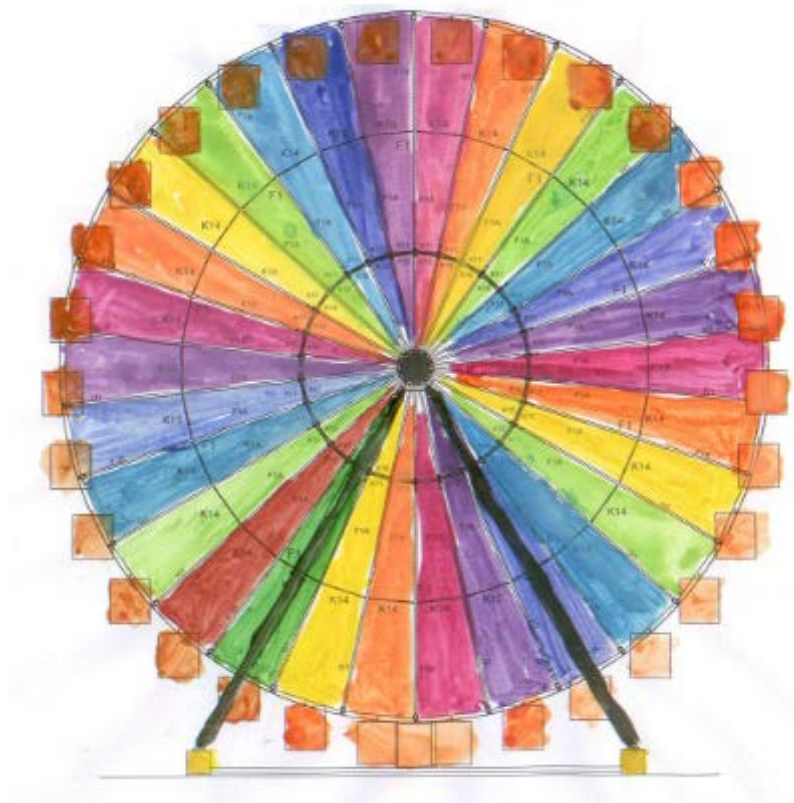




Скорук Л.Н.

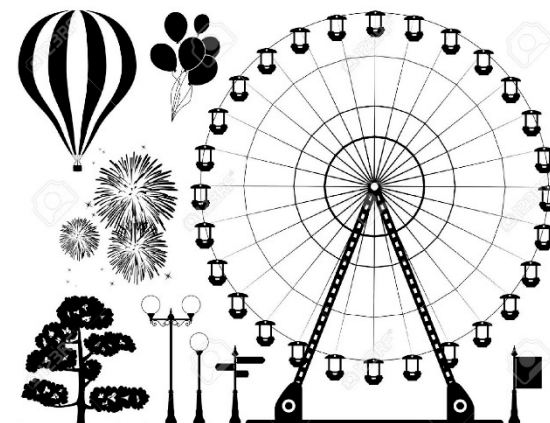
Опыт использования SCAD Office при расчете зданий и сооружений
(расчет колеса обозрения высотой 40 м по Евронормам)





Исходные данные для расчета:

Общая высота:	40 м
Диаметр колеса:	35 м
Ширина вращающейся части:	2,4 м
Размер основания:	16,92x22,8 м
Количество кабин:	30 шт.
Вес пустой кабины:	500 кг
Грузоподъемность кабины:	6 чел.
Общее кол-во людей в кабинах:	180 чел.
Вес металлокаркаса (без учета кабин):	116 250 кг
Вес каркаса с кабинами:	131 250 кг
Общий вес конструкции с людьми (1 чел \approx 75 кг):	144 750 кг





Исходные данные:



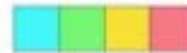
Общий вид сооружения



Исходные данные:



Dynamic base pressure	
Wind speed regions	2
Wind speed	24.0 m/s
Pressure	0.4 kN/m ²



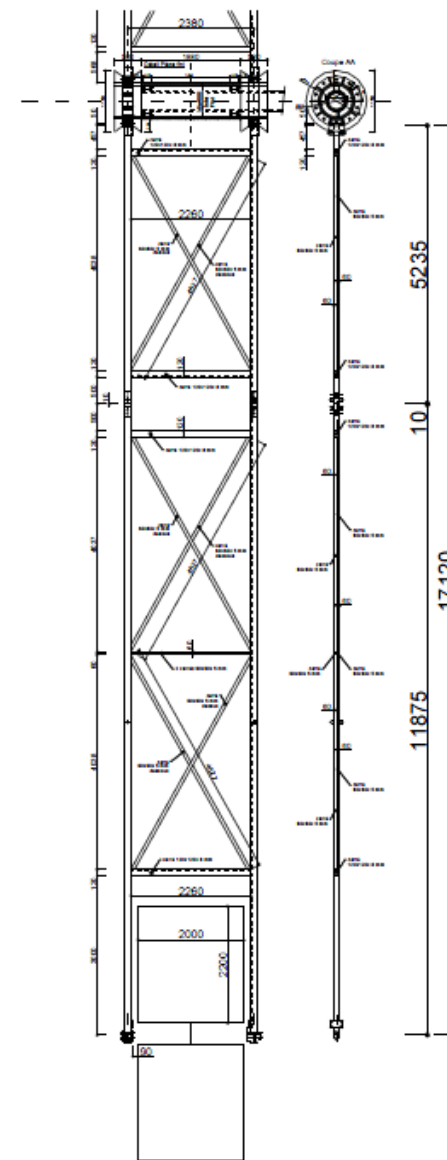
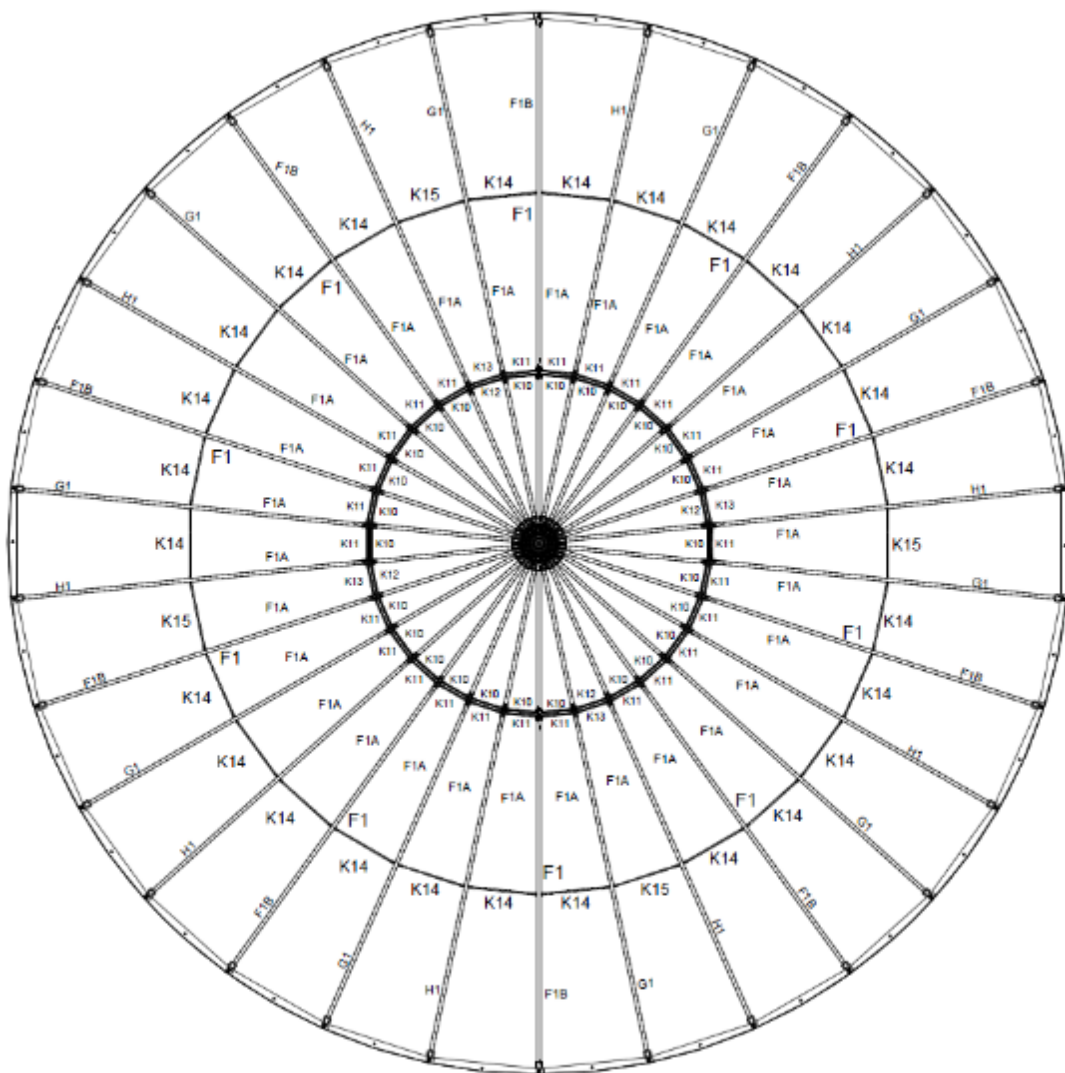
1	2	3	4
22	24	26	28

