**Rigging checks**

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# General

## Description of operation

Object to be lifted:

# References, DEFINITIONS, ABBREVIATIONS, ACRONYMS

## DEFINITION/ABBREVIATION

| **Definition/Abbreviation** | |
| --- | --- |
| Cable Laid Grommet | A loop made entirely of a single length of steel wire rope, laid-up 6 times over a steel core which belongs to the same length of rope. |

## REFERENCE

| **Ref** | **Document Titel** | **Description** | **Edition** |
| --- | --- | --- | --- |
| 2.1.1 | DNV-ST-N001 | Marine operations and marine warranty | September 2018 |

## Drawings

Hier wil ik dan de rigging tekeningen plaatsen

# Object Data

## Mass object/rigging

See table below for mass of object and the rigging weigh:

|  |  |  |  |
| --- | --- | --- | --- |
| What | Symbol | Value | Unit |
| Mass of lifted object | LW | {{LW}} | [t] |

## Coordinates lift points/COG

{{Top\_view\_image}}

See table below for the lift punt coardinates and, the COG coordinate

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Point | X  [m] | Y  [m] | Z  [m] | Load  [%] | Vert  [t] |
| {%tr for r in table\_lift\_points %} | | | | | |
| {{r[“point”]}} | {{r[“x”]}} | {{r[“y”]}} | {{r[“z”]}} | {{r[“perc”]}} | {{r[“t”]}} |
| {%tr endfor %} | | | | | |
| Sum | 100% | {{LW}}[t] |

See table below for COG point:

|  |  |  |  |
| --- | --- | --- | --- |
| Point | X  [m] | Y  [m] | Z  [m] |
| COG | {{COG\_x}} | {{COG\_y}} | {{COG\_z}} |

## Object geometry and COG envelope

See table below for the object the length width and height of the object:

|  |  |  |  |
| --- | --- | --- | --- |
| What | Symbol | Value | Unit |
| Object length (x direction) | Length | {{Object\_length}} | [m] |
| Object width (y direction) | Width | {{Object\_width}} | [m] |
| Object height (z direction) | Height | {{Object\_height}} | [m] |

The COG envelop size is equal to 0.05L x 0.05W x 0.05H, where L, W and H are the length width and height of the structure (see Ref 2.1, paragraph 5.6.2.3 guidance note 1). See table below for the size of the cog envelope:

|  |  |  |
| --- | --- | --- |
| What | Value | Unit |
| Total COG envelope x (0.05x Object Length) | {{COG\_envelope\_x}} | [mm] |
| Total COG envelope y (0.05x Object Width) | {{COG\_envelope\_y}} | [mm] |
| Total COG envelope z (0.05x Object Height) | {{COG\_envelope\_z}} | [mm] |

## COG shift factor total

See table below for total calculation of the COG shift factor:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Including envelope both directions | | Including envelope only x-direction | | Including envelope only y-direction | |
| Lifting points | Load | Cog shift factor | Load | Cog shift factor | Load | COG shift factor |
| {%tr for r in COG\_shift\_calc\_total %} | | | | | | |
| {{r[“point”]}} | {{r[“perc\_b”]}}% | {{r[“cog\_b”]}} | {{r[“perc\_x”]}}% | {{r[“cog\_x”]}} | {{r[“perc\_y”]}}% | {{r[“cog\_y”]}} |
| {%tr endfor %} | | | | | | |

# General factors

In this chapter the general factors will be discussed.

## Weight contingency factor

The weight contingency factor is based on Ref 2.1, paragraph 5.6.2.2. The weight class of the lifted object is: **{{ans\_WCF}}**, see table below for the weight contingency factor:

|  |  |  |  |
| --- | --- | --- | --- |
| What | Symbol | Value Factor | Unit |
| Weight contingency factor |  | {{WCF}} | [-] |

## Dynamic amplification factor

The dynamic amplification factor is based on Ref 2.1 paragraph 16.2.5.6. The weight of the object is equal to **{{LW}}** tons, and the lift is **{{ans\_DAF}}.** See table below for the dynamic amplification factor:

|  |  |  |  |
| --- | --- | --- | --- |
| What | Symbol | Value Factor | Unit |
| dynamic amplification factor |  | {{DAF}} | [-] |

