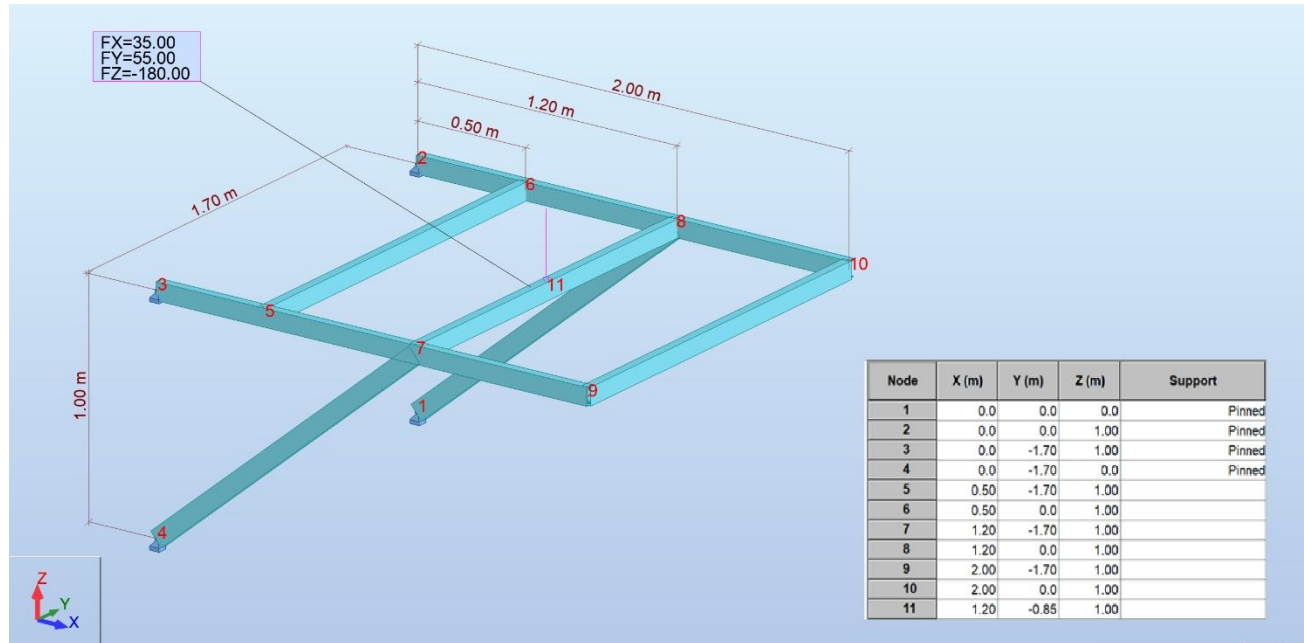
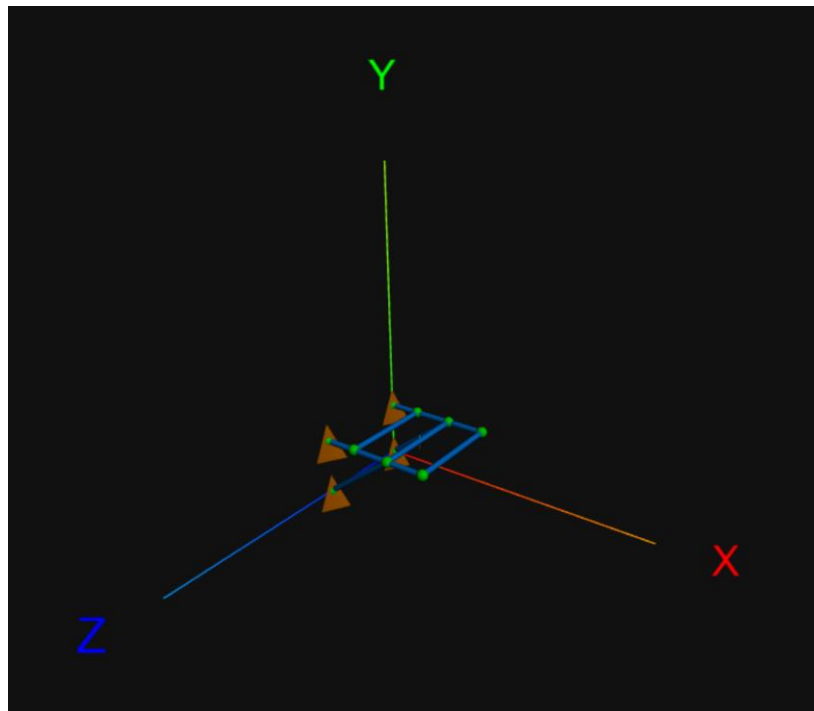