[m/s]

Возможно размещение сооружения на территории Франции в 3-м ветровом районе



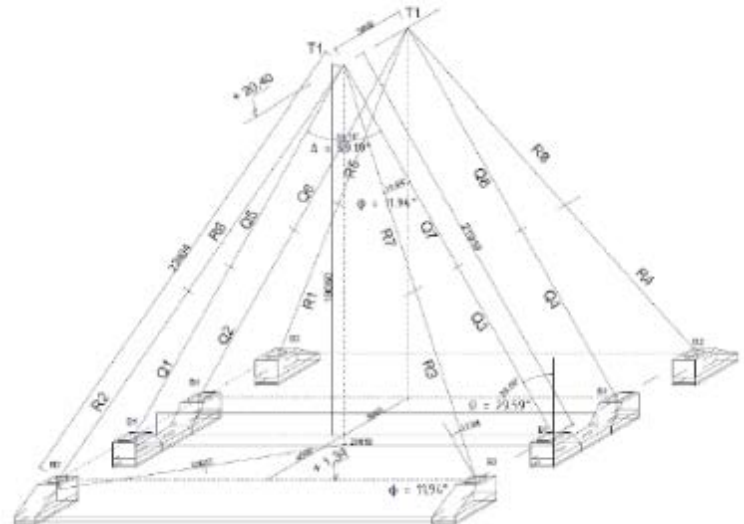
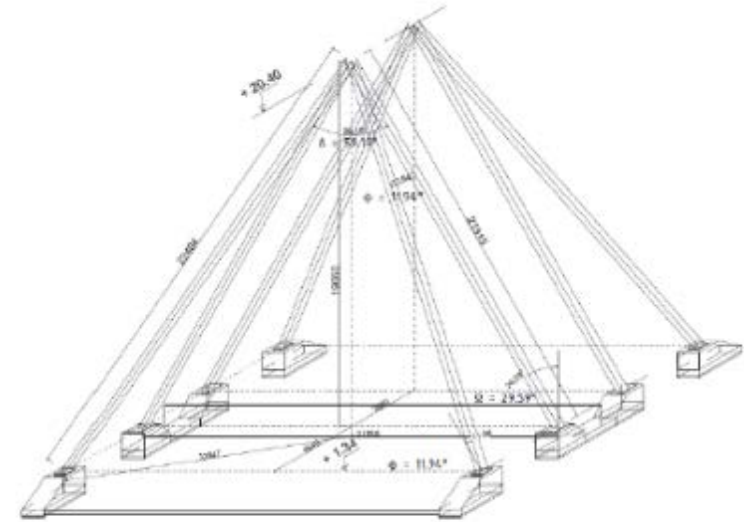
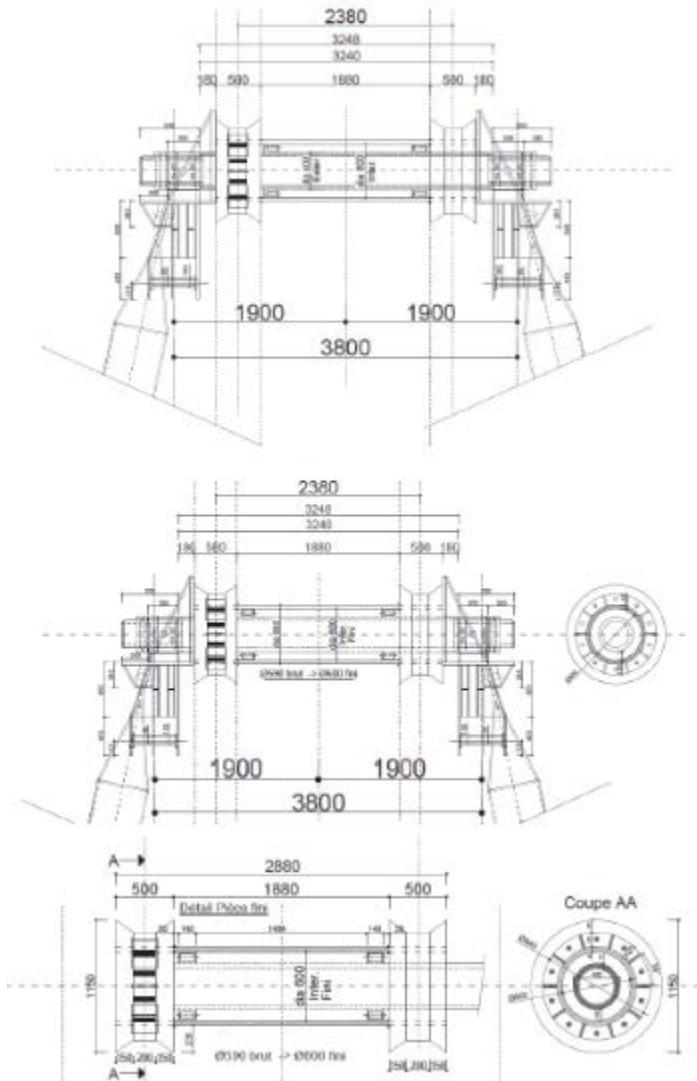
Исходные данные:



Главный фасад и радиусная часть колеса



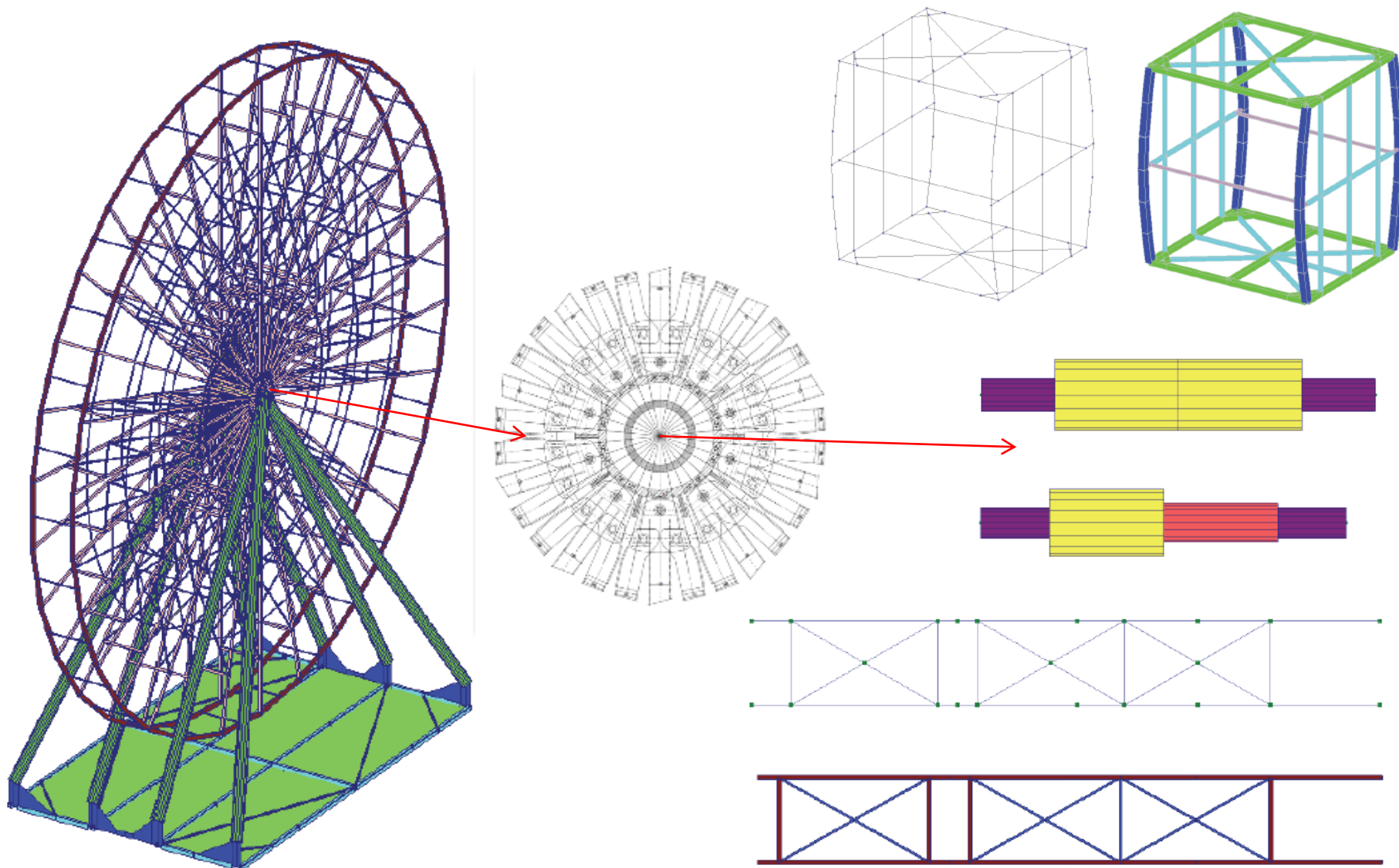
Исходные данные:



Ось вращения и опорные ноги



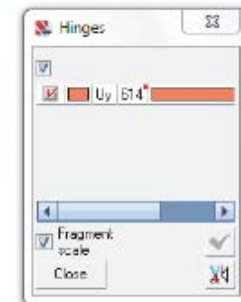
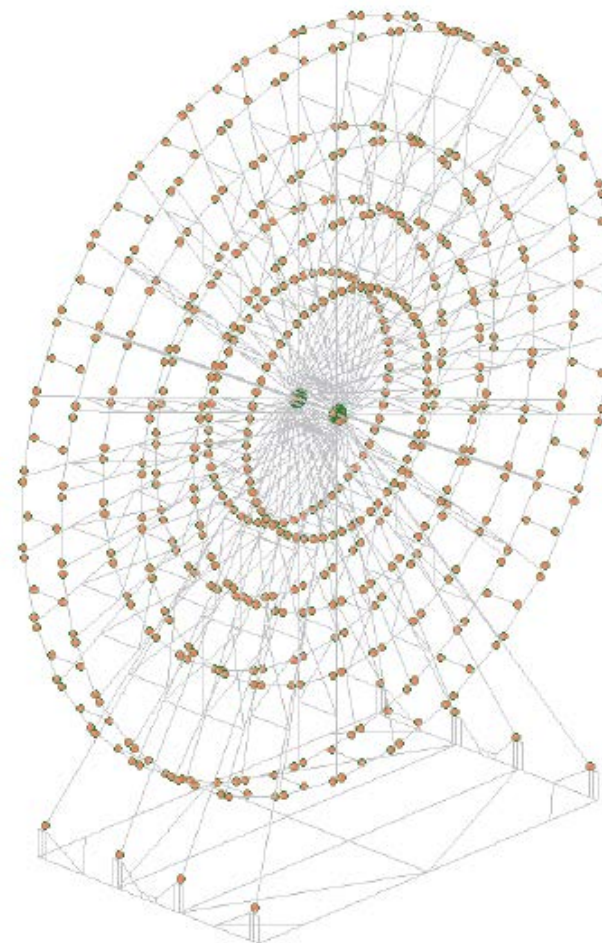
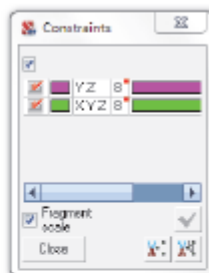
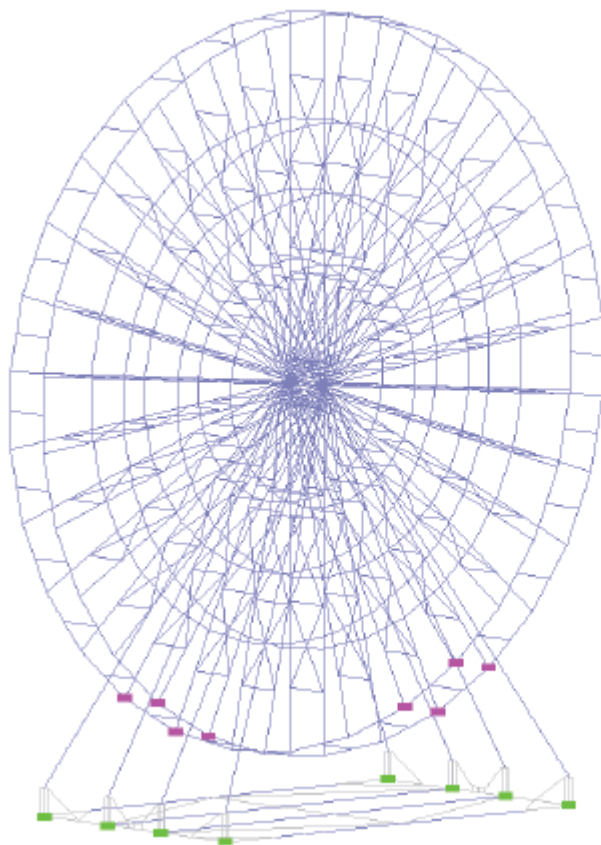
Представление конструкции в расчетной схеме



Общий вид расчетной схемы и ее отдельных элементов



Представление конструкции в расчетной схеме



Условия опирания

Отображение шарниров



Задание нагрузок

Table 7.1. Loadings (load cases)