## COG shift Factor

### COG shift Factor crane

The COG shift factor is based on Ref 2.1 paragraph 5.6.2.2&3. There are/is **{{ans\_COGCrane}}** hook/hooks used on the same vessel during the lift. See below the COG shift factor of the crane

|  |  |  |  |
| --- | --- | --- | --- |
| What | Symbol | Value Factor | Unit |
| COG factor crane |  | {{COG\_crane}} | [-] |

### COG shift rigging

The COG shift of the rigging is calculated in chapter 3.5. The type of operation that is used for the checks is: **{{ans\_COG}}.** See table below for the COG shift factors:

|  |  |
| --- | --- |
| Lifting point | Max COG shift factor [-] |
| {%tr for r in COG\_shift\_rigging %} | |
| {{r[“point”]}} | {{r[“COG\_shift”]}} |
| {%tr endfor %} | |

## Tilt factor

In this chapter the tilt effect shall be calculated to account for the increased sling load caused by the rotation of the object about a horizontal axis, due to the lift with multiple hooks.   
There are 3 options: 1. Only rotates on its x-axis( Roll)  
 2. Only rotates on its y-axis( Pitch)  
 3. Both pitch and roll  
In this case the lift hooks causes {{ANS\_TILT}}, the angles are based on REF 2.1 parapraph 16.2.4 , and are equal to:  
**{{TILT\_angle}}**

In appendix B the calculations are shown of the TILT effect factor, the TEF factors can be shown in the table below:

|  |  |
| --- | --- |
| Lifting point | TEF [-] |
| {%tr for r in TEF\_factors %} | |
| {{r[“point”]}} | {{r[“TEF”]}} |
| {%tr endfor %} | |

## Yaw factor

The yaw factor is based on Ref 2.1 paragraph 16.2.4.5. There is/are **{{ans\_YAW}}** sling/slings attached to the hook.

|  |  |  |  |
| --- | --- | --- | --- |
| What | Symbol | Value Factor | Unit |
| Increased sling loading due to rotation of the object |  | {{YAW }} | [-] |

## Sling safety factors

In this chapter the sling safety factor will be discussed, the sling safety factor is based on Ref 2.1 paragraph 16.4.3. With the follow equation:

When the slings/grommets are made of steel the safety factor shall not be less then 2.3.

The reduction factor is determined in the following chapter, where the rigging is checked. See below all the sling safety factors.

{%p for p in paragraphs1 %}

### {{p[“sling”]}}

|  |  |  |  |
| --- | --- | --- | --- |
| What | Symbol | Value | Source |
| Lifting factor |  | {{p[“Lift\_factor”]}} | Ref 2.1 paragraph 16.4.4 |
| Consequence factor |  | {{p[“Consequence\_factor”]}} | Ref 2.1 paragraph 16.4.5 |
| Material factor |  | {{p[“Material\_factor”]}} | Ref 2.1 paragraph 16.4.9 |
| Wear and application factor |  | {{p[“Wear\_application\_factor”] }} | Ref 2.1 paragraph 16.4.10 |
| {{p[“sling”]}} factor( | | {{p[“SSF”]}} | [-] |

{%p endfor %}

# Check rigging equipment

In this chapter the rigging will be checked, in the first chapter the calculations are explained with a step plan. In the chapters that follow the rigging will be checked.

