| T R U S S  S Y S T E M  A N A L Y S I S | |
|---|---|
| Software: | RUNTEMUND TRUSS ANALYSER V3.0 |
| Input File: | Christie_Lites_A_Type.txt |
| Date: | 2025-01-28 |
| Truss System: | **Christie Lites A Type Truss** Condensed Version |

## P R E A M B L E

### Summary

Subject of this calculation is a modular trussed beam system. It consists of elements in different lengths which can be assembled freely, as long as the construction principles of this document are respected. These are in particular:

- The bracing angle is never flatter than mentioned in this report.
- The framework is fully formed as defined here.
- Displacement offsets on connector or within the nodes does not exceed the range mentioned here.
- In case of deviating elements such as spacers, corner modules or elements without a complete framework, a separate consideration is always required.
- The manufacturer shall ensure that manufacturing is in accordance with the EN 1090 series of standards.

### Basis of Calculation

The system analysis was assembled on following basis of calculation:

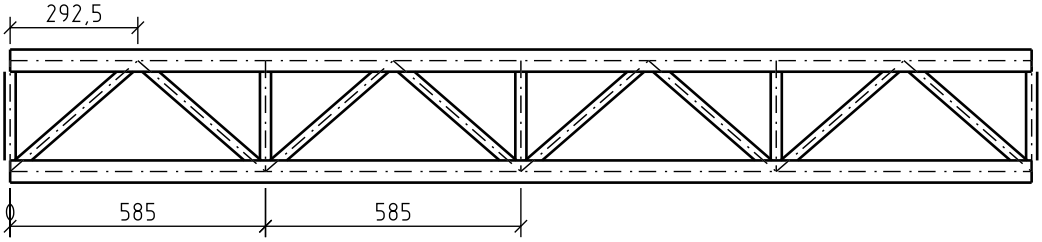
| | | |
|---|---|---|
| DIN EN 1990 | 2010-12 | Basis of structural design (Eurocode 0) |
| DIN EN 1993-1-1 | 2010-12 | Design of steel structures (Eurocode 3) |
| DIN EN 1999-1-1 | 2014-03 | Design of aluminium structures (Eurocode 9) |
| DIN EN 17115 | 2018-10 | Entertainment technology - Aluminium and steel trusses |

# S T R U C T U R A L  S Y S T E M

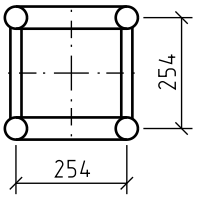
## Cross-Section

The framework plane at the rear in the respective view is indicated by grey centre lines if visible.