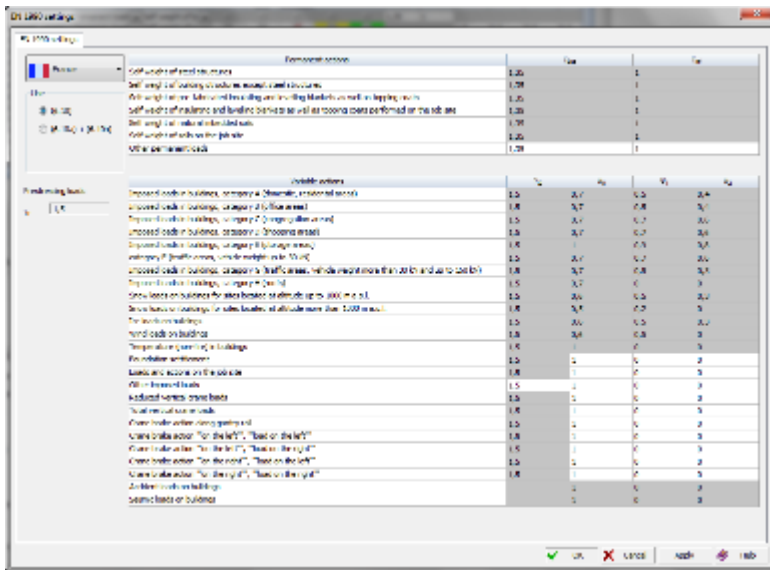
Number	Load case name
1	Dead load
2	Live load, variant 1
3	Live load, variant 2
4	Live load, variant 3
5	Live load, variant 4
6	Live load, variant 5
7	Live load, variant 6
8	Live load, variant 7
9	Live load, variant 8
10	Live load, variant 9
11	Design wind load (X direction)
12	Design wind load (Y direction)
13	Operatin wind load (X direction)
14	Operatin wind load (Y direction)
15	Modal

Table 7.2. Combinations of loadings (load cases)

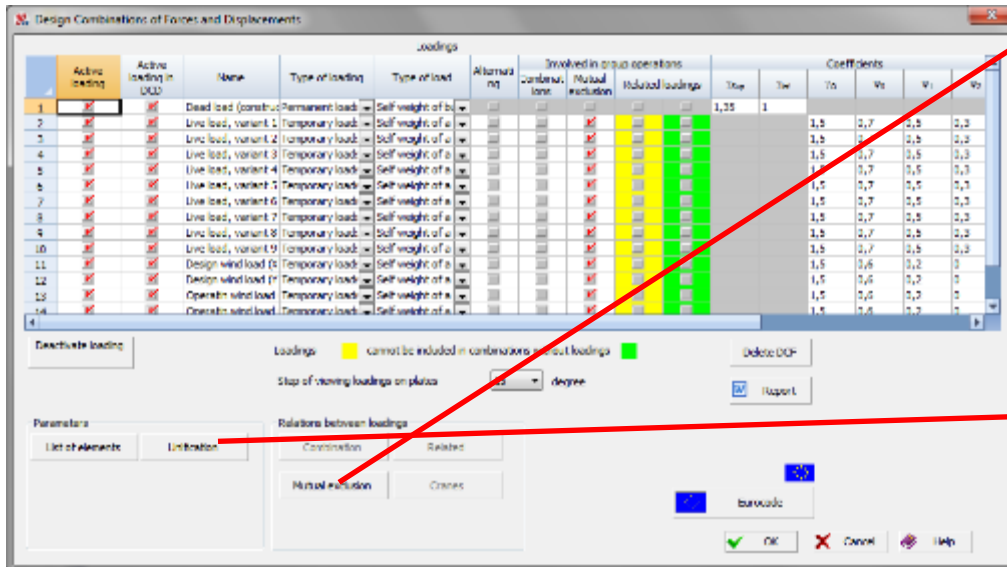
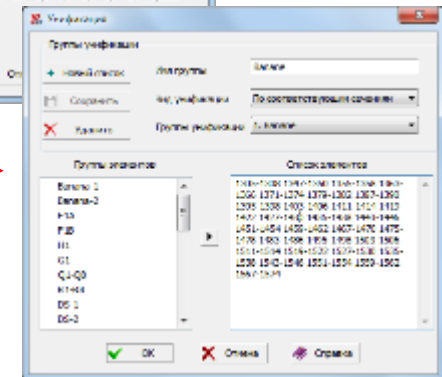
Number	Combination formula
1	$(L1)*1+(L10)*1$
2	$(L1)*1+(L11)*1$
3	$(L1)*1+(L12)*1$
4	$(L1)*1+(L10)*1+(L13)*1$
5	$(L1)*1+(L10)*1+(L14)*1$



Задание PCY

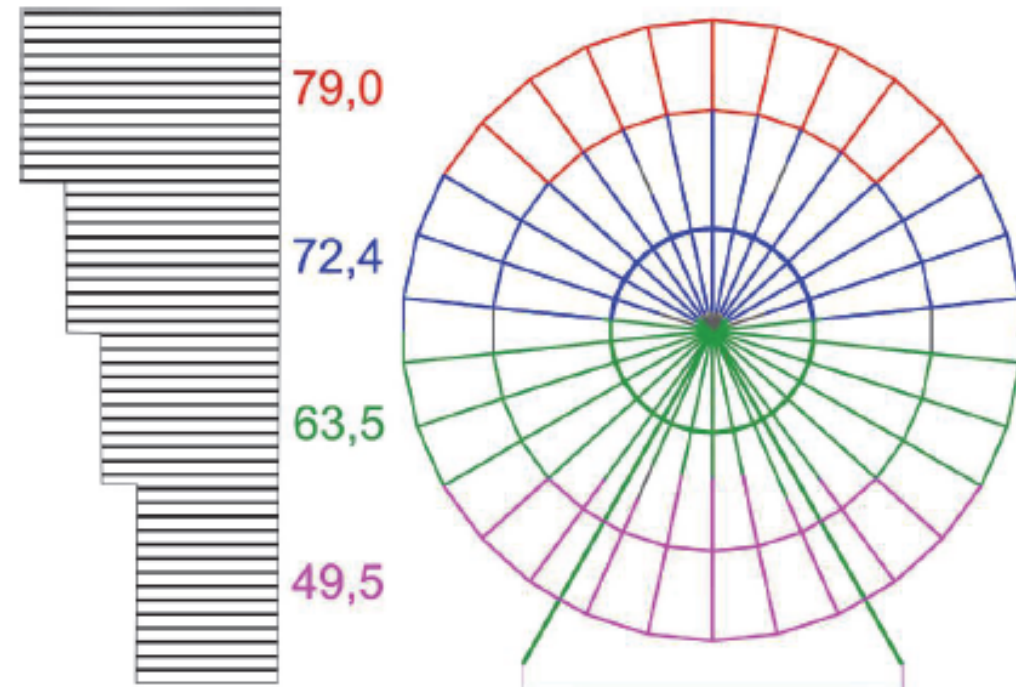


No.	Load names	Partial factor		Psi factor		
		γ_{sup}	γ_{inf}	ψ_0	ψ_1	ψ_2
1	Dead load	1,35	1,00	—	—	—
2	Live load, variant 1	1,50	0	0,7	0,5	0,3
3	Live load, variant 2	1,50	0	0,7	0,5	0,3
4	Live load, variant 3	1,50	0	0,7	0,5	0,3
5	Live load, variant 4	1,50	0	0,7	0,5	0,3
6	Live load, variant 5	1,50	0	0,7	0,5	0,3
7	Live load, variant 6	1,50	0	0,7	0,5	0,3
8	Live load, variant 7	1,50	0	0,7	0,5	0,3
9	Live load, variant 8	1,50	0	0,7	0,5	0,3
10	Live load, variant 9	1,50	0	0,7	0,5	0,3
11	Design wind load (X direction)	1,50	0	0,6	0,2	—
12	Design wind load (Y direction)	1,50	0	0,6	0,2	—
13	Operating wind load (X direction)	1,50	0	0,6	0,2	—
14	Operating wind load (Y direction)	1,50	0	0,6	0,2	—