## Calculations rigging

**Step 1**

Determine the factored dynamic load:

|  |  |  |  |
| --- | --- | --- | --- |
| What | Symbol | Value | Source |
| Mass object | LW | {{LW}}[t] | Client |
| Weight contingency factor |  | {{WCF}}[-] | Chapter 4.1 |
| Dynamic amplification factor |  | {{DAF}}[-] | Chapter 4.2 |
| Increased sling loading due to rotation of the object |  | {{YAW }}[-] | Chapter 4.5 |
| Factored dynamic load | FDRL | {{FDRL}}[t] | - |

**Step 2**

Determine vertical load to lifting point:

Where:  
= Load percentage on lifting point[%](see Chapter 3.4)  
= Cog shift factor[-](see Chapter 3.4)  
= Skew load factor(see chapter see Chapter 4.6)

**Step 3**

Determine vertical load on slings:

Where:  
= Vertical load to lifting point[t]  
= Rigging weight above lifting point[t]  
= Dynamic amplification factor[-](Chapter 4.2)  
= Weight contingency factor[-](Chapter 4.1)

**Step 4**

Determine inline force slings:

Where:  
=Vertical load sling[t]  
= Sling angle vertical, transvere[deg]  
= Sling angle vertical, longitudinal[deg]

**Step 5**Determine sling load distribution factor, the sling load distribution factor is based on Ref 2.1 paragraph 16.2.8. The sling load distribution depends on the number of parts that a grommet/sling has. The more parts a sling/grommet has the higher the sling load distribution factor is. The factor is calculated with the following equation:

Where:  
= Max load distribution [%]( see next chapters )  
= Number of parts sling/grommet[-]

**Step 6**

Determine inline force one part:

Where:  
= Inline force slings[t]  
= Number of parts sling/grommet [-]  
= Sling load distribution factor[-]

**Step 7**

The bending reduction factor is bases on Ref 2.1 paragraph chapter 16.4.8, and is calculated with the following equation:

Where:  
D=The minimum diameter over which the sling body, sling eye, or grommet is bent[mm]  
d= The sling/cable-laid rope diameter/grommet diameter[mm]

**Step 8:**

Determine required swl sling/grommet, with the follow equation:

Where:  
= Sling safety factor[-](see chapter 4.7)  
 = Reduction factor[-]

The reduction factor is to be taken as the greatest of the termination factor and the bending factor(see Ref 2.1 paragraph 16.4.6.1)

**Step 9:**

Determine required swl shackle, with the following equation:

{%p for p in paragraphs\_rigging %}

## Checks {{p[“rigging\_name”]}}

### Equipment used

See table below for info sling:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Id number | Type | SWL[t] | Diameter[mm] | Length[m] |
| {{p[“id\_number”]}} | {{p[“Type”]}} | {{p[“SWL\_sling”]}} | {{p[“Sling\_dia”]}} | {{p[“Length”]}} |

See table below for the connection data of the slings:

|  |  |  |  |
| --- | --- | --- | --- |
| Side | Type | SWL[t] | Diameter[mm] |
| Upper | {{p[“u\_type”]}} | {{p[“u\_swl”]}} | {{p[“u\_d”]}} |
| Lower | {{p[“l\_type”]}} | {{p[“l\_swl”]}} | {{p[“l\_d”]}} |

### Factors used

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **What** | **Answer** | **Symbol** | **Value** | **Source** |
| Skew load factor | {{p[“Ans\_skl”]}} | SKL | {{p[“SKL”]}} | {{p[“SKL\_source”]}} |
| Load distribution | {{p[“ANS\_SLDF”]}} | SLDF | {{p[“SLDF”]}} | Ref 2.1 par 16.2.8 |
| Termination factor | {{p[“Ans\_TRF”]}} |  | {{p[“TRF”]}} | Ref 2.1 par 16.4.7 |

### Calculations

Input parameters

|  |  |  |  |
| --- | --- | --- | --- |
| What | Symbol | Value | Unit |
| Type of material sling | Material | {{p[“material”]}} | [-] |
| Which lifting points connected | Lifting points | {{p[“points”]}} | [-] |
| Rigging weight above lifting point | RWP | {{p[“RWP”]}} | [t] |
| Sling angle with vertical, transverse | Angle 1 | {{p[“angle\_1”]}} | [deg] |
| Sling angle with vertical, longitudinal | Angle 2 | {{p[“angle\_2”]}} | [deg] |
| Amount of parts |  | {{p[“N\_parts”]}} | [-] |
| Grommet/sling diameter | D | {{p[“Diameter\_D”]}} | [mm] |
| Smallest bending diameter | d | {{p[“Diameter\_d”]}} | [mm] |

