

*SVEUČILIŠTE U ZAGREBU*  
**GRAĐEVINSKI FAKULTET**

## **ZAVRŠNI RAD**

Snimak stanja stare krovne konstrukcije i prijedlog  
sanacije

Assesment of the old roof structure and sanation proposal

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## **Sažetak**

Cilj ovog rada bio je napraviti ocjenu stanja konstrukcije postojećeg krovišta zgrade Gradske skupštine Grada Zagreba te dati prijedlog sanacije Zone 2. U prvom dijelu opisane su nedestruktivne metode ispitivanja i procjene stanja drva na temelju kojih dobijemo mehanička svojstva koja koristimo u daljnjim proračunima. Nakon toga, modelirana je konstrukcija postojećeg krovišta u programu Dlubal kako bi se napravilo izvješće u kojem su definirane dimenzije konstrukcije i njezinih presjeka te sva zadana opterećenja na temelju kojih je napravljen statički proračun same konstrukcije.

## **Summary**

The aim of this work was to evaluate the condition of the existing roof structure of the City Assembly Building of the City of Zagreb and to provide a proposal for its rehabilitation of Zone 2. In the first part, non-destructive testing methods and the evaluation of the condition of the wood were described, based on which mechanical properties were obtained and used in further calculations. Afterward, the existing roof structure was modeled in the Dlubal program to create a report that defines the dimensions of the structure and its cross-sections, as well as all specified loads, which were used for the static analysis of the structure itself.

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## NEDESTRUKTIVNE METODE ISPITIVANJA I PROCJENE STANJA DRVA

### 1. Drvo kao građevni materijal

Drvo je, kao ekološki i obnovljiv izvor, jedno od najtraženijih prirodnih materijala. Velika potražnja i razvoj novih proizvoda su doveli do brze sječe i nedostatka kvalitetne drvene sirovine pa se velika pažnja mora posvetiti njegovom racionalnom korištenju.



*Slika 1. Drvena crkva u Malopolskoj, izgrađena tijekom 15.-16. stoljeća*

Sve veća ekološka osviještenost nalaže smanjenje emisije stakleničkih plinova u industriji i potrebu da se gospodarstvo (građevinarstvo) preusmjeri na prirodne materijale kakvi su drvo i kamen.

Prirodna trajnost drva je njegova sposobnost da se odupre biološkim utjecajima. Ona ovisi o vrsti drva, te mjestu i načinu upotrebe drvenog proizvoda.

Prednosti drva s obzirom na druge materijale su laka obrada, niska osjetljivost na temperaturu, niska cijena, ekološki i obnovljiva sirovina, visoka čvrstoća paralelno s vlaknima, mala težina elemenata, jeftina obrada i dobra izolacijska svojstva.

## 2. Metode ispitivanja

Metode ispitivanja materijala dijelimo na destruktivne (razorne) i nedestruktivne (nerazorne).

### a) Destruktivne metode ispitivanja:

Destruktivne metode ispitivanja drva obuhvaćaju tehnike koje uzrokuju oštećenje ili uništavanje uzoraka drva kako bi se analizirala njihova unutrašnja struktura ili svojstva. Ova metoda se primjenjuje radi procjene čvrstoće, kvalitete ili drugih karakteristika drva.

### b) Nedestruktivne (nerazorne) metode ispitivanja:

Prednost nedestruktivnih metoda testiranja u odnosu na destruktivne je što one pridonose očuvanju materijala, čime se ostvaruje bolja kontrola kvalitete uz postizanje potpune automatizacije proizvodnje. U tim su ispitivanjima eksperimentalni uzorci manjih dimenzija i na istim je uzorcima moguće odrediti više različitih mehaničkih svojstava.

Nedestruktivne metode ispitivanja drva su tehnike koje omogućavaju procjenu svojstava drva bez oštećenja ili uništavanja uzorka. Neke od ovih metoda uključuju:

**Ultrazvuk.** Ova metoda se koristi za merenje brzine zvuka kroz drvo kako bi se utvrdila njegova gustoća i moguća oštećenja. Utvrđivanje kvalitete drva ultrazvukom je nerazorna metoda koja se često koristi u industriji drva kako bi se procjenila unutrašnja struktura drva. Ova tehnika koristi ultrazvučne valove koji prolaze kroz drvo i omogućuju analizu karakteristika kao što su gustoća, vlaga, prisustvo pukotina ili drugih oštećenja. Na osnovu rezultata ultrazvučnog testiranja, moguće je donijeti odluke o kvalitetu i upotrebljivosti drva za određenu svrhu, kao što su građevinski materijali ili proizvodi od drva.

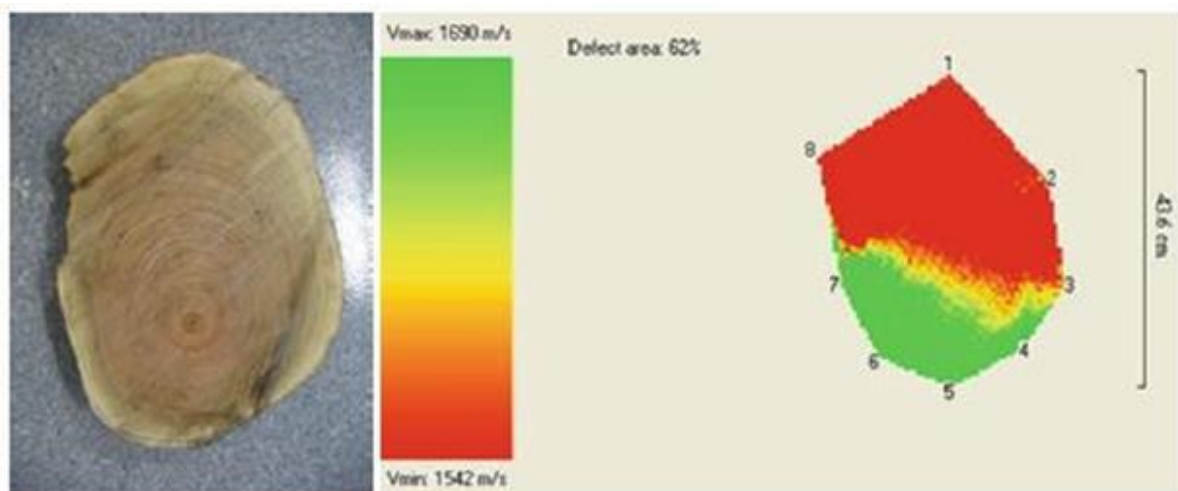
Ova metoda se često primjenjuje jer omogućava brzo i precizno ispitivanje unutrašnje strukture drva bez oštećenja materijala. Rezultati ultrazvučnog testiranja pomažu u optimizaciji procesa proizvodnje i smanjenju gubitaka u drvnoj industriji. Akustična tomografija stvara sliku raspodjele brzine ultrazvučnih valova koji se šire kroz drvo. U uzorak se zabiju sonde koje detektiraju širenje ultrazvučnih valova te šalju signal u računalo koje brzinu širenja valova pretvara u sliku.

Mehaničkim udarom u drvo izazovemo zvučne valove koji se preko sondi i računala pretvaraju u grafički prikaz. Veće brzine postižu se tangentsnog a manje

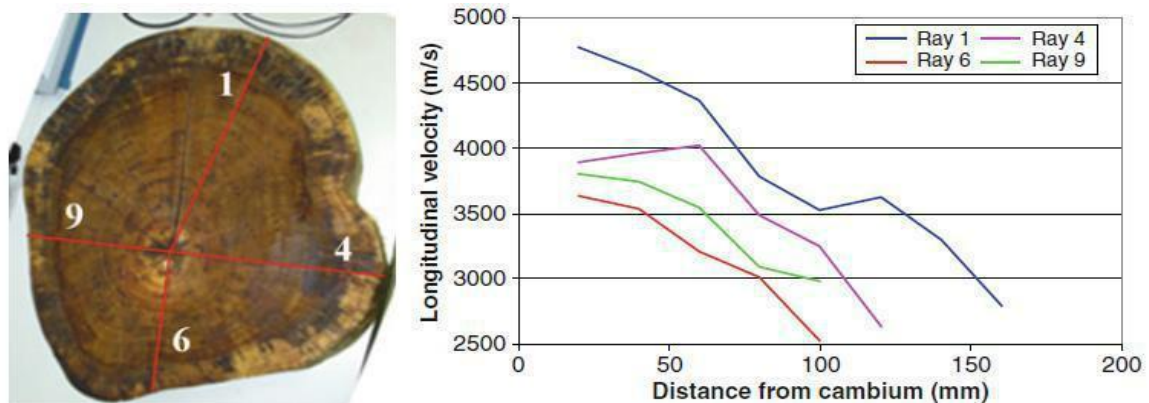
kod radijalnog ispitivanja. Značajni pad brzine upućuje na deformaciju ili trulež drva.



Slika 2. Prikaz pretvornika i pozicioniranja pinova kod ispitivanja u radijalnom smjeru (lijevo) i tangentnom smjeru (desno), (Bucur, 2011.)

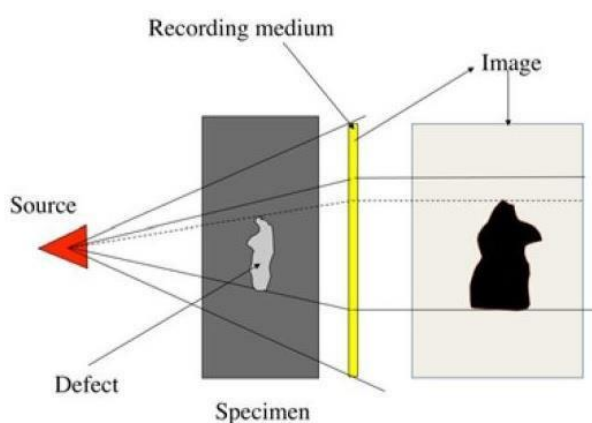


Slika 3. Prikaz brzine kretanja zvuka u radijalnom smjeru (Bucur, 2011.)



Slika 4. Prikaz brzine kretanja zvuka u longitudinalnom smjeru (Bucur, 2011.)

Radiografija. Metoda je slična kao u medicini, radiografija može otkriti unutrašnje nedostatke poput pukotina, čvorova ili insekata u drvu. Utvrđivanje kvalitete drva radiografijom je postupak koji se koristi za procjenu unutarnje strukture drva i identifikaciju eventualnih nedostataka ili oštećenja, kao što su pukotine, insektni napadi ili trulež. Ovaj postupak se obično naziva "radiografsko ispitivanje drva" ili "radiografija drva". Radiografija drva koristi rendgenske ili gama zrake kako bi se stvorila slika unutarnje strukture drveta. Ovaj postupak može biti koristan u različitim industrijama, kao što su građevinarstvo, proizvodnja namještaja ili drvna industrija, jer omogućava bolje razumijevanje kvalitete i pouzdanosti drva prije nego što se koristi u određenim projektima ili proizvodima. Radiografsko ispitivanje drva može pomoći u smanjenju rizika od korištenja nekvalitetnog drva i potencijalnih problema u budućnosti. Da bi se izvršilo radiografsko ispitivanje drva, potrebna je odgovarajuća oprema za generiranje rendgenskih ili gama zraka, kao i uređaj za snimanje i analizu dobivenih slika. Stručnjaci koji su obučeni za ovu vrstu ispitivanja mogu tumačiti rezultate i pružiti informacije o kvaliteti drva na temelju dobivenih slika.



Slika 5. Shematski prikaz principa rada

Termografska snimanja. Termalne kamere se koriste za identifikaciju varijacija temperature u drvu koje može ukazati na prisustvo oštećenja. Utvrđivanje kvalitete drva termografijom je postupak koji koristi termografsku kameru ili termalnu sliku kako bi se identificirale promjene u temperaturi drva. Ovaj postupak može pomoći u otkrivanju nedostataka u drvu kao što su pukotine, trulež ili nejednaka sušenost. Termografska slika može pokazati varijacije u temperaturi na površini drva, što može ukazivati na probleme. Kako bi se koristila termografija za utvrđivanje kvalitete drva, potrebno je provesti sljedeće korake:

1. Priprema: Drvo treba biti na sobnoj temperaturi kako bi se osigurala točna mjerenja.

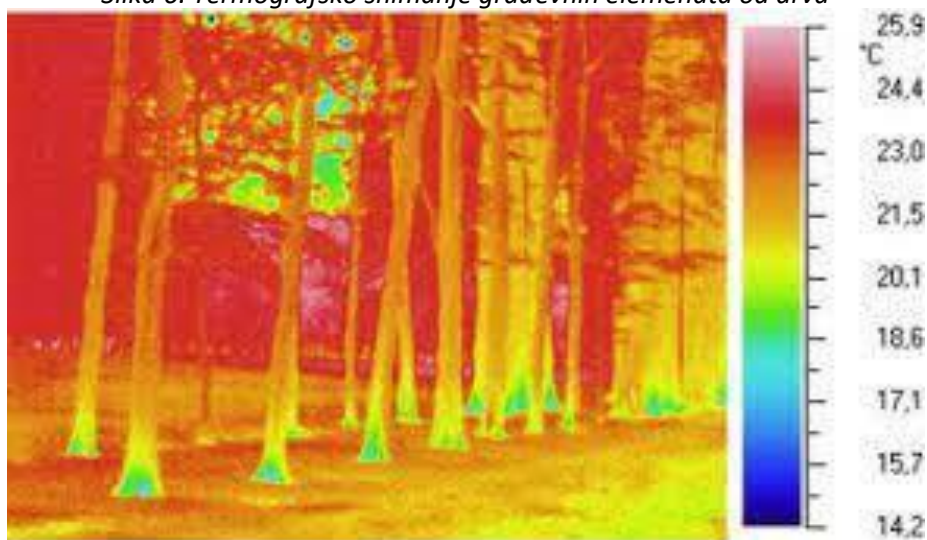
2. Skeniranje: Termalnom kamerom ili senzorom skenirati površinu drva. Različiti dijelovi drva mogu pokazivati različite temperature.
3. Analiza: Termografske slike se analiziraju kako bi se identificirale anomalije u temperature kao npr. povišene temperature na određenim područjima mogu ukazivati na trulež ili druge probleme.
4. Interpretacija: Stručnjak interpretira termografske slike i donosi zaključke o kvaliteti drva na temelju promjena u temperaturi.

Termografija može biti korisna u otkrivanju skrivenih nedostataka u drvu koji nisu vidljivi golim okom. Međutim, važno je napomenuti da termografski pregled neće dati sve informacije o kvaliteti drva i da se treba koristiti u kombinaciji s drugim metodama ispitivanja drva kako bi se dobio cjelovit pregled kvalitete.

Termografska snimanja drva vrše se preventivno i prije same sječe stabala kako bi se utvrdili nedostaci i spriječilo rušenje stabala uslijed vjetrova, posebno u urbanim sredinama.



Slika 6. Termografsko snimanje građevnih elemenata od drva



Slika 7. Primjena termografije u analizi stanja drveta



Računalni programi. Novija nedestruktivna metoda utemeljena je na računalnim programima koju omogućavaju dobivanje rezultata za veliki broj materijala i njihovih kombinacija bez opasnosti od uništenja kao što je slučaj kod destruktivnog ispitivanja. Kod analize stanja drva računalnim programima material ne mora biti fizički prisutan. Analiza se provodi na računalnim modelima različitih tipova drva šte su takve metode ekonomski prihvatljive.

Ova metoda ne može u potpunosti zamijeniti fizička ispitivanja ali može suziti izbor materijala u fazi projektiranja drvnih konstrukcija i drugih proizvoda što doprinosi bržem odabiru materijala a time i smanjenju vremena proizvodnje.

Metode procjene stanja drva pomoću računalnih programa uveliko pomažu kod procjene svojstva uslojenog drva i raznih ploča na bazi drva.

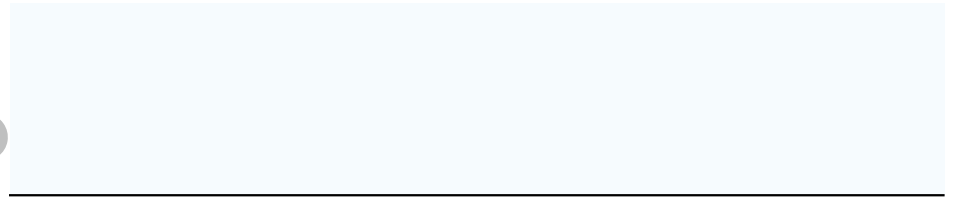
Za uslojeno drvo trenutno je važeća Europska norma za ispitivanje HRN EN 14272 – Računska metoda za pojedina mehanička svojstva. Računalni program koji je u potpunosti utemeljen je WoodLab Ply Calc.

Kako bi se dobila slika o pouzdanosti ove metode dobiveni rezultati se uspoređuju sa rezultatima dobiveni destruktivnom metodom koja se provode prema točno određenim pravilima koja propisuje norma HRN EN 310.

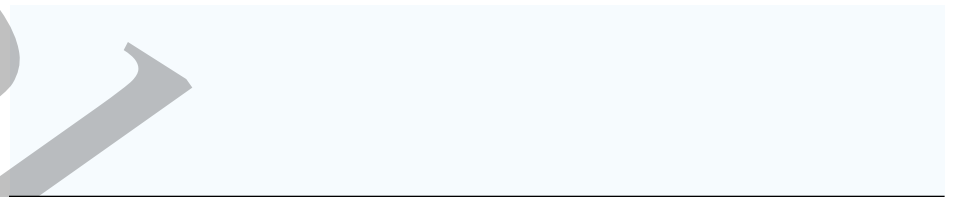


# Structural Analysis

## CLIENT



## CREATED BY



## Chapters

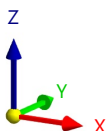
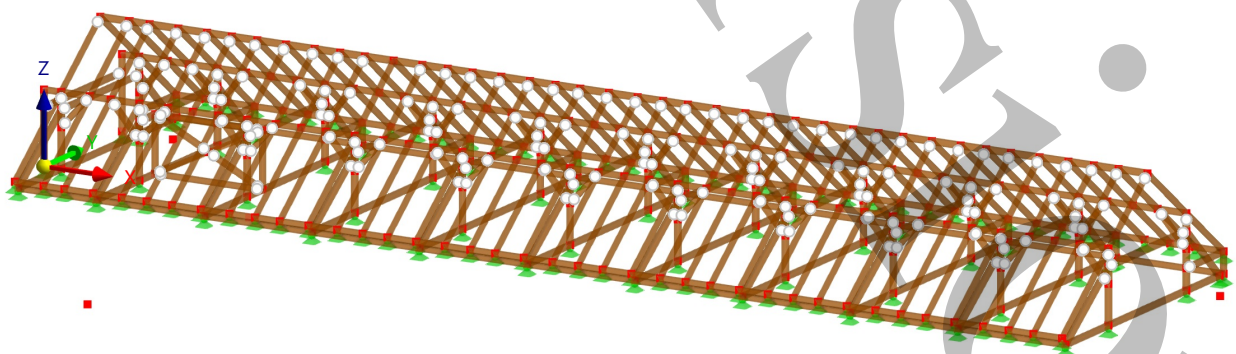
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## PROJECT



## MODEL

In Axonometric Direction by Default



Dimensions [m]



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A

### MODEL - LOCATION

#### Location



Country	: Croatia
Street	: Ćirilometodska ulica 5
Zip / Postal code	: 10000
City	: Zagreb
State	:
Latitude	: 45.816 deg
Longitude	: 15.973 deg
Altitude	: 162.929 m

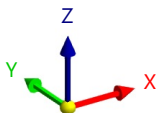


Graphic **MODEL, IN AXONOMETRIC DIRECTION**

**Static Analysis**

LC1 - Self-weight  
Static Analysis

In Axonometric Direction by Default





MODEL

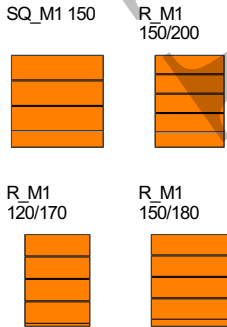
# 1 Basic Objects

## 1.1 MATERIALS

Legend  
 Stiffness modification

Material No.	Material Name	Material Type	Analysis Model	Options
3	GL24h   Isotropic   Linear Elastic	Timber	Isotropic   Linear Elastic	

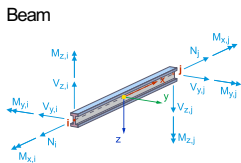
## 1.2 SECTIONS



Section No.	Material No.	Section Type	Manufacturing Type	J [cm <sup>4</sup> ] A [cm <sup>2</sup> ]	I <sub>u</sub> [cm <sup>4</sup> ] A <sub>u</sub> [cm <sup>2</sup> ]	I <sub>v</sub> [cm <sup>4</sup> ] A <sub>v</sub> [cm <sup>2</sup> ]	Overall Dimensions b [mm] h [mm]
3	3	SQ_M1 150   3 - GL24h		7129.69	4218.75	4218.75	500.0 500.0
		Parametric - Massive I		225.00	187.50	187.50	
4	3	R_M1 150/200   3 - GL24h		12149.07	10000.00	5625.00	150.0 200.0
		Parametric - Massive I		300.00	250.00	250.00	
5	3	R_M1 120/170   3 - GL24h		5527.53	4913.00	2448.00	120.0 170.0
		Parametric - Massive I		204.00	170.00	170.00	
6	3	R_M1 150/180   3 - GL24h		10046.00	7290.00	5062.50	150.0 180.0
		Parametric - Massive I		270.00	225.00	225.00	

## 1.3 MEMBERS

Legend  
 Design properties  
 Effective Length (Timber Design)  
 Member Hinge  
 Member Hinge  
 Service Class (Timber Design)



Member No.	Line No.	Member Type Section Distribution	Rotation Type β [deg]	Section i/k/j	Hinge i/j	Eccentricity i/j	Length L [m]	Position
1	2	Beam	Angle	0.00	3	1	2.398	Z
		Uniform						
2	4	Beam	Angle	0.00	3	1	2.412	Z
		Uniform						
3	8	Beam	Angle	0.00	4	1	4.700	Y
		Uniform						
4	14	Beam	Angle	0.00	3	1	1.522	In XZ
		Uniform						
5	15	Beam	Angle	0.00	3	1	1.523	In XZ
		Uniform						
6	16	Beam	Angle	0.00	3	1	1.496	XZ
		Uniform						
7	17	Beam	Angle	0.00	3	1	1.496	XZ
		Uniform						
8	21	Beam	Angle	0.00	5	1	2.961	YZ
		Uniform						
9	22	Beam	Angle	0.00	5		2.953	YZ
		Uniform						
10	26	Beam	Angle	0.00	5		2.827	YZ
		Uniform						
11	27	Beam	Angle	0.00	5		3.529	YZ
		Uniform						





**MODEL**

Phone: +385913520415  
 Email: petar.bacac@gmail.com

1.3 MEMBERS

Member No.	Line No.	Member Type Section Distribution	Rotation Type	$\beta$ [deg]	Section i/k/j	Hinge i/j	Eccentricity i/j	Length L [m]	Position
		Uniform							
12	28	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
13	29	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
14	30	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
15	31	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
16	32	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
17	33	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
18	34	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
20	11	Beam Uniform	Angle	0.00	6	--	--	3.750	X
23	12	Beam Uniform	Angle	0.00	6	--	--	3.750	X
24	9	Beam Uniform	Angle	0.00	3	1	--	2.398	Z
25	10	Beam Uniform	Angle	0.00	3	1	--	2.412	Z
26	13	Beam Uniform	Angle	0.00	4	1 1	--	4.700	Y
27	44	Beam Uniform	Angle	0.00	3	1 1	--	1.485	In XZ
28	45	Beam Uniform	Angle	0.00	3	1 1	--	1.485	In XZ
29	46	Beam Uniform	Angle	0.00	3	1 1	--	1.496	XZ
30	47	Beam Uniform	Angle	0.00	3	1 1	--	1.496	XZ
31	48	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
32	49	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
33	53	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ