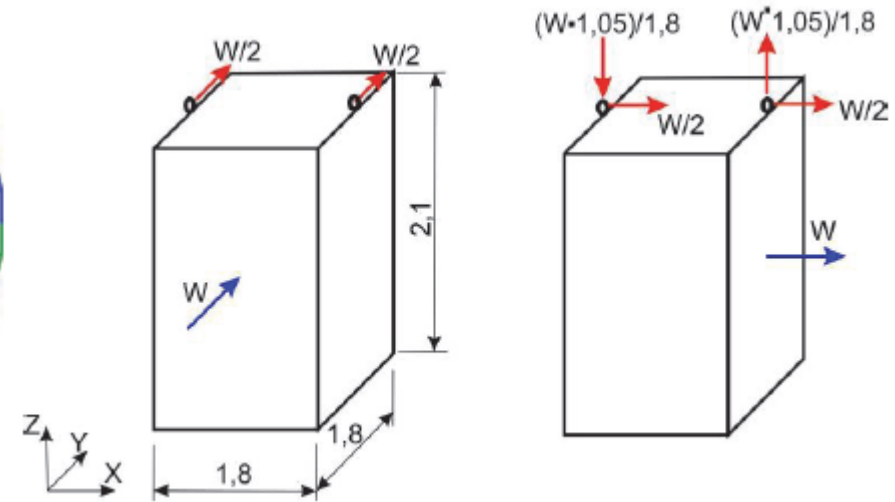



Задание взаимоисключения и групп унификации PCY

Задание ветровой нагрузки



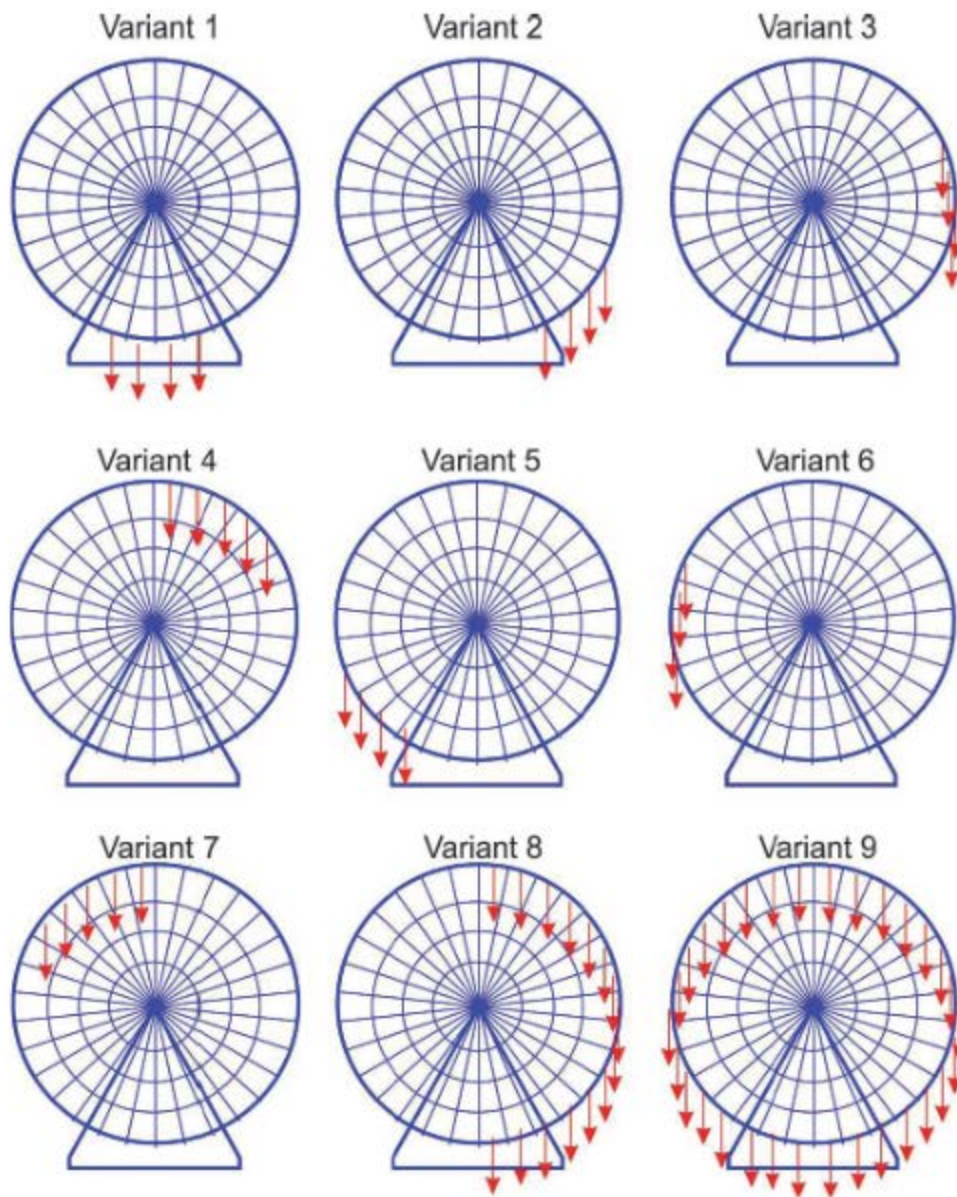
Давление ветра по высоте



Давление ветра от кабин в месте их крепления



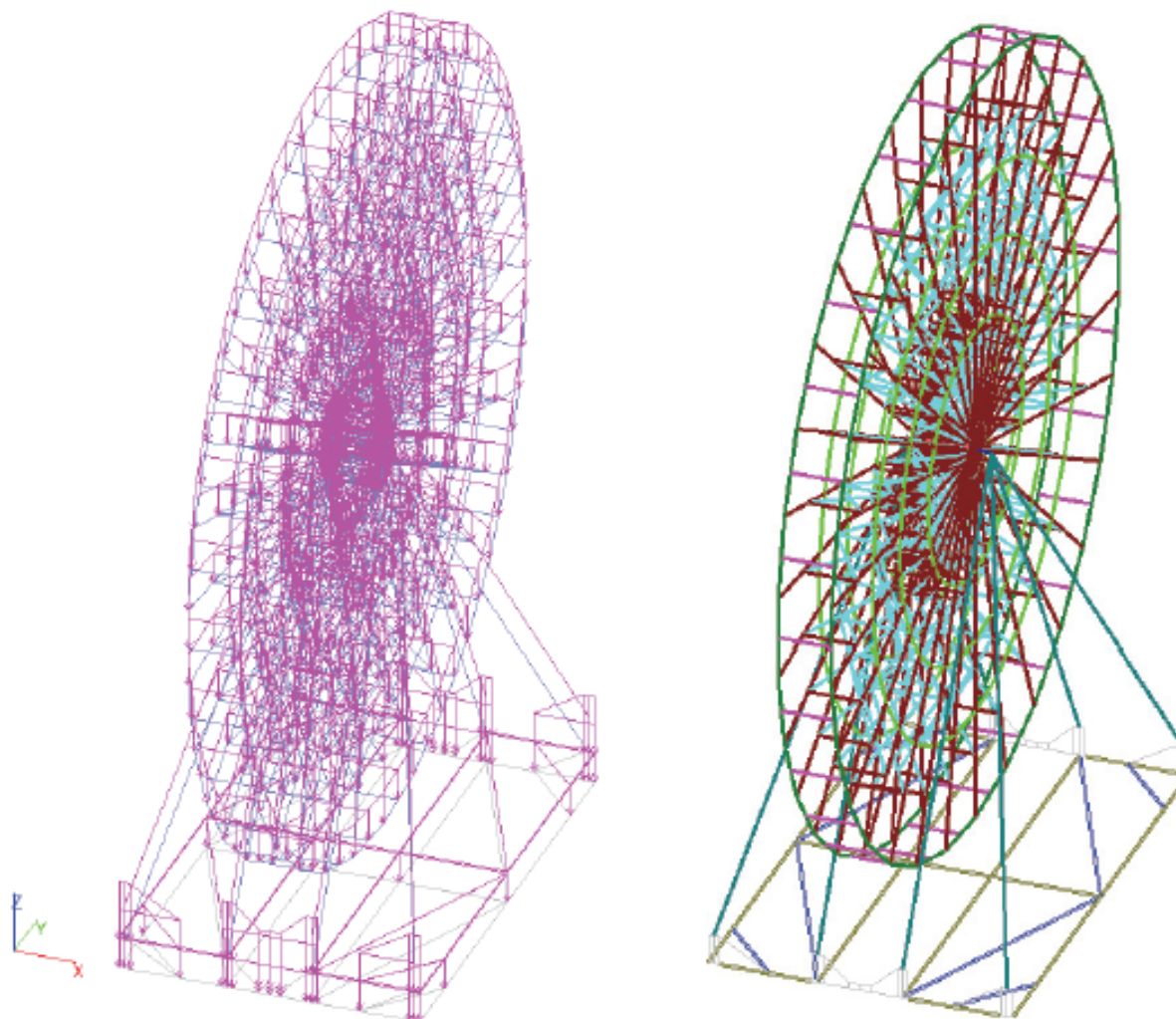
Задание нагрузок от людей в кабинах (варианты заполнения)





Загрузка №1

Load #1 – Dead load (self weight of Ferris wheel structure and cabins) (kg/m)



Map of Loads o...

	Z	
<input checked="" type="checkbox"/>	kg/m	
<input checked="" type="checkbox"/>	3.3	180°
<input checked="" type="checkbox"/>	8.13	420°
<input checked="" type="checkbox"/>	9.22	0°
<input checked="" type="checkbox"/>	22.2	30°
<input checked="" type="checkbox"/>	26.41	60°