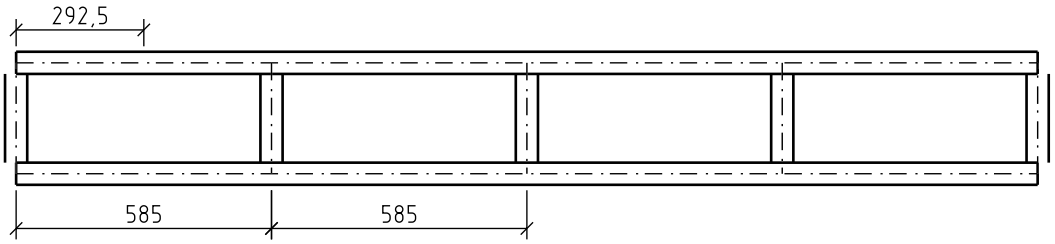
Side View From Right



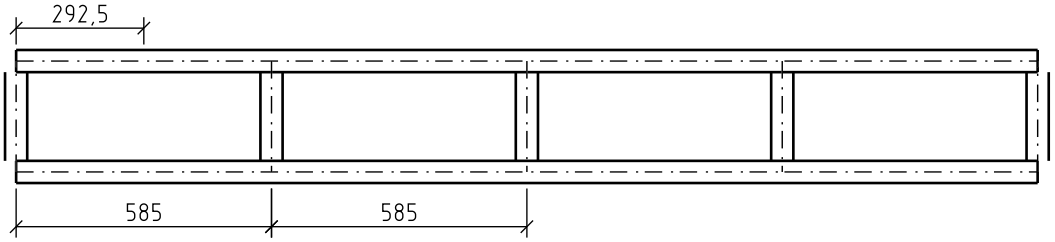

Front View




Top View




Bottom View



# I N P U T  D A T A

## Truss Summary

| | | | |
|---|---|---|---|
| Truss Type | | = 4 Chords, Rect | |
| Connection Geometry | | = Plate | |
| Outer Dimensions | ov×oh = | 305 × 305 | [mm×mm] |
| Axis Dimensions | av×ah = | 254 × 254 | [mm×mm] |
| Self-Weight | g = | 9,20 | [kg/m] |
| Material Type | | = Aluminium | |
| Young's Modulus | E = | 70000 | [N/mm²] |
| Shear Modulus | G = | 27000 | [N/mm²] |

## Truss Cross-Section Data

| | | | |
|---|---|---|---|
| Cross-Section Area | A = | 19,03 | [cm²] |
| Shear Area Timoshenko Beam | A_v,y = | 0,00 | [cm²] |
| | A_v,z = | 3,74 | [cm²] |
| 2nd Moment of Inertia | I_y = | 3123,44 | [cm⁴] |
| | I_z = | 3123,44 | [cm⁴] |
| Shear Stiffness | S_v,y = | 0,00 | [kN] |
| | S_v,z = | 10087,69 | [kN] |

## Truss Geometry Details

| | | | |
|---|---|---|---|
| Flattest Vertical Brace Angle | α_v = | 40,97 | [°] |
| Flattest Horizontal Brace Angle | α_h = | 0,00 | [°] |
| Maximum Infill Width | s = | 585 | [mm] |
| Maximum Offset at Connector | e_1 = | 0 | [mm] |
| Maximum Offset in Nodes | e_2 = | 0 | [mm] |

## Cross-Section Properties

Following part and cross-section properties are used whithin this calculation:

| Part | A [cm²] | I [cm⁴] | W [cm³] | Type |
|---|---|---|---|---|
| Chords | 4,76 | 13,55 | 5,33 | RO ⌀50.8×3.18 - EN AW 6061 T6 |
| Horiz. Posts, All | 4,76 | 13,55 | 5,33 | RO ⌀50.8×3.18 - EN AW 6061 T6 |
| Horiz. End Braces, All | 4,76 | 13,55 | 5,33 | RO ⌀50.8×3.18 - EN AW 6061 T6 |
| Vert. Diagonals, All | 2,22 | 1,40 | 1,10 | RO ⌀25.4×3.18 - EN AW 6061 T6 |
| Vert. Posts, All | 2,22 | 1,40 | 1,10 | RO ⌀25.4×3.18 - EN AW 6061 T6 |
| Vert. End Braces, All | 2,22 | 1,40 | 1,10 | RO ⌀25.4×3.18 - EN AW 6061 T6 |
| End Plate | 0,00 | 0,00 | 0,00 | - EN AW 6061 T6 |
| Bolt | 0,00 | 0,00 | 0,00 | ⌀15,88 - Grade 8 |

- If a value is 0, the value is not applicable or relevant for the part.
- Fitting means the part of the connection system which is permanently connected to the chords.
- Connector means a loose intermediate piece in the connection, if any.
- If the pin is conical, the value corresponds to the average diameter.

## Partial Safety Coefficients

| Material | γ_M0 | γ_M1 | γ_M2 | γ_Mw | γ_G | γ_Q |
|---|---|---|---|---|---|---|
| EN AW 6061 T6 | 1,00 | 1,10 | 1,25 | 1,25 | 1,35 | 1,50 |
| Grade 8 | 1,00 | 1,00 | 1,25 | 1,25 | 1,35 | 1,50 |

## Material Properties

| Material | f_o / f_y [N/mm²] | f_u [N/mm²] | f_o,haz [N/mm²] | f_u,haz [N/mm²] | f_w [N/mm²] |
|---|---|---|---|---|---|
| EN AW 6061 T6 | 240,00 | 260,00 | 92,16 | 139,36 | 170,00 |
| Grade 8 | 900,00 | 1000,00 | 0,00 | 0,00 | 0,00 |

- If a value is 0, the value is not applicable or relevant for the part.

