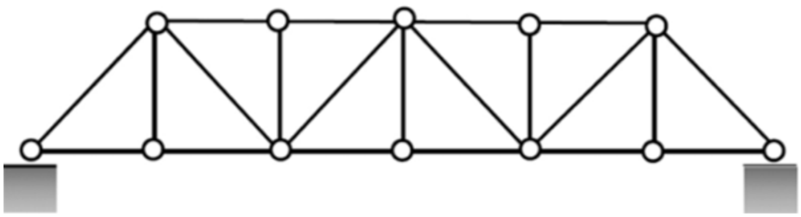
INDIAN INSTITUTE OF TECHNOLOGY PATNA

CE320: DESIGN OF STEEL STRUCTURES

PROJECT REPORT

Analysis and Design of Roof Truss for Industrial Building



WARREN TRUSS

By Group: 08

Under The Supervision of

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Table of contents

Objective

The objective of this project is to perform both the **structural analysis** and **design** of a steel **Warren truss** roof system for an industrial shed located in **Silchar**, ensuring safety, stability, and compliance with relevant Indian Standards. The truss is to be analysed using **SAP2000** software, and the critical members will be designed based on internal forces obtained from the analysis.

Key project parameters include:

- **Location**: Silchar
- **Design life**: 50 years
- **Terrain category**: Category 1
- **Shed dimensions**: 60 m × 20 m
- **Column spacing**: 15 m (centre to centre)
- **Ceiling height**: 10 m (from shop floor to truss bottom)
- **Truss type**: *Warren Truss*
- **Rise of truss**: 4 m
- **Truss spacing**: Not more than 5 m
- **Material**: Structural steel with yield strength $f_y = 250$ MPa

The primary objectives of the analysis are:

- To model the **Warren truss** structure accurately in SAP2000 based on the given geometry and support conditions.
- To apply relevant loads and combinations in accordance with IS codes, particularly:
    - 1.5 (Dead Load + Live Load)
    - 1.5 (Dead Load + Wind Load)
    - 1.2 (Dead Load + Live Load + Wind Load)
- To determine internal **axial forces**, **support reactions**, and **member force distribution** under different loading scenarios.
- To perform the **final design** of critical members in accordance with **IS 800:2007**, using the results from the analysis.

2D and 3D View

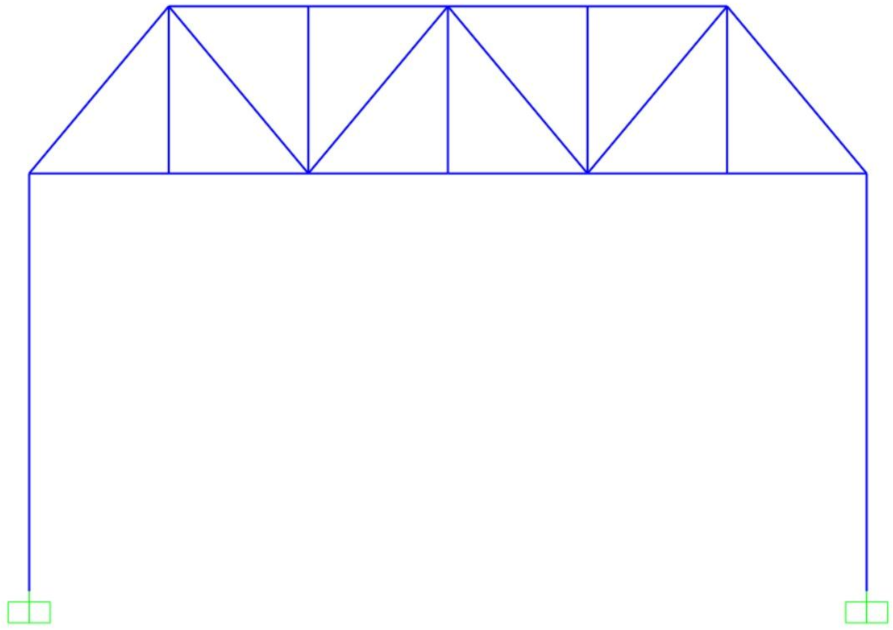


Figure: 2D View

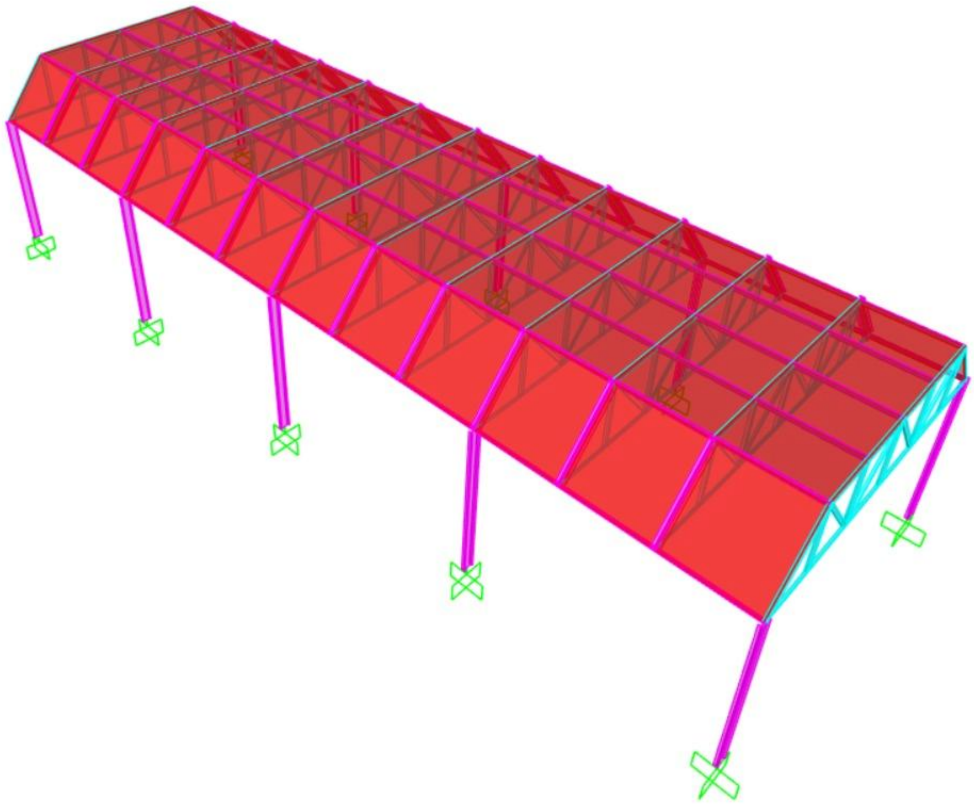
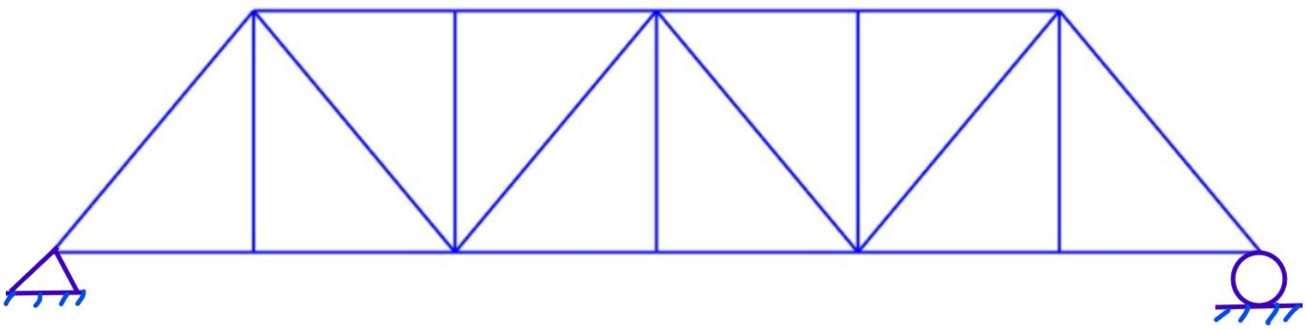


Figure: 3D View

Wind Load Calculations

(As per IS 875-Part 3: 2015)



As per the location given in the question, from IS 875- Part 3: 2015, by using the Basic Wind Speed map,