Autodesk Robot Structure Analysis



3D Structure Analysis Tool

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Introduction

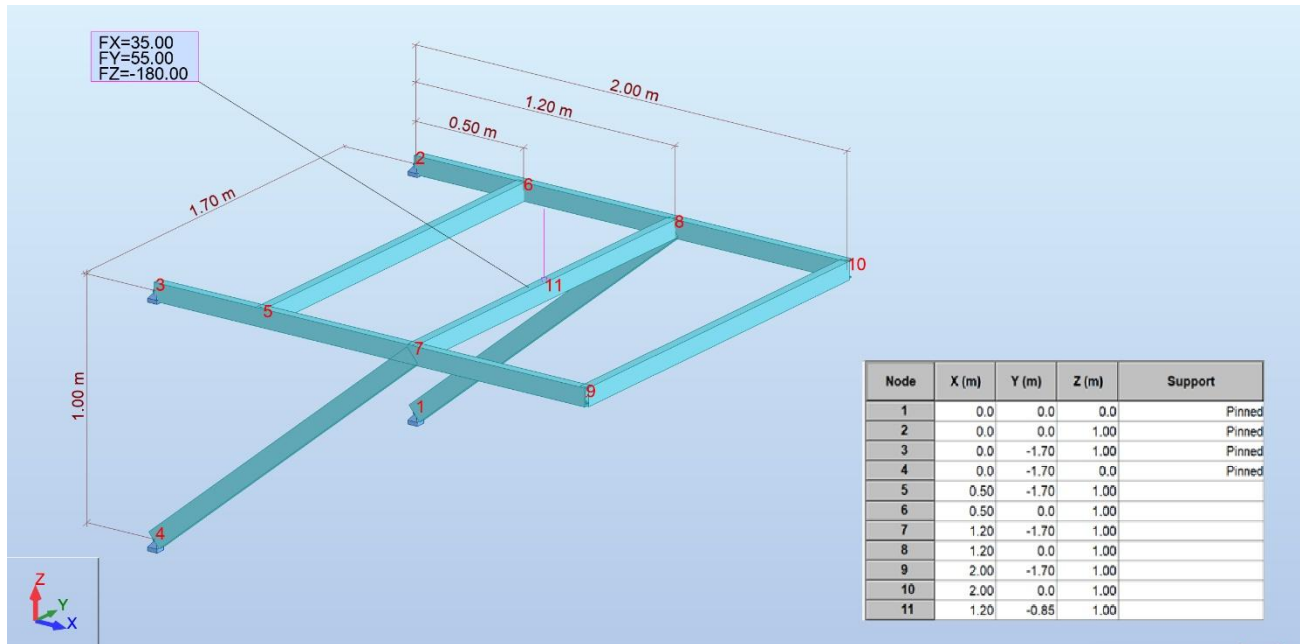
This report presents the validation of a 3D Structural Analysis Tool against commercial software (Autodesk Robot Structural Analysis). The validation focuses on a 3D Frame Structure subjected to point load on Node 11 with 4 pinned supports.

Problem Description

The structure shown in following figure is a 3D frame structure with point load applied at Node 11. Determine the reactions at supports Nodes 1, 2, 3, 4. The Dimensions and Loads are shown in following figure.