<input checked="" type="checkbox"/>	46.5	23°
<input checked="" type="checkbox"/>	59.53	120°
<input checked="" type="checkbox"/>	176.97	0°
<input checked="" type="checkbox"/>	306.19	2°
<input checked="" type="checkbox"/>	399.97	2°
<input checked="" type="checkbox"/>	715.6	2°

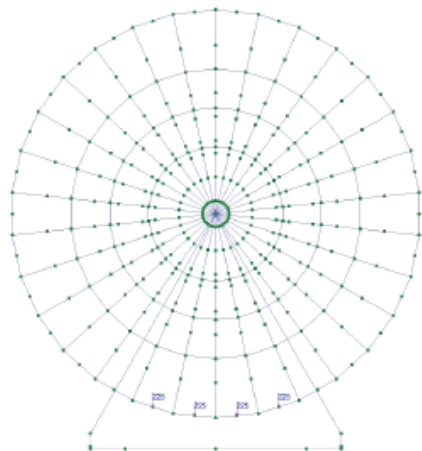
Fragment scale

Close

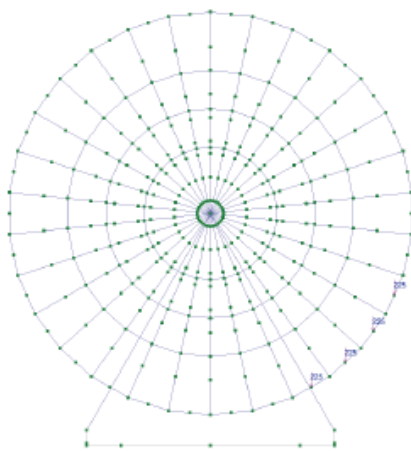


Загрузка №2-9

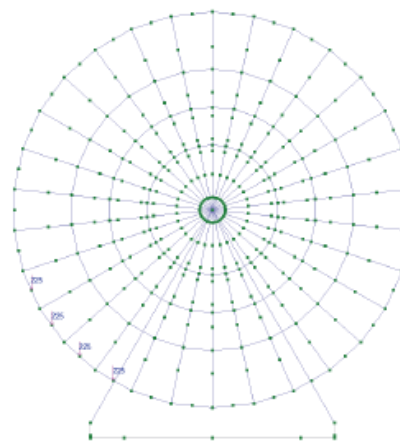
Load #2 – Live load, variant 1 (kg)



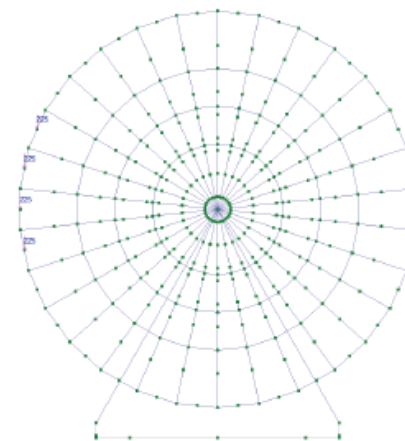
Load #3 – Live load, variant 2 (kg)



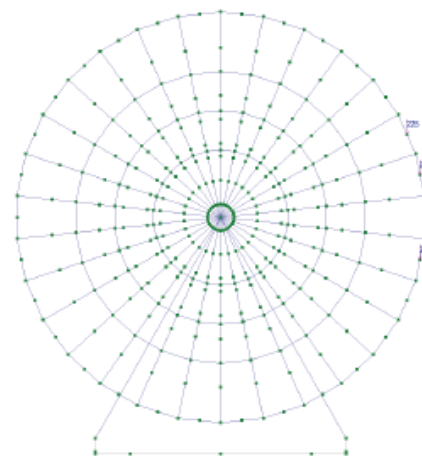
Load #6 – Live load, variant 5 (kg)



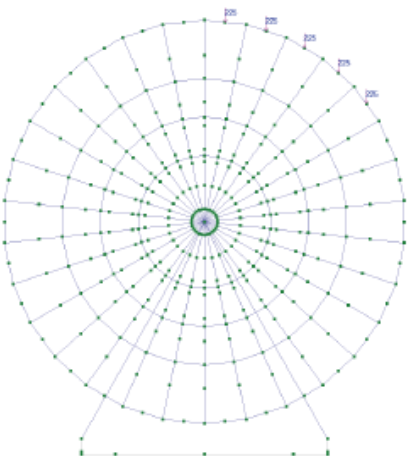
Load #7 – Live load, variant 6 (kg)



