S4GA	Test Report	12.03.2020
	Wind resistance simulation	
S4GA Laboratory		no.08/2020

Wind impact on SP-401 with rubber pad

Report No. 08/2020	Signature of the verifying examination	Pages 15	Original

1. Executive report

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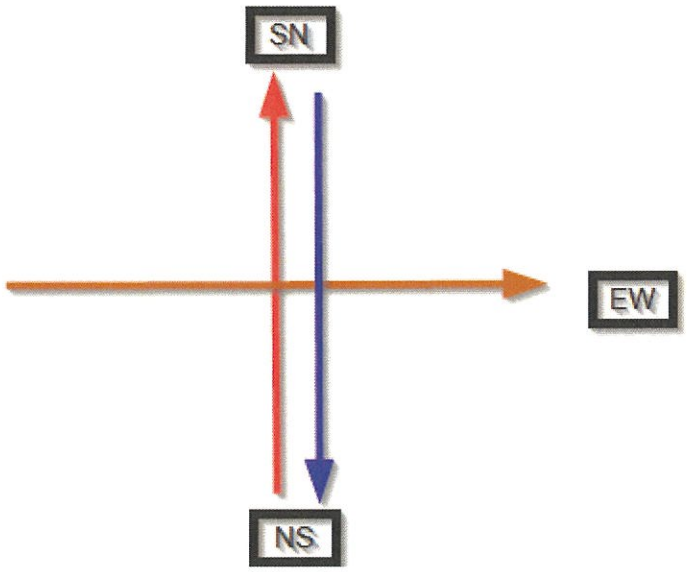
3. General Assumptions

3.1. General conditions

Every version is considered to be laid on flat and leveled surface. Surface is made of Stone Mastic Asphalt (SMA).

Lamp is tested against the resultant forces of winds heading from following directions.

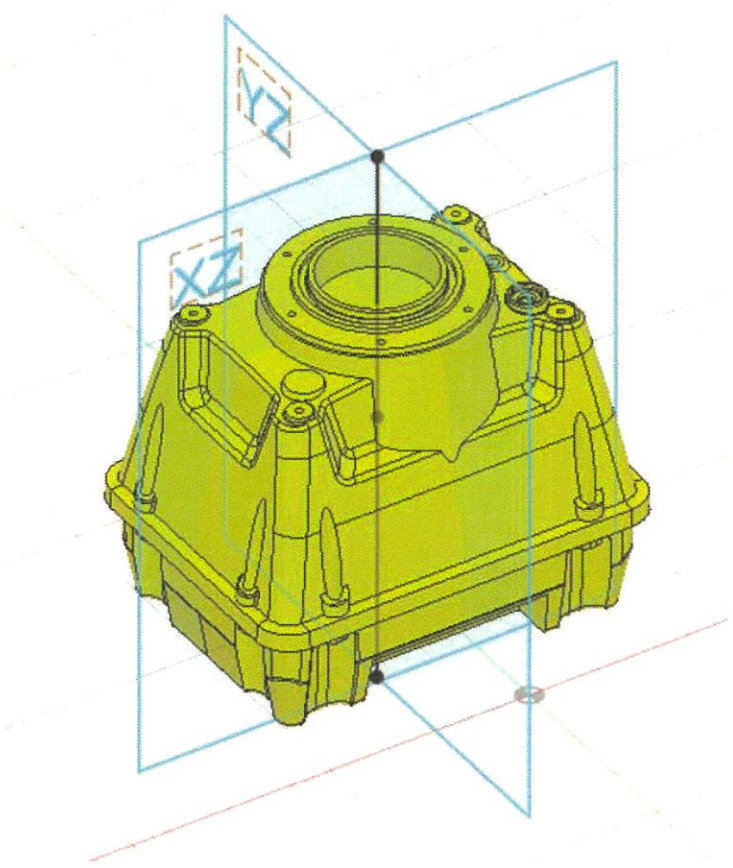
- North to South
- South to North (for cases with solar)
- East West



As the geometry of the lamp is symmetric around YZ plane and XZ plane following assumptions were made.

For version 1 and version 2 - Lamp is subjected to wind loads only from NS and EW direction

For version 3 and 4 - Lamp with solar is subjected to wind loads from NS, SN and EW direction.