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1.3 MEMBERS

Member No.	Line No.	Member Type Section Distribution	Rotation Type	$\beta$ [deg]	Section i/k/j	Hinge i/j	Eccentricity i/j	Length L [m]	Position
34	54	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
35	55	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
36	56	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
37	57	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
38	58	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
39	59	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
40	60	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
41	61	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
42	62	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
43	41	Beam Uniform	Angle	0.00	6	--	--	3.750	X
44	42	Beam Uniform	Angle	0.00	6	--	--	3.750	X
45	63	Beam Uniform	Angle	0.00	3	1	--	2.398	Z
46	64	Beam Uniform	Angle	0.00	3	1	--	2.412	Z
47	65	Beam Uniform	Angle	0.00	4	1	--	4.700	Y
48	71	Beam Uniform	Angle	0.00	3	1	--	1.485	In XZ
49	72	Beam Uniform	Angle	0.00	3	1	--	1.485	In XZ
50	73	Beam Uniform	Angle	0.00	3	1	--	1.496	XZ
51	74	Beam Uniform	Angle	0.00	3	1	--	1.496	XZ
52	75	Beam Uniform	Angle	0.00	5	--	--	2.961	YZ







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1.3 MEMBERS

Member No.	Line No.	Member Type Section Distribution	Rotation Type	$\beta$ [deg]	Section i/k/j	Hinge i/j	Eccentricity i/j	Length L [m]	Position
53	76	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
54	80	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
55	81	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
56	82	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
57	83	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
58	84	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
59	85	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
60	86	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
61	87	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
62	88	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
63	89	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
64	68	Beam Uniform	Angle	0.00	6	--	--	3.750	X
65	69	Beam Uniform	Angle	0.00	6	--	--	3.750	X
66	90	Beam Uniform	Angle	0.00	3	1	--	2.398	Z
67	91	Beam Uniform	Angle	0.00	3	1	--	2.412	Z
68	92	Beam Uniform	Angle	0.00	4	1	--	4.700	Y
69	98	Beam Uniform	Angle	0.00	3	1	--	1.485	In XZ
70	99	Beam Uniform	Angle	0.00	3	1	--	1.485	In XZ
71	100	Beam Uniform	Angle	0.00	3	1	--	1.496	XZ
72	101	Beam	Angle	0.00	3	1	--	1.496	XZ





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1.3 MEMBERS

Member No.	Line No.	Member Type Section Distribution	Rotation Type	$\beta$ [deg]	Section i/k/j	Hinge i/j	Eccentricity i/j	Length L [m]	Position
		Uniform				1	--		
73	102	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
74	103	Beam Uniform	Angle	0.00	5		--	2.953	YZ
75	107	Beam Uniform	Angle	0.00	5		--	2.827	YZ
76	108	Beam Uniform	Angle	0.00	5		--	3.529	YZ
77	109	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
78	110	Beam Uniform	Angle	0.00	5		--	2.953	YZ
79	111	Beam Uniform	Angle	0.00	5		--	2.827	YZ
80	112	Beam Uniform	Angle	0.00	5		--	3.529	YZ
81	113	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
82	114	Beam Uniform	Angle	0.00	5		--	2.953	YZ
83	115	Beam Uniform	Angle	0.00	5		--	2.827	YZ
84	116	Beam Uniform	Angle	0.00	5		--	3.529	YZ
85	95	Beam Uniform	Angle	0.00	6		--	3.750	X
86	96	Beam Uniform	Angle	0.00	6		--	3.750	X
87	117	Beam Uniform	Angle	0.00	3	1	--	2.398	Z
88	118	Beam Uniform	Angle	0.00	3	1	--	2.412	Z
89	119	Beam Uniform	Angle	0.00	4	1	--	4.700	Y
90	125	Beam Uniform	Angle	0.00	3	1	--	1.485	In XZ
91	126	Beam Uniform	Angle	0.00	3	1	--	1.485	In XZ





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92	127	Beam Uniform	Angle	0.00	3	1	--	1.496	XZ
93	128	Beam Uniform	Angle	0.00	3	1	--	1.496	XZ
94	129	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
95	130	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
96	134	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
97	135	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
98	136	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
99	137	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
100	138	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
101	139	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
102	140	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
103	141	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
104	142	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
105	143	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
106	122	Beam Uniform	Angle	0.00	6	--	--	3.750	X
107	123	Beam Uniform	Angle	0.00	6	--	--	3.750	X
108	144	Beam Uniform	Angle	0.00	3	1	--	2.398	Z
109	145	Beam Uniform	Angle	0.00	3	1	--	2.412	Z
110	146	Beam Uniform	Angle	0.00	4	1	--	4.700	Y





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1.3 MEMBERS

Member No.	Line No.	Member Type Section Distribution	Rotation Type	$\beta$ [deg]	Section i/k/j	Hinge i/j	Eccentricity i/j	Length L [m]	Position
111	152	Beam Uniform	Angle	0.00	3	1	--	1.485	In XZ
112	153	Beam Uniform	Angle	0.00	3	1	--	1.485	In XZ
113	154	Beam Uniform	Angle	0.00	3	1	--	1.496	XZ
114	155	Beam Uniform	Angle	0.00	3	1	--	1.496	XZ
115	156	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
116	157	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
117	161	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
118	162	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
119	163	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
120	164	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
121	165	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
122	166	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
123	167	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
124	168	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
125	169	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
126	170	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
127	149	Beam Uniform	Angle	0.00	6	--	--	3.750	X
128	150	Beam Uniform	Angle	0.00	6	--	--	3.750	X
129	147	Beam Uniform	Angle	0.00	3	1	--	2.398	Z
130	148	Beam	Angle	0.00	3	--	--	2.412	Z



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1.3 MEMBERS

Member No.	Line No.	Member Type Section Distribution	Rotation Type	$\beta$ [deg]	Section i/k/j	Hinge i/j	Eccentricity i/j	Length L [m]	Position
		Uniform				1	--		
131	151	Beam Uniform	Angle	0.00	4	1	--	4.700	Y
132	176	Beam Uniform	Angle	0.00	3	1	--	1.485	In XZ
133	177	Beam Uniform	Angle	0.00	3	1	--	1.485	In XZ
134	178	Beam Uniform	Angle	0.00	3	1	--	1.496	XZ
135	179	Beam Uniform	Angle	0.00	3	1	--	1.496	XZ
136	180	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
137	181	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
138	185	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
139	186	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
140	187	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
141	188	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
142	189	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
143	190	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
144	191	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
145	192	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
146	193	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
147	194	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
148	174	Beam Uniform	Angle	0.00	6	--	--	3.750	X
149	175	Beam Uniform	Angle	0.00	6	--	--	3.750	X





1.3 MEMBERS

Member No.	Line No.	Member Type Section Distribution	Rotation Type	$\beta$ [deg]	Section i/k/j	Hinge i/j	Eccentricity i/j	Length L [m]	Position
150	195	Beam Uniform	Angle	0.00	3	1	--	2.398	Z
151	196	Beam Uniform	Angle	0.00	3	1	--	2.412	Z
152	197	Beam Uniform	Angle	0.00	4	1	--	4.700	Y
153	200	Beam Uniform	Angle	0.00	3	1	--	1.485	In XZ
154	201	Beam Uniform	Angle	0.00	3	1	--	1.485	In XZ
155	202	Beam Uniform	Angle	0.00	3	1	--	1.496	XZ
156	203	Beam Uniform	Angle	0.00	3	1	--	1.496	XZ
157	204	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
158	205	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
159	209	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
160	210	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
161	211	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
162	212	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
163	213	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
164	214	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
165	215	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
166	216	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
167	217	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
168	218	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ



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1.3 MEMBERS

Member No.	Line No.	Member Type Section Distribution	Rotation Type	$\beta$ [deg]	Section i/k/j	Hinge i/j	Eccentricity i/j	Length L [m]	Position
169	198	Beam Uniform	Angle	0.00	6	--	--	3.750	X
170	199	Beam Uniform	Angle	0.00	6	--	--	3.750	X
171	219	Beam Uniform	Angle	0.00	3	1	--	2.398	Z
172	220	Beam Uniform	Angle	0.00	3	1	--	2.412	Z
173	221	Beam Uniform	Angle	0.00	4	1	--	4.700	Y
174	227	Beam Uniform	Angle	0.00	3	1	--	1.485	In XZ
175	228	Beam Uniform	Angle	0.00	3	1	--	1.485	In XZ
176	229	Beam Uniform	Angle	0.00	3	1	--	1.496	XZ
177	230	Beam Uniform	Angle	0.00	3	1	--	1.496	XZ
178	231	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
179	232	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
180	236	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
181	237	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
182	238	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
183	239	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
184	240	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
185	241	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
186	242	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
187	243	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
188	244	Beam	Angle	0.00	5	--	--	2.827	YZ





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1.3 MEMBERS

Member No.	Line No.	Member Type Section Distribution	Rotation Type	$\beta$ [deg]	Section i/k/j	Hinge i/j	Eccentricity i/j	Length L [m]	Position
		Uniform							
189	245	Beam Uniform	Angle	0.00	5			3.529	YZ
190	224	Beam Uniform	Angle	0.00	6			3.750	X
191	225	Beam Uniform	Angle	0.00	6			3.750	X
192	246	Beam Uniform	Angle	0.00	3		1	2.398	Z
193	247	Beam Uniform	Angle	0.00	3		1	2.412	Z
194	248	Beam Uniform	Angle	0.00	4		1	4.700	Y
195	251	Beam Uniform	Angle	0.00	3		1	1.485	In XZ
197	253	Beam Uniform	Angle	0.00	3		1	1.496	XZ
199	255	Beam Uniform	Angle	0.00	5		1	2.961	YZ
200	256	Beam Uniform	Angle	0.00	5			2.953	YZ
201	260	Beam Uniform	Angle	0.00	5			2.827	YZ
202	261	Beam Uniform	Angle	0.00	5			3.529	YZ
207	266	Beam Uniform	Angle	0.00	5		1	2.961	YZ
208	267	Beam Uniform	Angle	0.00	5			2.953	YZ
209	268	Beam Uniform	Angle	0.00	5			2.827	YZ
210	269	Beam Uniform	Angle	0.00	5			3.529	YZ
214	281	Beam Uniform	Angle	0.00	5			2.953	YZ
215	285	Beam Uniform	Angle	0.00	5			2.827	YZ
217	271	Beam Uniform	Angle	0.00	6			2.725	X







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218	272	Beam Uniform	Angle	0.00	6	--	--	2.725	X
226	273	Beam Uniform	Angle	0.00	6	--	--	1.300	Z
227	274	Beam Uniform	Angle	0.00	6	1	--	2.412	Z
228	291	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
229	292	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
230	293	Beam Uniform	Angle	0.00	3	1	--	1.485	In XZ
231	294	Beam Uniform	Angle	0.00	3	1	--	1.496	XZ
232	295	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
233	296	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
234	297	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
235	298	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
236	300	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
237	301	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
238	302	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
239	303	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
240	304	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
241	305	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
242	306	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
243	307	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ





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1.3 MEMBERS

Member No.	Line No.	Member Type Section Distribution	Rotation Type	$\beta$ [deg]	Section i/k/j	Hinge i/j	Eccentricity i/j	Length L [m]	Position
244	308	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
245	309	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
246	310	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
247	311	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
248	312	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
249	313	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
250	314	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
251	315	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
252	316	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
253	317	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
254	318	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
255	319	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
256	320	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
257	321	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
258	322	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
259	323	Beam Uniform	Angle	0.00	5	--	--	3.529	YZ
260	324	Beam Uniform	Angle	0.00	5	1	--	2.961	YZ
261	325	Beam Uniform	Angle	0.00	5	--	--	2.953	YZ
262	326	Beam Uniform	Angle	0.00	5	--	--	2.827	YZ
263	327	Beam	Angle	0.00	5	--	--	3.529	YZ





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1.3 MEMBERS

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		Uniform							
264	328	Beam Uniform	Angle	0.00	5	1		2.961	YZ
265	329	Beam Uniform	Angle	0.00	5			2.953	YZ
266	330	Beam Uniform	Angle	0.00	5			2.827	YZ
267	331	Beam Uniform	Angle	0.00	5			3.529	YZ
268	332	Beam Uniform	Angle	0.00	5	1		2.961	YZ
269	333	Beam Uniform	Angle	0.00	5			2.953	YZ
270	334	Beam Uniform	Angle	0.00	5			2.827	YZ
271	335	Beam Uniform	Angle	0.00	5			3.529	YZ
272	336	Beam Uniform	Angle	0.00	5			3.529	YZ
273	7	Beam Uniform	Angle	0.00	3	1		4.700	Y
274	275	Beam Uniform	Angle	0.00	3	1		4.700	Y
275	23	Beam Uniform	Angle	0.00	3			3.191	YZ
276	24	Beam Uniform	Angle	0.00	3			2.724	YZ
277	25	Beam Uniform	Angle	0.00	3	1		2.250	Y
278	50	Beam Uniform	Angle	0.00	3			3.191	YZ
279	51	Beam Uniform	Angle	0.00	3			2.724	YZ
280	52	Beam Uniform	Angle	0.00	3	1		2.250	Y
281	77	Beam Uniform	Angle	0.00	3			3.191	YZ
282	78	Beam Uniform	Angle	0.00	3			2.724	YZ





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Member No.	Line No.	Member Type Section Distribution	Rotation Type	$\beta$ [deg]	Section i/k/j	Hinge i/j	Eccentricity i/j	Length L [m]	Position
283	79	Beam Uniform	Angle	0.00	3	1	--	2.250	Y
284	104	Beam Uniform	Angle	0.00	3	--	--	3.191	YZ
285	105	Beam Uniform	Angle	0.00	3	--	--	2.724	YZ
286	106	Beam Uniform	Angle	0.00	3	1	--	2.250	Y
287	131	Beam Uniform	Angle	0.00	3	--	--	3.191	YZ
288	132	Beam Uniform	Angle	0.00	3	--	--	2.724	YZ
289	133	Beam Uniform	Angle	0.00	3	1	--	2.250	Y
290	158	Beam Uniform	Angle	0.00	3	--	--	3.191	YZ
291	159	Beam Uniform	Angle	0.00	3	--	--	2.724	YZ
292	160	Beam Uniform	Angle	0.00	3	1	--	2.250	Y
293	182	Beam Uniform	Angle	0.00	3	--	--	3.191	YZ
294	183	Beam Uniform	Angle	0.00	3	--	--	2.724	YZ
295	184	Beam Uniform	Angle	0.00	3	1	--	2.250	Y
296	206	Beam Uniform	Angle	0.00	3	--	--	3.191	YZ
297	207	Beam Uniform	Angle	0.00	3	--	--	2.724	YZ
298	208	Beam Uniform	Angle	0.00	3	1	--	2.250	Y
299	233	Beam Uniform	Angle	0.00	3	--	--	3.191	YZ
300	234	Beam Uniform	Angle	0.00	3	--	--	2.724	YZ
301	235	Beam Uniform	Angle	0.00	3	1	--	2.250	Y





MODEL

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1.3 MEMBERS

Member No.	Line No.	Member Type Section Distribution	Rotation Type	$\beta$ [deg]	Section i/k/j	Hinge i/j	Eccentricity i/j	Length L [m]	Position
302	257	Beam Uniform	Angle	0.00	3	--	--	3.191	YZ
303	258	Beam Uniform	Angle	0.00	3	--	--	2.724	YZ
304	259	Beam Uniform	Angle	0.00	3	1	--	2.250	Y
305	282	Beam Uniform	Angle	0.00	3	--	--	3.191	YZ
306	283	Beam Uniform	Angle	0.00	3	--	--	2.724	YZ
307	284	Beam Uniform	Angle	0.00	3	1	--	2.250	Y
308	1	Beam Uniform	Angle	0.00	3	--	--	1.850	On Z
309	3	Beam Uniform	Angle	0.00	3	--	--	2.412	Z
310	276	Beam Uniform	Angle	0.00	3	--	--	0.600	X
311	277	Beam Uniform	Angle	0.00	3	--	--	0.600	X
312	337	Beam Uniform	Angle	0.00	3	--	--	9.550	Y
313	338	Beam Uniform	Angle	0.00	3	--	--	9.550	Y
314	340	Beam Uniform	Angle	0.00	3	--	--	9.550	Y
315	341	Beam Uniform	Angle	0.00	3	--	--	9.550	Y
316	342	Beam Uniform	Angle	0.00	3	--	--	9.550	Y
317	343	Beam Uniform	Angle	0.00	3	--	--	9.550	Y
318	344	Beam Uniform	Angle	0.00	3	--	--	9.550	Y
319	345	Beam Uniform	Angle	0.00	3	--	--	9.550	Y
320	346	Beam Uniform	Angle	0.00	3	--	--	9.550	Y
321	347	Beam	Angle	0.00	3	--	--	9.550	Y





MODEL

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1.3 MEMBERS

Member No.	Line No.	Member Type Section Distribution	Rotation Type	$\beta$ [deg]	Section i/k/j	Hinge i/j	Eccentricity i/j	Length L [m]	Position
		Uniform							
329	355	Beam Uniform	Angle	0.00	3	1	--	2.091	XZ
330	356	Beam Uniform	Angle	0.00	3	1	--	4.181	XZ
331	357	Beam Uniform	Angle	0.00	3	--	--	1.850	Z
332	358	Beam Uniform	Angle	0.00	3	1	--	3.750	X
333	359	Beam Uniform	Angle	0.00	3	--	--	1.850	Z
334	360	Beam Uniform	Angle	0.00	3	1	--	3.750	X
335	361	Beam Uniform	Angle	0.00	3	1	--	2.091	XZ
336	362	Beam Uniform	Angle	0.00	4	--	--	36.475	X
337	364	Beam Uniform	Angle	0.00	3	--	--	0.548	On Z
338	365	Beam Uniform	Angle	0.00	6	--	--	0.550	Z
339	366	Beam Uniform	Angle	0.00	6	1	--	0.548	Z
340	377	Beam Uniform	Angle	0.00	3	--	--	9.550	Y
341	381	Beam Uniform	Angle	0.00	3	--	--	36.475	X
342	382	Beam Uniform	Angle	0.00	3	--	--	36.475	X
343	367	Beam Uniform	Angle	0.00	3	--	--	0.700	Z
344	368	Beam Uniform	Angle	0.00	3	--	--	0.700	Z
345	369	Beam Uniform	Angle	0.00	3	--	--	0.700	Z
346	370	Beam Uniform	Angle	0.00	3	--	--	0.700	Z
347	371	Beam Uniform	Angle	0.00	3	--	--	0.700	Z





1.3

MEMBERS

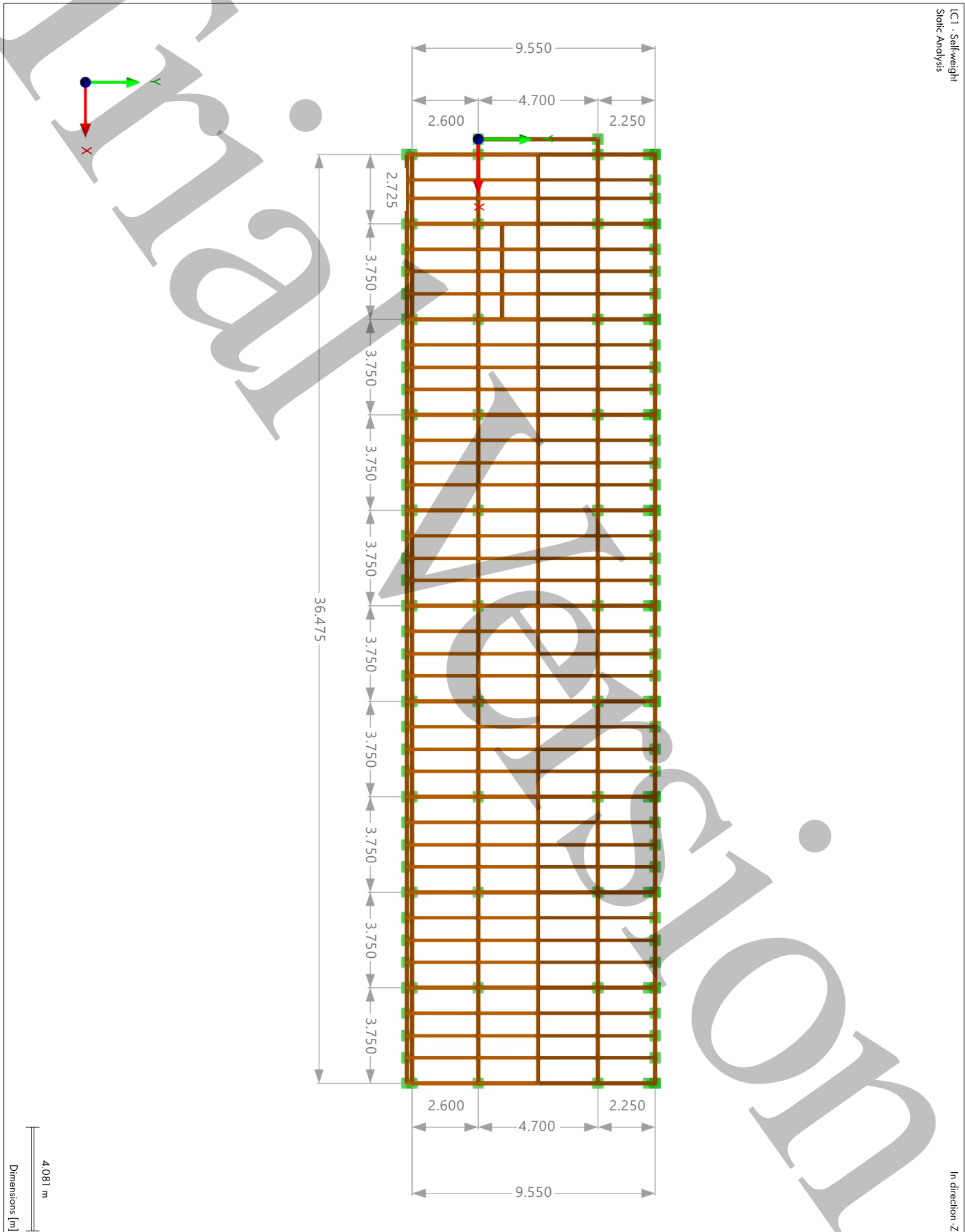
Member No.	Line No.	Member Type Section Distribution	Rotation Type	$\beta$ [deg]	Section i/k/j	Hinge i/j	Eccentricity i/j	Length L [m]	Position
348	372	Beam Uniform	Angle	0.00	3	--	--	0.700	Z
349	373	Beam Uniform	Angle	0.00	3	--	--	0.700	Z
350	374	Beam Uniform	Angle	0.00	3	--	--	0.700	Z
351	375	Beam Uniform	Angle	0.00	3	--	--	0.700	Z
352	376	Beam Uniform	Angle	0.00	3	--	--	0.700	Z
353	378	Beam Uniform	Angle	0.00	3	--	--	0.700	Z
354	379	Beam Uniform	Angle	0.00	3	--	--	36.475	X
355	380	Beam Uniform	Angle	0.00	3	--	--	36.475	X