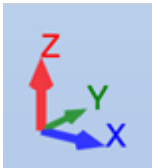
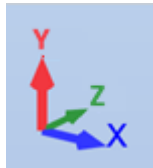
Support Conditions:

- Node 1 to Node 4: Pinned support



Coordinate System

The coordinate system in Autodesk Robot and 3D Structure Analysis Tool are shown below.

CS in Autodesk Robot	CS in 3D Structure Analysis Tool
	

Nodes

The nodes numbers and X,Y,Z values are shown below.

Nodes in Autodesk Robot				Nodes in 3D Structure Analysis Tool			
Node #	X	Y	Z	Node #	X	Y	Z
1	0.0	0.0	0.0	1	0.0	0.0	0.0
2	0.0	0.0	1.00	2	0.0	1.00	0.0
3	0.0	-1.70	1.00	3	0.0	1.00	-1.70
4	0.0	-1.70	0.0	4	0.0	0.0	-1.70
5	0.50	-1.70	1.00	5	0.50	1.00	-1.70
6	0.50	0.0	1.00	6	0.50	1.00	0.0
7	1.20	-1.70	1.00	7	1.20	1.00	-1.70
8	1.20	0.0	1.00	8	1.20	1.00	0.0
9	2.00	-1.70	1.00	9	2.00	1.00	-1.70
10	2.00	0.0	1.00	10	2.00	1.00	0.0
11	1.20	-0.85	1.00	11	1.20	1.00	-0.85

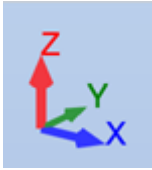
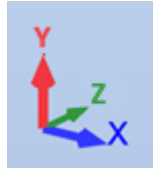
Supports

The supports are applied at nodes shown below.

Supports in Autodesk Robot		Supports in 3D Structure Analysis Tool	
Node #	Support Type	Node #	Support Type
1	Pinned	1	Pinned
2	Pinned	2	Pinned
3	Pinned	3	Pinned
4	Pinned	4	Pinned

Loads

The loads are applied at node 11 shown below.

Forces in Autodesk Robot				Forces in 3D Structure Analysis Tool			
Node #	FX [kN]	FY [kN]	FZ [kN]	Node #	FX [kN]	FY [kN]	FZ [kN]
11	35	55	-180	11	35	-180	55
							

Validation Methodology

The validation process employs a two-way comparison approach:

Reference Solutions

- **3D Struture Analysis Tool:** The software tool being validated.
- **Autodesk Robot:** Industry-standard structural analysis software for independent verification

Validation Parameters

The following parameters were compared across all two methods:

- Support reactions (forces and moments)

Acceptance Criteria

- Reaction force accuracy: $\pm 1\%$ deviation from Autodesk Robot solution

Validation Results

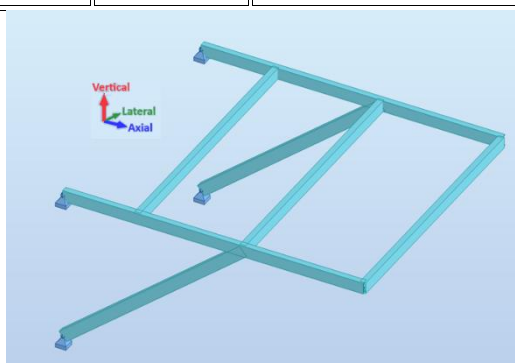
Support Reactions in kN

Node	Component	Autodesk Robot	3D Tool	Robot vs Transformed	Difference in kN	Status
1	Axial	111.67	113.093	111.67 vs 113.093	1.423	✓ OK
	Lateral	4.76	3.824	4.76 vs 3.824	0.936	✓ OK
	Vertical	92.97	94.222	92.97 vs 94.222	1.252	✓ OK