3.2. Initial data

Based on data from gathered data

Friction coefficients:

$$\mu_{Rubber-Asphlat} = 0.9$$

$$\mu_{Steel-Asphalt} = 0.58$$

$$\mu_{PCplastic-Asphalt} = 0.4$$

Used formulas :

Force exerted by the wind over the area can be expressed as following:

$$F = \frac{\rho_{air} \cdot v_{wind}{}^{2} \cdot Area}{2}$$

4. Version-2 Lamp SP-401 standing on ground with the rubber pad

5.1.Data

Setup: Lamp laid on Asphalt. SP401 is symmetrical in YZ and XZ this calculation is conducted only for NS and WE loads.

Friction coefficient = 0.9 - Friction between rubber and asphalt.

(Friction may vary depending on Asphalt mixture, other more significant changes may occur when the ground specification changes)

Version:	2
Description:	SP 401 without solar; with rubber pad
mass:	8000g SP-401 + 2000g Rubber pad Total 10000g
Area NS	0.0684 m^2
Area WE	0.0698 m^2

Rubber pad data:

dimensions:

$Lenght \equiv 600\ \text{mm}$

$Width \equiv 300\ \text{mm}$

$Thickness \equiv 48\ \text{mm}$

$Volume_{rubber} \equiv Lenght \cdot Width \cdot Thickness$

$0.00864\ \text{m}^3$

Weight:

$\rho_{rubber} \equiv 1{,}000 \cdot \frac{1\ \text{kg}}{1\ \text{m}^3}$

$m_{Rubber} \equiv Volume_{rubber} \cdot \rho_{rubber}$

$8.64\ \text{kg}$

Data for lamp:

$m_{ver2} \equiv m_{ver1} + m_{Rubber}$

$16.64\ \text{kg}$

$VER2_{weight} \equiv g \cdot m_{ver2}$

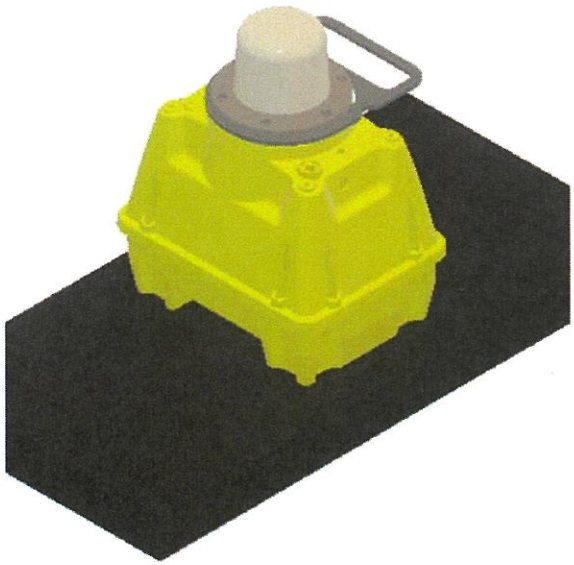
$163.24\ \text{N}$

$V2Area_{NS} \equiv V1Area_{NS} + (Width \cdot Thickness)$

$0.0684\ \text{m}^2$

$V2Area_{WE} \equiv V1Area_{WE} + (Lenght \cdot Thickness)$

$0.0698\ \text{m}^2$



5.2.Results

Version 2	
Wind load required to move the SP-401 lamp with rubber pad	
Direction:	Result in [N]:
NS	146.91
SN	146.91
WE	150.37
Wind speed corresponding to the loads	
Wind speed causing critical load	Result in:[m/s] ; [km/h] ; [knots]
NS	68.16 ; 215.39 ;116.3
SN	68.16 ; 215.39 ;116.3
WE	77.08 ; 213.22 ; 115.13