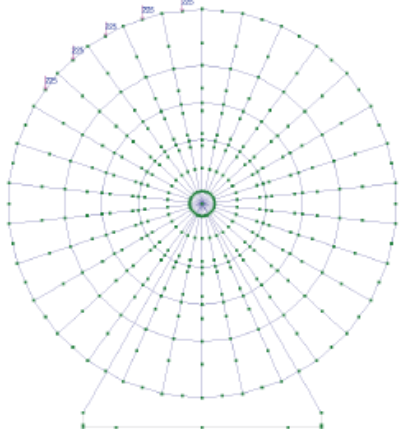
Load #4 – Live load, variant 3 (kg)



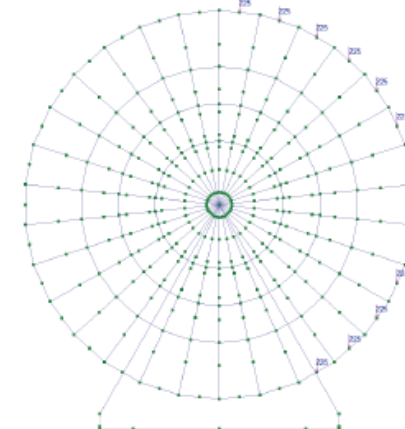
Load #5 – Live load, variant 4 (kg)



Load #8 – Live load, variant 7 (kg)



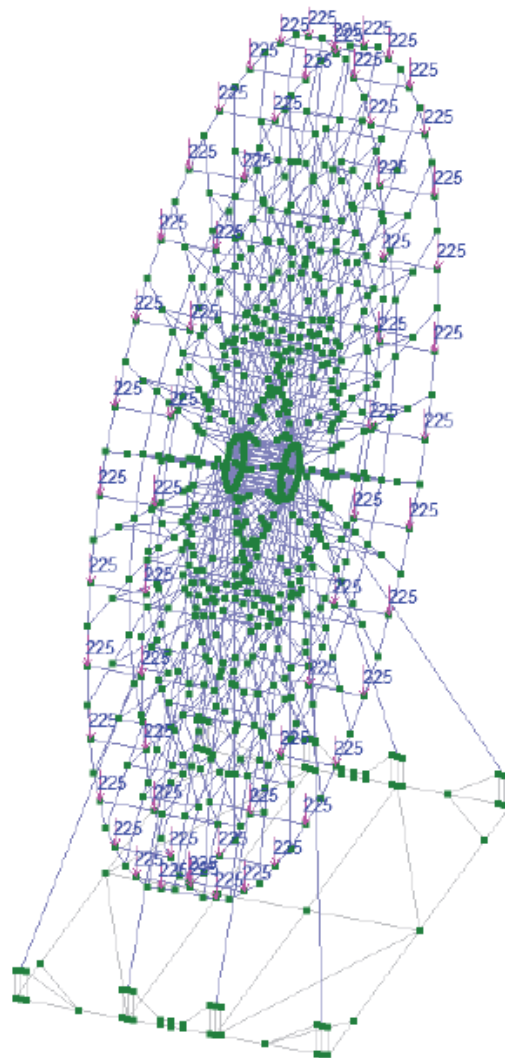
Load #9 – Live load, variant 8 (kg)





Загрузка №10

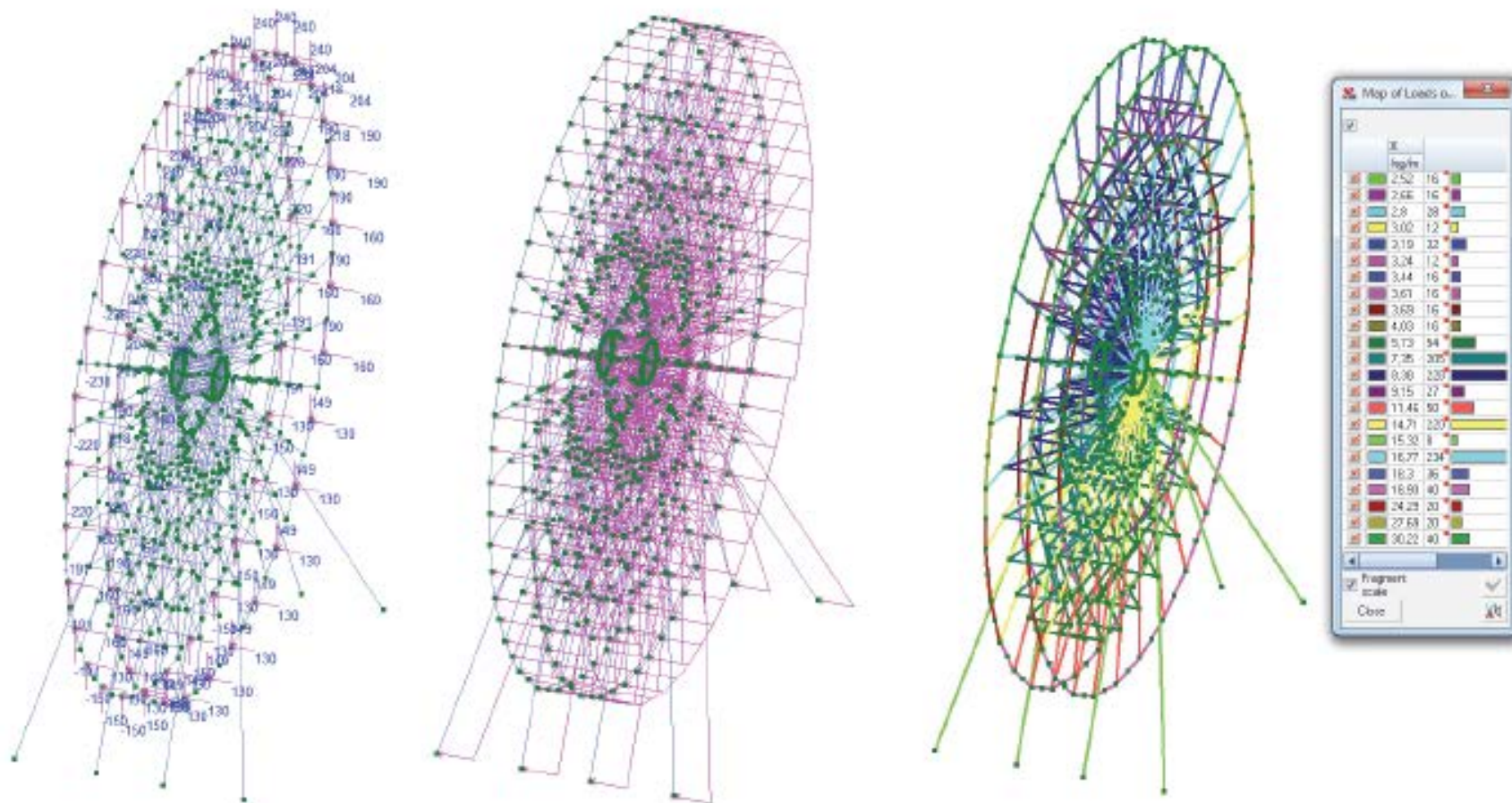
Load #10 – Live load, variant 9 (kg)





Загрузка №11

Load #11 – Design wind load (X direction) (kg, kg/m)