MODEL

Graphic DIMENZIJE

Static Analysis



LC1 - Selfweight  
Static Analysis

In direction Z





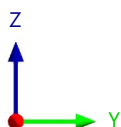
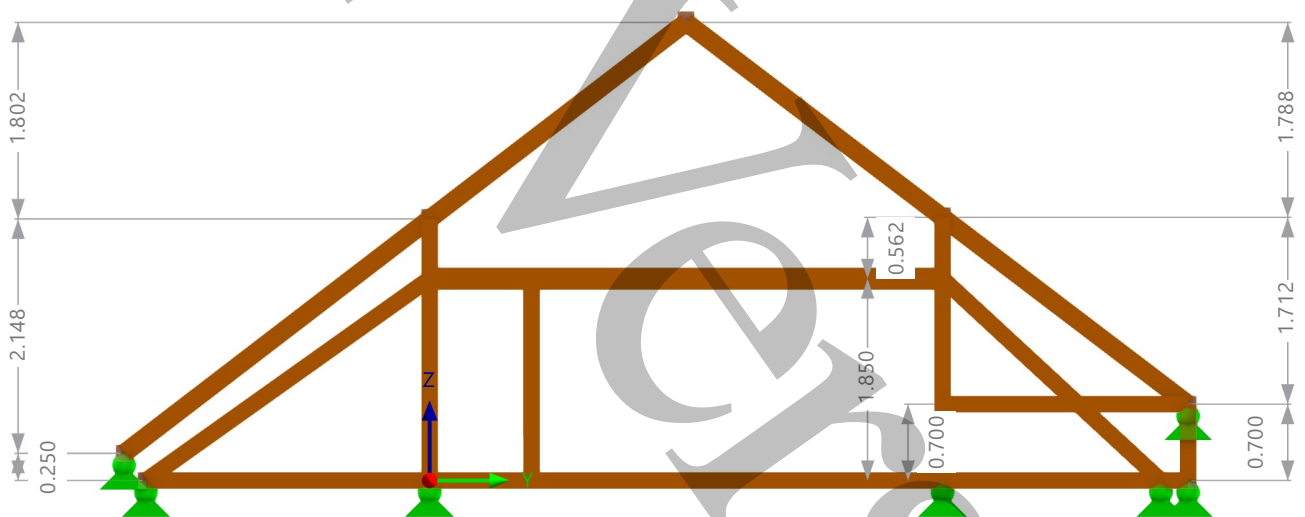


Graphic DIMENZIJE - OKVIR

Static Analysis

Visibility mode  
LC1 - Self-weight  
Static Analysis

In direction -X



1.386 m

Dimensions [m]





Graphic **POPREČNI PRESJECI**

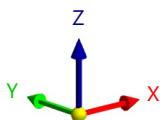
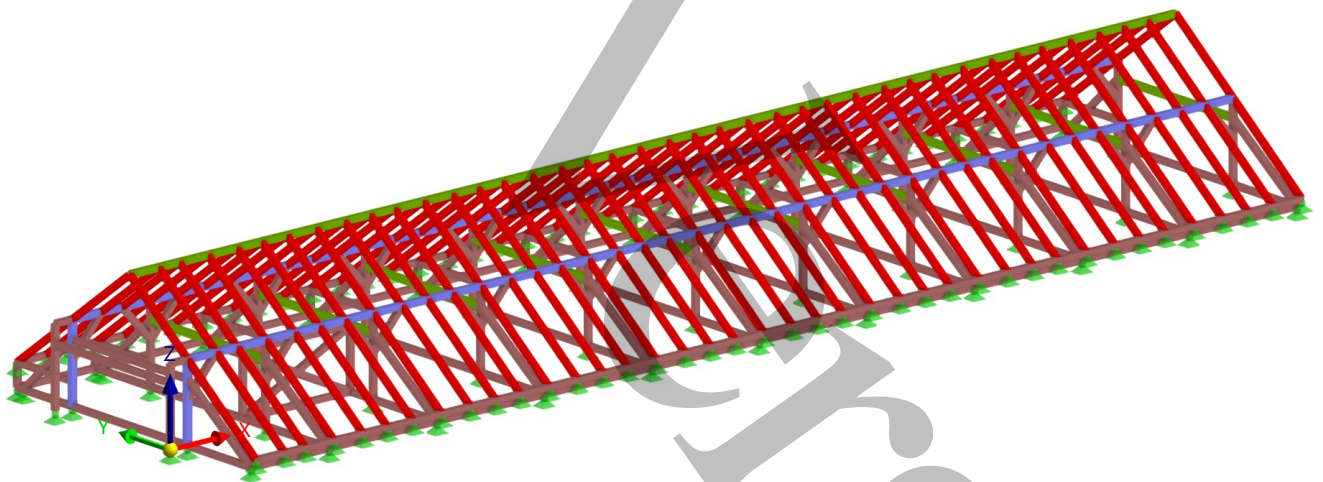
Static Analysis

LC1 - Self-weight  
Static Analysis

In Axonometric Direction by Default

Colors of Rendered Objects

Node	Display Properties
Line	Display Properties
Member	Section
3	SQ_M1 150
4	R_M1 150/200
5	R_M1 120/170
6	R_M1 150/180



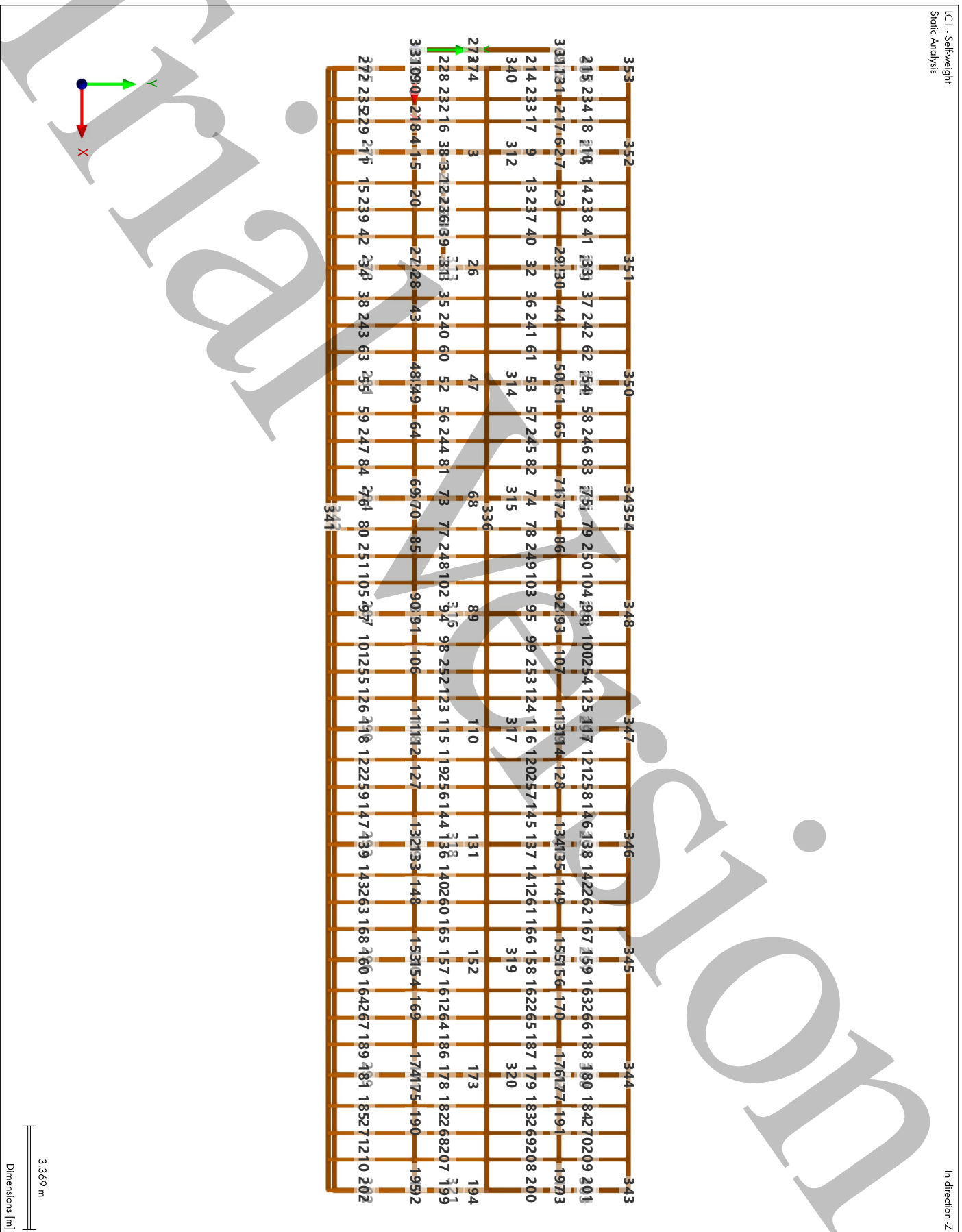
Dimensions [m]



**MODEL**

Graphic **MEMBER SETS - NUMBERING**

**Static Analysis**





## 2 Types for Nodes

### 2.1 NODAL SUPPORTS

Support No.	Nodes No.	Coordinate System	Translation Spring [kN/m]			Rotation Spring [kNm/rad]		
			C <sub>u,x</sub>	C <sub>u,y</sub>	C <sub>u,z</sub>	C <sub>φ,x</sub>	C <sub>φ,y</sub>	C <sub>φ,z</sub>
1	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>   Hinged 1, 3,5,7,13,15,28-31,33,35, 38,41,59-62,64,66,67,69 ,70,73,74,90-93,95,97,9 8,100,101,104,105,121- 124,126,128,129,131,13 2,135,136,152-155,157, 159,160,162,163,166,16 7,170,172,183-186,188, 190,191,193,194,208-21 0,212,214,215,217,218, 220,221,231-234,236,23 8,239,241,242,245,246, 262-265,267,269,270,27 2,273,277,278,288-290, 292,297,298,361,362,37 5-378,386,390,391,397, 398,403,404,408,409,41 3,414,418,419,423,424, 428,429,433,434,438,43 9,442,445,461	1 - Global XYZ	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

## 3 Types for Members

### 3.1 MEMBER HINGES

Hinge No.	Coordinate System	Translation Spring [kN/m]			Rotation Spring [kNm/rad]		
		C <sub>u,x</sub>	C <sub>u,y</sub>	C <sub>u,z</sub>	C <sub>φ,x</sub>	C <sub>φ,y</sub>	C <sub>φ,z</sub>
1	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/>   Local xyz Local xyz	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

## 4 Types for Timber Design

### 4.1 EFFECTIVE LENGTHS

Legend  
 Principal Section Axes y/u and z/v

Length No.	Description	Symbol	Value	Unit	Options
1	<input checked="" type="checkbox"/> Standard (Members : 2) Assigned to members Assigned to member sets Flexural buckling about y Flexural buckling about z Lateral-torsional buckling Determination of M <sub>cr</sub> Fire design - different buckling factors Intermediate nodes Different properties	2			<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> Analytical (for rectangular or trapezoidal section) <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/>

#### 4.1.1 EFFECTIVE LENGTHS - NODAL SUPPORTS

Length No.	Node Seq. No.	Fixed in		Restraint About x	Nodes	Springs		Eccentricity	
		z/v	y/u			C <sub>y/u</sub> [kN/m]	C <sub>φ,x</sub> [kNm/rad]	Type	e <sub>z</sub> [mm]
1	Standard (Members : 2)								
	Start	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	7			None	
	End	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	8			None	

#### 4.1.2 EFFECTIVE LENGTHS - FACTORS

Length No.	Segment No.	Flexural Buckling		Lateral-Torsional	Critical Moment
		k <sub>y/u</sub> [-]	k <sub>z/v</sub> [-]		
1	Standard (Members : 2)				
	1	1.00	1.00	1.00	



**TIMBER**

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4.2 SERVICE CLASSES

Class No.	Members	Assigned to			Service Class Type	Comment
		Member Sets	Surfaces	Surface Sets		
1	Service Class 1 (Members : 1-18,20,23-195,197,199,202,207-210,214,215,217,218,226-321,329-355)				1 - Dry	

5 Load Cases & Combinations

5.1 LOAD CASES

LC No.	Settings	Value	Unit	To Solve
1	Self-weight Analysis type Static analysis settings Action category Self-weight - Factor in direction X Self-weight - Factor in direction Y Self-weight - Factor in direction Z Load duration	Static Analysis SA1 - Geometrically linear Permanent 0.000 0.000 -1.000 Permanent	-- -- -- --	<input checked="" type="checkbox"/>
2	Dodatno stalno Analysis type Static analysis settings Action category Load duration	Static Analysis SA1 - Geometrically linear Permanent Permanent		<input checked="" type="checkbox"/>
3	vjetar Analysis type Static analysis settings Action category Load duration	Static Analysis SA1 - Geometrically linear Wind Short-term		<input checked="" type="checkbox"/>
4	snijeg Analysis type Static analysis settings Action category Load duration	Static Analysis SA1 - Geometrically linear Snow / Ice loads - H <= 1000 m Short-term		<input checked="" type="checkbox"/>

5.2 ACTIONS

Action No.	Settings	Value	Active
1	Permanent Action Category Action Type	Permanent Simultaneously	<input checked="" type="checkbox"/>
2	Wind Action Category Action Type	Wind Alternatively	<input checked="" type="checkbox"/>
3	Snow / Ice loads - H <= 1000 m Action Category Action Type	Snow / Ice loads - H <= 1000 m Alternatively	<input checked="" type="checkbox"/>

5.2.1 ACTIONS - LOAD CASES

Action No.	Load Case	Acting Group No.
1	Permanent LC1 LC2	- - -
2	Wind LC3	-
3	Snow / Ice loads - H <= 1000 m LC4	-





**MODEL**

5.3

**DESIGN SITUATIONS**

DS No.	Settings	Value	Active
1	<b>ULS</b> ULS (STR/GEO) - Permanent and transient - Eq. 6.10 Design situation type Combination wizard	<b>ULS</b> ULS (STR/GEO) - Permanent and transient - Eq. 6.10 1	<input checked="" type="checkbox"/>
2	<b>SCh</b> SLS - Characteristic Design situation type Combination wizard	<b>SCh</b> SLS - Characteristic 1	<input checked="" type="checkbox"/>
3	<b>SQp</b> SLS - Quasi-permanent Design situation type Combination wizard	<b>SQp</b> SLS - Quasi-permanent 1	<input checked="" type="checkbox"/>

5.4

**ACTION COMBINATIONS**

AC No.	Settings	Value	Active
1	<b>ULS</b> 1.35 * A1 Design Situation Generated load combinations Generated by	<b>ULS</b> DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10 1 Design Situation No. 1	<input checked="" type="checkbox"/>
2	<b>ULS</b> 1.35 * A1 + 1.50 * A2 Design Situation Generated load combinations Generated by	<b>ULS</b> DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10 2 Design Situation No. 1	<input checked="" type="checkbox"/>
3	<b>ULS</b> 1.35 * A1 + 1.50 * A2 + 0.75 * A3 Design Situation Generated load combinations Generated by	<b>ULS</b> DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10 3 Design Situation No. 1	<input checked="" type="checkbox"/>
4	<b>ULS</b> 1.35 * A1 + 1.50 * A3 Design Situation Generated load combinations Generated by	<b>ULS</b> DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10 4 Design Situation No. 1	<input checked="" type="checkbox"/>
5	<b>ULS</b> 1.35 * A1 + 0.90 * A2 + 1.50 * A3 Design Situation Generated load combinations Generated by	<b>ULS</b> DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10 5 Design Situation No. 1	<input checked="" type="checkbox"/>
6	<b>SCh</b> A1 Design Situation Generated load combinations Generated by	<b>SCh</b> DS2 - SLS - Characteristic 6 Design Situation No. 2	<input checked="" type="checkbox"/>
7	<b>SCh</b> A1 + A2 Design Situation Generated load combinations Generated by	<b>SCh</b> DS2 - SLS - Characteristic 7 Design Situation No. 2	<input checked="" type="checkbox"/>
8	<b>SCh</b> A1 + A2 + 0.50 * A3 Design Situation Generated load combinations Generated by	<b>SCh</b> DS2 - SLS - Characteristic 8 Design Situation No. 2	<input checked="" type="checkbox"/>
9	<b>SCh</b> A1 + A3 Design Situation Generated load combinations Generated by	<b>SCh</b> DS2 - SLS - Characteristic 9 Design Situation No. 2	<input checked="" type="checkbox"/>
10	<b>SCh</b> A1 + 0.60 * A2 + A3 Design Situation Generated load combinations Generated by	<b>SCh</b> DS2 - SLS - Characteristic 10 Design Situation No. 2	<input checked="" type="checkbox"/>
11	<b>SQp</b> 1.60 * A1 Design Situation Generated load combinations Generated by	<b>SQp</b> DS3 - SLS - Quasi-permanent 11 Design Situation No. 3	<input checked="" type="checkbox"/>
12	<b>SQp</b> 1.60 * A1 + A2 Design Situation Generated load combinations Generated by	<b>SQp</b> DS3 - SLS - Quasi-permanent 12 Design Situation No. 3	<input checked="" type="checkbox"/>





**MODEL**

5.4 **ACTION COMBINATIONS**

AC No.	Settings	Value	Active
13	<b>S<sub>Qp</sub></b> 1.60 * A1 + A2 + 0.50 * A3 Design Situation Generated load combinations Generated by	<b>S<sub>Qp</sub></b> DS3 - SLS - Quasi-permanent 13 Design Situation No. 3	<input checked="" type="checkbox"/>
14	<b>S<sub>Qp</sub></b> 1.60 * A1 + A3 Design Situation Generated load combinations Generated by	<b>S<sub>Qp</sub></b> DS3 - SLS - Quasi-permanent 14 Design Situation No. 3	<input checked="" type="checkbox"/>
15	<b>S<sub>Qp</sub></b> 1.60 * A1 + 0.60 * A2 + A3 Design Situation Generated load combinations Generated by	<b>S<sub>Qp</sub></b> DS3 - SLS - Quasi-permanent 15 Design Situation No. 3	<input checked="" type="checkbox"/>

5.4.1 **ACTION COMBINATIONS - INCLUDED ACTIONS**

Action No.	Factor	No.	Operator	Leading	γ	ψ	K <sub>def</sub>	ψ <sub>0</sub>	ψ <sub>2</sub>
1	<b>ULS</b> 1.35 * A1 1.35 <b>G</b> A1			<input type="checkbox"/>	1.35				
2	<b>ULS</b> 1.35 * A1 + 1.50 * A2 1.35 <b>G</b> A1 1.50 <b>Q<sub>w</sub></b> A2		+	<input type="checkbox"/> <input checked="" type="checkbox"/>	1.35 1.50				
3	<b>ULS</b> 1.35 * A1 + 1.50 * A2 + 0.75 * A3 1.35 <b>G</b> A1 1.50 <b>Q<sub>w</sub></b> A2 0.75 <b>Q<sub>s</sub></b> A3		+	<input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	1.35 1.50 1.50	0.50			
4	<b>ULS</b> 1.35 * A1 + 1.50 * A3 1.35 <b>G</b> A1 1.50 <b>Q<sub>s</sub></b> A3		+	<input type="checkbox"/> <input checked="" type="checkbox"/>	1.35 1.50				
5	<b>ULS</b> 1.35 * A1 + 0.90 * A2 + 1.50 * A3 1.35 <b>G</b> A1 0.90 <b>Q<sub>w</sub></b> A2 1.50 <b>Q<sub>s</sub></b> A3		+	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/>	1.35 1.50 1.50	0.60			
6	<b>S<sub>Ch</sub></b> A1 1.00 <b>G</b> A1			<input type="checkbox"/>					
7	<b>S<sub>Ch</sub></b> A1 + A2 1.00 <b>G</b> A1 1.00 <b>Q<sub>w</sub></b> A2		+	<input type="checkbox"/> <input checked="" type="checkbox"/>					
8	<b>S<sub>Ch</sub></b> A1 + A2 + 0.50 * A3 1.00 <b>G</b> A1 1.00 <b>Q<sub>w</sub></b> A2 0.50 <b>Q<sub>s</sub></b> A3		+	<input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>		0.50			
9	<b>S<sub>Ch</sub></b> A1 + A3 1.00 <b>G</b> A1 1.00 <b>Q<sub>s</sub></b> A3		+	<input type="checkbox"/> <input checked="" type="checkbox"/>					
10	<b>S<sub>Ch</sub></b> A1 + 0.60 * A2 + A3 1.00 <b>G</b> A1 0.60 <b>Q<sub>w</sub></b> A2 1.00 <b>Q<sub>s</sub></b> A3		+	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/>		0.60			
11	<b>S<sub>Qp</sub></b> 1.60 * A1 1.60 <b>G</b> A1			<input type="checkbox"/>			0.60		
12	<b>S<sub>Qp</sub></b> 1.60 * A1 + A2 1.60 <b>G</b> A1 1.00 <b>Q<sub>w</sub></b> A2		+	<input type="checkbox"/> <input checked="" type="checkbox"/>			0.60 0.60		0.00
13	<b>S<sub>Qp</sub></b> 1.60 * A1 + A2 + 0.50 * A3 1.60 <b>G</b> A1 1.00 <b>Q<sub>w</sub></b> A2 0.50 <b>Q<sub>s</sub></b> A3		+	<input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>			0.60 0.60 0.60	0.50	0.00
14	<b>S<sub>Qp</sub></b> 1.60 * A1 + A3 1.60 <b>G</b> A1 1.00 <b>Q<sub>s</sub></b> A3		+	<input type="checkbox"/> <input checked="" type="checkbox"/>			0.60 0.60		0.00





**MODEL**

5.4.1

**ACTION COMBINATIONS - INCLUDED ACTIONS**

Action No.	Factor	No.	Operator	Leading	$\gamma$	$\psi$	$K_{def}$	$\psi_0$	$\psi_2$
15	1.60	1.60 * A1 + 0.60 * A2 + A3	+	☐			0.60	0.60	0.00
	0.60	A1							
	1.00	A2							
				☒			0.60		0.00

5.5

**LOAD COMBINATIONS**

CO No.	Settings	Value	Unit	To Solve
1	ULS 1.35 * LC1 + 1.35 * LC2 Analysis type: Static Analysis Static analysis settings: SA2 - Second-order (P-Δ)   Picard   100   1 Design Situation: ULS DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10 Structure modification: 1 Load duration: Permanent			☒
2	ULS 1.35 * LC1 + 1.35 * LC2 + 1.50 * LC3 Analysis type: Static Analysis Static analysis settings: SA2 - Second-order (P-Δ)   Picard   100   1 Design Situation: ULS DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10 Structure modification: 1 Load duration: Short-term			☒
3	ULS 1.35 * LC1 + 1.35 * LC2 + 1.50 * LC3 + 0.75 * LC4 Analysis type: Static Analysis Static analysis settings: SA2 - Second-order (P-Δ)   Picard   100   1 Design Situation: ULS DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10 Structure modification: 1 Load duration: Short-term			☒
4	ULS 1.35 * LC1 + 1.35 * LC2 + 1.50 * LC4 Analysis type: Static Analysis Static analysis settings: SA2 - Second-order (P-Δ)   Picard   100   1 Design Situation: ULS DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10 Structure modification: 1 Load duration: Short-term			☒
5	ULS 1.35 * LC1 + 1.35 * LC2 + 0.90 * LC3 + 1.50 * LC4 Analysis type: Static Analysis Static analysis settings: SA2 - Second-order (P-Δ)   Picard   100   1 Design Situation: ULS DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10 Structure modification: 1 Load duration: Short-term			☒
6	SCh LC1 + LC2 Analysis type: Static Analysis Static analysis settings: SA2 - Second-order (P-Δ)   Picard   100   1 Design Situation: SCh DS2 - SLS - Characteristic Load duration: Permanent			☒
7	SCh LC1 + LC2 + LC3 Analysis type: Static Analysis Static analysis settings: SA2 - Second-order (P-Δ)   Picard   100   1 Design Situation: SCh DS2 - SLS - Characteristic Load duration: Short-term			☒
8	SCh LC1 + LC2 + LC3 + 0.50 * LC4 Analysis type: Static Analysis Static analysis settings: SA2 - Second-order (P-Δ)   Picard   100   1 Design Situation: SCh DS2 - SLS - Characteristic Load duration: Short-term			☒
9	SCh LC1 + LC2 + LC4 Analysis type: Static Analysis Static analysis settings: SA2 - Second-order (P-Δ)   Picard   100   1 Design Situation: SCh DS2 - SLS - Characteristic Load duration: Short-term			☒
10	SCh LC1 + LC2 + 0.60 * LC3 + LC4 Analysis type: Static Analysis Static analysis settings: SA2 - Second-order (P-Δ)   Picard   100   1 Design Situation: SCh DS2 - SLS - Characteristic Load duration: Short-term			☒
11	SCo 1.60 * LC1 + 1.60 * LC2 Analysis type: Static Analysis			☒







