

3) DMHL

Table 4 – Results DMHL

LC	Max. load	Displacement [mm]	Displacement (gravity excluded) [mm]	Moment of inertia [mm^4]
1a – Point strong	9120 N	12.45	12.35	3516484
1b – Distr. strong	3340 N/m	9.17	9.07	3507114

4) SQ62

Table 5 – Results SQ62

LC	Max. load	Displacement [mm]	Displacement (gravity excluded) [mm]	Moment of inertia [mm^4]
1a – Point strong	2137 N	28.22	27.72	367106
1b – Distr. strong	766 N/m	21.18	20.68	352768

4. OVERVIEW

In Table 8 the maximum allowable forces are given for all sections taking into account the load factor of EN1990. Also, for each combination a formula is given to determine the maximum load for a different length l_x.

Table 8 – Overview results with load factor included

Section	LC	Max. load	Moment of inertia [mm^4]	Formula [N]
DMK	1a – Point strong	368 N	171242	$1460/l_x$
	1b – Distr. strong	143 N/m	171924	$2252/l_x^2$
	2a – Point weak	640 N	147561	$2540/l_x$
	2b – Distr. weak	230 N/m	141932	$3621/l_x^2$
b62	1a – Point strong	598 N	236775	$2373/l_x$
	1b – Distr. strong	230 N/m	236723	$3621/l_x^2$
	2a – Point weak	880 N	212427	$3492/l_x$
	2b – Distr. weak	323 N/m	207917	$5086/l_x^2$
DMHL	1a – Point strong	6080 N	3516484	$24320/l_x$
	1b – Distr. strong	2227 N/m	3507114	$35632/l_x^2$

Note that the maximum loads are a result of the stresses calculated with a finite element model. It is expected that simple beam formulas would result in higher allowable loads as they cannot take into account the stress concentrations found near small details or holes.

Legend:

- Point strong: Point load in the strong direction (middle of the beam)
- Distr. strong: Distributed load in the strong direction
- Point weak: Point load in the weak direction (middle of the beam)
- Distr. weak: Distributed load in the weak direction