Basic wind speed, $\mathbf{V_b = 55\ m/s}$

Using Clause 6.3,

Design Wind Speed, $V_z = V_b*k_1*k_2*k_3*k_4$

Where, k1 = Probability factor (risk coefficient)

k2 = Terrain roughness and height factor

k3 = Topography factor

k4 = importance factor for the cyclonic region

According to Clause 6.3.1,

Considering our structure under the important building category,

From Table 1, k1 = 1.08

From Clause 6.3.2.2 and Table 2,

For terrain category 1, and Height of structure = 14 m

By interpolation, k2 = 1.082

Using Clause 6.3.3.1, k3 = 1.0

Using Clause 6.3.4,

For industrial structures, k4 = 1.15

Therefore,

$$V_z = V_b*k_1*k_2*k_3*k_4$$

$$V_z = 55*1.08*1.082*1.0*1.15$$

i.e., **Vz = 73.91 m/s**

From Clause 7.2,

Design Wind Pressure, $P_d = k_d{*}k_a{*}k_c{*}p_z$

Where,

k_d = wind directionality factor

K_a = area averaging factor

K_c = combination factor

p_z = 0.6 Vz2

= 0.6* (73.91)2

p_z = 3277.61 Pa

From Clause 7.2.1, for trussed structure, $k_d = 0.9$

From Clause 7.2.2 and Table 4,

Tributary area = (10/3) * 5 = 16.67 m2

By interpolation, $k_a = 0.95$

From Clause 7.3.3.13, $k_c = 0.9$

Therefore,

$P_d = k_d{*}k_a{*}k_c{*}p_z$

= 3277.61 * 0.9 * 0.95 * 0.9

i.e., $\mathbf{P_d = 2522.12\ Pa}$

From Clause 7.3.2.2,

For openongs larger than 20%, $C_{p_i} = \pm 0.7$

From Clause 7.3.2.2 and Table 6,

We have, h = 10m

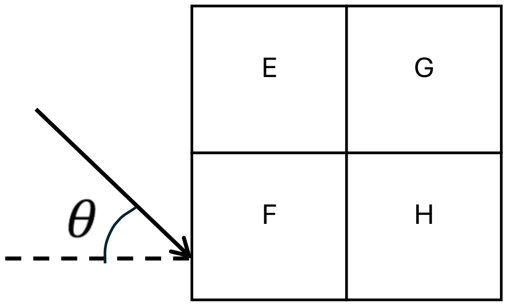
W = 20 m

Therefore, $\frac{h}{w} = \frac{10}{20} = \frac{1}{2}$

Assume, $\theta = roof\ angle$

Therefore, $tan\,\theta = \frac{4}{10/3}$

i.e., $\theta = 50.2^0$



Wind Direction	C_{p_i}	C_{pe}		$C_{p_e} - C_{p_i}$	
		Windward (EF , EG)	Leeward (GH , FH)	Windward	Leeward
Normal to levee strut (0^0)	+ 0.7	+ 0.35	- 0.52	- 0.35	- 1.22
	-0.7	+ 0.35	- 0.52	+ 1.05	+ 0.18
Normal to ridge strut (90^0)	+ 0.7	- 0.70	- 0.60	**- 1.40**	- 1.30
	- 0.7	- 0.70	- 0.60	+ 0.00	+ 0.10

Therefore, $\boldsymbol{(C_{pe} - C_{Pi})_{\max} = -1.40}$

From Clause 7.3.1,

$$P'_d = (C_{pe} - C_{pi}) \times P_d$$

= -1.40 * 2522.12
= -3530.97 Pa

$\boldsymbol{P'_d}$ **= - 3.53 kPa**

Since, spacing of Purlins = 3.33 m

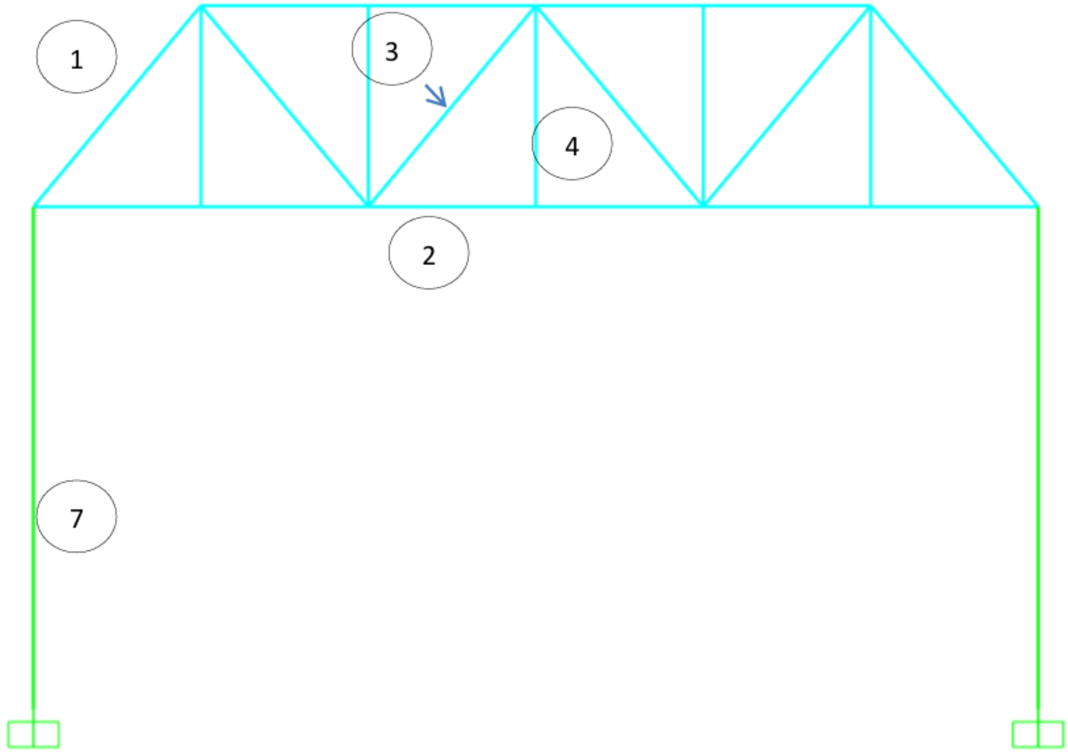
Therefore, **Resultant Wind Load =** - 3.53 * 3.33

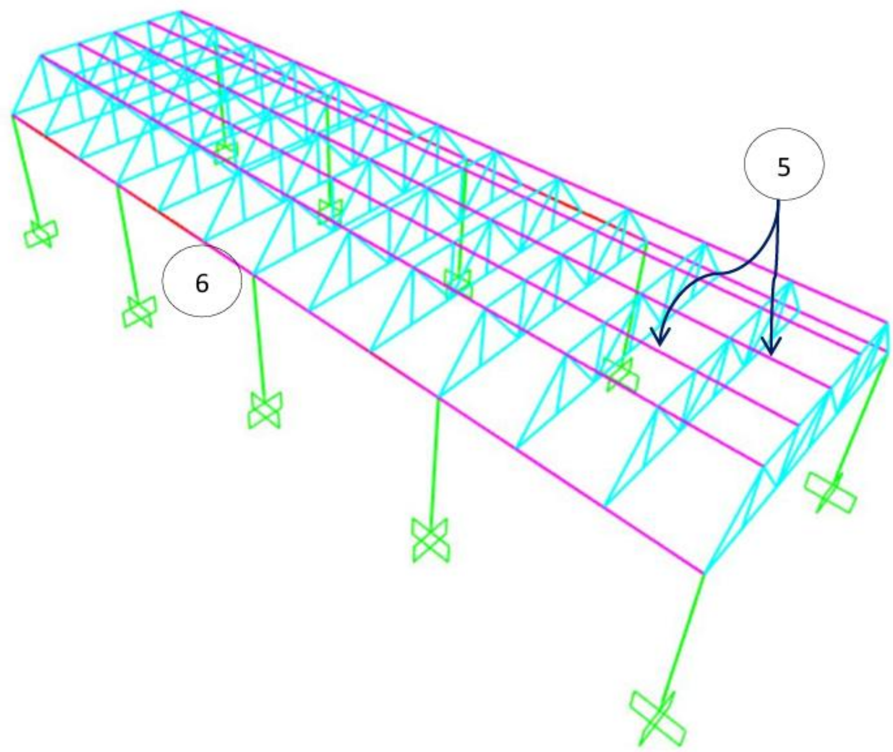
= -11.75 kN/m

Details of Applied Loads

Type of Load	Load Value
Dead Load	Self-weight + GI Sheet: 1.2 KPa
Live Load	1.0 Kpa
Wind Load	-11.75 KN/m