5.3. Graphs

5.3.1 Version 2 NS/SN graph

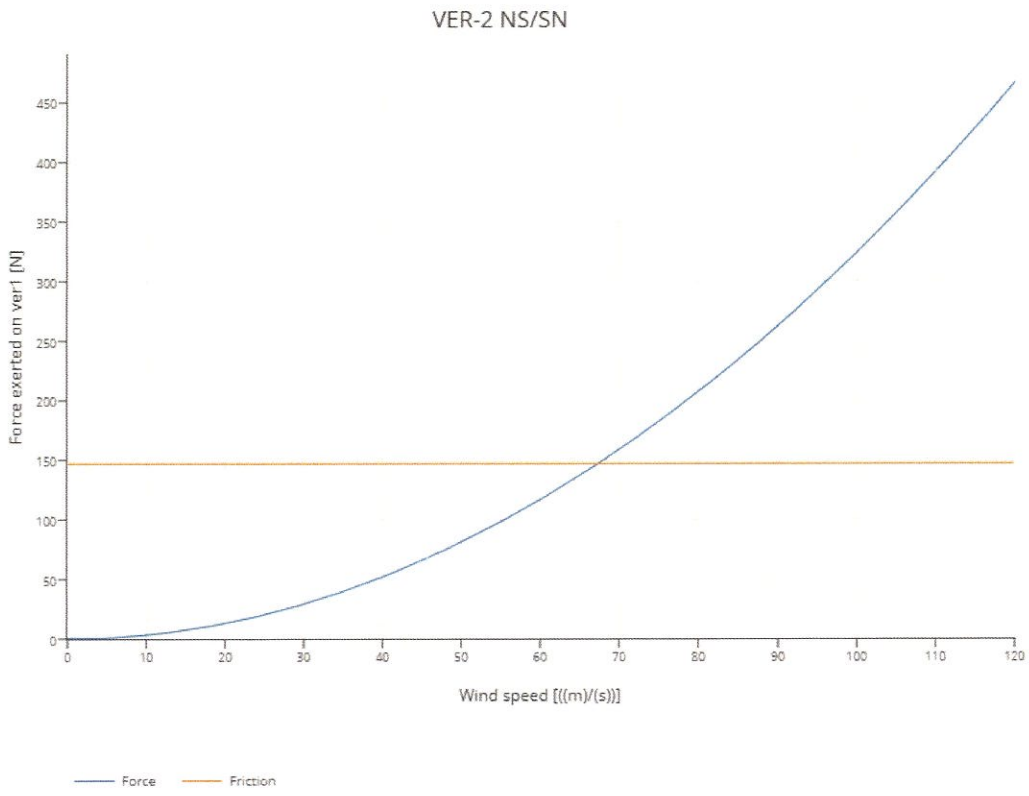
$$Force_{NSver2}(v_{wind}) \equiv \frac{\rho_{air} \cdot v_{wind}^{2} \cdot V2Area_{NS}}{2}$$

$$v_{check} \equiv \sqrt{\frac{StaticFrictionV2 \cdot 2}{\rho_{air} \cdot V2Area_{NS}}}$$

$v_{check} = 215.39 \ \frac{km}{h}$

v_{check}

$= 116.3 \ knot$



5.3.2 Version 2 WE graph

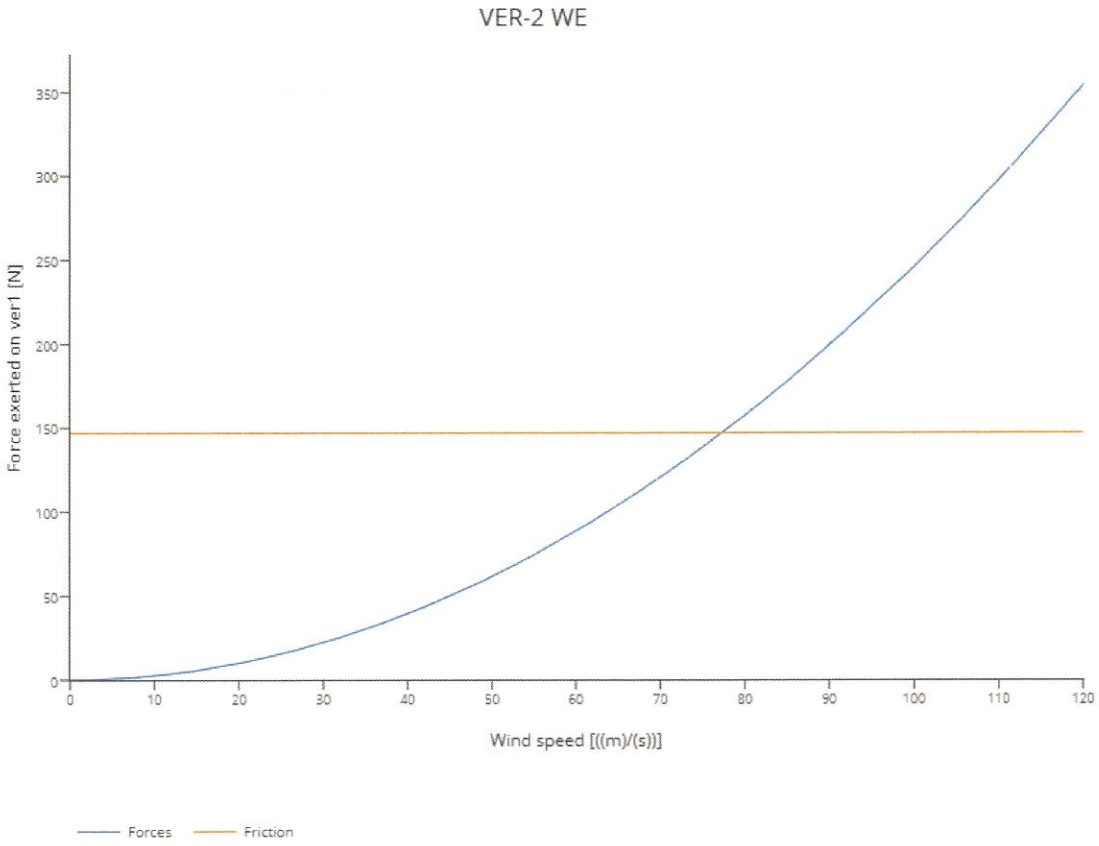
$$Force_{WEver2}(v_{wind}) \equiv \frac{\rho_{air} \cdot v_{wind}^{2} \cdot V2Area_{WE}}{2}$$