**MODEL**

5.5 **LOAD COMBINATIONS**

CO No.	Settings	Value	Unit	To Solve
	Static analysis settings	SA2 - Second-order (P-Δ)   Picard   100   1		
	Design Situation	DS3 - SLS - Quasi-permanent		
	Load duration	Permanent		
12	1.60 * LC1 + 1.60 * LC2 + LC3			
	Analysis type	Static Analysis		<input checked="" type="checkbox"/>
	Static analysis settings	SA2 - Second-order (P-Δ)   Picard   100   1		
	Design Situation	DS3 - SLS - Quasi-permanent		
	Load duration	Short-term		
13	1.60 * LC1 + 1.60 * LC2 + LC3 + 0.50 * LC4			
	Analysis type	Static Analysis		<input checked="" type="checkbox"/>
	Static analysis settings	SA2 - Second-order (P-Δ)   Picard   100   1		
	Design Situation	DS3 - SLS - Quasi-permanent		
	Load duration	Short-term		
14	1.60 * LC1 + 1.60 * LC2 + LC4			
	Analysis type	Static Analysis		<input checked="" type="checkbox"/>
	Static analysis settings	SA2 - Second-order (P-Δ)   Picard   100   1		
	Design Situation	DS3 - SLS - Quasi-permanent		
	Load duration	Short-term		
15	1.60 * LC1 + 1.60 * LC2 + 0.60 * LC3 + LC4			
	Analysis type	Static Analysis		<input checked="" type="checkbox"/>
	Static analysis settings	SA2 - Second-order (P-Δ)   Picard   100   1		
	Design Situation	DS3 - SLS - Quasi-permanent		
	Load duration	Short-term		

5.5.1 **LOAD COMBINATIONS - INCLUDED LOAD CASES**

CO No.	Factor	Load Case	Action	Leading	γ	ψ	K <sub>def</sub>	ψ <sub>0</sub>	ψ <sub>2</sub>
1	1.35	LC1	A1	<input type="checkbox"/>	1.35				
	1.35	LC2	A1	<input type="checkbox"/>	1.35				
	1.35 * LC1 + 1.35 * LC2								
2	1.35	LC1	A1	<input type="checkbox"/>	1.35				
	1.35	LC2	A1	<input type="checkbox"/>	1.35				
	1.50	LC3	A2	<input checked="" type="checkbox"/>	1.50				
	1.35 * LC1 + 1.35 * LC2 + 1.50 * LC3								
3	1.35	LC1	A1	<input type="checkbox"/>	1.35				
	1.35	LC2	A1	<input type="checkbox"/>	1.35				
	1.50	LC3	A2	<input checked="" type="checkbox"/>	1.50				
	0.75	LC4	A3	<input type="checkbox"/>	1.50	0.50			
	1.35 * LC1 + 1.35 * LC2 + 1.50 * LC3 + 0.75 * LC4								
4	1.35	LC1	A1	<input type="checkbox"/>	1.35				
	1.35	LC2	A1	<input type="checkbox"/>	1.35				
	1.50	LC4	A3	<input checked="" type="checkbox"/>	1.50				
	1.35 * LC1 + 1.35 * LC2 + 1.50 * LC4								
5	1.35	LC1	A1	<input type="checkbox"/>	1.35				
	1.35	LC2	A1	<input type="checkbox"/>	1.35				
	0.90	LC3	A2	<input type="checkbox"/>	1.50	0.60			
	1.50	LC4	A3	<input checked="" type="checkbox"/>	1.50				
	1.35 * LC1 + 1.35 * LC2 + 0.90 * LC3 + 1.50 * LC4								
6	1.00	LC1	A1	<input type="checkbox"/>					
	1.00	LC2	A1	<input type="checkbox"/>					
	LC1 + LC2								
7	1.00	LC1	A1	<input type="checkbox"/>					
	1.00	LC2	A1	<input type="checkbox"/>					
	1.00	LC3	A2	<input checked="" type="checkbox"/>					
	LC1 + LC2 + LC3								
8	1.00	LC1	A1	<input type="checkbox"/>					
	1.00	LC2	A1	<input type="checkbox"/>					
	1.00	LC3	A2	<input checked="" type="checkbox"/>					
	0.50	LC4	A3	<input type="checkbox"/>		0.50			
	LC1 + LC2 + LC3 + 0.50 * LC4								
9	1.00	LC1	A1	<input type="checkbox"/>					
	1.00	LC2	A1	<input type="checkbox"/>					
	LC1 + LC2 + LC4								





**MODEL**

5.5.1

**LOAD COMBINATIONS - INCLUDED LOAD CASES**

CO No.	Factor	Load Case	Action	Leading	$\gamma$	$\psi$	$K_{def}$	$\psi_0$	$\psi_2$
	1.00	Qs LC4	Qs A3	<input checked="" type="checkbox"/>					
10	1.00	SCh LC1 + LC2 + 0.60 * LC3 + LC4							
	1.00	G LC1	G A1	<input type="checkbox"/>					
	1.00	G LC2	G A1	<input type="checkbox"/>					
	0.60	Qw LC3	Qw A2	<input type="checkbox"/>		0.60			
	1.00	Qs LC4	Qs A3	<input checked="" type="checkbox"/>					
11	1.60	SOp 1.60 * LC1 + 1.60 * LC2							
	1.60	G LC1	G A1	<input type="checkbox"/>			0.60		
	1.60	G LC2	G A1	<input type="checkbox"/>			0.60		
12	1.60	SOp 1.60 * LC1 + 1.60 * LC2 + LC3							
	1.60	G LC1	G A1	<input type="checkbox"/>			0.60		
	1.60	G LC2	G A1	<input type="checkbox"/>			0.60		
	1.00	Qw LC3	Qw A2	<input checked="" type="checkbox"/>			0.60		0.00
13	1.60	SOp 1.60 * LC1 + 1.60 * LC2 + LC3 + 0.50 * LC4							
	1.60	G LC1	G A1	<input type="checkbox"/>			0.60		
	1.60	G LC2	G A1	<input type="checkbox"/>			0.60		
	1.00	Qw LC3	Qw A2	<input checked="" type="checkbox"/>			0.60		0.00
	0.50	Qs LC4	Qs A3	<input type="checkbox"/>			0.60	0.50	0.00
14	1.60	SOp 1.60 * LC1 + 1.60 * LC2 + LC4							
	1.60	G LC1	G A1	<input type="checkbox"/>			0.60		
	1.60	G LC2	G A1	<input type="checkbox"/>			0.60		
	1.00	Qs LC4	Qs A3	<input checked="" type="checkbox"/>			0.60		0.00
15	1.60	SOp 1.60 * LC1 + 1.60 * LC2 + 0.60 * LC3 + LC4							
	1.60	G LC1	G A1	<input type="checkbox"/>			0.60		
	1.60	G LC2	G A1	<input type="checkbox"/>			0.60		
	0.60	Qw LC3	Qw A2	<input type="checkbox"/>			0.60	0.60	0.00
	1.00	Qs LC4	Qs A3	<input checked="" type="checkbox"/>			0.60		0.00

5.6

**STATIC ANALYSIS SETTINGS**

Settings No.	Description	Symbol	Value	Unit
1	Geometrically linear			
	Analysis type		Geometrically linear	
	Modify loading by multiplier factor		<input type="checkbox"/>	
	Displacements due to member load of type 'Pipe internal pressure' (Bourdon effect)		<input type="checkbox"/>	
	Method for equation system		Direct	
	Plate bending theory		Mindlin	
	Activate mass conversion to load		<input type="checkbox"/>	
	Asymmetric direct solver		<input type="checkbox"/>	
2	Second-order (P-Δ)   Picard   100   1			
	Analysis type		Second-order (P-Δ)	
	Iterative method for nonlinear analysis		Picard	
	Maximum number of iterations		100	
	Number of load increments		1	
	Modify standard precision and tolerance settings		<input type="checkbox"/>	
	Ignore all nonlinearities		<input type="checkbox"/>	
	Modify loading by multiplier factor		<input type="checkbox"/>	
	Consider favorable effect due to tension in members		<input checked="" type="checkbox"/>	
	Displacements due to member load of type 'Pipe internal pressure' (Bourdon effect)		<input type="checkbox"/>	
	Refer internal forces to deformed structure		<input checked="" type="checkbox"/>	
	Refer internal forces to deformed structure for normal forces		<input checked="" type="checkbox"/>	
	Refer internal forces to deformed structure for shear forces		<input checked="" type="checkbox"/>	
	Refer internal forces to deformed structure for moments		<input checked="" type="checkbox"/>	
	Method for equation system		Direct	
	Plate bending theory		Mindlin	
	Activate mass conversion to load		<input type="checkbox"/>	
	Asymmetric direct solver		<input type="checkbox"/>	
3	Large deformations   Newton-Raphson   100   1			
	Analysis type		Large deformations	
	Iterative method for nonlinear analysis		Newton-Raphson	
	Maximum number of iterations		100	
	Number of load increments		1	
	Modify standard precision and tolerance settings		<input type="checkbox"/>	





**MODEL**

5.6 **STATIC ANALYSIS SETTINGS**

Settings No.	Description	Symbol	Value	Unit
	Ignore all nonlinearities		<input type="checkbox"/>	
	Modify loading by multiplier factor		<input type="checkbox"/>	
	Consider favorable effect due to tension in members		<input checked="" type="checkbox"/>	
	Try to calculate unstable structure		<input type="checkbox"/>	
	Displacements due to member load of type 'Pipe internal pressure' (Bourdon effect)		<input type="checkbox"/>	
	Method for equation system		Direct	
	Plate bending theory		Mindlin	
	Activate mass conversion to load		<input type="checkbox"/>	
	Asymmetric direct solver		<input type="checkbox"/>	

5.7 **COMBINATION WIZARDS**

Wizard No.	Settings	Value
1	Load combinations   SA2 - Second-order (P-Δ)   Picard   100   1 Assigned to Generate combinations Static analysis settings Consider imperfection case Consider initial state Structure modification enabled Generate same load combinations without imperfection case Consider construction stages User-defined action combinations Favorable permanent actions Reduce number of generated combinations	DS 1-3 Load combinations (non-linear analysis) SA2 - Second-order (P-Δ)   Picard   100   1 <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
2	Load combinations   SA1 - Geometrically linear Assigned to Generate combinations Static analysis settings Consider imperfection case Consider initial state Structure modification enabled Consider construction stages User-defined action combinations Favorable permanent actions Reduce number of generated combinations	Load combinations (non-linear analysis) SA1 - Geometrically linear <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

**6 Loads**

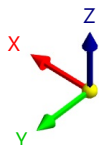
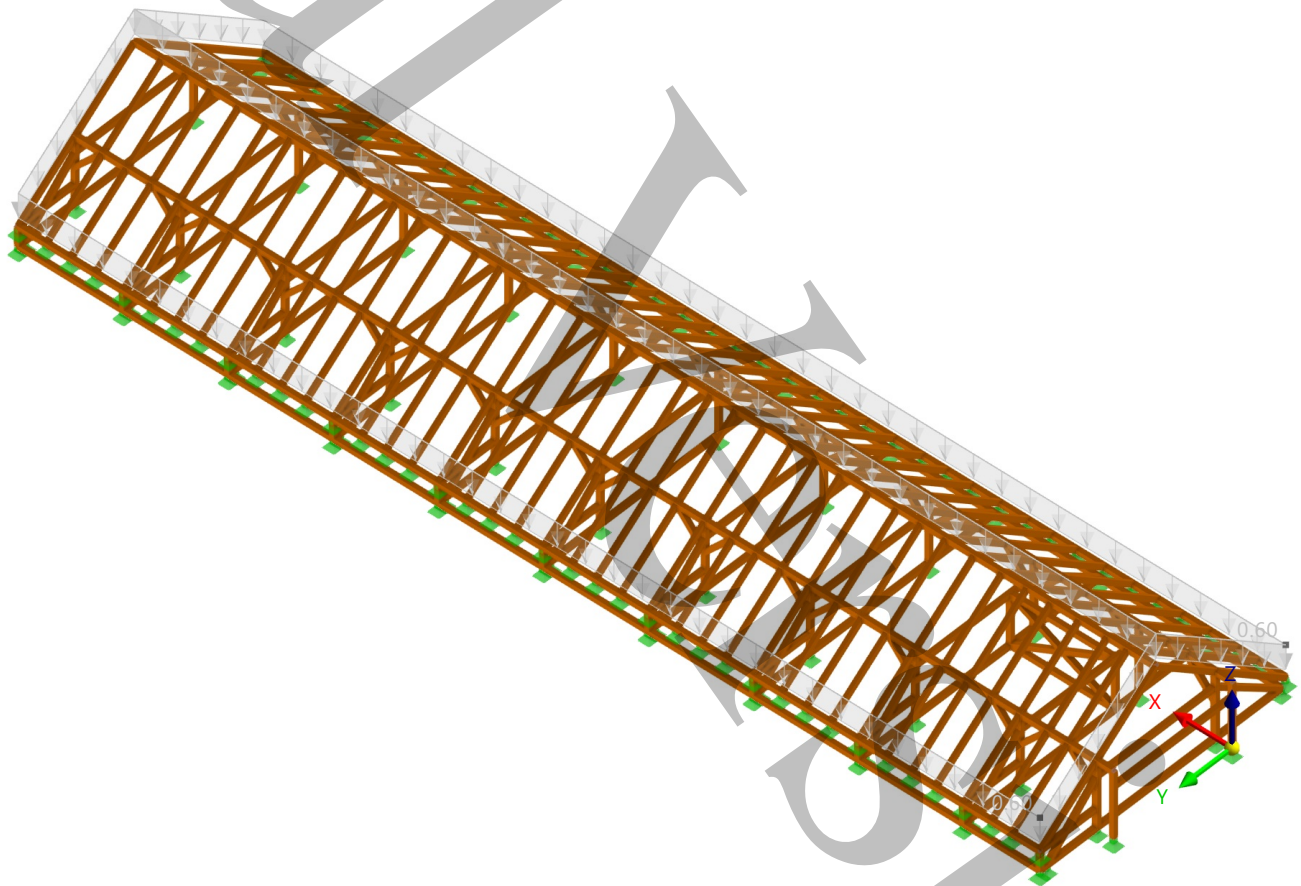


Graphic LC2: , LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT

Static Analysis

LC2 - Dodatno stalno  
Loads [kN/m<sup>2</sup>]  
Static Analysis

In Axonometric Direction by Default



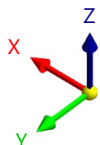
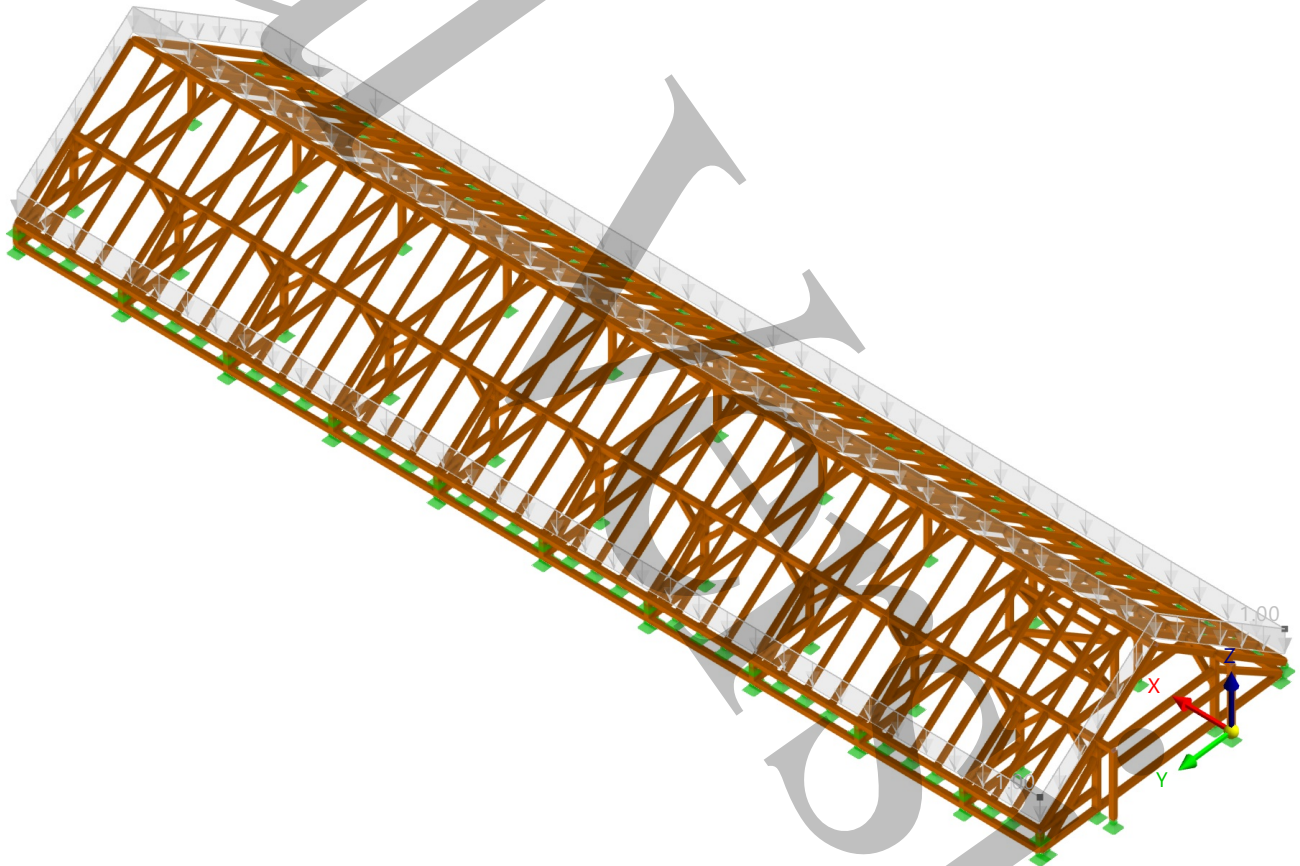


Graphic LC4: , LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT

Static Analysis

LC4 - snijeg  
Loads [kN/m<sup>2</sup>]  
Static Analysis

In Axonometric Direction by Default



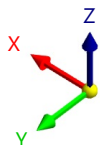
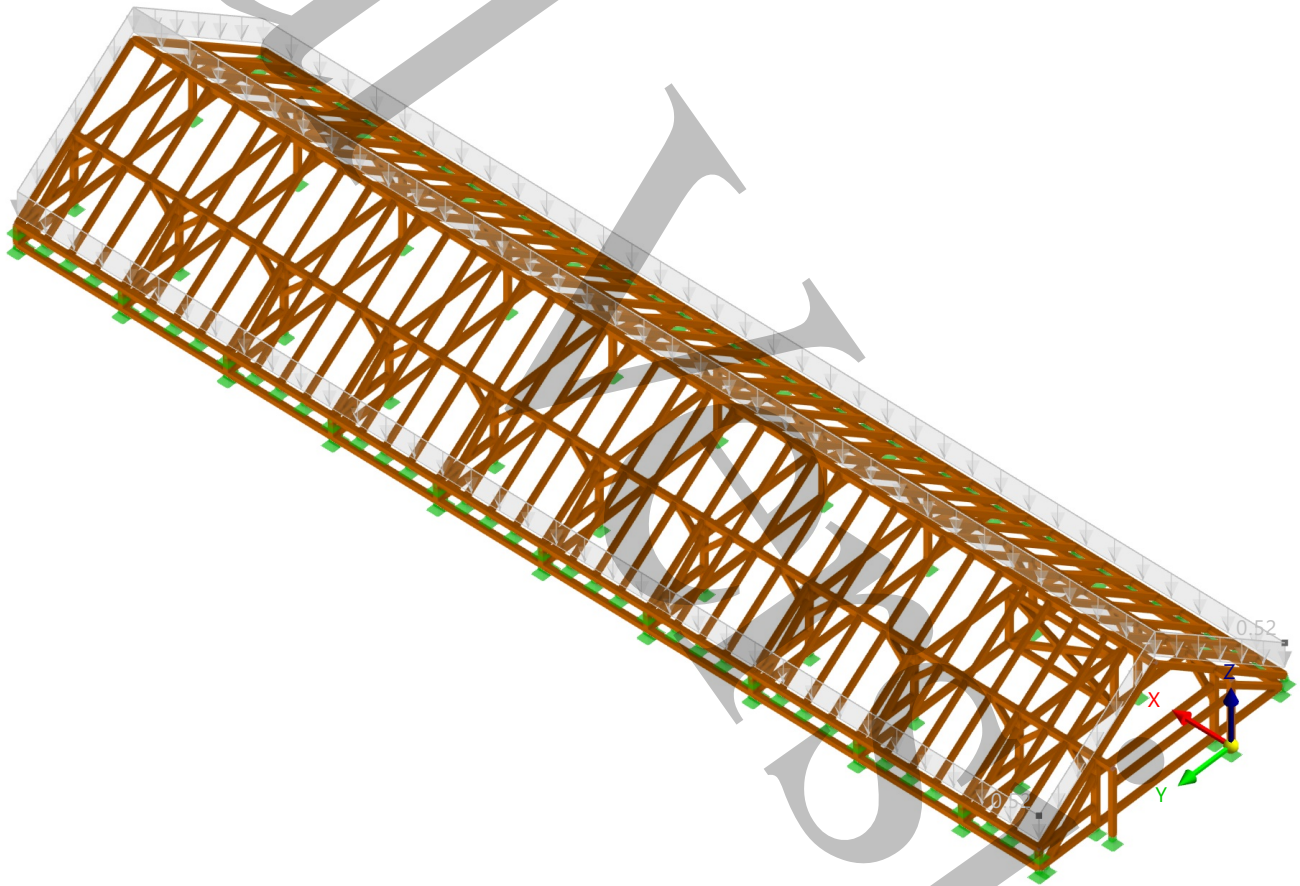


Graphic LC3: , LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT

Static Analysis

LC3 - vjetar  
Loads [kN/m<sup>2</sup>]  
Static Analysis

In Axonometric Direction by Default





## 7 Guide Objects

### 7.1 COORDINATE SYSTEMS

System No.	Type	Symbol	Coordinates		Rotation			Comment
			Value	Unit	Sequence	Symbol	Value	
1	Global XYZ							