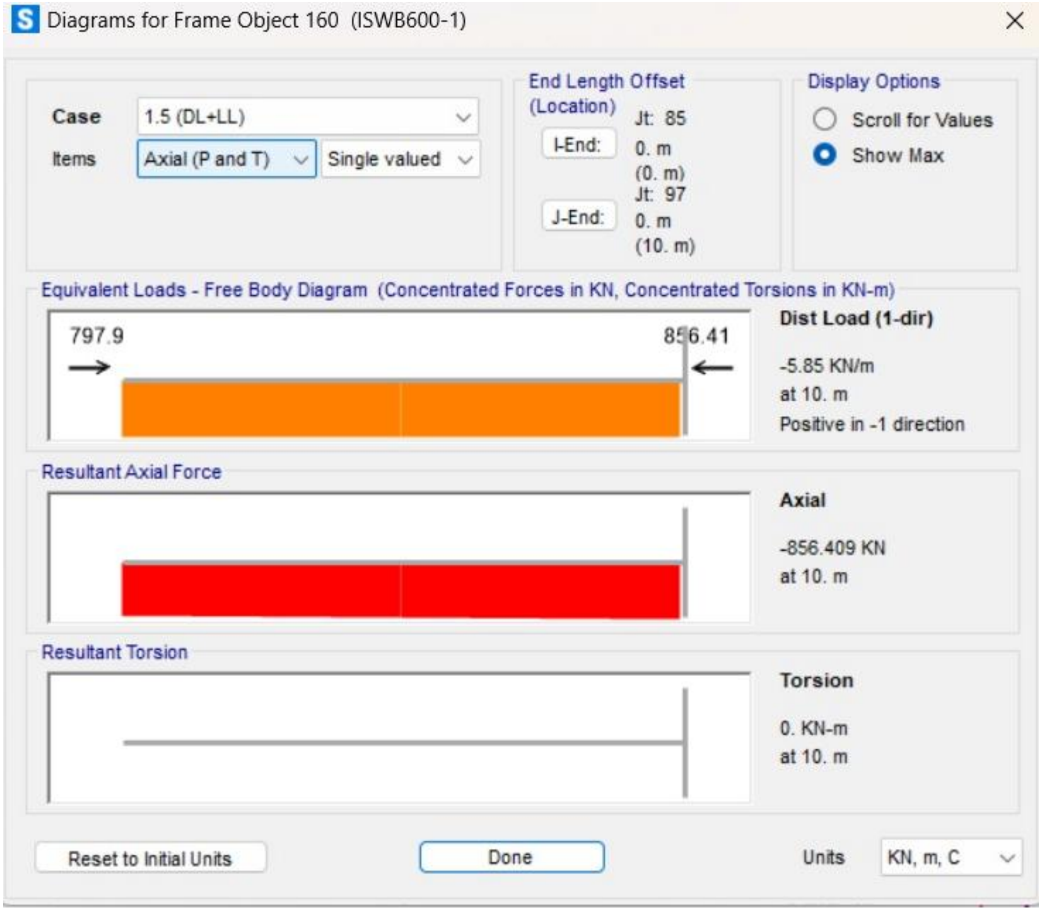
Analysis





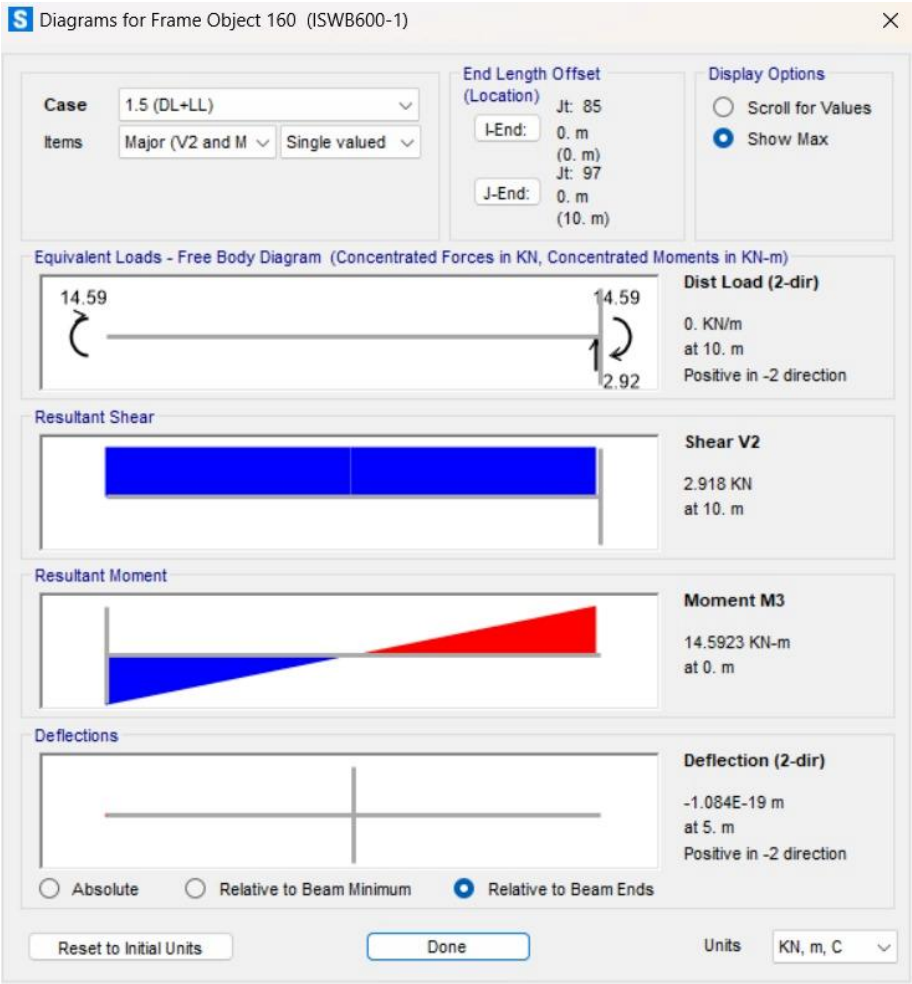
Column

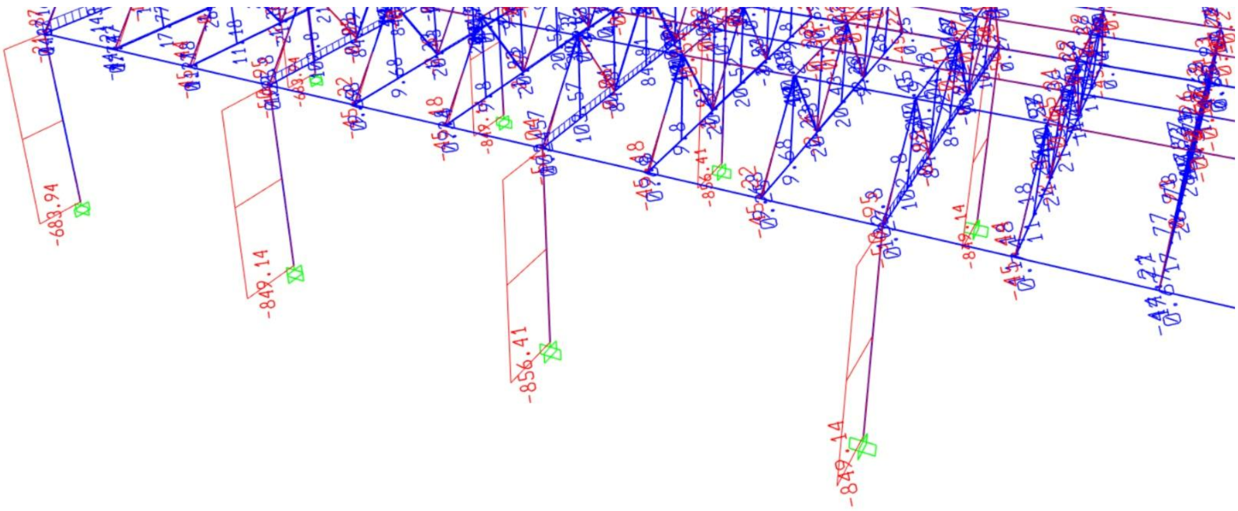
- Maximum Axial Compression Load: - 856.409 kN
- Load Combination: 1.5 (DL+LL)



Major Axis

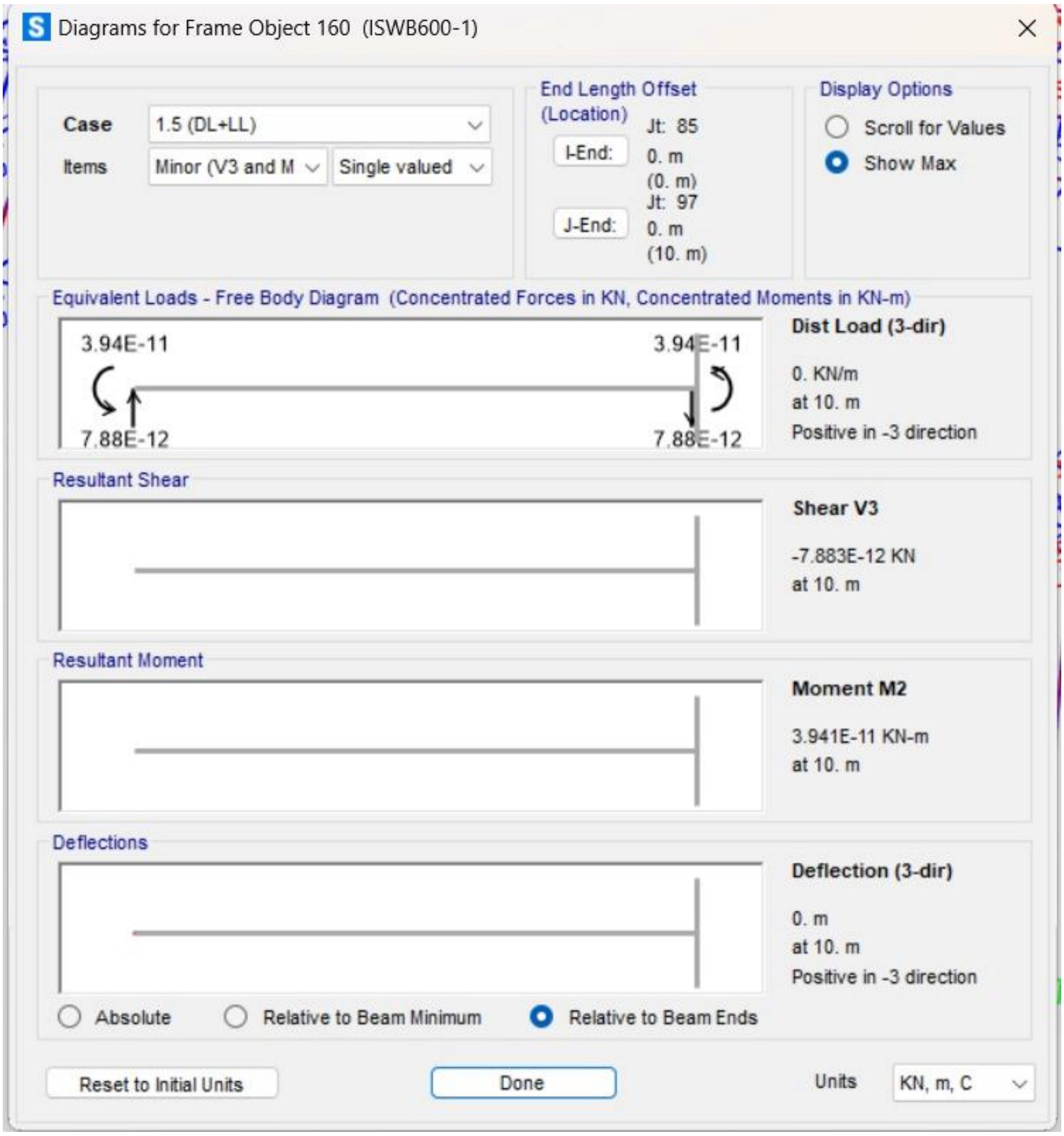
- Maximum Shear Force: 2.918 kN
- Maximum Bending Moment: 14.5923 kNm
- Loading Combination: 1.5 (DL+LL)