Node	Component	Autodesk Robot	3D Tool	Robot vs Transformed	Difference in kN	Status
2	Axial	90.35	91.770	90.35 vs 91.770	1.42	✓ OK
	Lateral	27.48	23.676	27.48 vs 23.676	3.804	✓ OK
	Vertical	0.09	0.277	0.09 vs 0.277	0.187	✓ OK

Node	Component	Autodesk Robot	3D Tool	Robot vs Transformed	Difference in kN	Status
3	Axial	160.65	159.230	-160.65 vs 159.230	1.42	✓ OK
	Lateral	22.48	23.676	22.48 vs 22.203	1.196	✓ OK
	Vertical	0.08	0.255	0.08 vs -0.255	0.175	✓ OK

Node	Component	Autodesk Robot	3D Tool	Robot vs Transformed	Difference in kN	Status
4	Axial	104.33	102.907	104.33 vs 102.907	1.423	✓ OK
	Lateral	0.44	3.824	0.44 vs 3.824	3.384	✓ OK
	Vertical	86.86	85.755	86.86 vs 85.755	1.105	✓ OK



Conclusion

Validation Summary

The 3D Structure Analysis Tool has been successfully validated against commercial structural analysis software. The validation demonstrates little bit difference in reaction loads. The difference is due to method used in calculation. In 3D Structure Analysis Tool, the Direct Sparse Matrix Solver is used.

Reliability Assessment

Based on the validation results, the 3D Structural Analysis Tool is deemed RELIABLE for quickly computation of reactions.

Recommendations

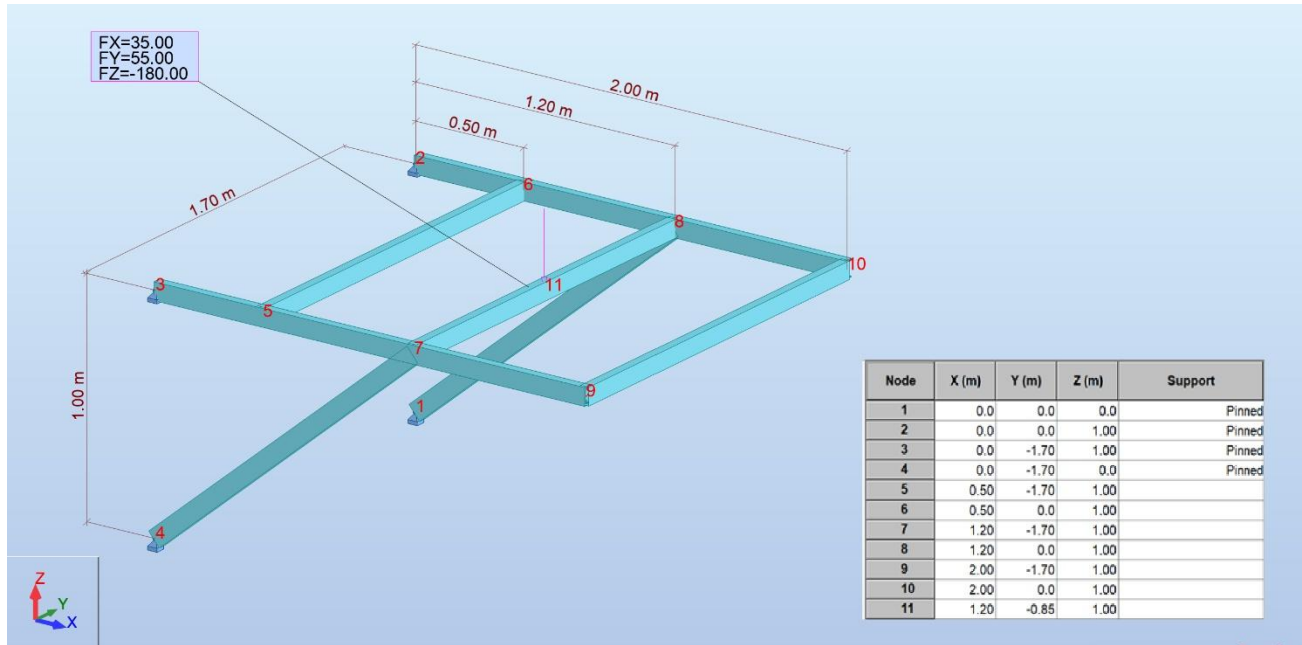
1. **Approved for Use:** The 3D Structural Analysis Tool is recommended for computation of reactions for 3D Frame Structures and 3D Truss Structures.
2. **Quality Assurance:** The validation confirms the tool meets professional engineering standards
3. **Documentation:** Results are presented in clear, professional format.
4. **Benefit:** The 3D Structure Analysis Tool works online on Web Browser on any device which eliminates the installation of software on PC.