## 8 Static Analysis Results



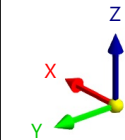
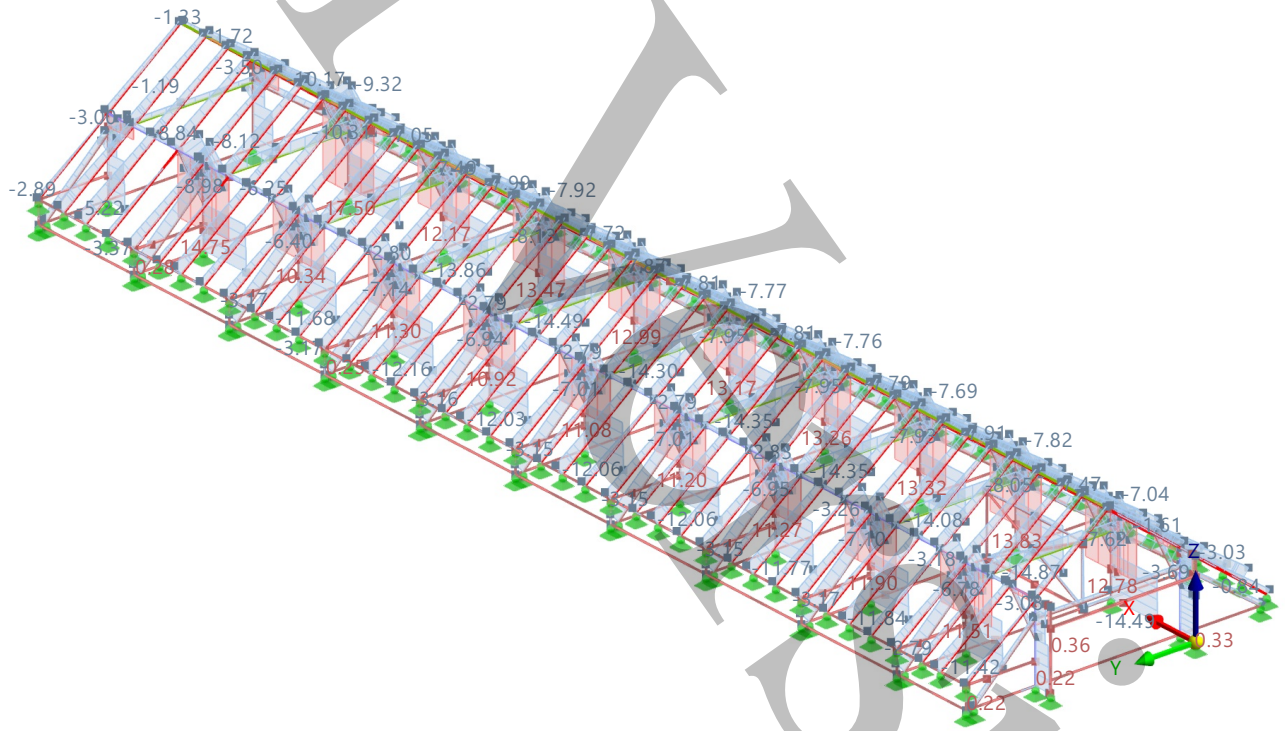
**MODEL**

**Graphic DS1: ENVELOPE VALUES - MAX VALUES, INTERNAL FORCES N, LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT Static Analysis**

DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10  
 Static Analysis  
 Forces N [kN]

In Axonometric Direction by Default  
**Colors of Rendered Objects**

- Node | Display Properties
- Line | Display Properties
- Member | Section
- 3 - SQ\_M1 150
- 4 - R\_M1 150/200
- 5 - R\_M1 120/170
- 6 - R\_M1 150/180



max N : 17.50 | min N : -15.97 kN

Dimensions [m]







**MODEL**

**Graphic DS1: ENVELOPE VALUES - MAX AND MIN VALUES, INTERNAL FORCES N, LOADING, IN DIRECTION +X**

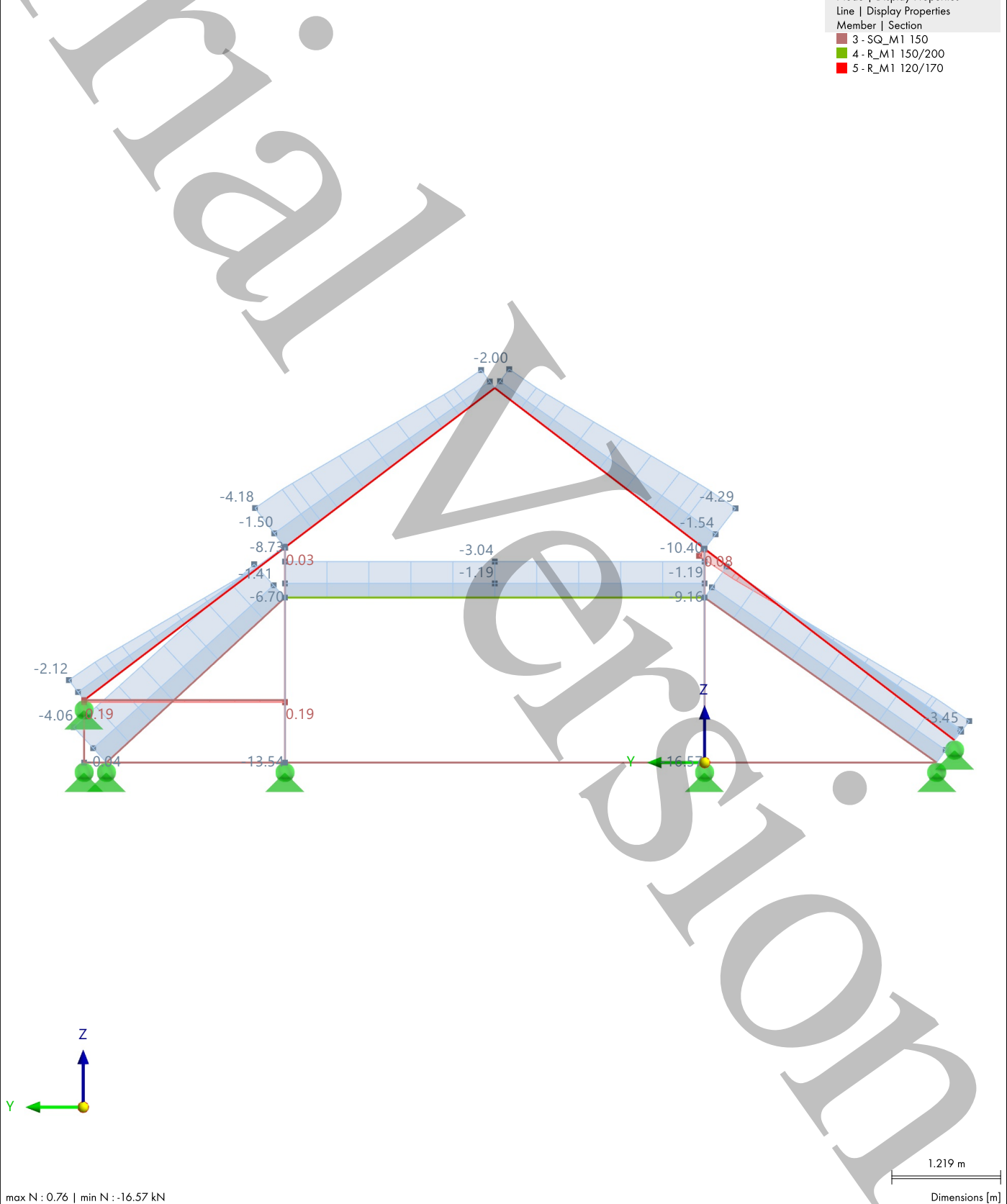
**Static Analysis**

Visibility mode  
 DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10  
 Static Analysis  
 Forces N [kN]

In direction +X

**Colors of Rendered Objects**

- Node | Display Properties
- Line | Display Properties
- Member | Section
- 3 - SQ\_M1 150
- 4 - R\_M1 150/200
- 5 - R\_M1 120/170



max N : 0.76 | min N : -16.57 kN

1.219 m  
 Dimensions [m]



**MODEL**

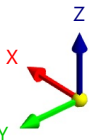
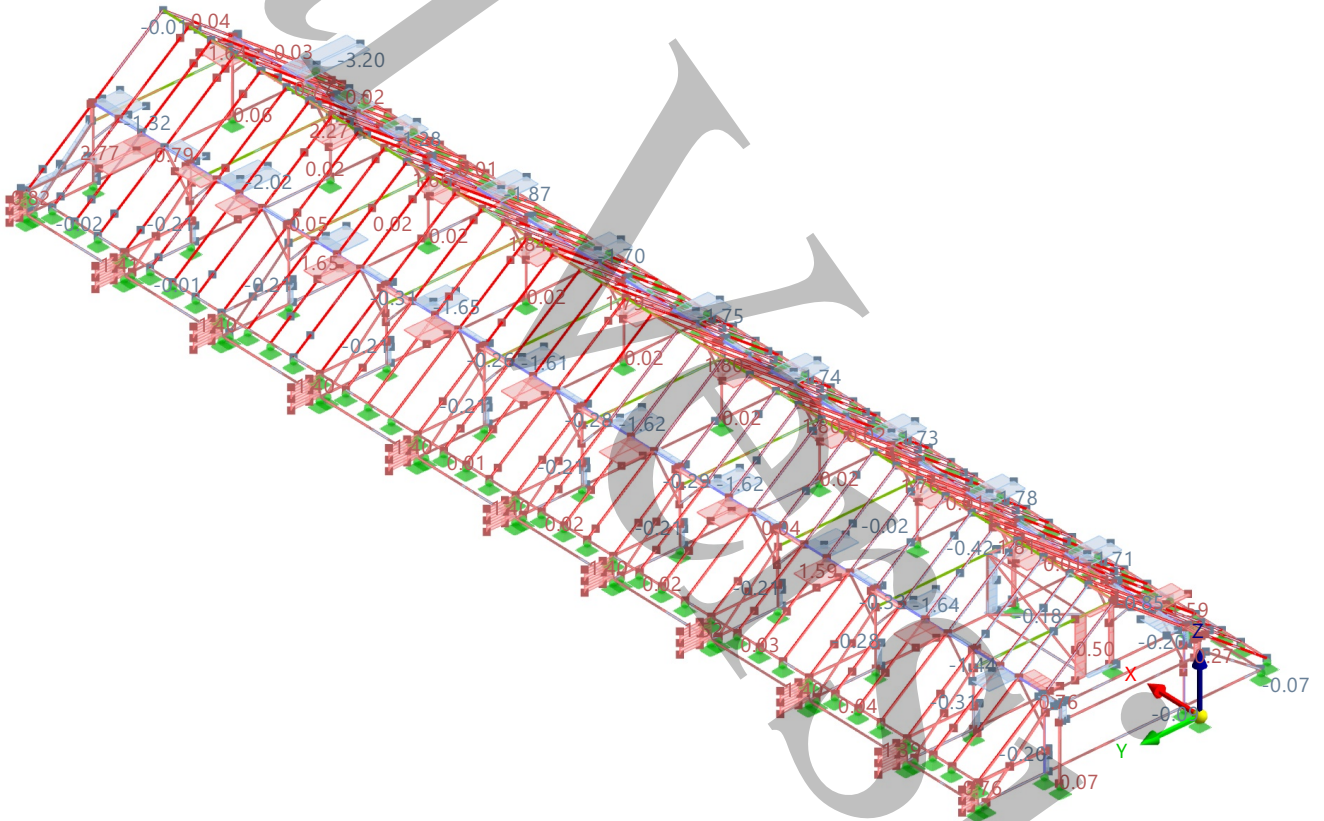
**Graphic DS1: ENVELOPE VALUES - MAX AND MIN VALUES, INTERNAL FORCES  $V_y$ , LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT**

**Static Analysis**

DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10  
 Static Analysis  
 Forces  $V_y$  [kN]

In Axonometric Direction by Default  
**Colors of Rendered Objects**

- Node | Display Properties
- Line | Display Properties
- Member | Section
- 3 - SQ\_M1 150
- 4 - R\_M1 150/200
- 5 - R\_M1 120/170
- 6 - R\_M1 150/180



max  $V_y$ : 2.77 | min  $V_y$ : -3.20 kN

Dimensions [m]





MODEL

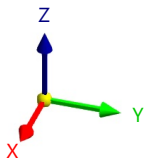
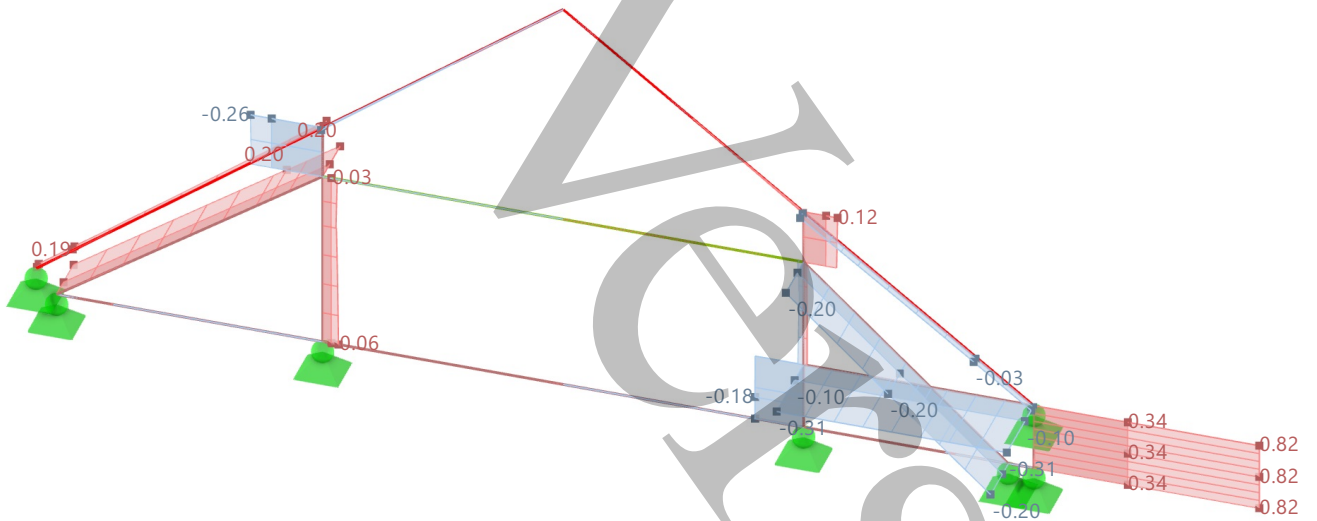
Graphic DS1: ENVELOPE VALUES - MAX AND MIN VALUES, INTERNAL FORCES  $V_y$ , LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT

Static Analysis

Visibility mode  
DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10  
Static Analysis  
Forces  $V_y$  [kN]

In Axonometric Direction by Default  
Colors of Rendered Objects

- Node | Display Properties
- Line | Display Properties
- Member | Section
- 3 - SQ\_M1 150
- 4 - R\_M1 150/200
- 5 - R\_M1 120/170



max  $V_y$  : 0.82 | min  $V_y$  : -0.31 kN

Dimensions [m]





**MODEL**

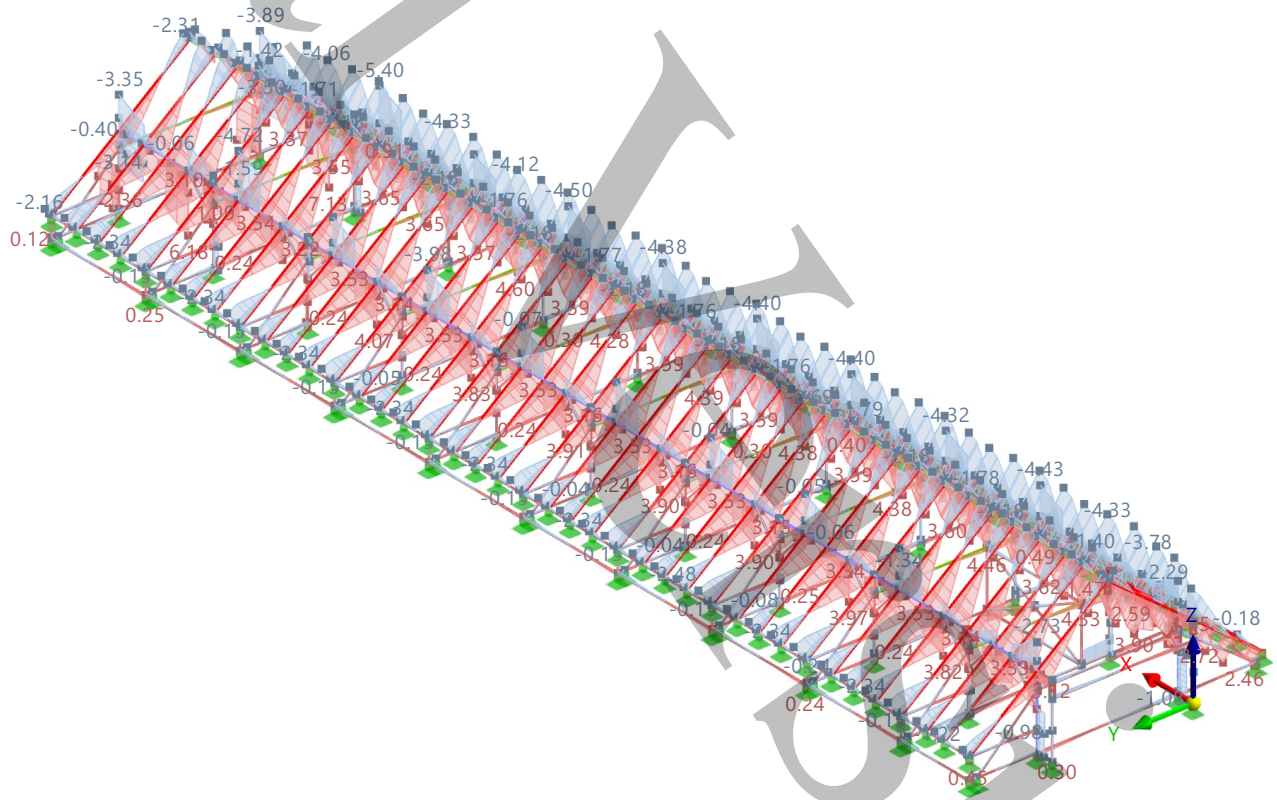
**Graphic DS1: ENVELOPE VALUES - MAX AND MIN VALUES, INTERNAL FORCES  $V_z$ , LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT**

**Static Analysis**

DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10  
 Static Analysis  
 Forces  $V_z$  [kN]

In Axonometric Direction by Default  
**Colors of Rendered Objects**

- Node | Display Properties
- Line | Display Properties
- Member | Section
- 3 - SQ\_M1 150
- 4 - R\_M1 150/200
- 5 - R\_M1 120/170
- 6 - R\_M1 150/180



max  $V_z$  : 7.13 | min  $V_z$  : -5.40 kN

Dimensions [m]





**MODEL**

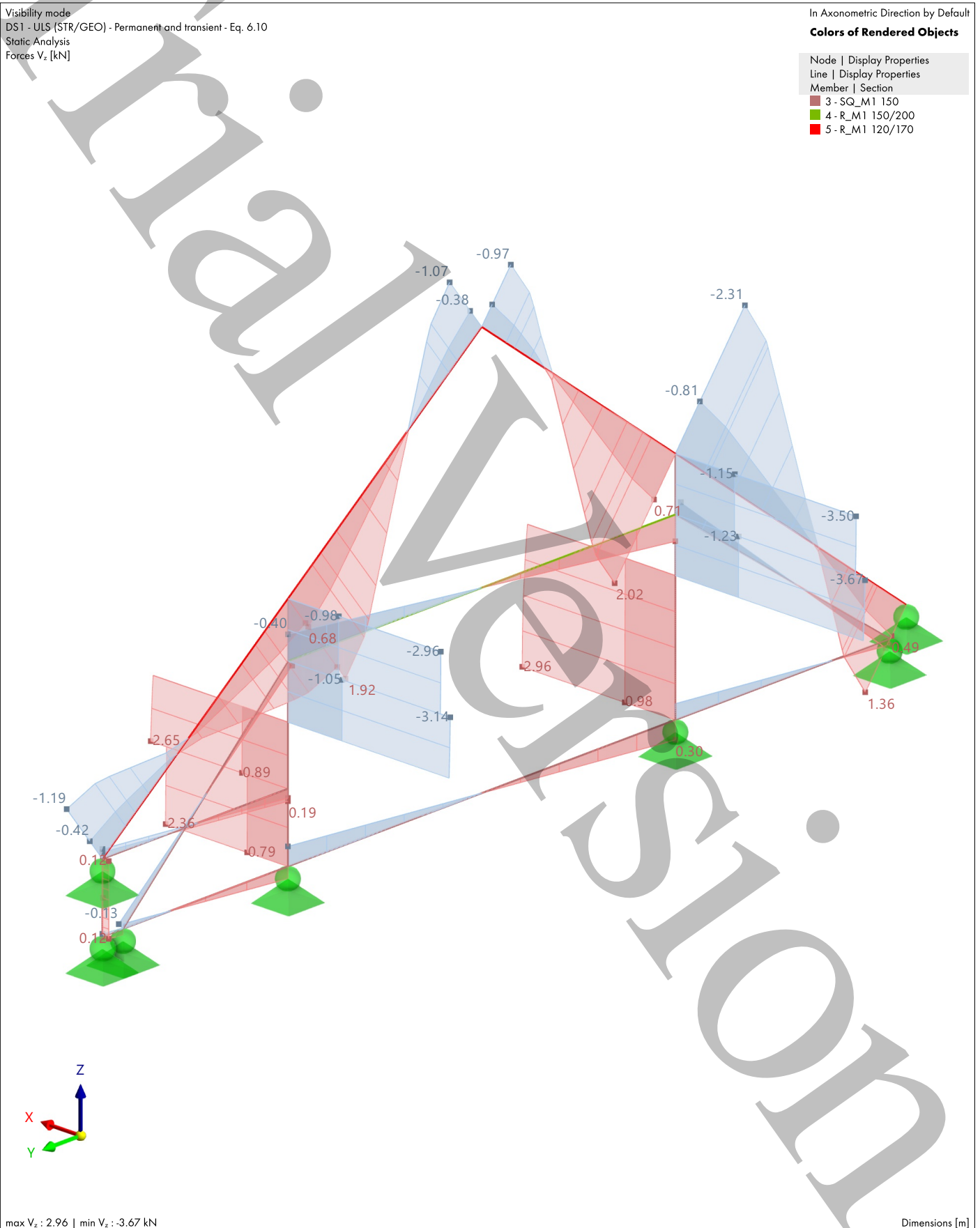
**Graphic DS1: ENVELOPE VALUES - MAX AND MIN VALUES, INTERNAL FORCES  $V_z$ , LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT**

**Static Analysis**

Visibility mode  
 DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10  
 Static Analysis  
 Forces  $V_z$  [kN]

In Axonometric Direction by Default  
**Colors of Rendered Objects**

- Node | Display Properties
- Line | Display Properties
- Member | Section
- 3 - SQ\_M1 150
- 4 - R\_M1 150/200
- 5 - R\_M1 120/170