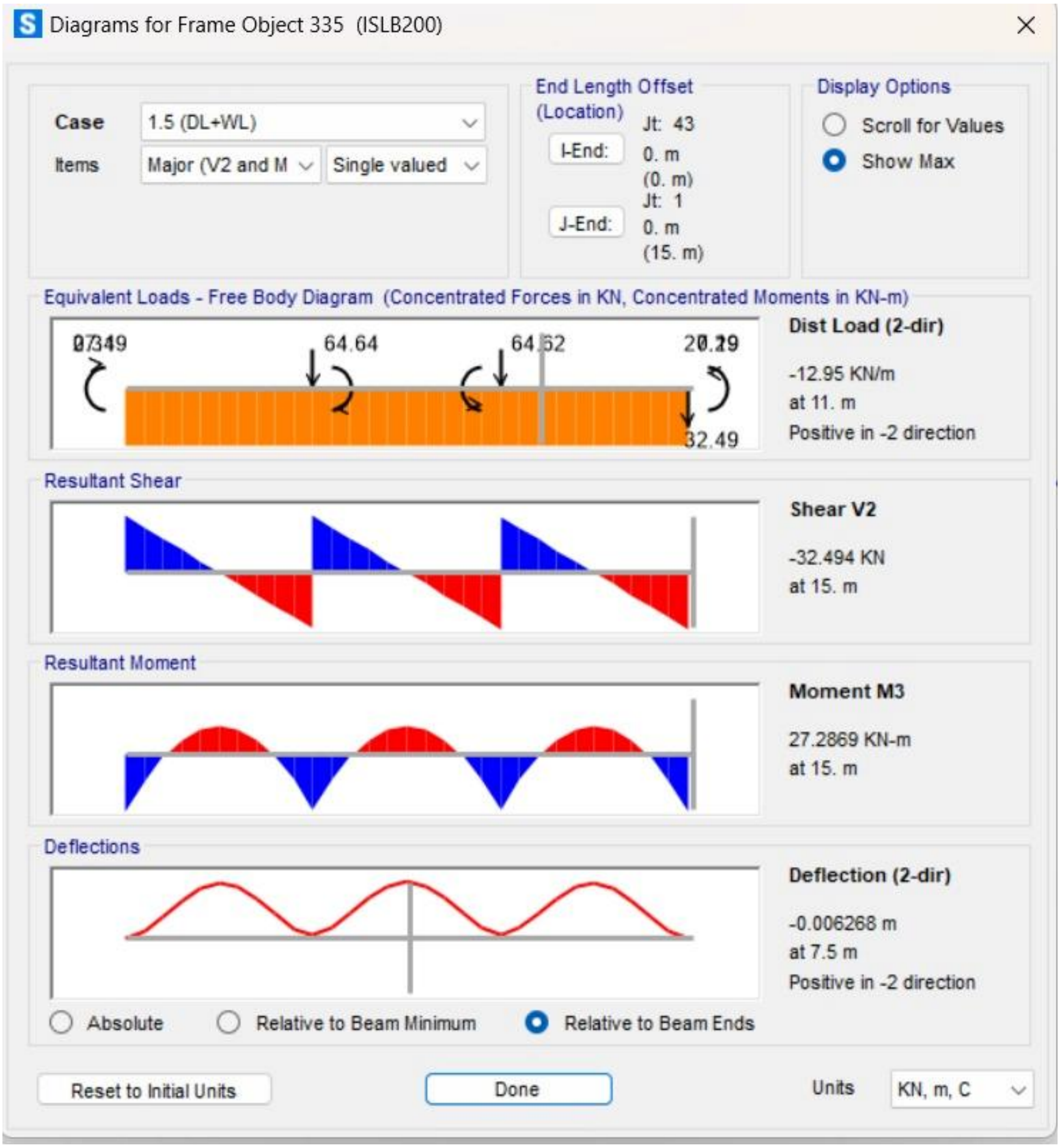
Minor Axis

- Maximum Shear Force: 0 kN
- Maximum Bending Moment: 0 kNm
- Loading Combination: 1.5 (DL+LL)



Beam

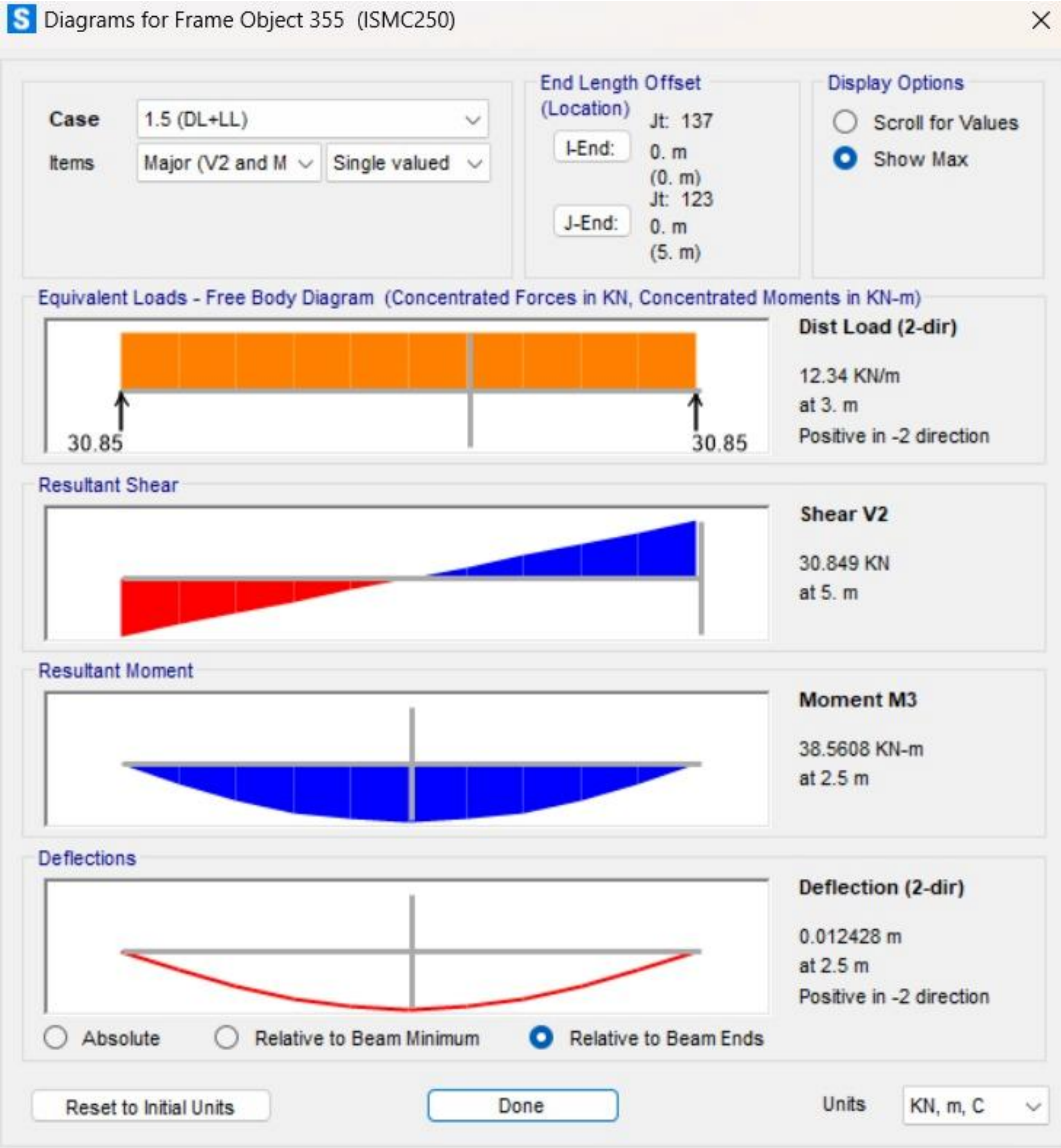
- Maximum Shear Force: - 32.494 kN
- Maximum Bending Moment: 28.2869 kNm
- Load Combination: 1.5(DL+WL)