See table below for the results of the calculations:

|  |  |  |  |
| --- | --- | --- | --- |
| What | Symbol | Value | Unit |
| Percentage load on lifting point | Perc | {{p[“perc”]}} | % |
| COG shift factor | COG | {{p[“COG”]}} | [-] |
| Skew load factor | SKL | {{p[“SKL”]}} | [-] |
| Vertical load to lifting point | VLLP | {{p[“VLLP”]}} | [t] |
| Inline force slings | IFUS | {{p[“IFUS”]}} | [t] |
| Sling load distribution factor |  | {{p[“SLDF”]}} | [-] |
| Inline force one parts | IFUP | {{p[“IFUP”]}} | [t] |
| Bending reduction factor |  | {{p[“BRF”]}} | [-] |
| Required SWL sling/grommet |  | {{p[“SWL\_req”]}} | [t] |

See table below for unity check of sling/grommet:

|  |  |  |
| --- | --- | --- |
| What | Value | Unit |
| Required SWL sling/grommet | {{p[“SWL\_req”]}} | [t] |
| Safe working load sling/grommet | {{p[“SWL\_sling”]}} | [t] |
| Unity check sling/grommet | {{p[“UC\_sling”]}} | [-] |

{%p if p[“u\_show\_UC\_shackle”] == “yes” %}

See table below for unity check of the shackle that is connected to the upper point of the sling/grommet:

|  |  |  |
| --- | --- | --- |
| What | Value | Unit |
| Required SWL shackle | {{p[“u\_SWL\_req\_shackle”]}} | [t] |
| Safe working shackle | {{p[“u\_swl”]}} | [t] |
| Unity check shackle | {{p[“u\_UC”]}} | [-] |

{%p endif %}

{%p if p[“l\_show\_UC\_shackle”] == “yes” %}

See table below for unity check of the shackle that is connected to the lower point of the sling/grommet:

|  |  |  |
| --- | --- | --- |
| What | Value | Unit |
| Required SWL shackle | {{p[“l\_SWL\_req\_shackle”]}} | [t] |
| Safe working shackle | {{p[“l\_swl”]}} | [t] |
| Unity check shackle | {{p[“l\_UC”]}} | [-] |

{%p endif %}

{{“\f”}}

{%p endfor %}

# Checks equipment rigging

In this chapter the checks will be done for the other lifting equipment. The factored dynamic rigging load is equal to {{FDRL}}[t](see chapter 5.1). The maximum dynamic rigging load is equal to:

Where:  
= Tilt effect factor[-]  
=Cog shift factor[-]  
= Skew load factor[-]  
Perc= Percantage of load[%]

{%p for p in paragraphs\_rigging\_other %}

## Checks {{p[“name”]}}

See table below for info about the rigging equipment:

|  |  |  |  |
| --- | --- | --- | --- |
| Id number | Type | WLL[t] | Weight[kg] |
| {{p[“id\_number”]}} | {{p[“Type”]}} | {{p[“WLL”]}} | {{p[“Weight”]}} |

See table below for the skl factor:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **What** | **Answer** | **Symbol** | **Value** | **Source** |
| Skew load factor | {{p[“Ans\_skl”]}} | SKL | {{p[“SKL”]}} | {{p[“SKL\_source”]}} |

Input parameters:

|  |  |  |  |
| --- | --- | --- | --- |
| What | Symbol | Value | Unit |
| Which points are connected | Points | {{p[“Points”]}} | [-] |
| COG shift factor | COG | {{p[“COG”]}} | [-] |
| Load perc | Perc | {{p[“Perc”]}} | % |
| Skew load factor | SKL | {{p[“SKL”]}} | [-] |
| maximum dynamic rigging load | MDRL | {{p[“MDRL”]}} | [t] |

See table below for the unity check:

|  |  |  |
| --- | --- | --- |
| What | Value | Unit |
| Maximum dynamic rigging load | {{p[“MDRL”]}} | [t] |
| Safe working load | {{p[“WLL”]}} | [t] |
| Unity check | {{p[“Uc”]}} | [-] |