$$v_{check} \equiv \sqrt{\frac{StaticFrictionV2 \cdot 2}{\rho_{air} \cdot V2Area_{WE}}}$$

$$213.22\ \frac{km}{h}$$

$$v_{check}$$

$$115.13\ knot$$

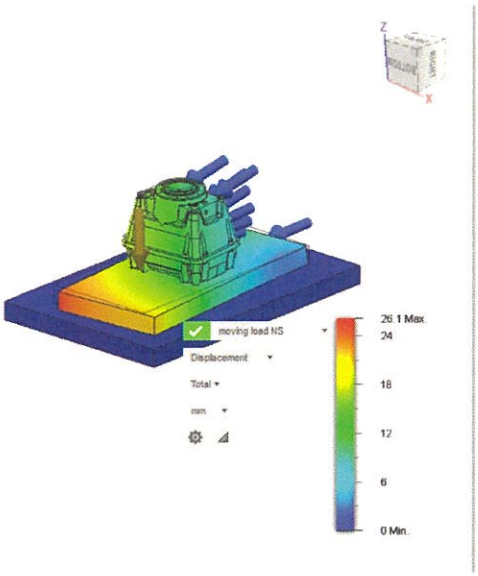

VER-2 WE
Force exerted on ver1 [N]
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
90
100
110
120
Wind speed [((m)/(s))]
Forces
Friction

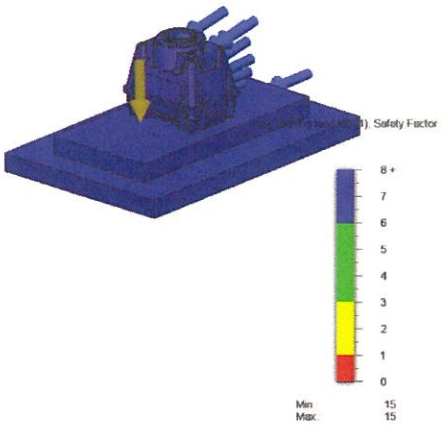
5.5 Results from simulation

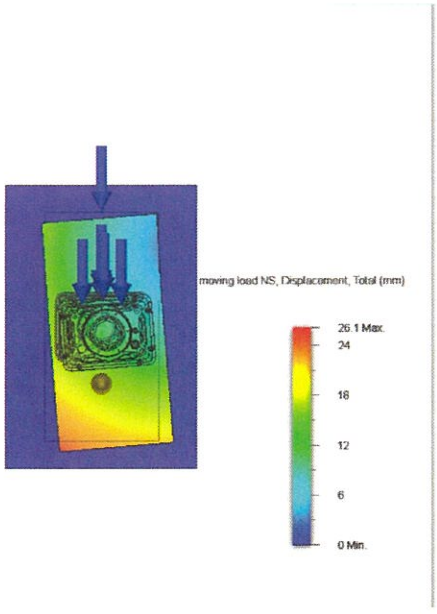
5.5.1 Simulation NS direction

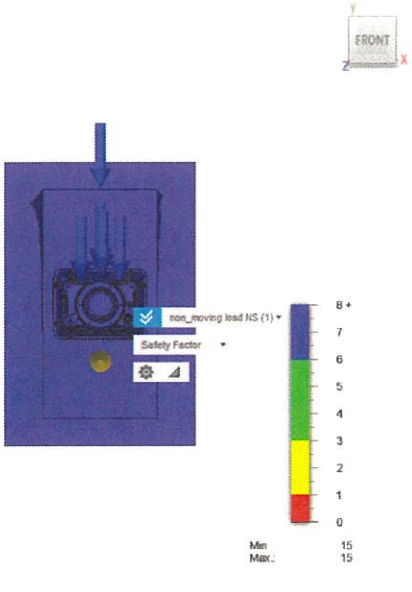
Load on loadcase 1 is equal to 150N the force that may cause the movement.