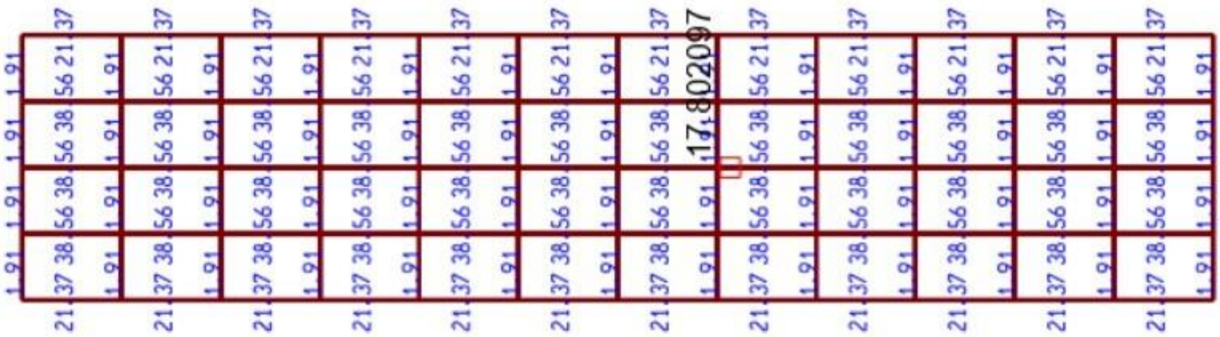


Purlins

Major Axis

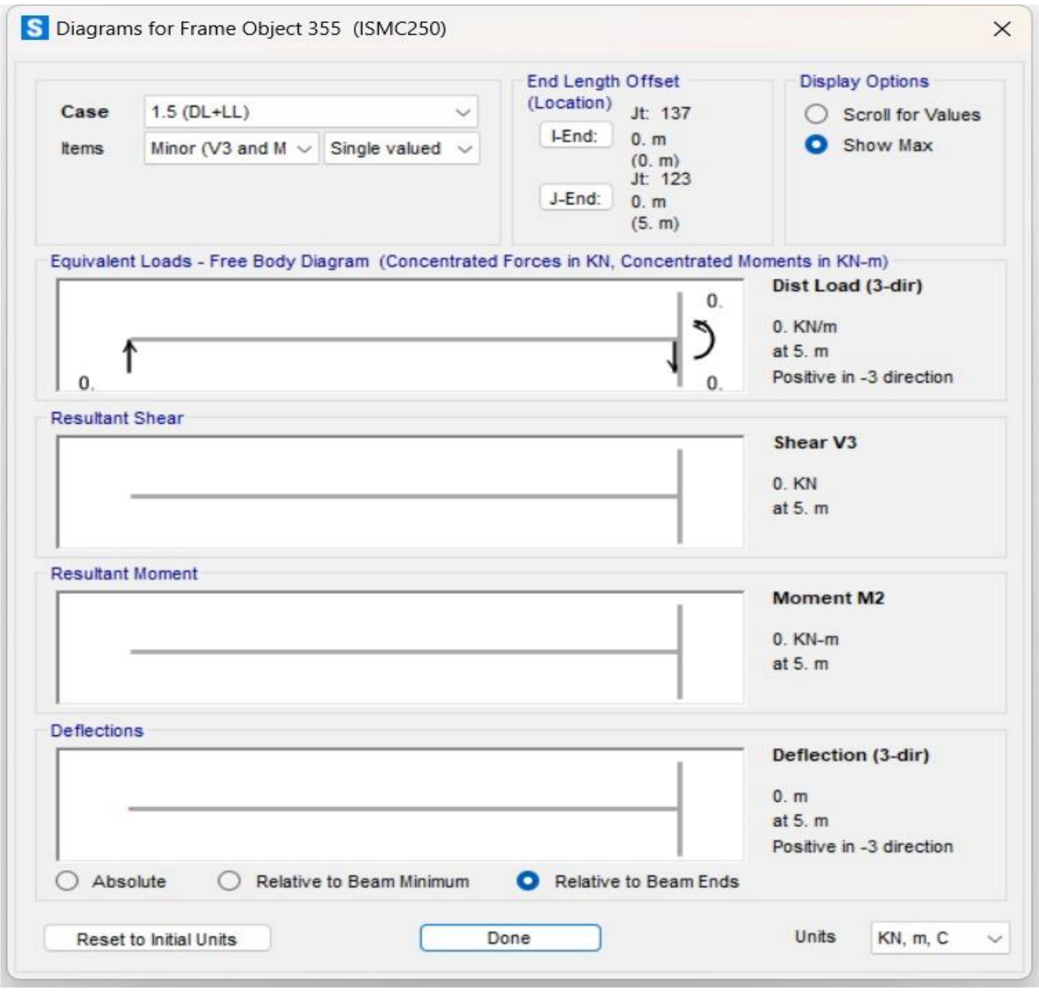
- Maximum Shear Force: 30.849 kN
- Maximum Bending Moment: 38.5608 kNm
- Loading Combination: 1.5 (DL+LL)





Minor Axis

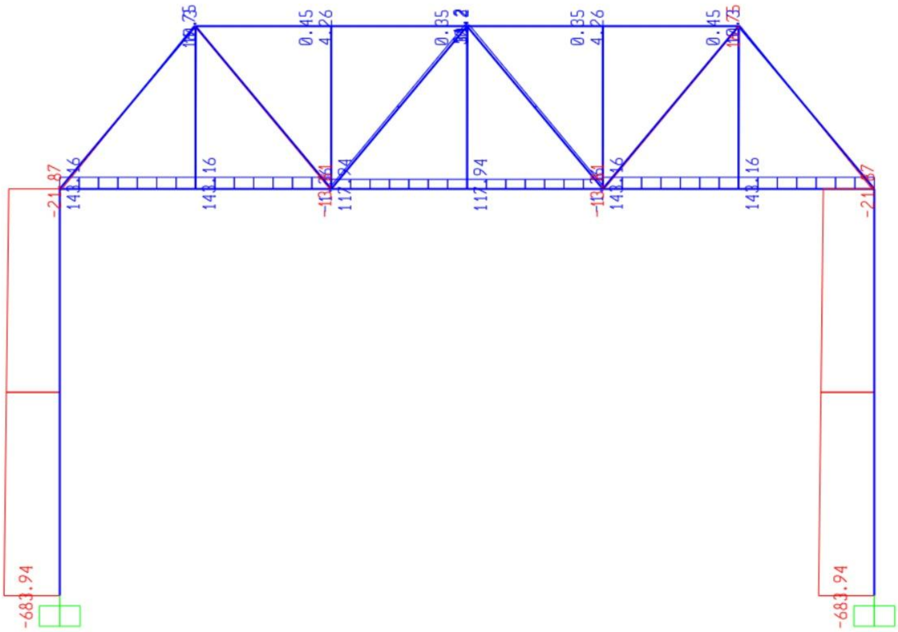
- Maximum Shear Force: 0 kN
- Maximum Bending Moment: 0 kNm