**MODEL**

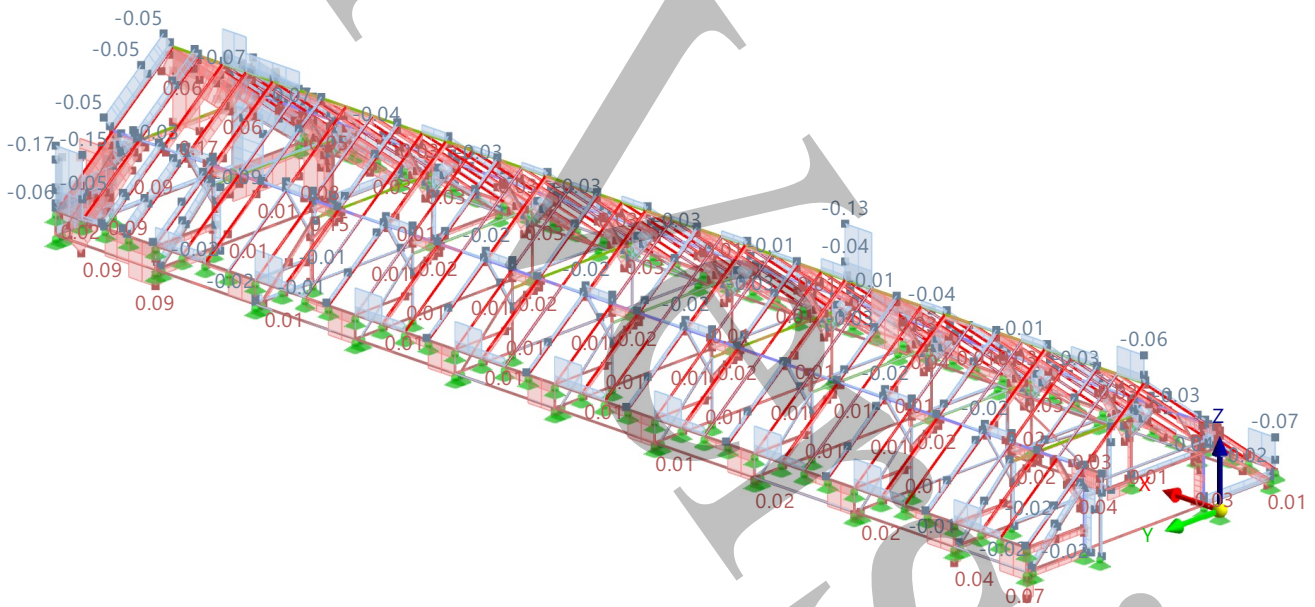
**Graphic DS1: ENVELOPE VALUES - MAX AND MIN VALUES, INTERNAL FORCES  $M_T$ , LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT**

**Static Analysis**

DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10  
 Static Analysis  
 Moments  $M_T$  [kNm]

In Axonometric Direction by Default  
**Colors of Rendered Objects**

- Node | Display Properties
- Line | Display Properties
- Member | Section
- 3 - SQ\_M1 150
- 4 - R\_M1 150/200
- 5 - R\_M1 120/170
- 6 - R\_M1 150/180



max  $M_T$  : 0.17 | min  $M_T$  : -0.17 kNm

Dimensions [m]





**MODEL**

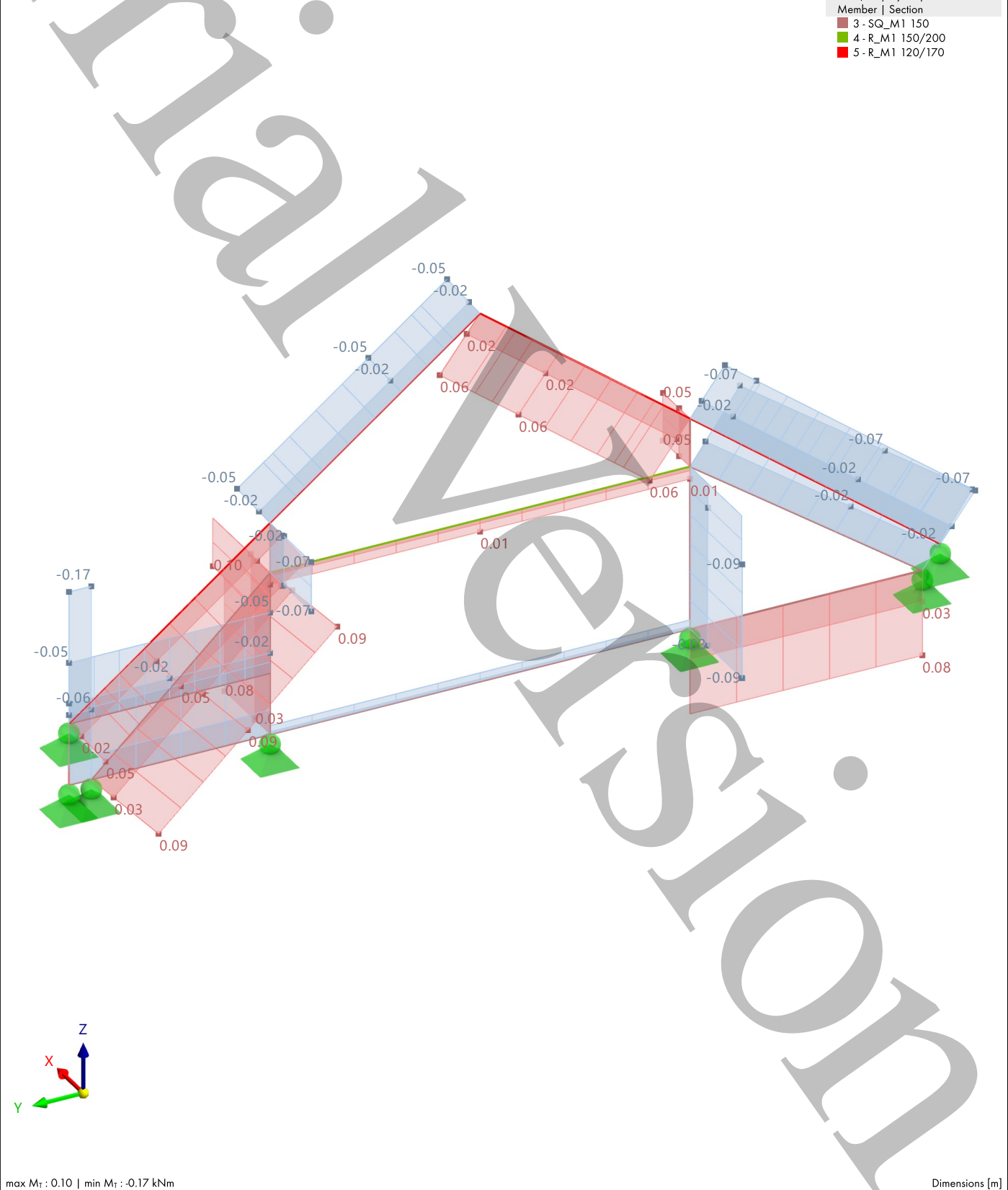
**Graphic DS1: ENVELOPE VALUES - MAX AND MIN VALUES, INTERNAL FORCES  $M_T$ , LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT**

**Static Analysis**

Visibility mode  
 DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10  
 Static Analysis  
 Moments  $M_T$  [kNm]

In Axonometric Direction by Default  
**Colors of Rendered Objects**

- Node | Display Properties
- Line | Display Properties
- Member | Section
- 3 - SQ\_M1 150
- 4 - R\_M1 150/200
- 5 - R\_M1 120/170



max  $M_T$  : 0.10 | min  $M_T$  : -0.17 kNm

Dimensions [m]





**MODEL**

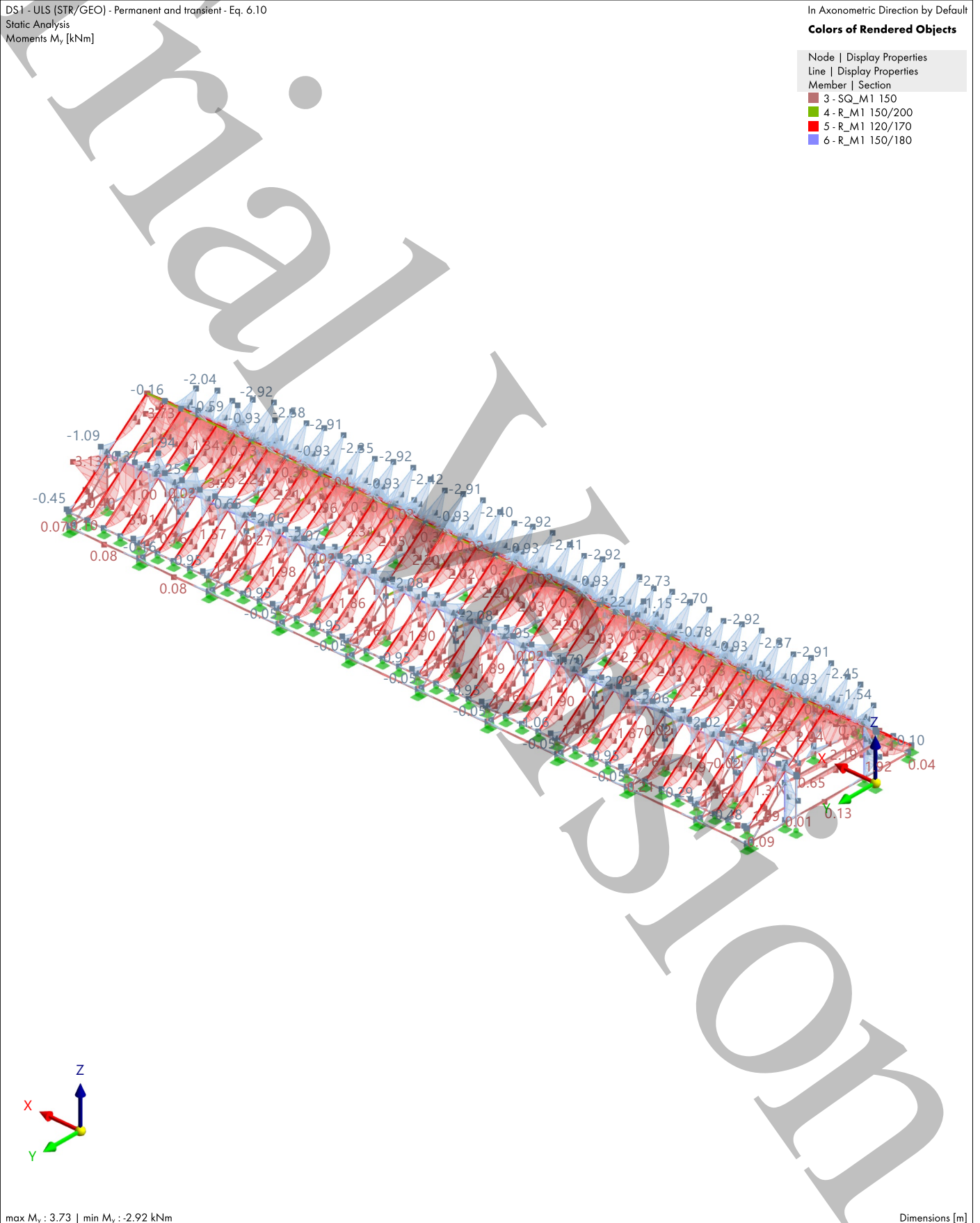
**Graphic DS1: ENVELOPE VALUES - MAX AND MIN VALUES, INTERNAL FORCES  $M_y$ , LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT**

**Static Analysis**

DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10  
Static Analysis  
Moments  $M_y$  [kNm]

In Axonometric Direction by Default  
**Colors of Rendered Objects**

- Node | Display Properties
- Line | Display Properties
- Member | Section
- 3 - SQ\_M1 150
- 4 - R\_M1 150/200
- 5 - R\_M1 120/170
- 6 - R\_M1 150/180



max  $M_y$  : 3.73 | min  $M_y$  : -2.92 kNm

Dimensions [m]







**MODEL**

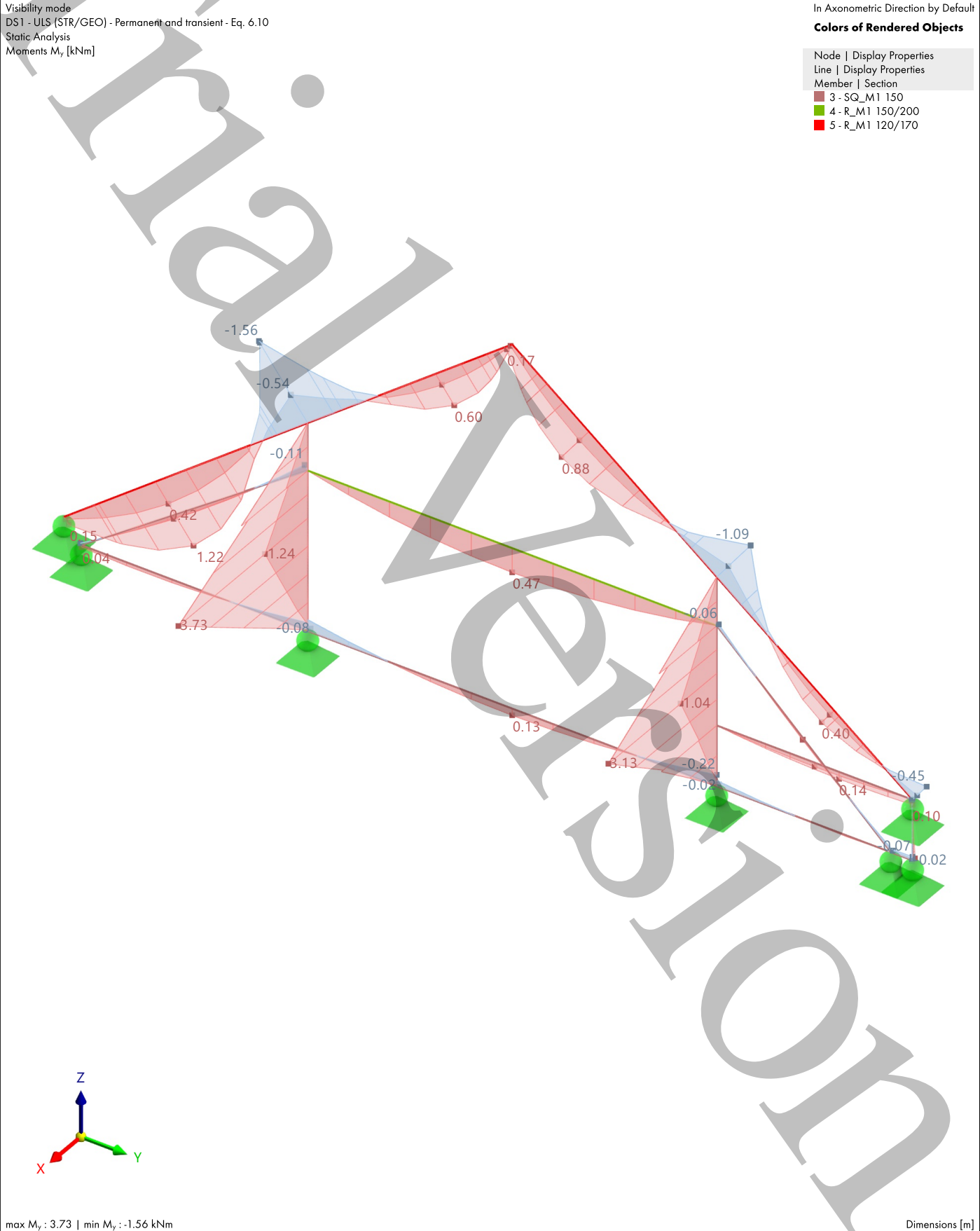
Graphic **DS1: ENVELOPE VALUES - MAX AND MIN VALUES, INTERNAL FORCES  $M_y$ , LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT**

Static Analysis

Visibility mode  
DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10  
Static Analysis  
Moments  $M_y$  [kNm]

In Axonometric Direction by Default  
**Colors of Rendered Objects**

- Node | Display Properties
- Line | Display Properties
- Member | Section
- 3 - SQ\_M1 150
- 4 - R\_M1 150/200
- 5 - R\_M1 120/170





**MODEL**

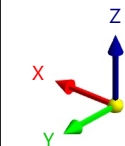
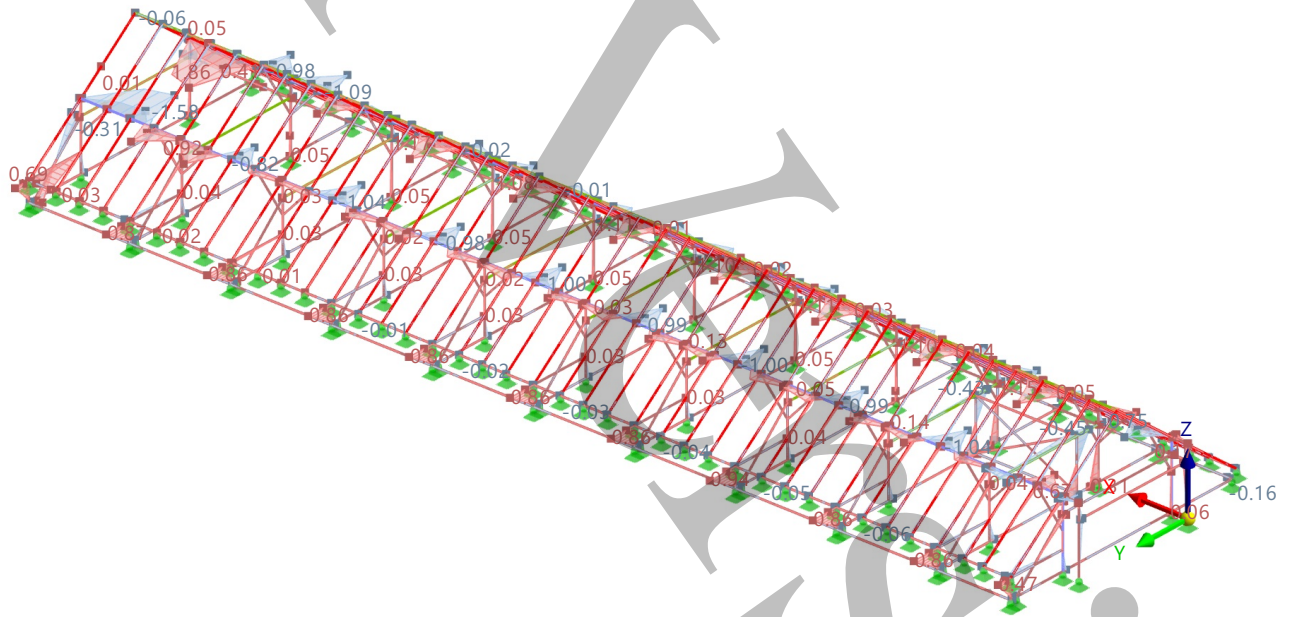
Graphic **DS1: ENVELOPE VALUES - MAX AND MIN VALUES, INTERNAL FORCES  $M_z$ , LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT**

Static Analysis

DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10  
 Static Analysis  
 Moments  $M_z$  [kNm]

In Axonometric Direction by Default  
**Colors of Rendered Objects**

- Node | Display Properties
- Line | Display Properties
- Member | Section
- 3 - SQ\_M1 150
- 4 - R\_M1 150/200
- 5 - R\_M1 120/170
- 6 - R\_M1 150/180



max  $M_z$  : 1.86 | min  $M_z$  : -1.58 kNm

Dimensions [m]





**MODEL**

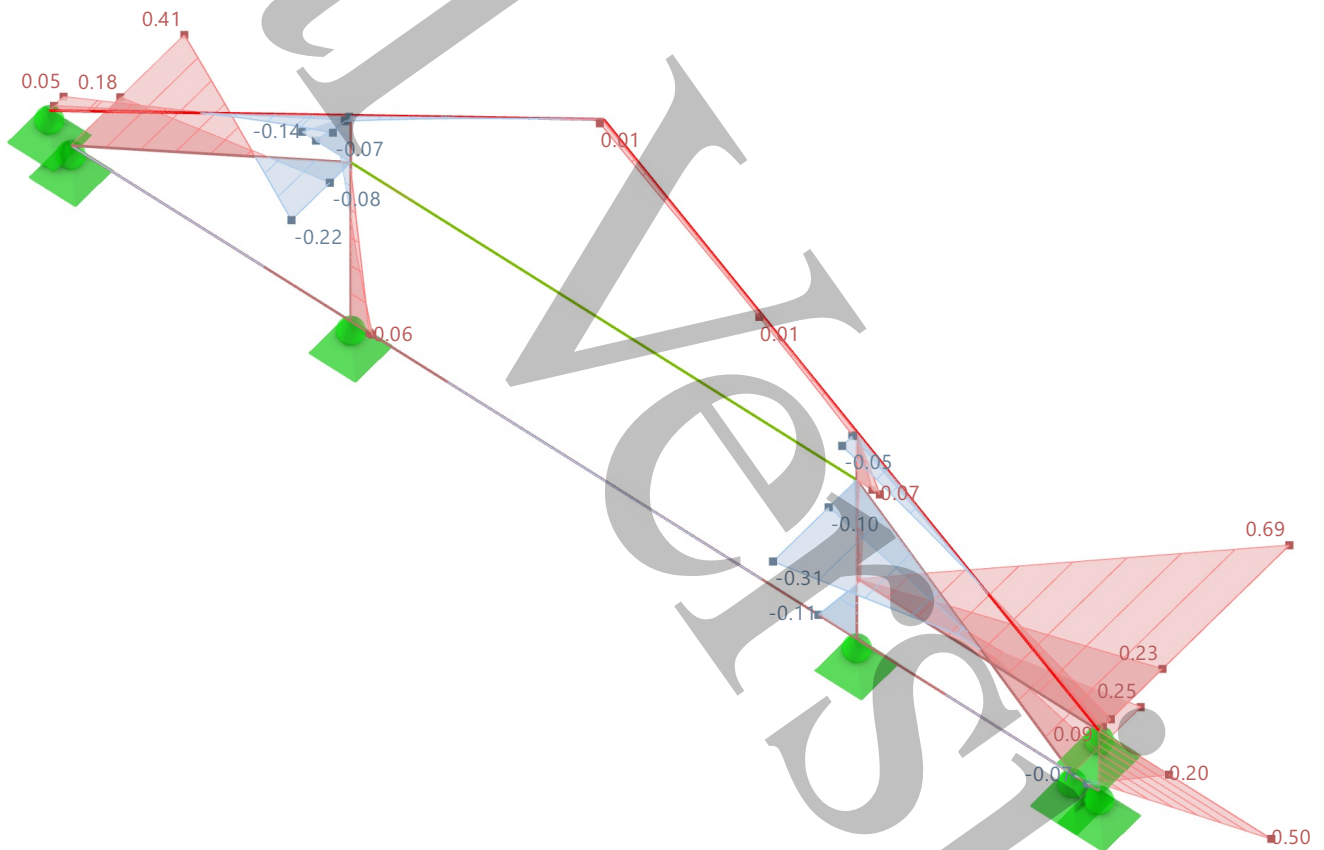
Graphic **DS1: ENVELOPE VALUES - MAX AND MIN VALUES, INTERNAL FORCES  $M_z$ , LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT**

Static Analysis

Visibility mode  
 DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10  
 Static Analysis  
 Moments  $M_z$  [kNm]

In Axonometric Direction by Default  
**Colors of Rendered Objects**

- Node | Display Properties
- Line | Display Properties
- Member | Section
- 3 - SQ\_M1 150
- 4 - R\_M1 150/200
- 5 - R\_M1 120/170



max  $M_z$  : 0.69 | min  $M_z$  : -0.31 kNm

Dimensions [m]