Load on loadcase2 is equal to 130N the force that should not cause the movement.





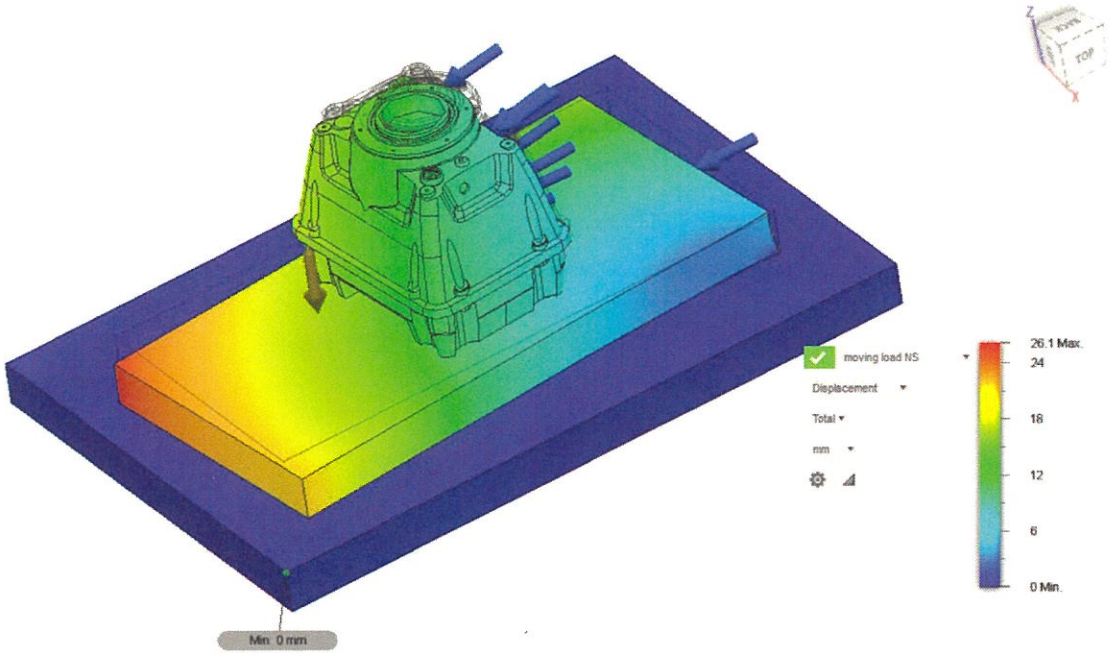




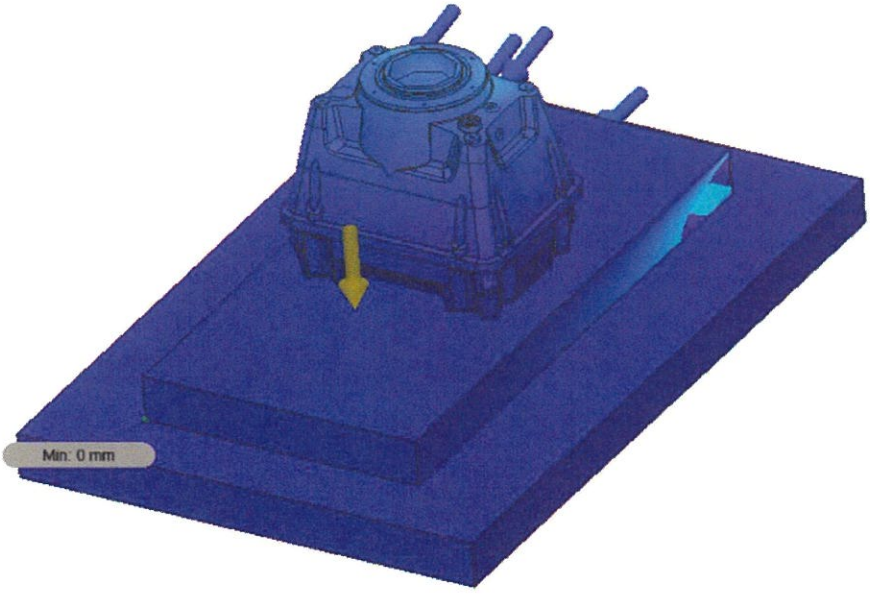
Load case comparison above: Load case 1 is located on the left, loadcase 2 is located on the right.