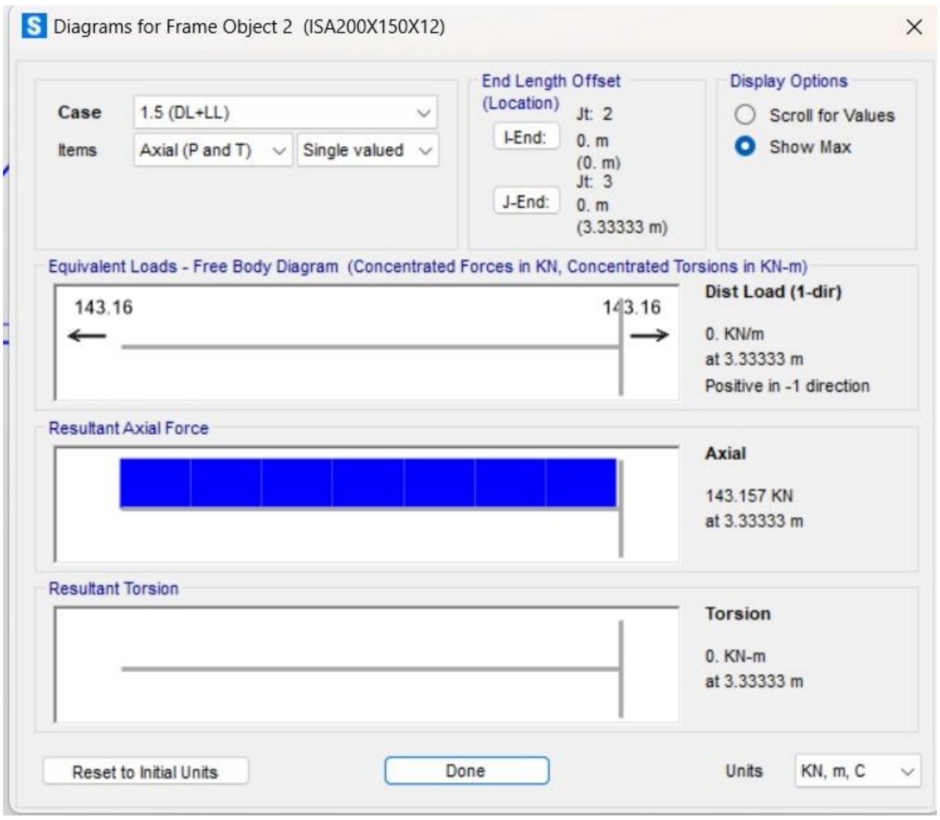


Truss Members

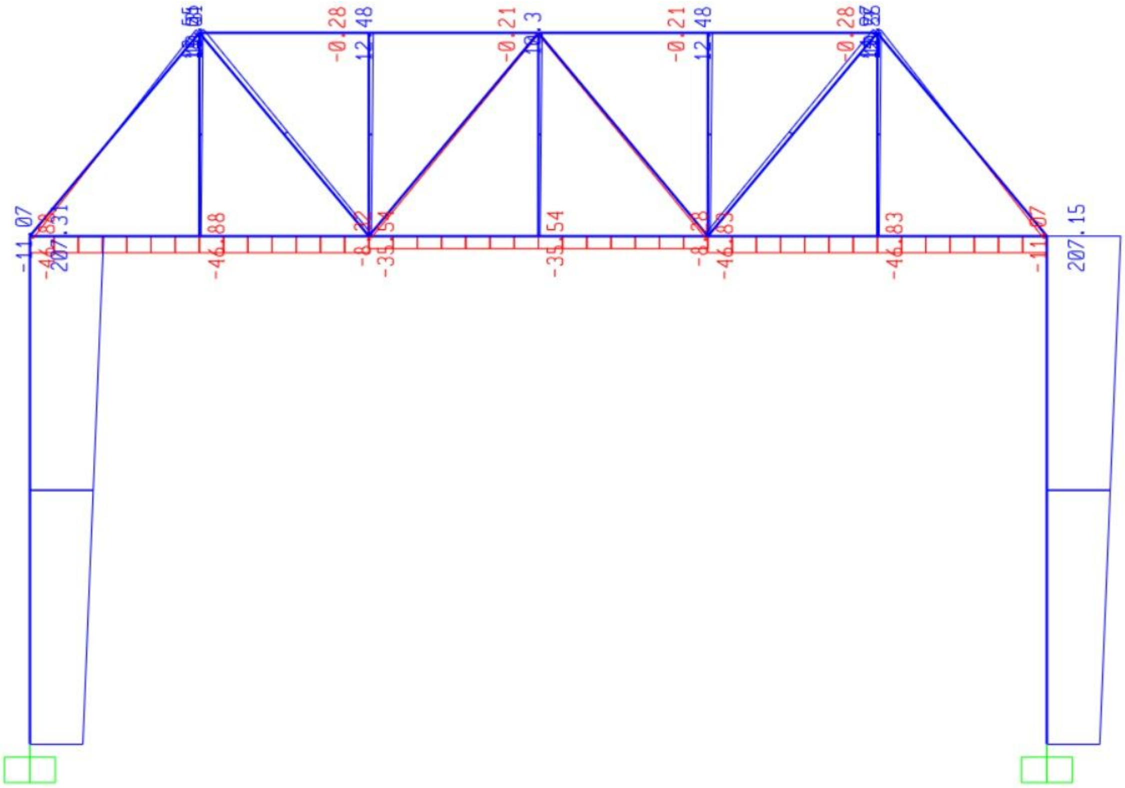
Bottom Chord

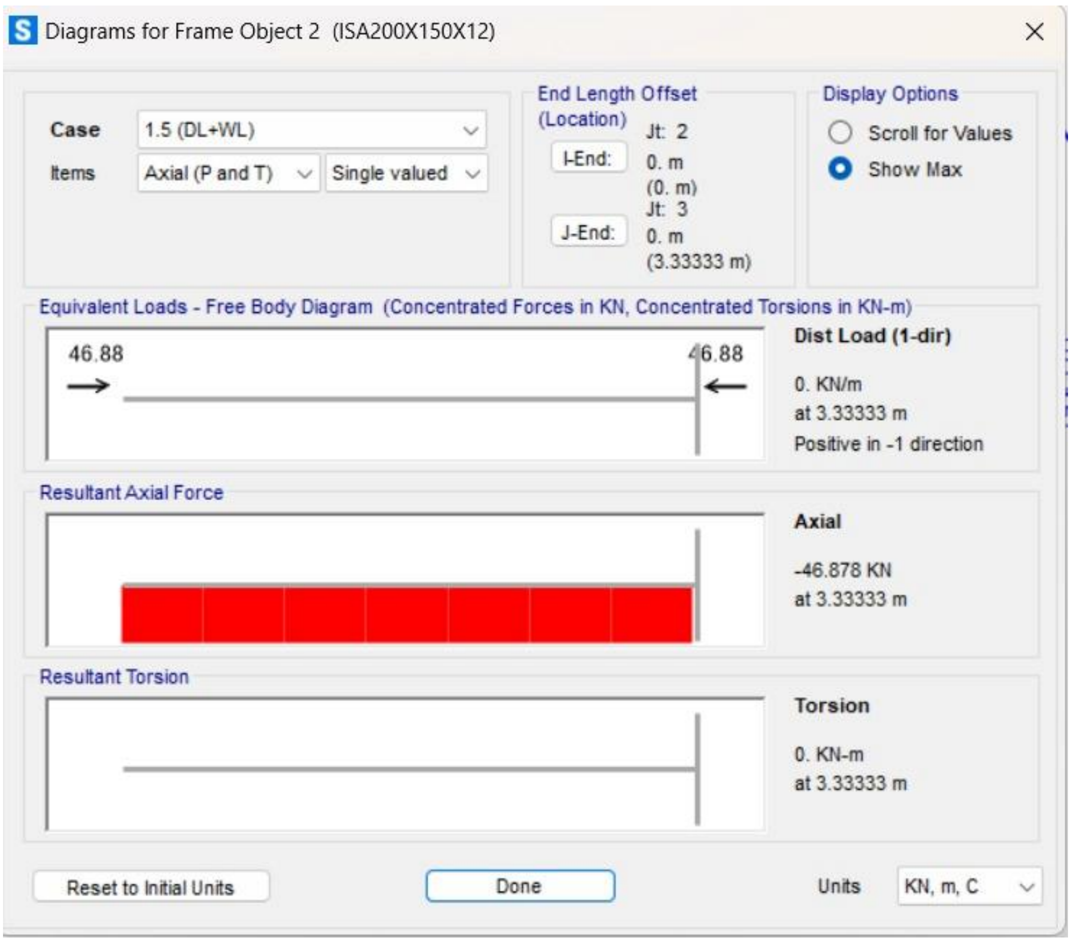
- Maximum Axial Tension Load: 143.157 kN
- Load Combination: 1.5(DL+LL)





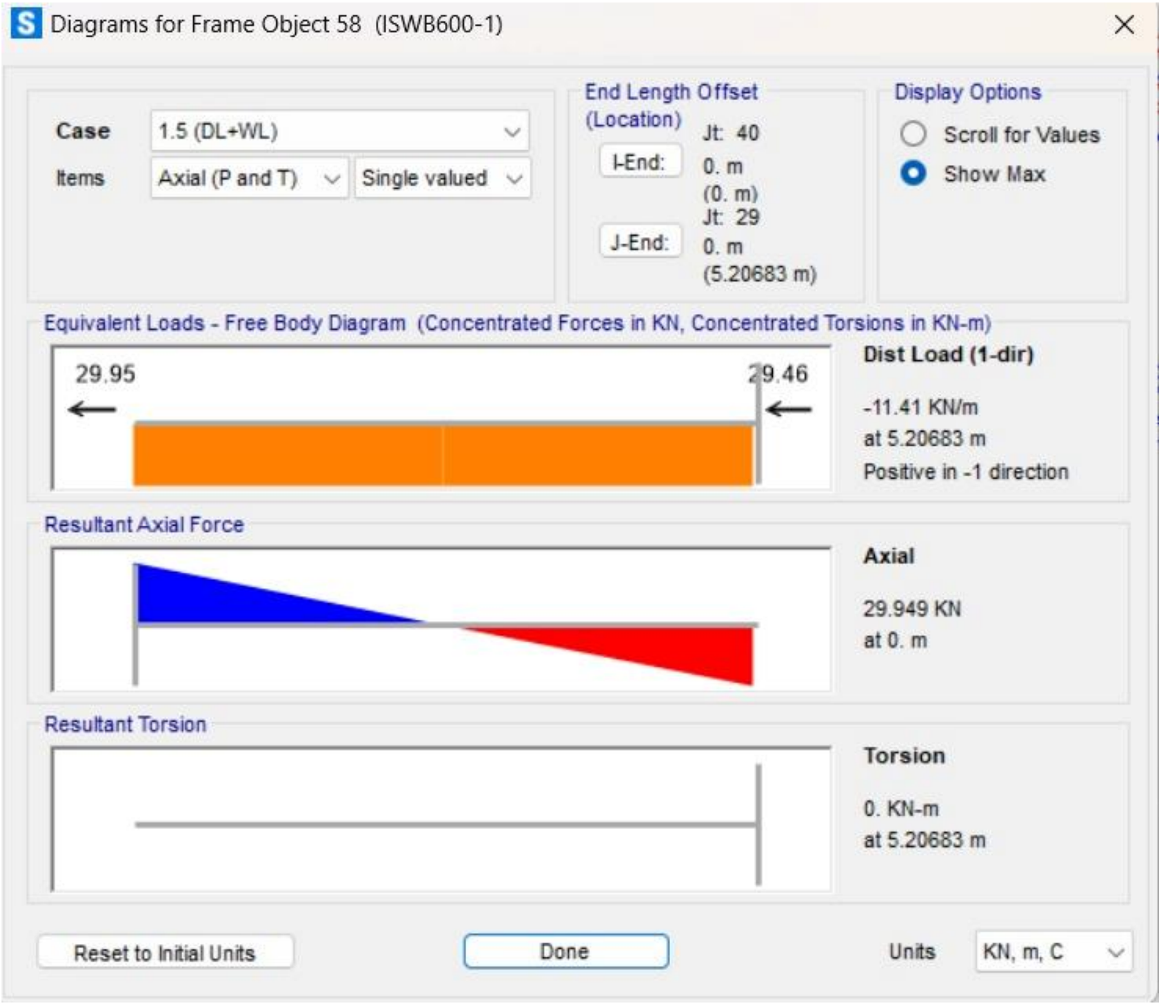
- Maximum Axial Compression Load: - 46.878 kN
- Load Combination: 1.5(DL+WL)