Certification Statement

This validation report confirms that the 3D Structure Analysis Tool produces satisfactory and reliable results consistent with industry-standard structural analysis software. The tool is suitable for professional engineering applications within the validated scope of 3D Frame and Truss Structural problems.

Appendix A: [Report] Autodesk Robot Structural Analysis

Structure View



Data - Nodes

Node	X (m)	Y (m)	Z (m)	Support code	Support
1	0.0	0.0	0.0	xxxxff	Pinned
2	0.0	0.0	1.00	xxxxff	Pinned
3	0.0	-1.70	1.00	xxxxff	Pinned
4	0.0	-1.70	0.0	xxxxff	Pinned
5	0.50	-1.70	1.00		
6	0.50	0.0	1.00		
7	1.20	-1.70	1.00		
8	1.20	0.0	1.00		
9	2.00	-1.70	1.00		
10	2.00	0.0	1.00		
11	1.20	-0.85	1.00		

Data - Members

Member	Node 1	Node 2	Section	Material	Length (m)	Gamma (Deg)	Type
2	3	9	C 3x5	STEEL	2.00	0.0	Simple member
3	9	10	C 3x5	STEEL	1.70	0.0	Simple member
4	2	10	C 3x5	STEEL	2.00	0.0	Simple member
5	5	6	C 3x5	STEEL	1.70	0.0	Simple member
6	7	8	C 3x5	STEEL	1.70	0.0	Simple member
7	1	8	C 3x5	STEEL	1.56	0.0	Simple member
8	4	7	C 3x5	STEEL	1.56	0.0	Simple member

Data - Sections

	Section name	Member list	AX (cm2)	AY (cm2)	AZ (cm2)	IX (cm4)	IY (cm4)	IZ (cm4)
	C 3x5	2to8	9.484	5.284	4.994	1.769	77.003	10.031

Data - Materials

	Material	E (MPa)	G (MPa)	NI	LX (1/°C)	RO (kN/m3)	Re (MPa)
1	STEEL	199947.97	76904.12	0.30	0.00	76.97	248.21

Data - Supports

	Support name	List of nodes	List of edges	List of objects	Support conditions
	Pinned	1to4			UX UY UZ

Loads - Cases

Case	Label	Case name	Nature	Analysis type
------	-------	-----------	--------	---------------