As a conclusion it was proven that forces above 146 N acting in NS direction will cause the movement of the lamp.

Load case 1:



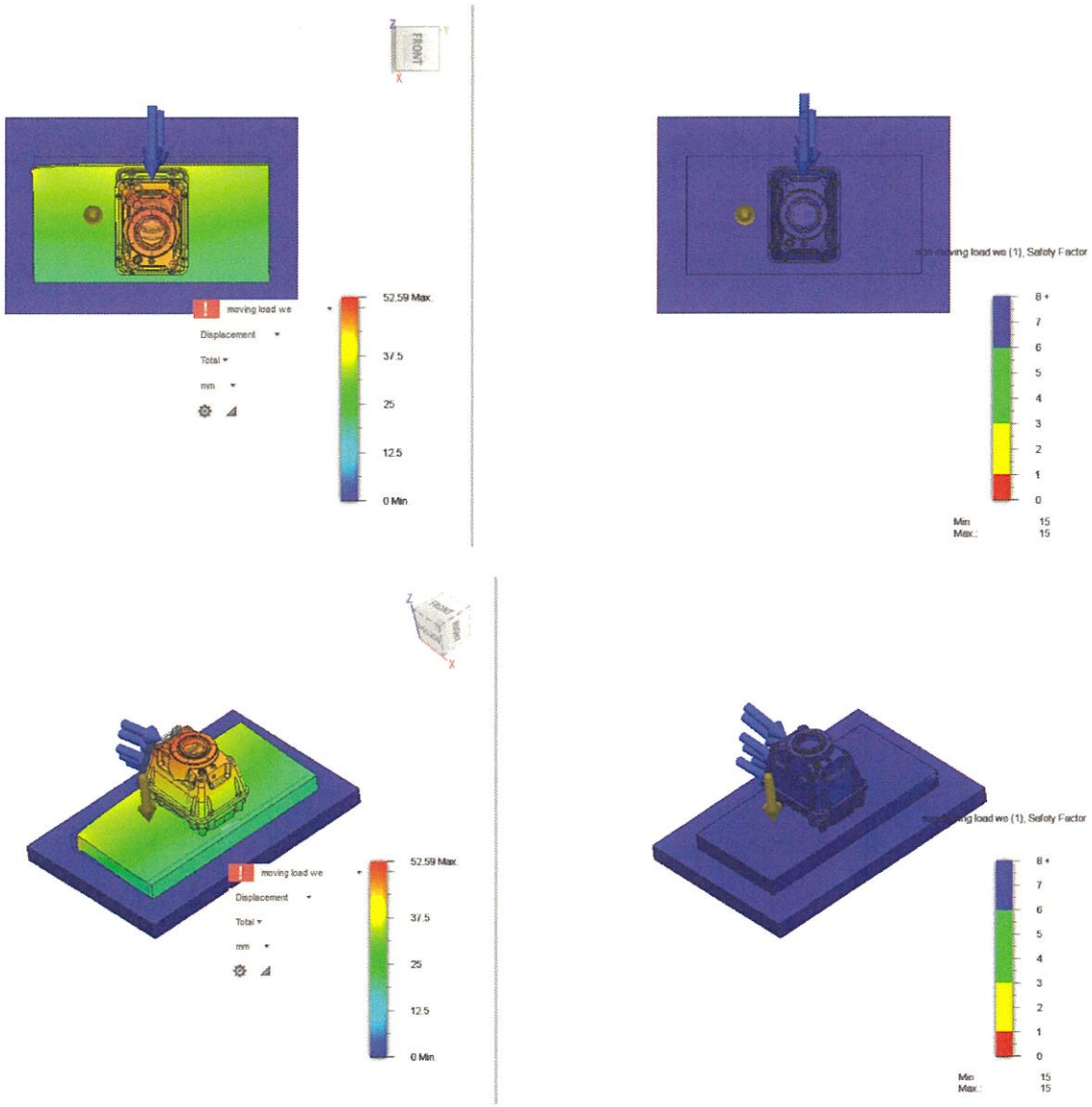
Load case 2:



5.5.2 Simulation WE

Load on loadcase 1 is equal to 155N the force that may cause the movement.