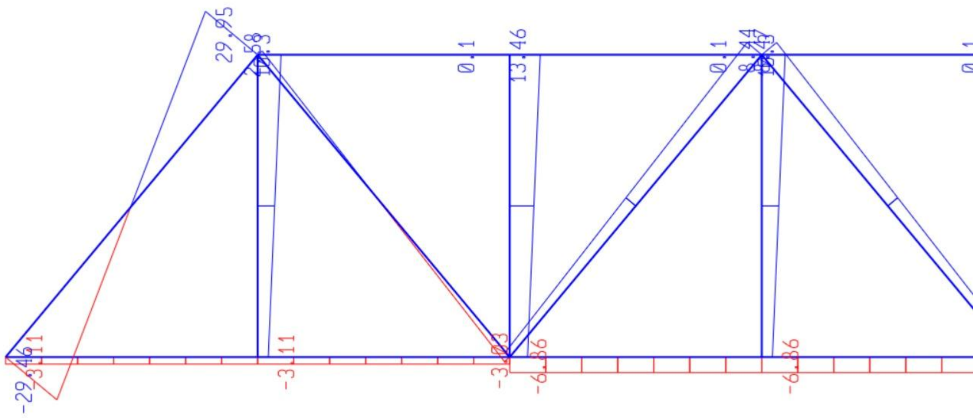




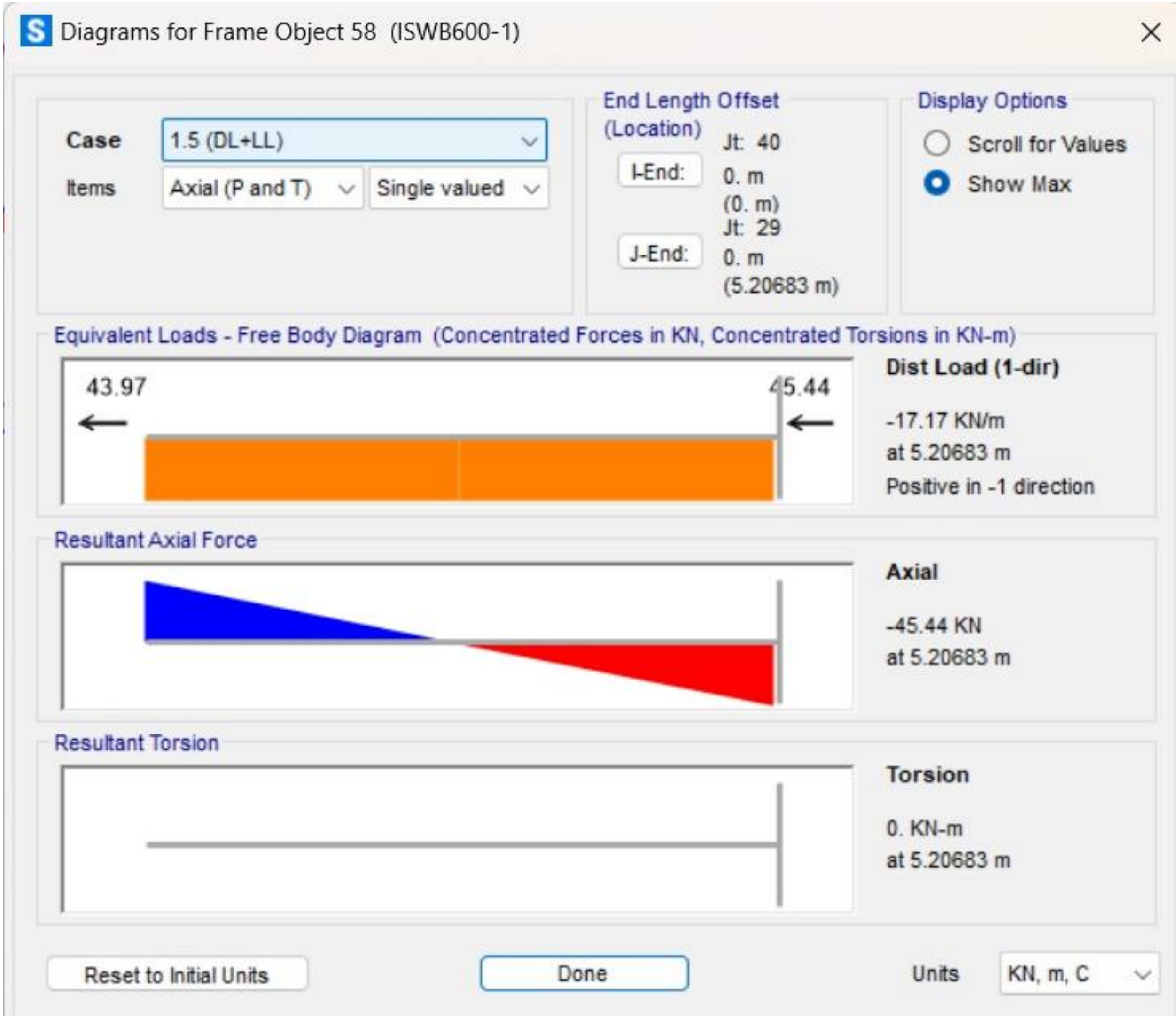
Top Chord

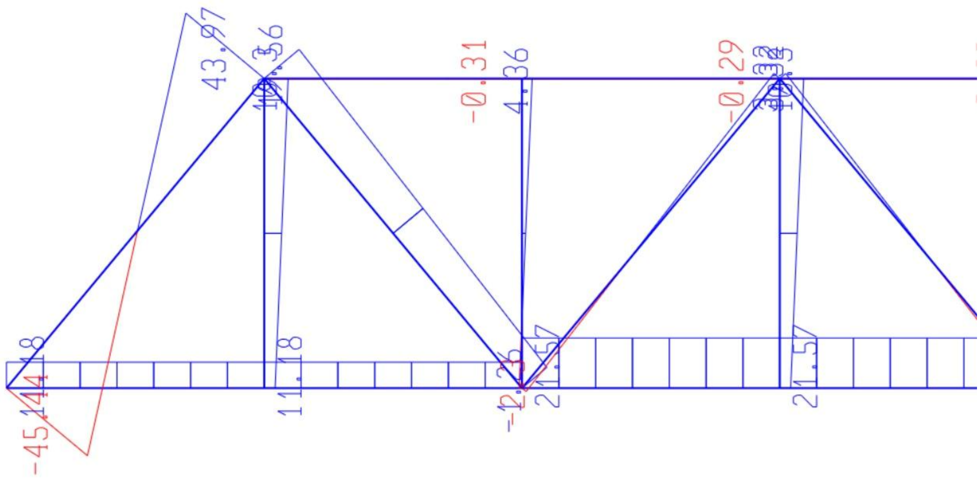
- Maximum Axial Tension Load: 29.949 kN
- Load Combination: 1.5(DL+WL)





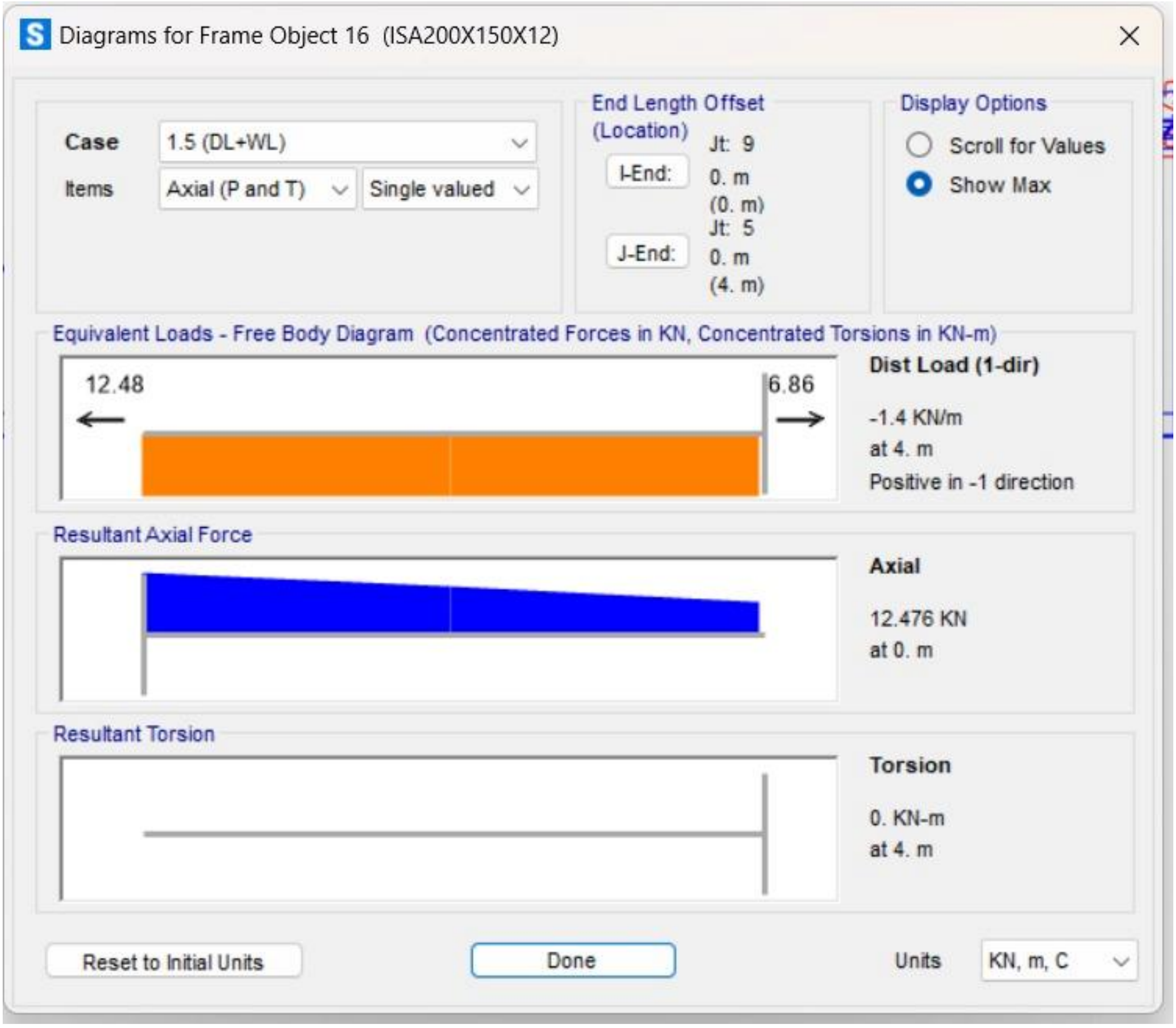
- Maximum Axial Compression Load: - 45.44 kN
- Load Combination: 1.5(DL+LL)