# O U T P U T  D A T A

## Determination of the Chord Design Resistance

**Result**

| | | | |
|---|---|---|---|
| General Yielding Along Member | N_Rd = | 103,80 | [kN] |
| Local Failure at Welds | N_Rd = | 59,25 | [kN] |
| Buckling in Areas Without Welds | N_Rd = | 88,73 | [kN] |
| Buckling in Areas With Welds | N_Rd = | 59,64 | [kN] |
| Design Resistance of Chord Force | N_c,Rd = | 59,25 | [kN] |

## Determination of the Vertical Bracing Design Resistance

**Result**

| | | | |
|---|---|---|---|
| General Yielding Along Member | N_Rd = | 48,43 | [kN] |
| Buckling in Areas Without Welds | N_Rd = | 34,66 | [kN] |
| HAZ General | N_Rd = | 24,75 | [kN] |
| Weld Seam | N_Rd = | 32,68 | [kN] |
| HAZ Along Seam | N_Rd = | 26,79 | [kN] |
| Design Resistance of Brace Force | N_b,Rd = | 24,75 | [kN] |

## Determination of the Horizontal Bracing Design Resistance

No diagonal bracing present. The values are not calculated.

## Determination of the Connection Design Resistance

**Result**

| | | | |
|---|---|---|---|
| Bolt | N_Rd = | 111,12 | [kN] |
| Connector - FEA load determination | N_Rd = | 14,00 | [kN] |
| Design Resistance of Connection | N_c,Rd = | 14,00 | [kN] |

# C O N C L U S I O N

## Design Resistance of Parts

| | | | |
|---|---|---|---|
| Chord | $N_{ch,Rd}$ = | 59,25 | [kN] |
| Connection | $N_{c,Rd}$ = | 14,00 | [kN] |
| Horizontal Brace | $N_{bh,Rd}$ = | 0,00 | [kN] |
| Vertical Brace | $N_{bv,Rd}$ = | 23,22 | [kN] |

## Design Internal Forces of Truss

| | | | | |
|---|---|---|---|---|
| Normal Force | $N_{Rd} = 4 \times N_{ch,Rd}$ | $N_{Rd}$ = | 56,00 | [kN] |
| Shear Force v | $V_{z,Rd} = 2 \times N_{bv,Rd} \times \sin \alpha_v$ | $V_{z,Rd}$ = | 30,45 | [kN] |
| Shear Force h | $V_{y,Rd} = 0 \times N_{bh,Rd} \times \sin \alpha_h$ | $V_{y,Rd}$ = | 0,00 | [kN] |
| Bending Moment v | $M_{y,Rd} = 2 \times N_{ch,Rd} \times av$ | $M_{y,Rd}$ = | 7,11 | [kNm] |
| Bending Moment h | $M_{z,Rd} = 2 \times N_{ch,Rd} \times ah$ | $M_{z,Rd}$ = | 7,11 | [kNm] |

- The design resistance values must be divided by the safety factor $\gamma_Q$ to roughly estimate allowable characteristic values.
- Structural analyses may only be calculated by authorised and experienced engineering professionals.

## Further Notes

- Maximum Allowable Free Applicable Load $P$ = 75 [kg]
- Loads up to the maximum allowable free load may be positioned arbitrary on the chord. Higher loads have to be positioned in the nodes or have to be checked separately.
- On combined occurance of shear force, bending or torsion at connection or node displacement, this must be checked.

## Notes to the Load Charts

- The values only apply to horizontal beams. Inclined beams or columns require assessment by experienced engineers. The installation position assumed here can be seen in chapter "Structural System".
- Both top chords or both bottom chords serve as supports. Never use one chord alone as a support.
- The values are characteristic according to Eurocode. Partial safety factors (1,35/1,5) are considered. This includes permanent and variable actions.
- The optional frequent use factor (0,85) acc. to DIN EN 17115 chapter 5.3.2 was not used in the tables. If necessary, the values can be multiplied by this.
- The values given are static loads without any factors for dynamic influences like motion or hoisting operation. These would have to be considered separately if necessary.
- The loads are only vertical. In particular, no wind loads were taken into account.
- For deviating applications based on other codes, the partial safety factors may be adjusted.
- Interaction of internal forces at connector are considered.
- The table data have no limitation of deflection.
- The system is perfect and secured against lateral buckling.
- The self-weight of the truss system is considered.
- The deflection is calculated for an ideal Timoshenko-Beam. Because of the flexibility of the connector real deflection is a little bit higher.
- Load application occurs directly in the nodes of the vertical framework and is