Load on loadcase2 is equal to 140N the force that should not cause the movement.



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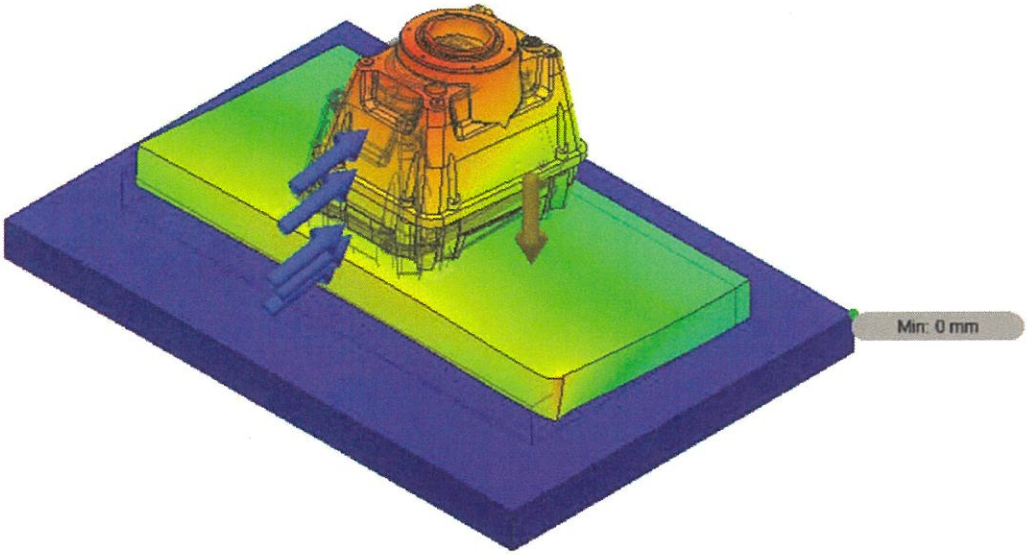
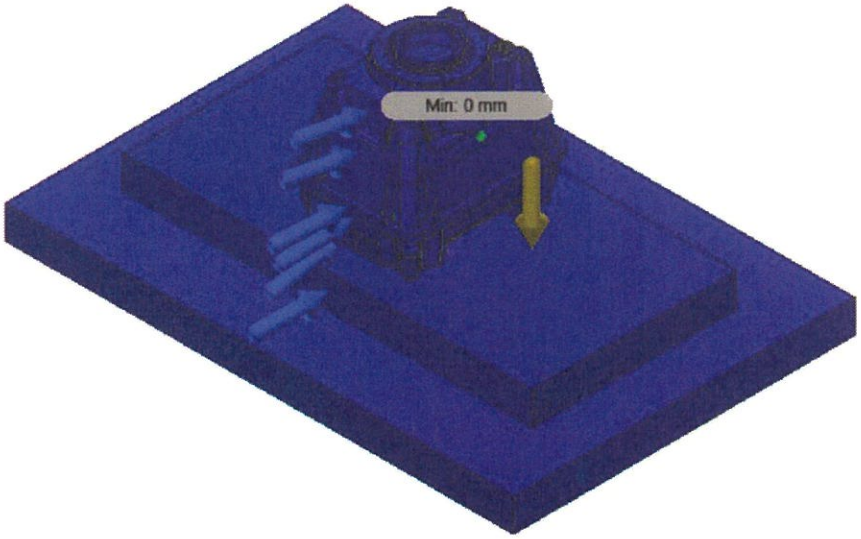
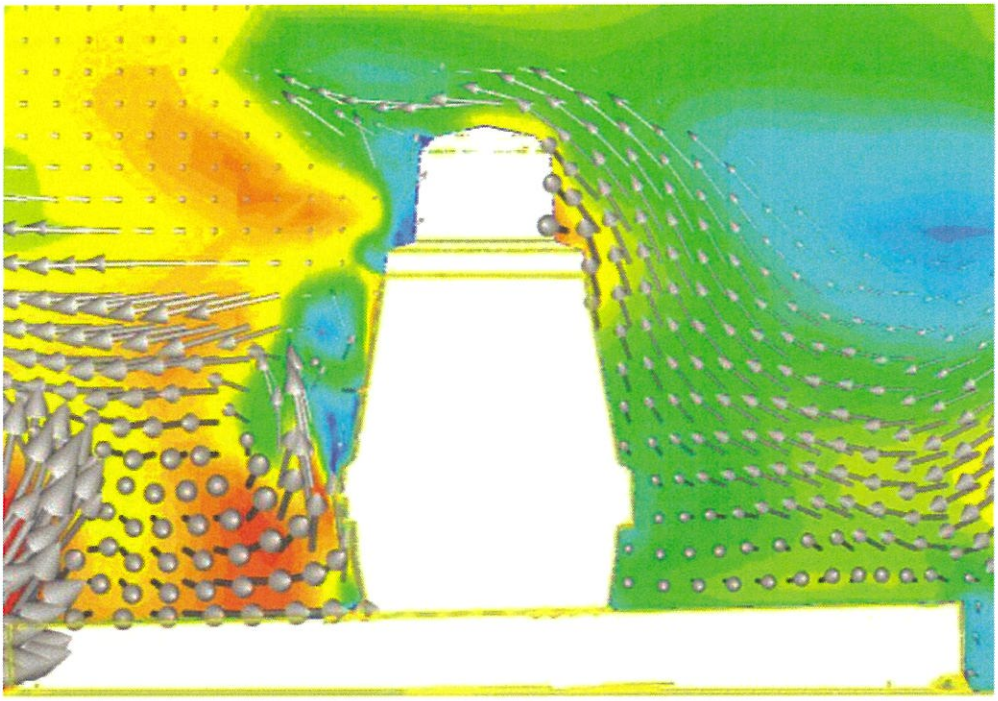