**MODEL**

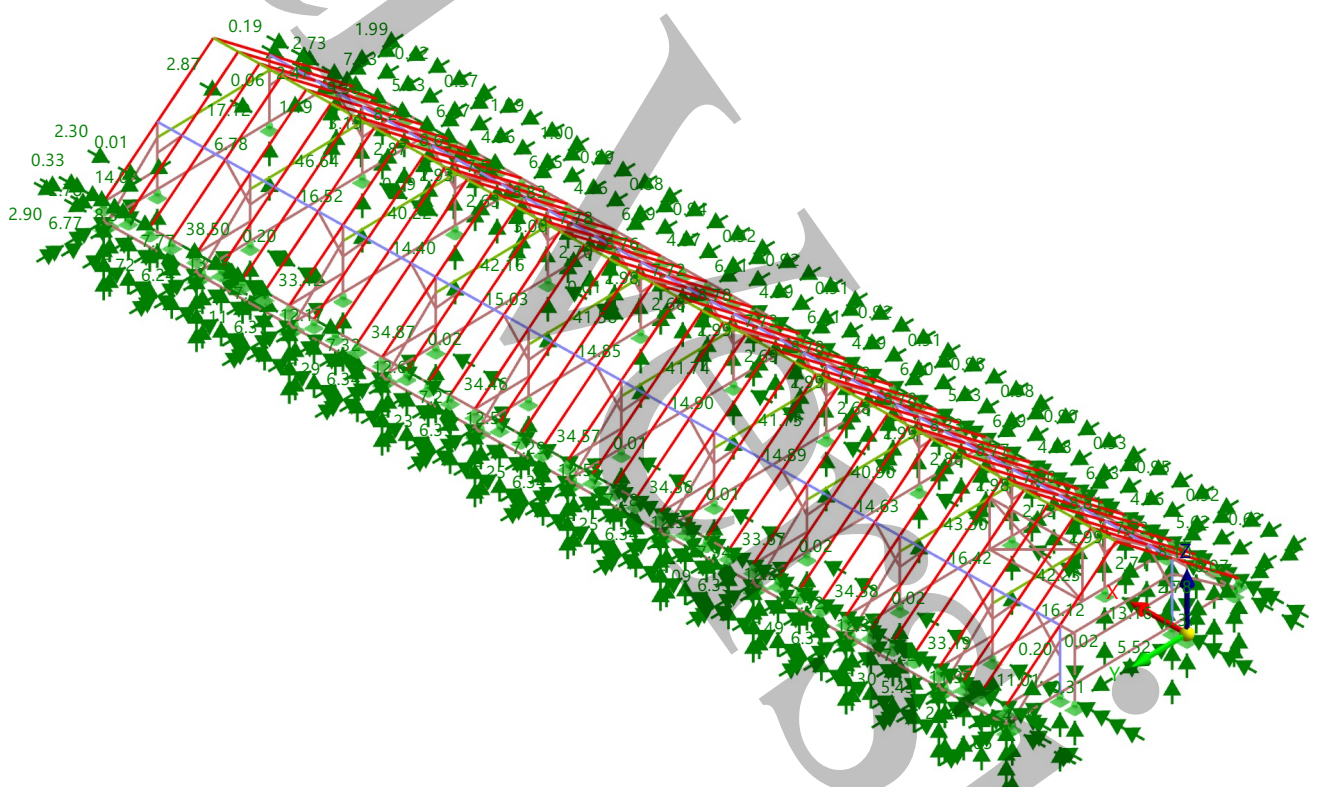
**Graphic DS1: ENVELOPE VALUES - MAX AND MIN VALUES, NODAL SUPPORTS P<sub>X</sub>, NODAL SUPPORTS P<sub>Y</sub>, NODAL SUPPORTS P<sub>Z</sub>, LINE SUPPORTS P<sub>X</sub>, LINE SUPPORTS P<sub>Y</sub>, LINE SUPPORTS P<sub>Z</sub>, LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT Static Analysis**

DS1 - ULS (STR/GEO) - Permanent and transient - Eq. 6.10  
 Static Analysis  
 Local Reaction Forces P<sub>x</sub>, P<sub>y</sub>, P<sub>z</sub> [kN]

In Axonometric Direction by Default

**Colors of Rendered Objects**

Node	Display Properties
Line	Display Properties
Member	Section
3 - SQ_M1	150
4 - R_M1	150/200
5 - R_M1	120/170
6 - R_M1	150/180



max P<sub>x</sub> : 2.87 | min P<sub>x</sub> : -1.07 kN  
 max P<sub>y</sub> : 6.77 | min P<sub>y</sub> : -7.13 kN  
 max P<sub>z</sub> : 0.33 | min P<sub>z</sub> : -46.64 kN

Dimensions [m]





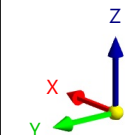
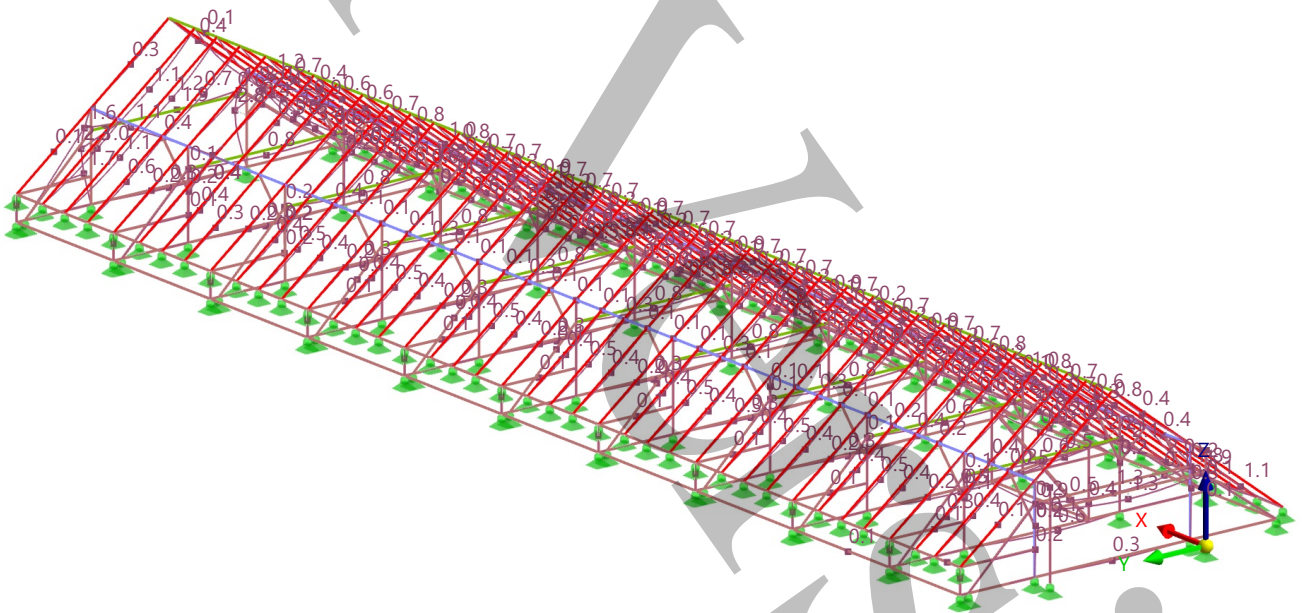
**MODEL**

Graphic **DS2: ENVELOPE VALUES - MAX VALUES, GLOBAL DEFORMATIONS |U|, LINE SUPPORTS P<sub>x</sub>, LINE SUPPORTS P<sub>y</sub>, LINE SUPPORTS P<sub>z</sub>, LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT** Static Analysis

DS2 - SLS - Characteristic  
Static Analysis  
Displacements |u| [mm]

In Axonometric Direction by Default  
**Colors of Rendered Objects**

Node	Display Properties
Line	Display Properties
Member	Section
3	SQ_M1 150
4	R_M1 150/200
5	R_M1 120/170
6	R_M1 150/180



max |u| : 3.4 | min |u| : 0.0 mm

Dimensions [m]





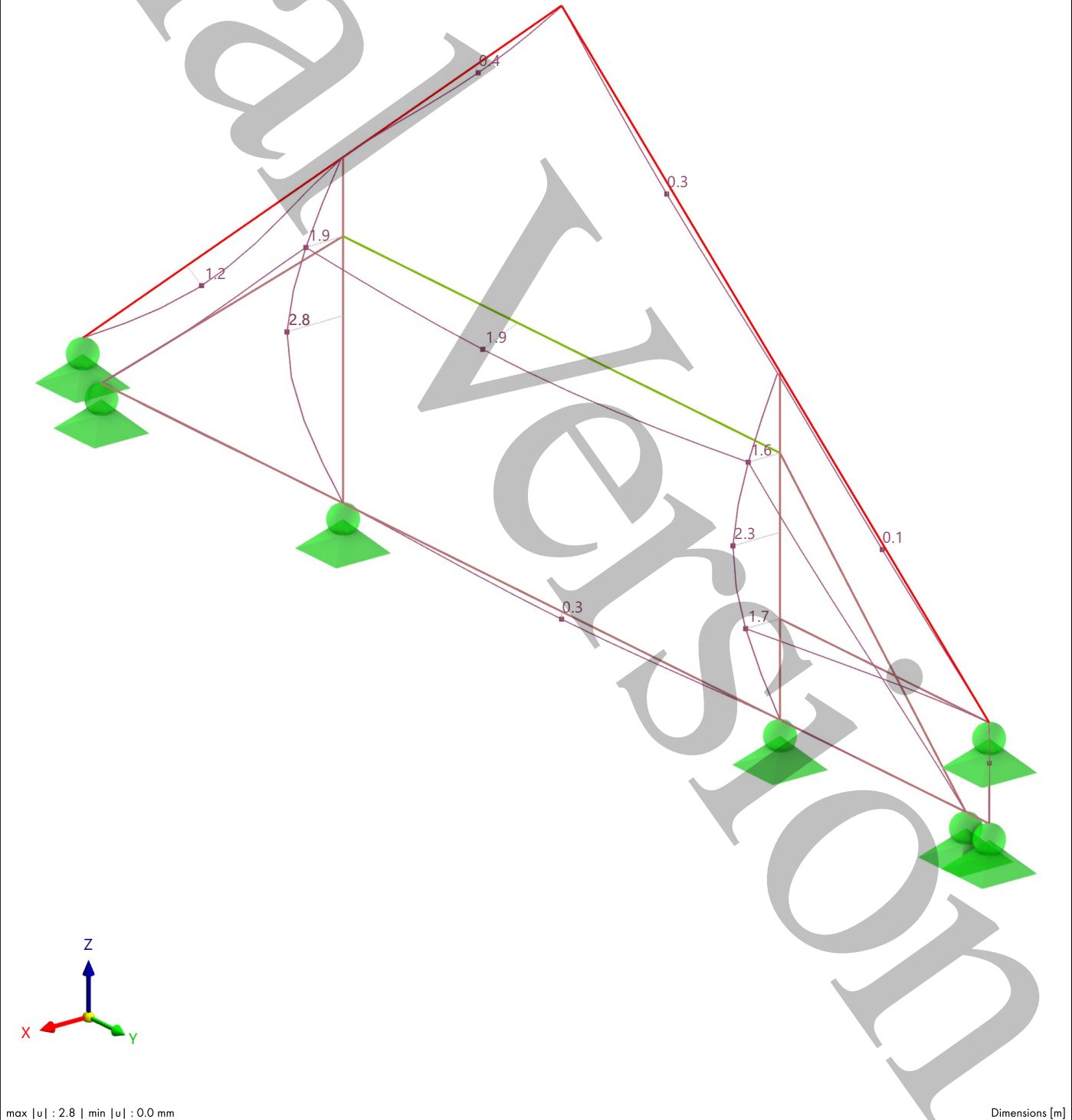
**MODEL**

Graphic **DS2: ENVELOPE VALUES - MAX VALUES, GLOBAL DEFORMATIONS |U|, LINE SUPPORTS P<sub>x</sub>, LINE SUPPORTS P<sub>y</sub>, LINE SUPPORTS P<sub>z</sub>, LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT** Static Analysis

Visibility mode  
DS2 - SLS - Characteristic  
Static Analysis  
Displacements |u| [mm]

In Axonometric Direction by Default  
**Colors of Rendered Objects**

- Node | Display Properties
- Line | Display Properties
- Member | Section
- 3 - SQ\_M1 150
- 4 - R\_M1 150/200
- 5 - R\_M1 120/170



max |u| : 2.8 | min |u| : 0.0 mm

Dimensions [m]





**MODEL**

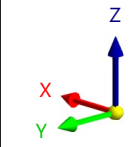
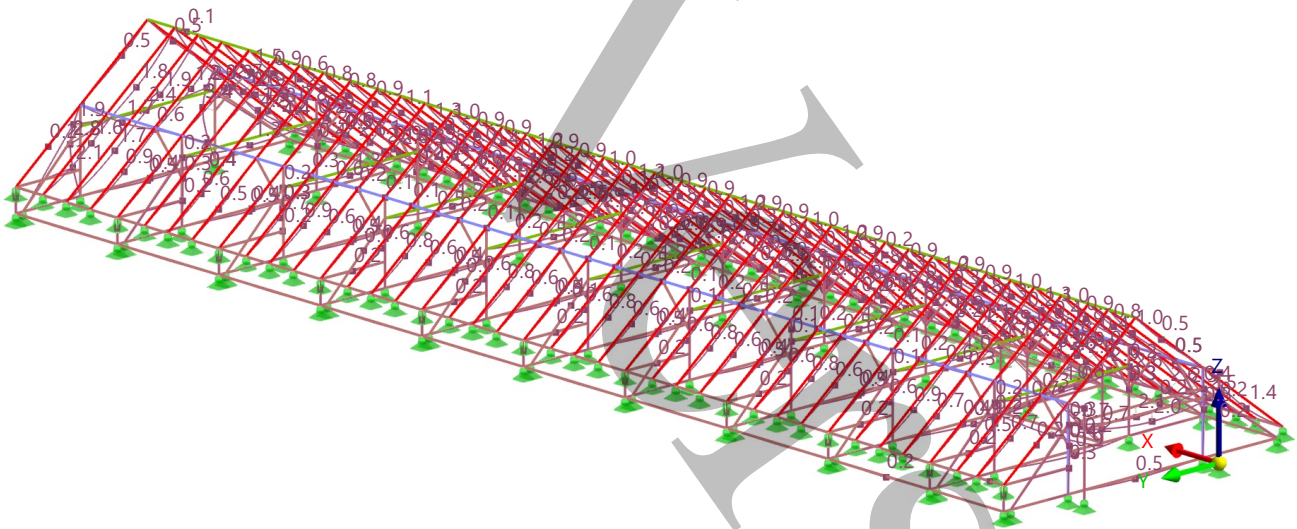
Graphic **DS3: ENVELOPE VALUES - MAX VALUES, GLOBAL DEFORMATIONS |U|, LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT**

Static Analysis

DS3 - SLS - Quasi-permanent  
Static Analysis  
Displacements |u| [mm]

In Axonometric Direction by Default  
**Colors of Rendered Objects**

- Node | Display Properties
- Line | Display Properties
- Member | Section
- 3 - SQ\_M1 150
- 4 - R\_M1 150/200
- 5 - R\_M1 120/170
- 6 - R\_M1 150/180



max |u| : 4.4 | min |u| : 0.0 mm

Dimensions [m]





**MODEL**

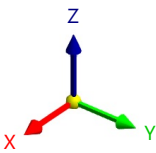
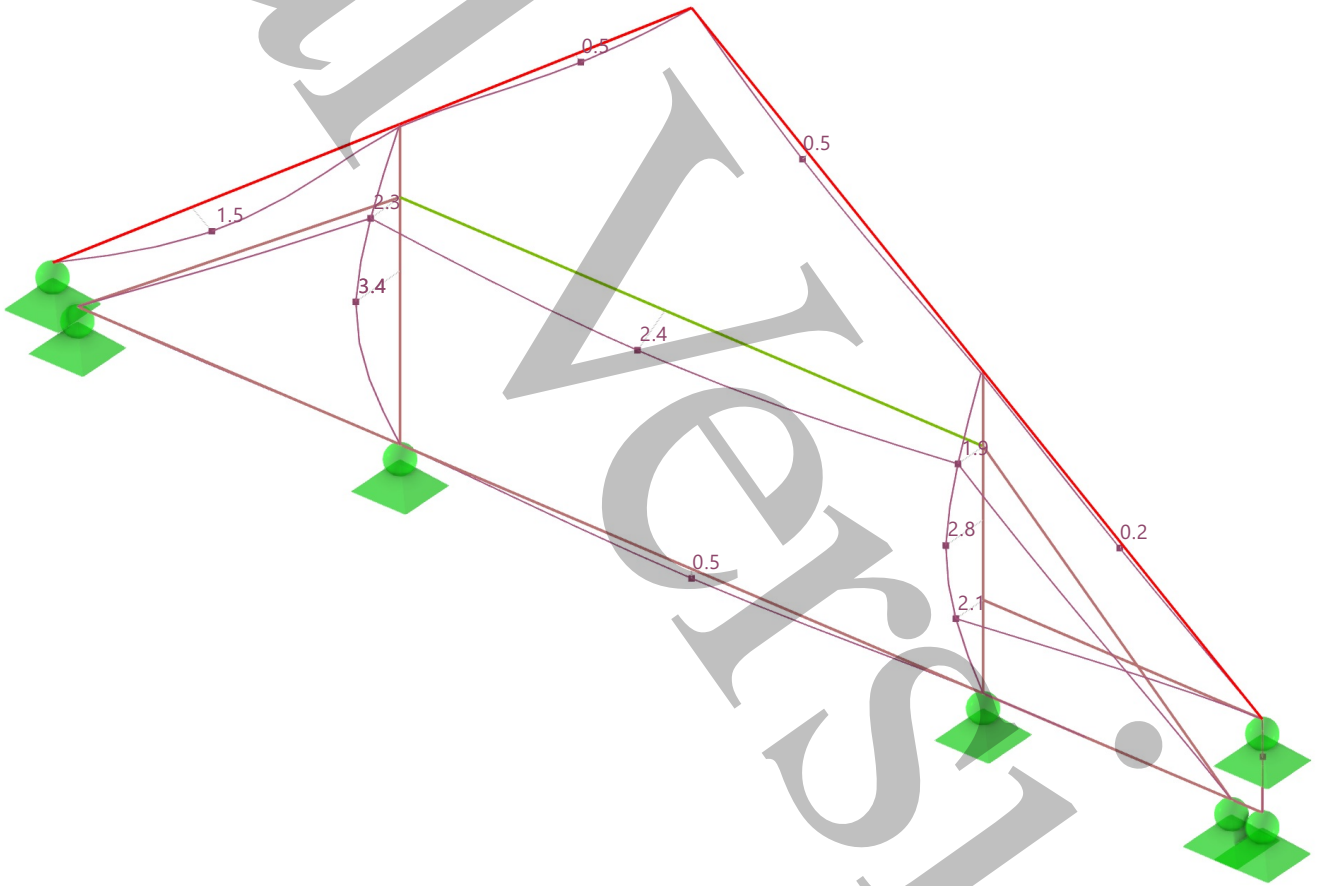
Graphic **DS3: ENVELOPE VALUES - MAX VALUES, GLOBAL DEFORMATIONS |U|, LOADING, IN AXONOMETRIC DIRECTION BY DEFAULT**

Static Analysis

Visibility mode  
DS3 - SLS - Quasi-permanent  
Static Analysis  
Displacements |u| [mm]

In Axonometric Direction by Default  
**Colors of Rendered Objects**

- Node | Display Properties
- Line | Display Properties
- Member | Section
- 3 - SQ\_M1 150
- 4 - R\_M1 150/200
- 5 - R\_M1 120/170



max |u| : 3.4 | min |u| : 0.0 mm

Dimensions [m]







**TIMBER**

Phone: +385913520415  
 Email: petar.bacac@gmail.com

## 9 Timber Design

### 9.1 OBJECTS TO DESIGN

Object Type	Design All	Objects to Design				Not Valid / Deact.	Comment
		Selected	To Calculate	Removed			
Members	<input checked="" type="checkbox"/>	1-18,20,23-195,197 ,199-202,207-210,2 14,215,217,218,22 6-321,329-355	1-18,20,23-195,197 ,199-202,207-210,2 14,215,217,218,22 6-321,329-355				

### 9.2 DESIGN SITUATIONS

DS No.	EN 1990   Timber   CEN   2010-04 Design Situation Type	To Design	Active	EN 1995   CEN   2014-05 Design Situation Type	Combinations to Design for Enumeration Method
1	<b>ULS</b> ULS (STR/GEO) - Permanent and transient - Eq. 6.10	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<b>ULS</b> ULS (STR/GEO) - Permanent and transient	All
2	<b>S Ch</b> SLS - Characteristic	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<b>S Ch</b> SLS - Characteristic	All
3	<b>S Qp</b> SLS - Quasi-permanent	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<b>S Qp1</b> SLS - Quasi-permanent 1	All

### 9.3 MATERIALS

Legend  
 Stiffness modification

Material No.	Name	To Design	Material Type	Options	Comment
3	GL24h	<input checked="" type="checkbox"/>	Timber		

### 9.4 SECTIONS

Legend  
 Warping stiffness deactivated

Section No.	Name	Material	To Design	Section Type	Use Other Section for Design	Options
3	SQ_M1 150	3	<input checked="" type="checkbox"/>	Parametric - Massive I		AAAA
4	R_M1 150/200	3	<input checked="" type="checkbox"/>	Parametric - Massive I		AAAA
5	R_M1 120/170	3	<input checked="" type="checkbox"/>	Parametric - Massive I		AAAA
6	R_M1 150/180	3	<input checked="" type="checkbox"/>	Parametric - Massive I		AAAA





Text MEMBER NO. 289 | DS1 | CO5 | 0.000 M | STRESS POINT NO. 1 | SP3100.01

Timber Design

Design Check SP3100.01 | EN 1995 | CEN | 2014-05

Section Proof  
Shear in z-axis acc. to 6.1.7

$$\begin{aligned} f_{v,d} &= k_{mod} \cdot \frac{f_{v,k}}{\gamma_M} \\ &= 0.90 \cdot \frac{3.500 \text{ N/mm}^2}{1.25} \\ &= 2.520 \text{ N/mm}^2 \end{aligned}$$

$$\begin{aligned} \tau_{xz,d} &= \frac{\tau_{xz}}{k_{cr}} \\ &= \frac{0.000 \text{ N/mm}^2}{0.67} \\ &= 0.000 \text{ N/mm}^2 \end{aligned}$$

$$\begin{aligned} \eta &= \frac{\tau_{xz,d}}{f_{v,d}} \\ &= \frac{0.000 \text{ N/mm}^2}{2.520 \text{ N/mm}^2} \\ &= 0.000 \end{aligned}$$

$$\eta = 0.000 \leq 1 \quad \checkmark$$

EN 1995-1-1, 2.4.1, Eq. 2.14

6.1.7, Eq. 6.13

- $f_{v,d}$  Design shear strength
- $k_{mod}$  Modification factor
- $f_{v,k}$  Characteristic shear strength
- $\gamma_M$  Partial factor
- $\tau_{xz,d}$  Design shear stress
- $\tau_{xz}$  Shear stress
- $k_{cr}$  Crack influence factor



Text MEMBER NO. 173 | DS1 | CO5 | 0.000 M | STRESS POINT NO. 1 | SP1200

Timber Design

Design Check SP1200 | EN 1995 | CEN | 2014-05

Section Proof  
Compression along grain acc. to 6.1.4.