{%p endfor %}

# Crane checks

In this chapter the crane/cranes will be checked, in the first chapter the calculations are explained with a step plan. In the chapters that follow the rigging will be checked:

## Calculations Crane

Step 1 is calculating the factored dynamic crane load:

|  |  |  |  |
| --- | --- | --- | --- |
| What | Symbol | Value | Source |
| Mass object | LW | {{LW}}[t] | Client |
| Weight contingency factor |  | {{WCF}}[-] | Chapter 4.1 |
| Dynamic amplification factor |  | {{DAF}}[-] | Chapter 4.2 |
| COG shift factor |  | {{COG\_crane }}[-] | Chapter 4.5 |
| Factored dynamic crane load | FDCL | {{FDCL}}[t] | - |

Step 2: Determine TILT factor

Determine what the tilt factor is see chapter

Step 3: Determine the percentage   
Determine the load percentage that the hoist needs to withstand

Step 4: Determine the vertical load hoist:

The vertical load hoist is calculated with the following equation:

Step 5: Determine the hook load

The vertical load hoist is calculated with the following equation:

Where:  
= Angle with vertical, in line with boom[deg]

## Checks: {{Crane\_name1}}

The vessel dynamic design factor is equal to {{DDF\_1}}

{%p for p in paragraphs\_crane1\_checks %}

### Checks: {{p[“Hoist”]}}

The capacity of the {{p[“Hoist”]}} at outreach is equal to {{p[“CAP”]}}

Input parameters:

|  |  |  |  |
| --- | --- | --- | --- |
| What | Symbol | Value | Unit |
| Points that are connected | Points | {{p[“Points”]}} | [-] |
| Tilt effect factor | TEF | {{p[“TEF”]}} | [-] |
| Load perc | Perc | {{p[“perc”]}} | % |
| Rigging weight | RW | {{p[“RW”]}} | [t] |
| Angle with vertical, in line with boom | Offlead | {{p[“Offlead”]}} | [deg] |

Input parameters:

|  |  |  |  |
| --- | --- | --- | --- |
| What | Symbol | Value | Unit |
| Vertical load | HLV | {{p[“HLV”]}} | t |
| Hook load | HL | {{p[“HL”]}} | t |

See table below for the unity check of the hoist:

|  |  |  |  |
| --- | --- | --- | --- |
| What | Symbol | Value | Unit |
| Capacity | CAP | {{p[“CAP”]}} | t |
| Unity check hoist | Uc | {{p[“UC”]}} | t |

{{“\f”}}

{%p endfor %}

## 

{%p if check\_crane2\_show == “yes” %}

## Checks: {{Crane\_name2}}

The vessel dynamic design factor is equal to {{DDF\_2}}

{%p for p in paragraphs\_crane2\_checks %}

### Checks: {{p[“Hoist”]}}

The capacity of the {{p[“Hoist”]}} at outreach is equal to {{p[“CAP”]}}

Input parameters:

|  |  |  |  |
| --- | --- | --- | --- |
| What | Symbol | Value | Unit |
| Points that are connected | Points | {{p[“points”]}} | [-] |
| Tilt effect factor | TEF | {{p[“TEF”]}} | [-] |
| Load perc | Perc | {{p[“perc”]}} | % |
| Rigging weight | RW | {{p[“RW”]}} | [t] |
| Angle with vertical, in line with boom | Offlead | {{p[“Offlead”]}} | [deg] |

Input parameters:

|  |  |  |  |
| --- | --- | --- | --- |
| What | Symbol | Value | Unit |
| Vertical load | HLV | {{p[“HLV”]}} | t |
| Hook load | HL | {{p[“HL”]}} | t |

Hier moet nog unity check komen

{{p[“UC”]}}

{{“\f”}}

{%p endfor %}

{%p endif %}

# Appendix A: Load chart crane

Tekening van de

# Appendix B: Tilt calculations

In this chapter the results of the tilt calculations will be discussed, first the load factor will be determined. This load factor is equal to {{ANS\_envelope\_TILT}} calculated in chapter 3.4.