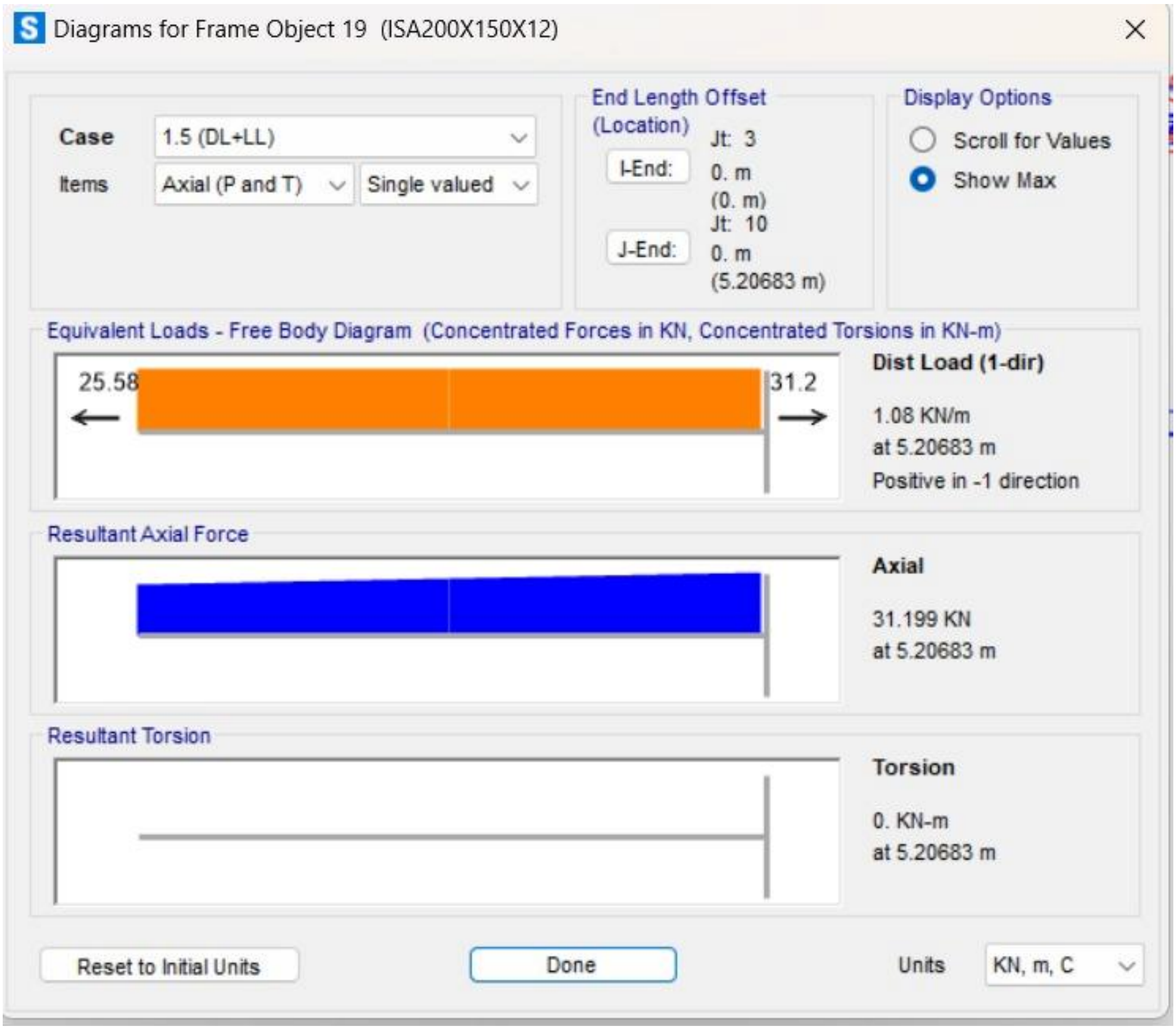
Vertical Chord

- Maximum Axial Tension Load: 12.476 kN
- Load Combination: 1.5(DL+WL)

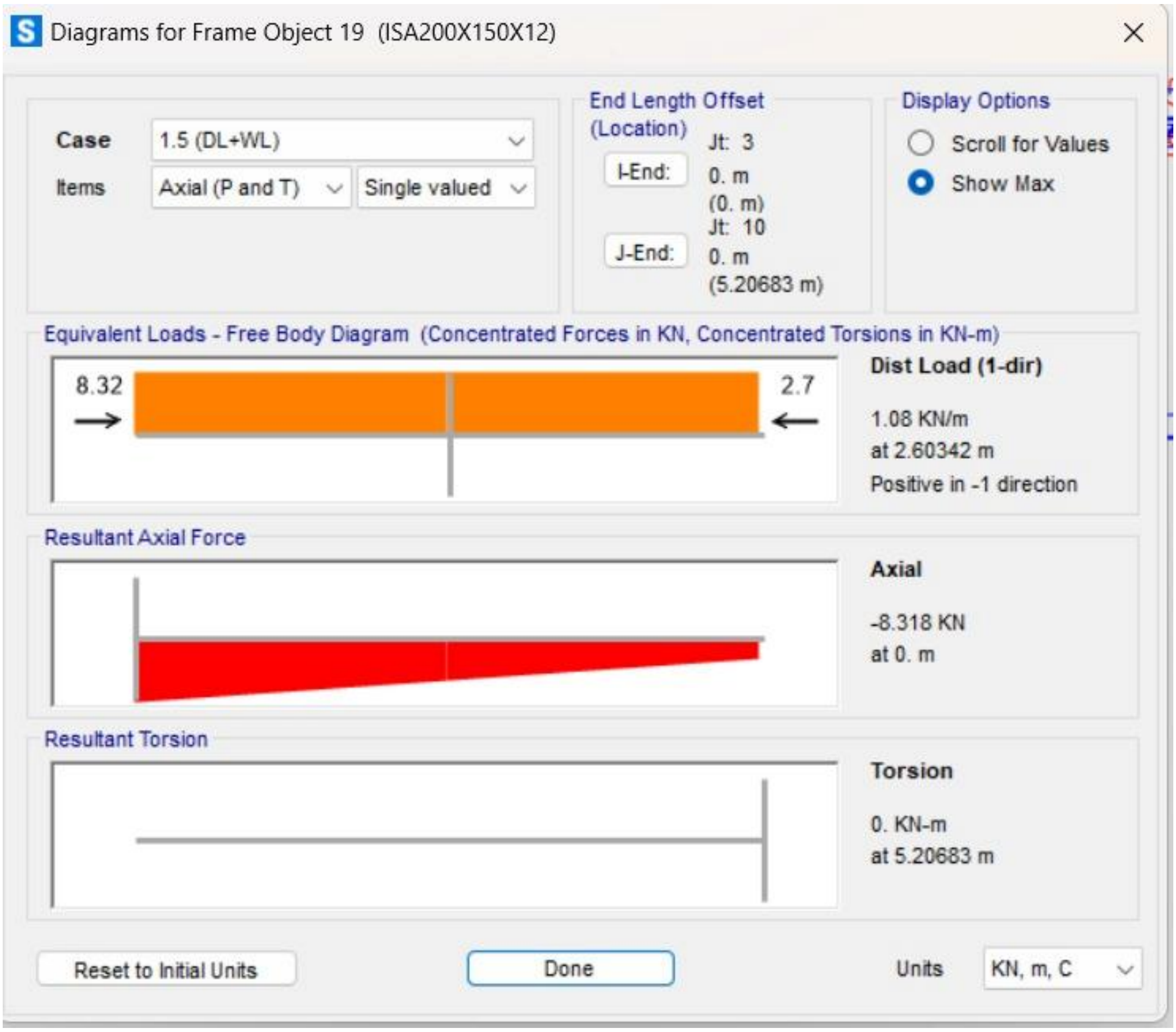


Diagonal Chord

- Maximum Axial Tension Load: 31.199 kN
- Load Combination: 1.5(DL+LL)



- Maximum Axial Tension Load: -8.318 kN
- Load Combination: 1.5(DL+WL)



Design Forces in Critical Members

Member no.	Member	Load Type	Maximum Load	Load Case (in which maximum is coming)
1	Top Chord	Axial Force	- 45.44 kN	1.5 (DL+LL)
			29.95 kN	1.5(DL+WL)
2	Bottom Chord	Axial Force	143.157 kN	1.5 (DL+LL)
			- 46.878KN	1.5(DL +WL)
3	Diagonal Chord	Axial Force	31.2 kN	1.5 (DL+LL)
			- 8.318 kN	1.5(DL+ WL)
4	Vertical Chord	Axial Force	12.476 kN	1.5 (DL+WL)
			0	
5	Purlin	Moment (Major)	38.561 kN-m	1.5 (DL+LL)
		Moment (minor)	0	
6	Beam	Shear Force	- 32.494 kN	1.5 (DL+WL)
		Bending Moment	27.287 kN-m	
7	Column	Axial Force	- 856.41 kN	1.5 (DL+LL)
		Major axis Moment	14.5923 kN-m	
		Minor axis Moment	0 kN-m	

Thank You