2	DL2	DL2	D Dead load	Static - Linear
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Loads - Values

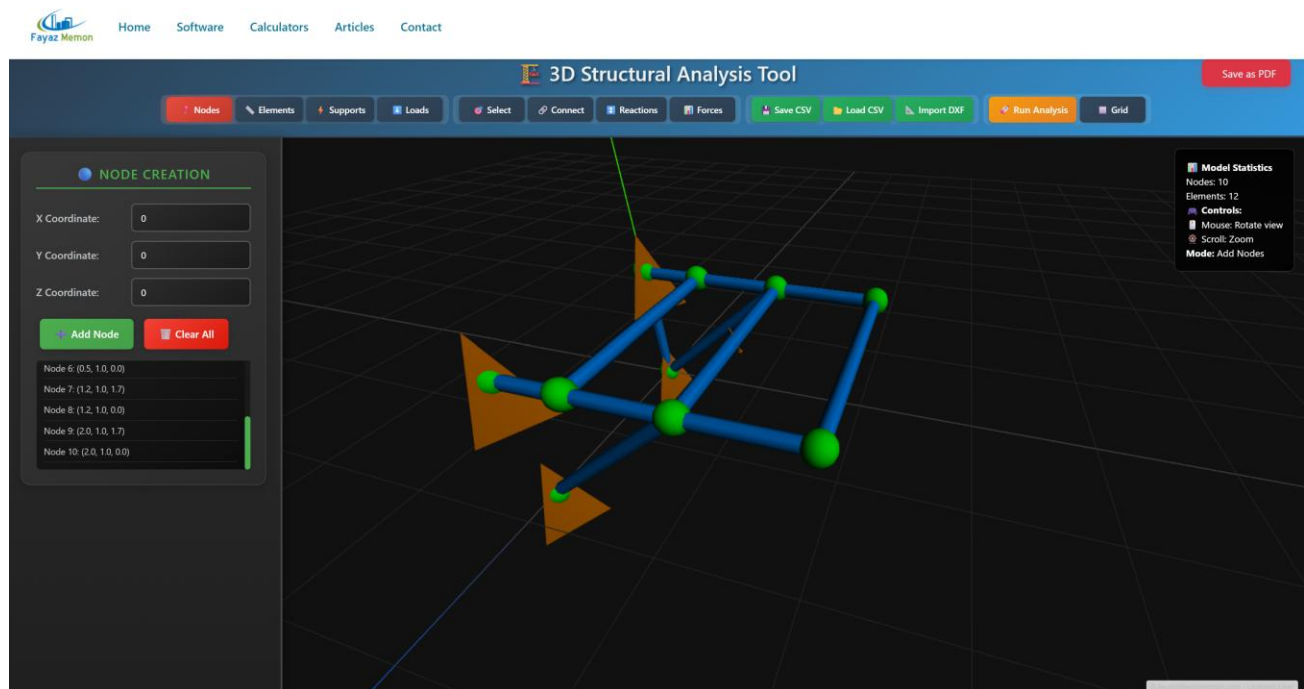
#	Case	Load type	List	Load values
1	2	nodal force	11	FX=35.00(kN) FY=55.00(kN) FZ=-180.00(kN)

Reactions - Values

Node/Case	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
1/ 2	111.67	-4.76	92.97	-0.00	0.0	0.00
2/ 2	-90.35	-27.48	0.09	0.00	0.0	-0.00
3/ 2	-160.65	-22.32	0.08	0.00	-0.00	0.0
4/ 2	104.33	-0.44	86.86	-0.00	-0.00	-0.00
Case 2	DL2					
Sum of val.	-35.00	-55.00	180.00	-0.00	-0.00	-0.00
Sum of reac.	-35.00	-55.00	180.00	-98.00	-251.00	-95.75
Sum of forc.	35.00	55.00	-180.00	98.00	251.00	95.75
Check val.	0.00	0.00	0.00	-0.00	0.00	0.00
Precision	8.27842e-14	2.23559e-26				

Appendix B: 3D Structural Analysis Tool

Model



Nodes

Node 1: (0.0, 0.0, 0.0)

Node 2: (0.0, 1.0, 0.0)

Node 3: (0.0, 1.0, 1.7)

Node 4: (0.0, 0.0, 1.7)

Node 5: (0.5, 1.0, 1.7)

Node 6: (0.5, 1.0, 0.0)

Node 7: (1.2, 1.0, 1.7)

Node 8: (1.2, 1.0, 0.0)

Node 9: (2.0, 1.0, 1.7)

Node 10: (2.0, 1.0, 0.0)

Elements

Element 1: 2 → 6 (FRAME, L=0.50m)

Element 2: 6 → 8 (FRAME, L=0.70m)