{%p for p in paragraphs\_TEF\_factors %}

**{{p[“text\_points”]}}**

In the table below the COG point is given:

|  |  |  |
| --- | --- | --- |
|  | x [mm] | y [mm] |
| COG | {{p[“COG\_x”]}} | {{p[“COG\_y”]}} |

In the table below the angles are given:

|  |  |  |
| --- | --- | --- |
| What | Value | Unit |
| Pitch | {{p[“Pitch”]}} | Deg |
| Roll | {{p[“Roll”]}} | Deg |

In the table the input parameters of the lift points and the load distributions:

|  |  |  |  |
| --- | --- | --- | --- |
| Lifting point | x [mm] | y [mm] | Load) [%] |
| {%tr for r in p[“INPUT”] %} | | | |
| {{r[“point”]}} | {{r[“x”]}} | {{r[“y”]}} | {{r[“Load\_dis”]}} |
| {%tr endfor %} | |  |  |

{{“\f”}}

{%p endfor %}

{%p if skl\_show == “yes” %}

# Appendix C: Analysis skew load factor

The analyses is based on a iterative process. With each iteration the force will be higher until the total force in the slings/grommets is equal to the weight of the lifting object, then lifting object is lifted. The strain in the slings/grommets and the displacement of the hook is based on the stiffness method.

The analyses is done for all options for the four slings for short and long. In total these are 16 options.

All four the lifting point are connected to the hook, the assumption is made that the hook is one point.

**Input parameters**

See table below for the lifting points and the data of the slings. The diameter(D) of the sling/grommet is equal to the nominal diameter given by the suppler. Also the E-modulus is given by the suplyer.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Point | X  [m] | Y  [m] | Z  [m] | E  [N/mm^2] | D  [mm^2] |
| {%tr for r in table\_lift\_points\_skl\_analyse %} | | | | | |
| {{r[“point”]}} | {{r[“x”]}} | {{r[“y”]}} | {{r[“z”]}} | {{r[“E”]}} | {{r[“D”]}} |
| {%tr endfor %} | | | | | |

See table below for the start of the hook:

|  |  |  |  |
| --- | --- | --- | --- |
| Point | X  [m] | Y  [m] | Z  [m] |
| COG | {{x\_hook\_skl}} | {{y\_hook\_skl}} | {{z\_hook\_skl}} |

**Result sling normal length**

|  |  |  |  |
| --- | --- | --- | --- |
| Sling/grommet | Effective Length sling  [mm] | Distance lift point to hook point[mm] | Total stretch  [mm] |
| 1 | {{L\_slings\_1}} | {{Dis\_1}} | {{s\_slings\_1}} |
| 2 | {{L\_slings\_2}} | {{Dis\_2}} | {{s\_slings\_2}} |
| 3 | {{L\_slings\_3}} | {{Dis\_3}} | {{s\_slings\_3}} |
| 4 | {{L\_slings\_4}} | {{Dis\_4}} | {{s\_slings\_4}} |

See for the start hook point/ displacement the table below:`

|  |  |  |  |
| --- | --- | --- | --- |
| Point | X  [mm] | Y  [mm] | Z  [mm] |
| Start hook | {{start\_h\_x}} | {{start\_h\_y}} | {{start\_h\_z}} |
| End hook | {{end\_h\_x}} | {{end\_h\_y}} | {{end\_h\_z}} |
| Displacement hook | {{dis\_h\_x}} | {{dis\_h\_y}} | {{dis\_h\_z}} |

The total force of the object is equal to {{F\_load\_total}} N, the x and y forces in the hook are not equal to zero, this is because it is an iterative process. The difference is very low, so in the iterative process the assumption is made that the forces are equal to zero. See table below for the forces in point hook:

|  |  |  |  |
| --- | --- | --- | --- |
| What | x | y | z |
| Force in point hook | {{Force\_x\_h}} | {{Force\_y\_h}} | {{F\_load\_total}} |
| Percentage of total load | {{perc\_x\_h}}% | {{perc\_x\_h}}% | 0% |