balanced. The load application is centric and not one-sided.
- The values are only valid for the single span girders analysed here. Complex structures are not covered by this.
- Complex structures shall always be checked by an experienced professional engineer, as the load tables usually do not cover these cases.
- Complex structures, special cases or special constructions can be analysed by Runtemund Engineering acc. to German, European or International standards.

# L O A D  C H A R T S

## Load Chart - Single Span Beam

| Span [m] | UDL [kg/m] | Defl [mm] | CPL [kg] | Defl [mm] | TPL [kg] | Defl [mm] | QPL [kg] | Defl [mm] | FPL [kg] | Defl [mm] | Swt [kg] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 939 | 2 | 939 | 2 | 704 | 2 | 469 | 2 | 391 | 2 | 19 |
| 3 | 413 | 3 | 619 | 3 | 464 | 3 | 309 | 3 | 258 | 3 | 28 |
| 4 | 228 | 5 | 457 | 4 | 343 | 5 | 228 | 4 | 190 | 5 | 37 |
| 5 | 143 | 7 | 358 | 6 | 268 | 7 | 179 | 6 | 149 | 7 | 46 |
| 6 | 97 | 9 | 291 | 8 | 218 | 9 | 145 | 9 | 121 | 9 | 56 |
| 7 | 69 | 12 | 241 | 10 | 181 | 12 | 120 | 12 | 100 | 12 | 65 |
| 8 | 50 | 16 | 203 | 13 | 152 | 16 | 101 | 15 | 84 | 16 | 74 |
| 9 | 38 | 20 | 173 | 17 | 130 | 20 | 86 | 19 | 72 | 20 | 83 |
| 10 | 29 | 24 | 148 | 21 | 111 | 25 | 74 | 23 | 61 | 24 | 92 |
| 11 | 23 | 29 | 126 | 25 | 95 | 30 | 63 | 28 | 52 | 29 | 102 |
| 12 | 18 | 35 | 108 | 30 | 81 | 35 | 54 | 34 | 45 | 35 | 111 |

Load Colour:
- Bending Moment decisive
- Shear Force decisive
- Connection Interaction decisive
- Nodal Joint decisive
- Load Equality decisive

Deflection Colour:
Deflection is less than w/200, w/150, w/100
Deflection is more than w/100

**Abbreviations**
- UDL : Uniformly Distributed Load
- CPL : Centre Point Load
- TPL : Third Point Load
- QPL : Quarter Point Load
- FPL : Fifth Point Load
- Swt : Self-Weight

## Load Chart - Cantilever

| Length [m] | UDL [kg/m] | Defl [mm] | EPL [kg] | Defl [mm] | Swt [kg] |
|---|---|---|---|---|---|
| 0,5 | 946 | 1 | 946 | 1 | 5 |
| 1,0 | 469 | 1 | 469 | 2 | 10 |
| 1,5 | 413 | 2 | 309 | 3 | 14 |
| 2,0 | 228 | 3 | 228 | 4 | 19 |
| 2,5 | 143 | 4 | 179 | 5 | 23 |
| 3,0 | 97 | 6 | 145 | 7 | 28 |
| 3,5 | 69 | 8 | 120 | 10 | 33 |
| 4,0 | 50 | 10 | 101 | 12 | 37 |

Load Colour:
- Bending Moment decisive
- Shear Force decisive
- Connection Interaction decisive
- Nodal Joint decisive
- Load Equality decisive

Deflection Colour:
Deflection is less than w/400, w/300, w/200
Deflection is more than w/200

### Abbreviations
- UDL : Uniformly Distributed Load
- EPL : End Point Load
- Swt : Self-Weight