Element 3: 8 → 10 (FRAME, L=0.80m)

Element 4: 10 → 9 (FRAME, L=1.70m)

Element 5: 9 → 7 (FRAME, L=0.80m)

Element 6: 7 → 5 (FRAME, L=0.70m)

Element 7: 5 → 3 (FRAME, L=0.50m)

Element 8: 1 → 8 (FRAME, L=1.56m)

Element 9: 4 → 7 (FRAME, L=1.56m)

Element 10: 8 → 7 (FRAME, L=1.70m)

Element 11: 6 → 5 (FRAME, L=1.70m)

Supports

⚡ SUPPORT CONDITIONS

Node:

Select Node

Support Type:

Pinned (Tx,Ty,Tz)

+ Add Support

Clear Supports

Node 1: pinned
Node 2: pinned
Node 3: pinned
Node 4: pinned

Loads: Load applied at Mid of Element 10.

⬇️ LOADING

Load Type:

Element Mid Force

Element:

Element 10 (8-7)

Fx (N):

35000

Fy (N):

-180000

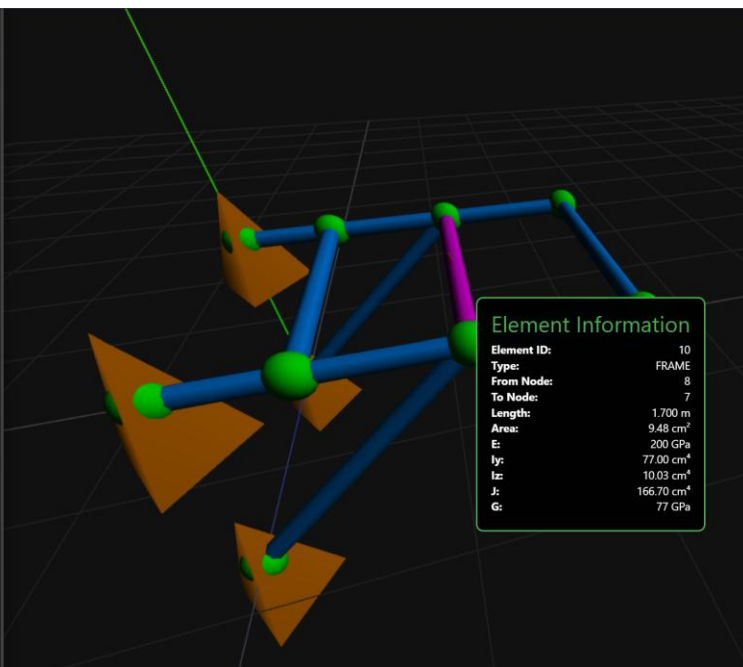
Fz (N):

-55000

+ Add Load

Clear Loads

Load 1: element_force on Element 10 (35000, -180000, -55000)N



Element Information

Element ID:	10
Type:	FRAME
From Node:	8
To Node:	7
Length:	1.700 m
Area:	9.48 cm ²
E:	200 GPa
Iy:	77.00 cm ⁴
Iz:	10.03 cm ⁴
J:	166.70 cm ⁴
G:	77 GPa

Reactions:



Support Reactions

Node	Support Type	Fx (kN)	Fy (kN)	Fz (kN)	Mx (kNm)	My (kNm)	Mz (kNm)
1	Pinned	113.093	94.222	3.824	0.000	0.000	0.000
2	Pinned	-91.770	0.277	23.676	0.000	0.000	0.000
3	Pinned	-159.230	-0.255	23.676	0.000	0.000	0.000
4	Pinned	102.907	85.755	3.824	0.000	0.000	0.000

Equilibrium Check

Component	Sum	Status
ΣF_x	-0.000000	✓
ΣF_y	-0.000000	✓
ΣF_z	0.000000	✓
ΣM_x	0.000000	✓
ΣM_y	0.000000	✓
ΣM_z	0.000000	✓