See table below for the forces in the sling:

|  |  |  |  |
| --- | --- | --- | --- |
| Sling/Grommet | Force sling | Z-force sling[N] | Load dis[%] |
| 1 | {{F\_sling\_1}} | {{Fz\_sling\_1}} | {{Load\_dis\_1}} |
| 2 | {{F\_sling\_2}} | {{Fz\_sling\_2}} | {{Load\_dis\_2}} |
| 3 | {{F\_sling\_3}} | {{Fz\_sling\_3}} | {{Load\_dis\_3}} |
| 4 | {{F\_sling\_4}} | {{Fz\_sling\_4}} | {{Load\_dis\_4}} |
| Sum | {{F\_load\_total}} | 100% |

{%p for p in paragraphs\_skl\_appendix %}

**Result {{p[“Sling”]}}**

|  |  |  |  |
| --- | --- | --- | --- |
| Sling/grommet | Short/Long | Length sling  [mm] | Total stretch  [mm] |
| 1 | {{p[“short\_1”]}} | {{p[“L\_slings\_1”]}} | {{p[“s\_slings\_1”]}} |
| 2 | {{p[“short\_2”]}} | {{p[“L\_slings\_2”]}} | {{p[“s\_slings\_2”]}} |
| 3 | {{p[“short\_3”]}} | {{p[“L\_slings\_3”]}} | {{p[“s\_slings\_3”]}} |
| 4 | {{p[“short\_4”]}} | {{p[“L\_slings\_4”]}} | {{p[“s\_slings\_4”]}} |

See for the start hook point/ displacement the table below:

|  |  |  |  |
| --- | --- | --- | --- |
| Point | X  [mm] | Y  [mm] | Z  [mm] |
| Start hook | {{p[“start\_h\_x”]}} | {{p[“start\_h\_y”]}} | {{p[“start\_h\_z”]}} |
| End hook | {{p[“end\_h\_x”]}} | {{p[“end\_h\_y”]}} | {{p[“end\_h\_z”]}} |
| Displacement hook | {{p[“dis\_h\_x”]}} | {{p[“dis\_h\_y”]}} | {{p[“dis\_h\_z”]}} |

The total force of the object is equal to {{p[“F\_load\_total”]}} N, the x and y forces in the hook are not equal to zero, this is because it is an iterative process. The difference is very low, so in the iterative process the assumption is made that the forces are equal to zero. See table below for the forces in point hook:

|  |  |  |  |
| --- | --- | --- | --- |
| What | x | y | z |
| Force in point hook | {{p[“Force\_x\_h”]}} | {{p[“Force\_y\_h”]}} | {{p[“F\_load\_total”]}} |
| Percentage of total load | {{p[“perc\_x\_h”]}}% | {{p[“perc\_x\_h”]}}% | 0% |

See table below for the forces in the sling:

|  |  |  |  |
| --- | --- | --- | --- |
| Sling/Grommet | Force sling | Z-force sling[N] | Load dis[%] |
| 1 | {{p[“F\_sling\_1”]}} | {{p[“Fz\_sling\_1”]}} | {{p[“Load\_dis\_1”]}} |
| 2 | {{p[“F\_sling\_2”]}} | {{p[“Fz\_sling\_2”]}} | {{p[“Load\_dis\_2”]}} |
| 3 | {{p[“F\_sling\_3”]}} | {{p[“Fz\_sling\_3”]}} | {{p[“Load\_dis\_3”]}} |
| 4 | {{p[“F\_sling\_4”]}} | {{p[“Fz\_sling\_4”]}} | {{p[“Load\_dis\_4”]}} |
| Sum | {{p[“F\_load\_total”]}} | 100% |

The skl factor is equal to the force of sling/grommet {{p[“number”]}} divided by the force of sling/grommet {{p[“number”]}} determined in chapter: results normal length sling.

SKL factor is equal to: **{{p[“SKL”]}}**

{{“\f”}}

{%p endfor %}

{%p endif %}