Load case 2:

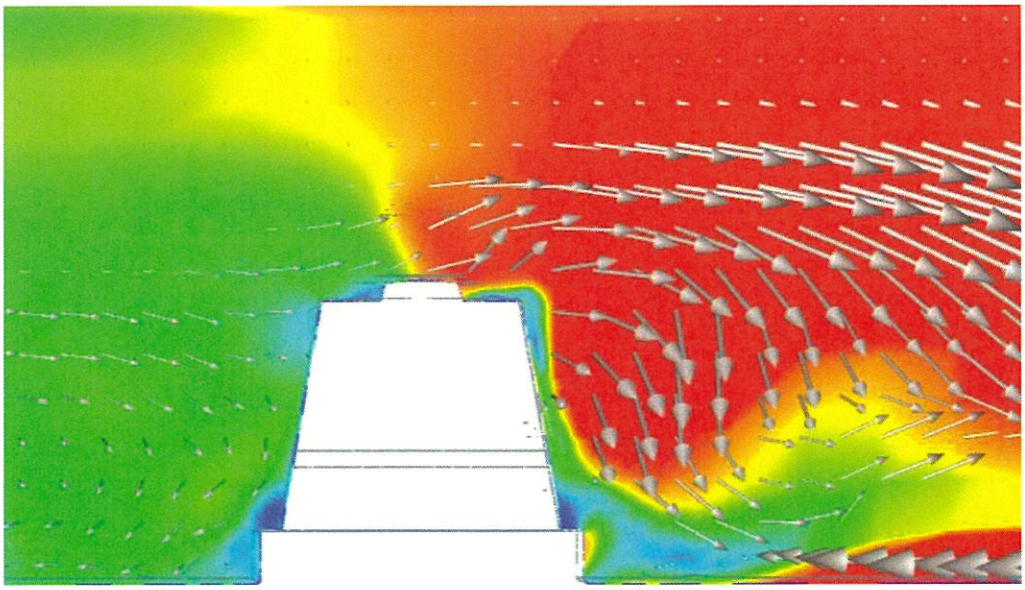


5.5.3 Flow around the Version 2

NS direction wind loads on the lamp.



WE direction wind loads on the lamp.



6.Conclusions

Lamp will be able to withstand loads, without moving up to

direction - NS - 146.91 [N] resulting speed 68.16 [m/s] ; 215.39 [km/h] ;116.3 [knots]

direction - SN - 146.91[N] resulting speed 68.16 [m/s] ; 215.39 [km/h] ;116.3 [knots]

direction - WE - 150.37 [N] resulting speed 77.08[m/s] ; 215.39 [km/h] ;115.13[knots]

Please ensure operation in winds below stated values. Note that the speeds and forces that SP-401 lamp can withstand are strictly bounded by the friction coefficient of the surface, where the lamp is placed. The values may vary depending on surface materials, or how wet the surface is. The observation of the lamp behaviour, when placed in a new environment, is strictly advised.

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