$$\begin{aligned} f_{c,0,d} &= k_{mod} \cdot \frac{f_{c,0,k}}{\gamma_M} \\ &= 0.90 \cdot \frac{24.000 \text{ N/mm}^2}{1.25} \\ &= 17.280 \text{ N/mm}^2 \end{aligned}$$

$$\begin{aligned} \eta &= \left| \frac{\sigma_{c,0,d}}{f_{c,0,d}} \right| \\ &= \left| \frac{-0.221 \text{ N/mm}^2}{17.280 \text{ N/mm}^2} \right| \\ &= 0.013 \end{aligned}$$

$$\eta = 0.013 \leq 1 \quad \checkmark$$

EN 1995-1-1, 2.4.1, Eq. 2.14

6.1.4, Eq. 6.2

- $f_{c,0,d}$  Design compressive strength
- $k_{mod}$  Modification factor
- $f_{c,0,k}$  Characteristic compressive strength
- $\gamma_M$  Partial factor
- $\sigma_{c,0,d}$  Design compressive stress



Text MEMBER NO. 90 | DS1 | CO5 | 0.000 M | STRESS POINT NO. 1 | SP1200

Timber Design

Design Check SP1200 | EN 1995 | CEN | 2014-05

Section Proof  
Compression along grain acc. to 6.1.4.

$$\begin{aligned} f_{c,0,d} &= k_{mod} \cdot \frac{f_{c,0,k}}{\gamma_M} \\ &= 0.90 \cdot \frac{24.000 \text{ N/mm}^2}{1.25} \\ &= 17.280 \text{ N/mm}^2 \end{aligned}$$

$$\begin{aligned} \eta &= \left| \frac{\sigma_{c,0,d}}{f_{c,0,d}} \right| \\ &= \left| \frac{-1.045 \text{ N/mm}^2}{17.280 \text{ N/mm}^2} \right| \\ &= 0.060 \end{aligned}$$

$$\eta = 0.060 \leq 1 \quad \checkmark$$

EN 1995-1-1, 2.4.1, Eq. 2.14

6.1.4, Eq. 6.2

- $f_{c,0,d}$  Design compressive strength
- $k_{mod}$  Modification factor
- $f_{c,0,k}$  Characteristic compressive strength
- $\gamma_M$  Partial factor
- $\sigma_{c,0,d}$  Design compressive stress



Text MEMBER NO. 87 | DS1 | CO5 | 0.000 M | STRESS POINT NO. 1 | SP1200

Timber Design

Design Check SP1200 | EN 1995 | CEN | 2014-05

Section Proof  
Compression along grain acc. to 6.1.4.

$$\begin{aligned} f_{c,0,d} &= k_{mod} \cdot \frac{f_{c,0,k}}{\gamma_M} \\ &= 0.90 \cdot \frac{24.000 \text{ N/mm}^2}{1.25} \\ &= 17.280 \text{ N/mm}^2 \end{aligned}$$

$$\begin{aligned} \eta &= \left| \frac{\sigma_{c,0,d}}{f_{c,0,d}} \right| \\ &= \left| \frac{-1.831 \text{ N/mm}^2}{17.280 \text{ N/mm}^2} \right| \\ &= 0.106 \end{aligned}$$

EN 1995-1-1, 2.4.1, Eq. 2.14

6.1.4, Eq. 6.2

$$\eta = 0.106 \leq 1 \quad \checkmark$$

- $f_{c,0,d}$  Design compressive strength
- $k_{mod}$  Modification factor
- $f_{c,0,k}$  Characteristic compressive strength
- $\gamma_M$  Partial factor
- $\sigma_{c,0,d}$  Design compressive stress



Text MEMBER NO. 284 | DS1 | CO5 | 0.000 M | STRESS POINT NO. 1 | SP1200

Timber Design

Design Check SP1200 | EN 1995 | CEN | 2014-05

Section Proof  
Compression along grain acc. to 6.1.4.

$$\begin{aligned} f_{c,0,d} &= k_{mod} \cdot \frac{f_{c,0,k}}{\gamma_M} \\ &= 0.90 \cdot \frac{24.000 \text{ N/mm}^2}{1.25} \\ &= 17.280 \text{ N/mm}^2 \end{aligned}$$

$$\begin{aligned} \eta &= \left| \frac{\sigma_{c,0,d}}{f_{c,0,d}} \right| \\ &= \left| \frac{-0.334 \text{ N/mm}^2}{17.280 \text{ N/mm}^2} \right| \\ &= 0.019 \end{aligned}$$

$$\eta = 0.019 \leq 1 \quad \checkmark$$

EN 1995-1-1, 2.4.1, Eq. 2.14

6.1.4, Eq. 6.2

- $f_{c,0,d}$  Design compressive strength
- $k_{mod}$  Modification factor
- $f_{c,0,k}$  Characteristic compressive strength
- $\gamma_M$  Partial factor
- $\sigma_{c,0,d}$  Design compressive stress



Text MEMBER NO. 229 | DS1 | CO5 | 0.000 M | STRESS POINT NO. 1 | SP1200

Timber Design

Design Check SP1200 | EN 1995 | CEN | 2014-05

Section Proof  
Compression along grain acc. to 6.1.4.

$$\begin{aligned} f_{c,0,d} &= k_{mod} \cdot \frac{f_{c,0,k}}{\gamma_M} \\ &= 0.90 \cdot \frac{24.000 \text{ N/mm}^2}{1.25} \\ &= 17.280 \text{ N/mm}^2 \end{aligned}$$

$$\begin{aligned} \eta &= \left| \frac{\sigma_{c,0,d}}{f_{c,0,d}} \right| \\ &= \left| \frac{-0.250 \text{ N/mm}^2}{17.280 \text{ N/mm}^2} \right| \\ &= 0.014 \end{aligned}$$

$$\eta = 0.014 \leq 1 \quad \checkmark$$

EN 1995-1-1, 2.4.1, Eq. 2.14

6.1.4, Eq. 6.2

- $f_{c,0,d}$  Design compressive strength
- $k_{mod}$  Modification factor
- $f_{c,0,k}$  Characteristic compressive strength
- $\gamma_M$  Partial factor
- $\sigma_{c,0,d}$  Design compressive stress



Text MEMBER NO. 8 | DS1 | CO5 | 0.000 M | STRESS POINT NO. 1 | SP1200

Timber Design

Design Check SP1200 | EN 1995 | CEN | 2014-05

Section Proof  
Compression along grain acc. to 6.1.4.

$$\begin{aligned} f_{c,0,d} &= k_{mod} \cdot \frac{f_{c,0,k}}{\gamma_M} \\ &= 0.90 \cdot \frac{24.000 \text{ N/mm}^2}{1.25} \\ &= 17.280 \text{ N/mm}^2 \end{aligned}$$

$$\begin{aligned} \eta &= \left| \frac{\sigma_{c,0,d}}{f_{c,0,d}} \right| \\ &= \left| \frac{-0.385 \text{ N/mm}^2}{17.280 \text{ N/mm}^2} \right| \\ &= 0.022 \end{aligned}$$

$$\eta = 0.022 \leq 1 \quad \checkmark$$

EN 1995-1-1, 2.4.1, Eq. 2.14

6.1.4, Eq. 6.2

- $f_{c,0,d}$  Design compressive strength
- $k_{mod}$  Modification factor
- $f_{c,0,k}$  Characteristic compressive strength
- $\gamma_M$  Partial factor
- $\sigma_{c,0,d}$  Design compressive stress





Text MEMBER NO. 341 | DS1 | CO5 | 0.000 M | STRESS POINT NO. 1 | SP2100

Timber Design

Design Check SP2100 | EN 1995 | CEN | 2014-05

Section Proof  
Shear due to torsion acc. to 6.1.8

$$\begin{aligned} f_{v,d} &= k_{mod} \cdot \frac{f_{v,k}}{\gamma_M} \\ &= 0.90 \cdot \frac{3.500 \text{ N/mm}^2}{1.25} \\ &= 2.520 \text{ N/mm}^2 \end{aligned}$$

$$\begin{aligned} \eta &= \frac{\tau_{tor,d}}{k_{shape} \cdot f_{v,d}} \\ &= \frac{0.008 \text{ N/mm}^2}{1.05 \cdot 2.520 \text{ N/mm}^2} \\ &= 0.003 \end{aligned}$$

$$\eta = 0.003 \leq 1 \quad \checkmark$$

EN 1995-1-1, 2.4.1, Eq. 2.14

6.1.8, Eq. 6.14

$f_{v,d}$  Design shear strength  
 $k_{mod}$  Modification factor  
 $f_{v,k}$  Characteristic shear strength  
 $\gamma_M$  Partial factor  
 $\tau_{tor,d}$  Design torsional stress  
 $k_{shape}$  Torsion factor



Text MEMBER NO. 43 | DS1 | CO5 | 0.000 M | STRESS POINT NO. 1 | SP1100

Timber Design

Design Check SP1100 | EN 1995 | CEN | 2014-05

Section Proof  
Tension along grain acc. to 6.1.2

$$\begin{aligned} f_{t,0,d} &= k_{mod} \cdot \frac{f_{t,0,k}}{\gamma_M} \\ &= 0.90 \cdot \frac{19.200 \text{ N/mm}^2}{1.25} \\ &= 13.824 \text{ N/mm}^2 \end{aligned}$$

$$\begin{aligned} \eta &= \frac{\sigma_{t,0,d}}{f_{t,0,d}} \\ &= \frac{0.512 \text{ N/mm}^2}{13.824 \text{ N/mm}^2} \\ &= 0.037 \end{aligned}$$

$$\eta = 0.037 \leq 1 \quad \checkmark$$

2.4.1, Eq. 2.14

6.1.2(1), Eq. 6.1

- $f_{t,0,d}$  Design tensile strength
- $k_{mod}$  Modification factor
- $f_{t,0,k}$  Characteristic tensile strength
- $\gamma_M$  Partial factor
- $\sigma_{t,0,d}$  Design tensile stress



Text MEMBER NO. 336 | DS1 | CO5 | 0.000 M | STRESS POINT NO. 1 | SP2100

Timber Design

Design Check SP2100 | EN 1995 | CEN | 2014-05

Section Proof  
Shear due to torsion acc. to 6.1.8

$$\begin{aligned} f_{v,d} &= k_{mod} \cdot \frac{f_{v,k}}{\gamma_M} \\ &= 0.90 \cdot \frac{3.500 \text{ N/mm}^2}{1.25} \\ &= 2.520 \text{ N/mm}^2 \end{aligned}$$

$$\begin{aligned} \eta &= \frac{\tau_{tor,d}}{k_{shape} \cdot f_{v,d}} \\ &= \frac{0.004 \text{ N/mm}^2}{1.07 \cdot 2.520 \text{ N/mm}^2} \\ &= 0.002 \end{aligned}$$

$$\eta = 0.002 \leq 1 \quad \checkmark$$

EN 1995-1-1, 2.4.1, Eq. 2.14

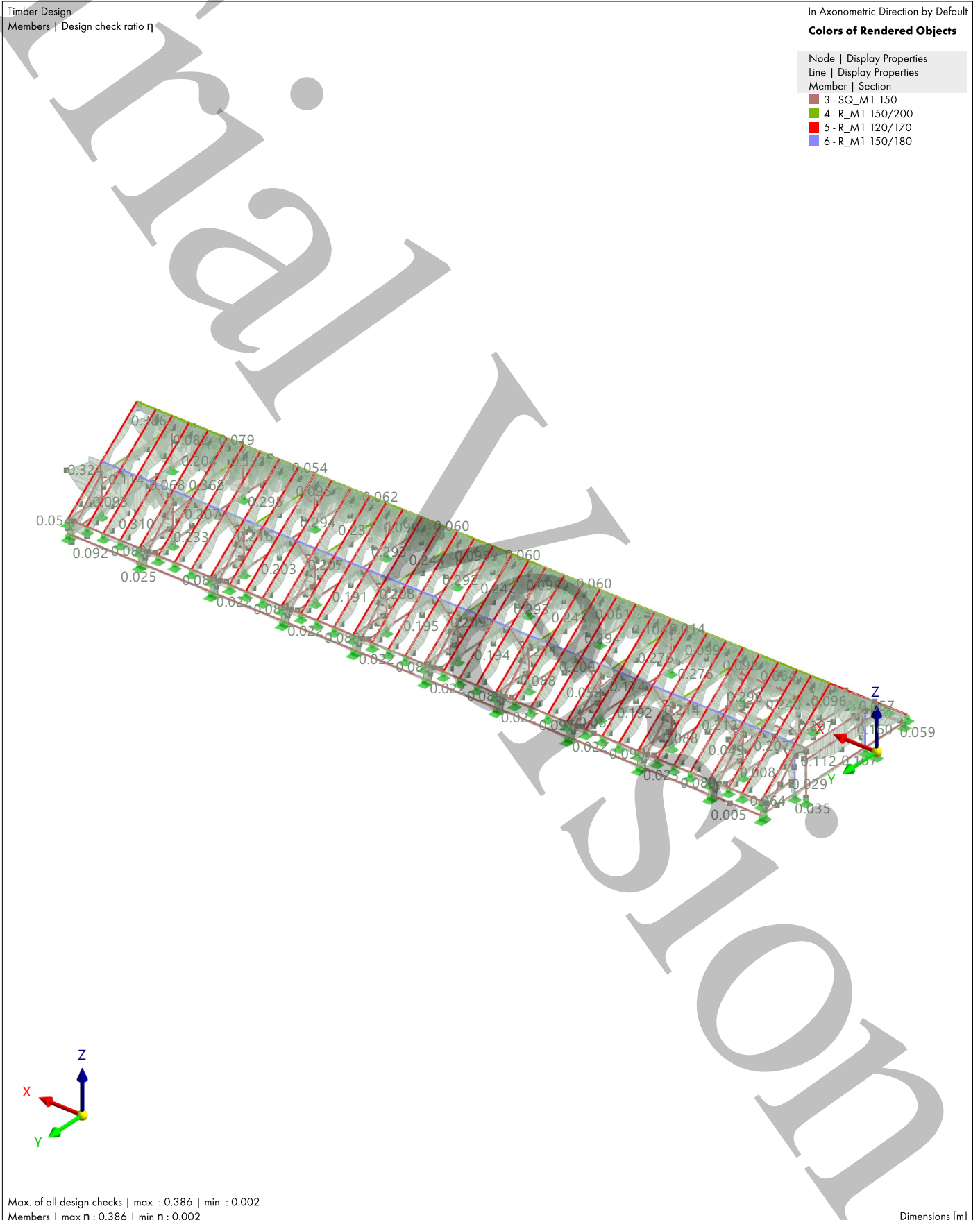
6.1.8, Eq. 6.14

$f_{v,d}$  Design shear strength  
 $k_{mod}$  Modification factor  
 $f_{v,k}$  Characteristic shear strength  
 $\gamma_M$  Partial factor  
 $\tau_{tor,d}$  Design torsional stress  
 $k_{shape}$  Torsion factor



**MODEL**

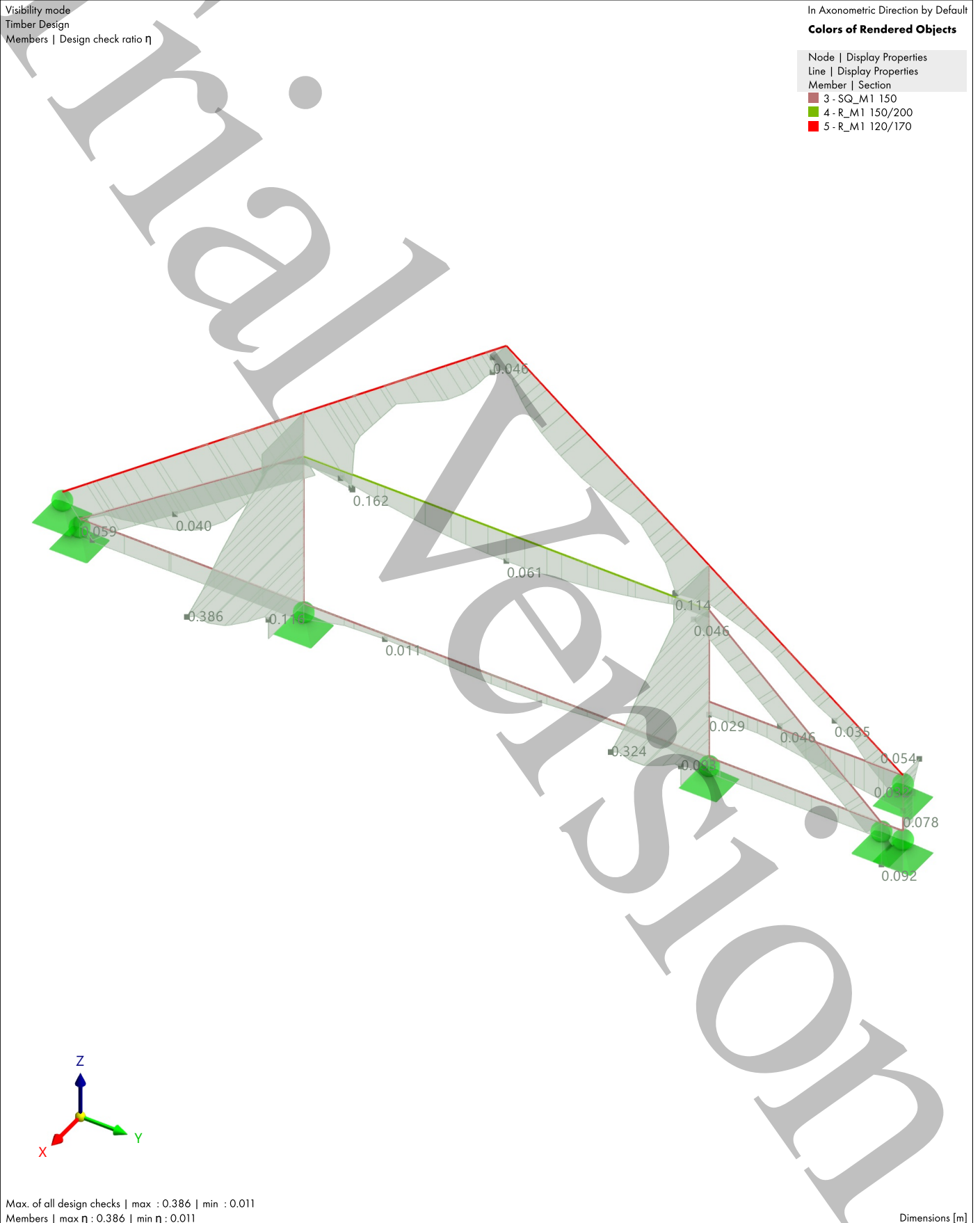
**Graphic** **TIMBER DESIGN: MAX. OF ALL DESIGN CHECKS, DS1: LOADING, IN AXONOMETRIC DIRECTION** Timber Design **BY DEFAULT**





**MODEL**

Graphic **TIMBER DESIGN: MAX. OF ALL DESIGN CHECKS, DS1: LOADING, IN AXONOMETRIC DIRECTION** Timber Design  
**BY DEFAULT**





**MODEL**

**10 Design Overview**

**10.1 DESIGN OVERVIEW**

**Design Overview**

Addon	Type	Objects		Location [m]	Design Situation	Loading No.	Design Check		Type	Description
		No.					Ratio $\eta$ [-]			
Timber Design	Member	192		x: 1.300	DS1	CO5	0.386	✓	SP6100.00	Section Proof   Bending about y-axis and compressive axial force acc. to 6.2.4
Timber Design	Member	190		x: 1.888	DS1	CO5	0.368	✓	SP6300.00	Section Proof   Biaxial bending and compressive axial force acc. to 6.2.4
Timber Design	Member	192		x: 1.300	DS3	CO15	0.343	✓	SE1200.02	Serviceability   Combination of actions 'Quasi-permanent 1'   z-direction acc. to 7.2
Timber Design	Member	192		x: 1.300	DS2	CO10	0.338	✓	SE1200.01	Serviceability   Combination of actions 'Characteristic'   z-direction acc. to 7.2
Timber Design	Member	190		x: 2.750	DS1	CO5	0.323	✓	SP5300.00	Section Proof   Biaxial bending and tensile axial force acc. to 6.2.3
Timber Design	Member	38		x: 3.529	DS1	CO5	0.279	✓	SP4300.00	Section Proof   Biaxial bending acc. to 6.1.6
Timber Design	Member	122		x: 3.529	DS1	CO5	0.274	✓	SP4100.00	Section Proof   Bending about y-axis acc. to 6.1.6
Timber Design	Member	190		x: 1.000	DS1	CO5	0.234	✓	SP3100.01	Section Proof   Shear in z-axis acc. to 6.1.7
Timber Design	Member	190		x: 2.319	DS3	CO15	0.167	✓	SE1100.02	Serviceability   Combination of actions 'Quasi-permanent 1'   y-direction acc. to 7.2
Timber Design	Member	190		x: 2.319	DS2	CO10	0.165	✓	SE1100.01	Serviceability   Combination of actions 'Characteristic'   y-direction acc. to 7.2
Timber Design	Member	2		x: 1.300	DS1	CO5	0.135	✓	ST1600.03	Stability   Biaxial bending and compression with buckling about both axes acc. to 6.3.2
Timber Design	Member	171		x: 0.000	DS1	CO5	0.119	✓	SP1200.00	Section Proof   Compression along grain acc. to 6.1.4
Timber Design	Member	190		x: 1.364	DS1	CO5	0.105	✓	SP3100.02	Section Proof   Shear in y-axis acc. to 6.1.7
Timber Design	Member	321		x: 9.300	DS1	CO5	0.092	✓	SP2100.00	Section Proof   Shear due to torsion acc. to 6.1.8
Timber Design	Member	344		x: 0.000	DS1	CO5	0.089	✓	SP4200.00	Section Proof   Bending about z-axis acc. to 6.1.6
Timber Design	Member	2		x: 1.300	DS1	CO2	0.080	✓	ST1600.01	Stability   Bending about y-axis and compression with buckling about both axes acc. to 6.3.2
Timber Design	Member	2		x: 0.000	DS1	CO2	0.078	✓	ST1600.02	Stability   Bending about z-axis and compression with buckling about both axes acc. to 6.3.2
Timber Design	Member	172		x: 1.447	DS1	CO5	0.073	✓	SP5100.00	Section Proof   Bending about y-axis and tensile axial force acc. to 6.2.3
Timber Design	Member	331		x: 1.850	DS1	CO1	0.070	✓	SP6200.00	Section Proof   Bending about z-axis and compressive axial force acc. to 6.2.4
Timber Design	Member	190		x: 0.000	DS1	CO5	0.047	✓	SP1100.00	Section Proof   Tension along grain acc. to 6.1.2
Timber Design	Member	2		x: 2.412	DS1	CO5	0.026	✓	ST1300.00	Stability   Axial compression with buckling about both axes acc. to 6.3.2
Timber Design	Member	1-18,20,23-195,197,199-202,207-210,214,215,217,218,226-321,329-355		x: 0.000	DS2	CO6	0.000	✓	SE0100.01	Serviceability   Negligible deflection   Combination of actions 'Characteristic'
Timber Design	Member	1-18,20,23-195,197,199-202,207-210,214,215,217,218,226-321,329-355		x: 0.000	DS3	CO11	0.000	✓	SE0100.02	Serviceability   Negligible deflection   Combination of actions 'Quasi-permanent 1'

## Izvori

- 1) Voichita Bucur, *Delamination in Wood, Wood Products and Wood-Based Composites*, 2011.
- 2) Bohumil Kasal, *Semi-destructive method for in-situ evaluation of compressive strength of wood structural members*, 2003.
- 3) Gretchen Lear, Bohumil Kasal and Ron Anthony, poglavlje 4. . Bohumil Kasal- In Situ Assessment of Structural Timber
- 4) Rajčić, V. (2020.). *www.grad.hr*. Retrieved from Drvene konstrukcije