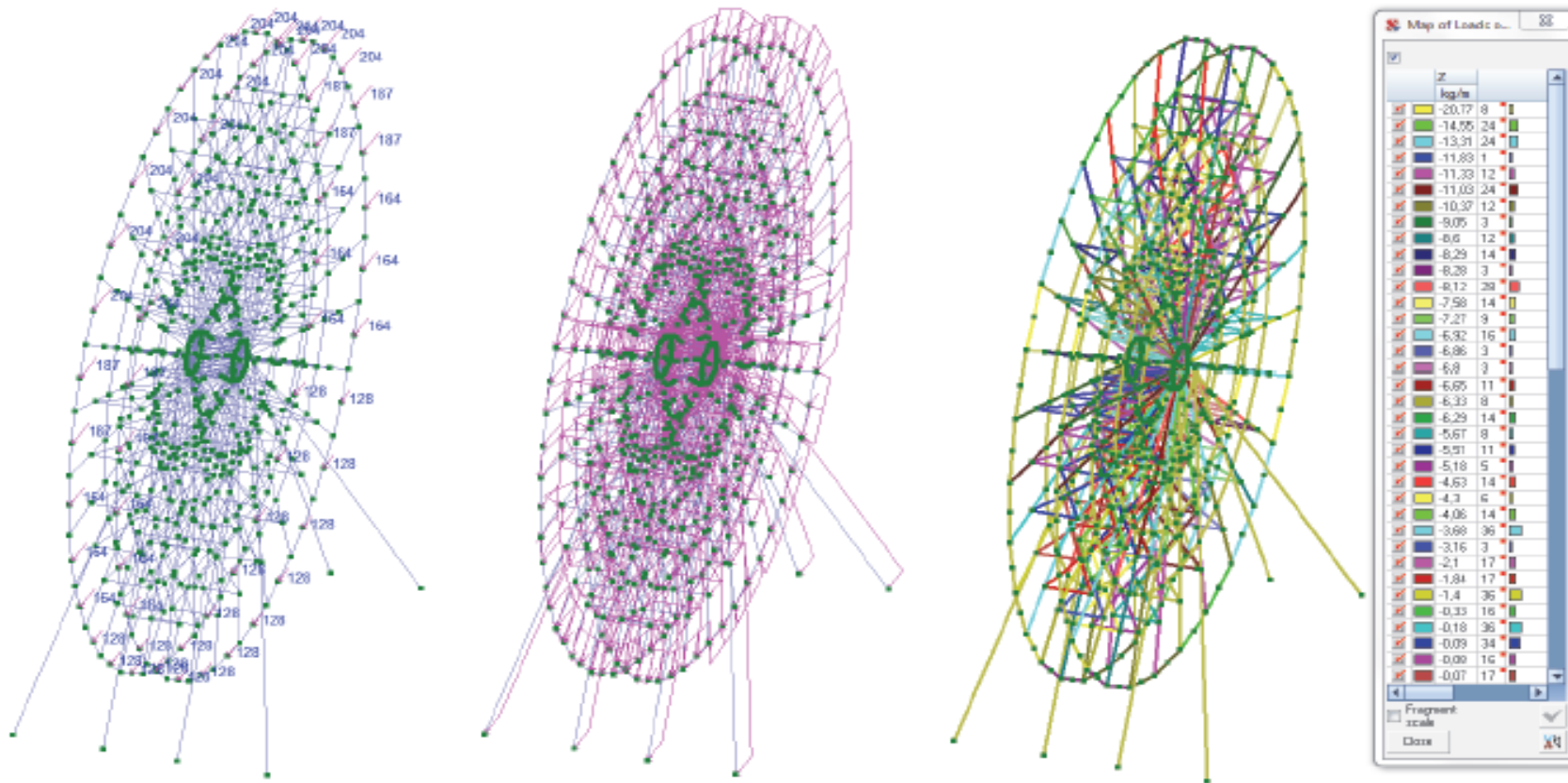




Загрузка №12

Load #12 – Design wind load (Y direction)

(kg; kg/m)

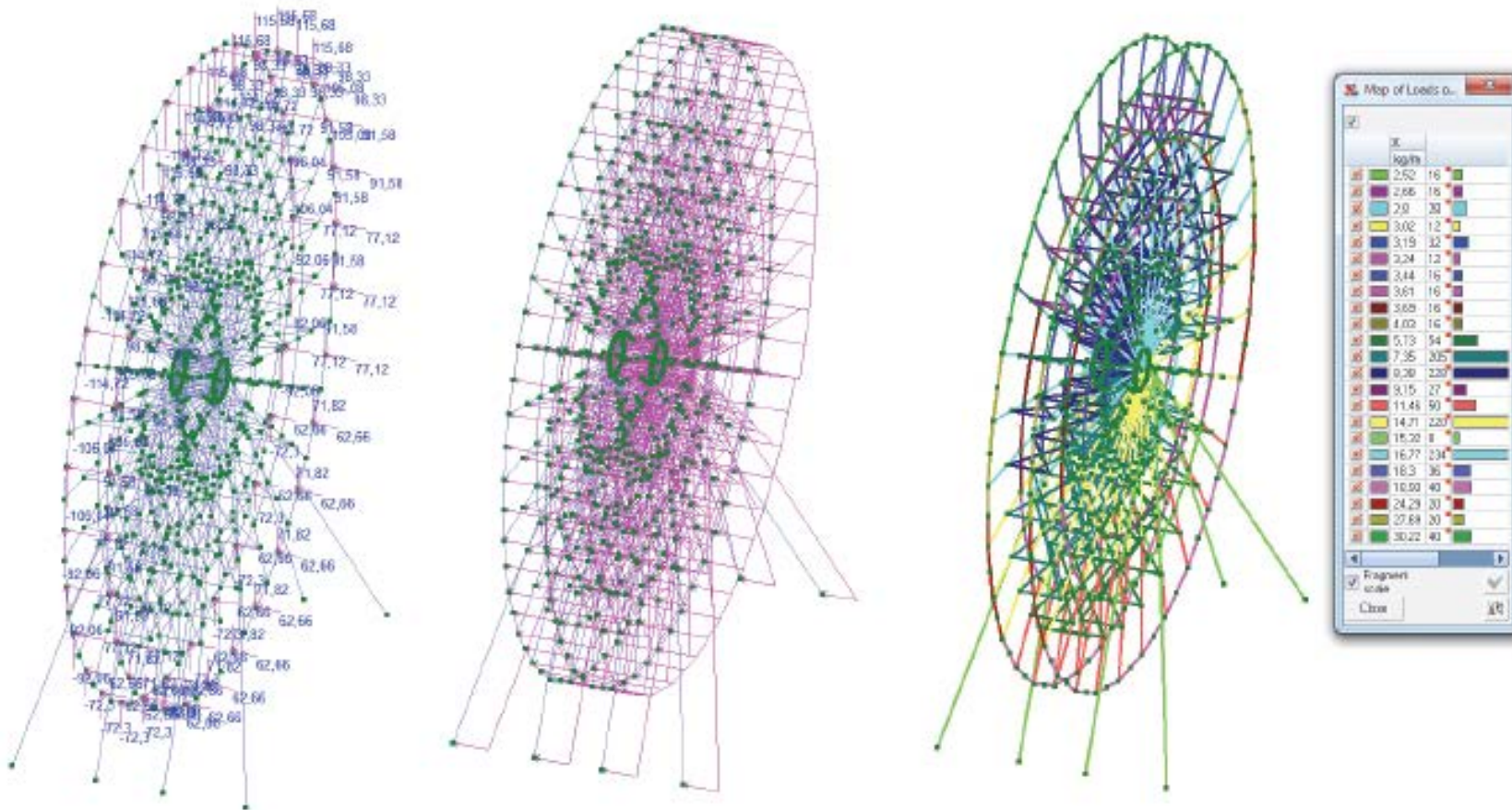




Загрузка №13

Load #13 – Operatin wind load (X direction)

(kg; kg/m)

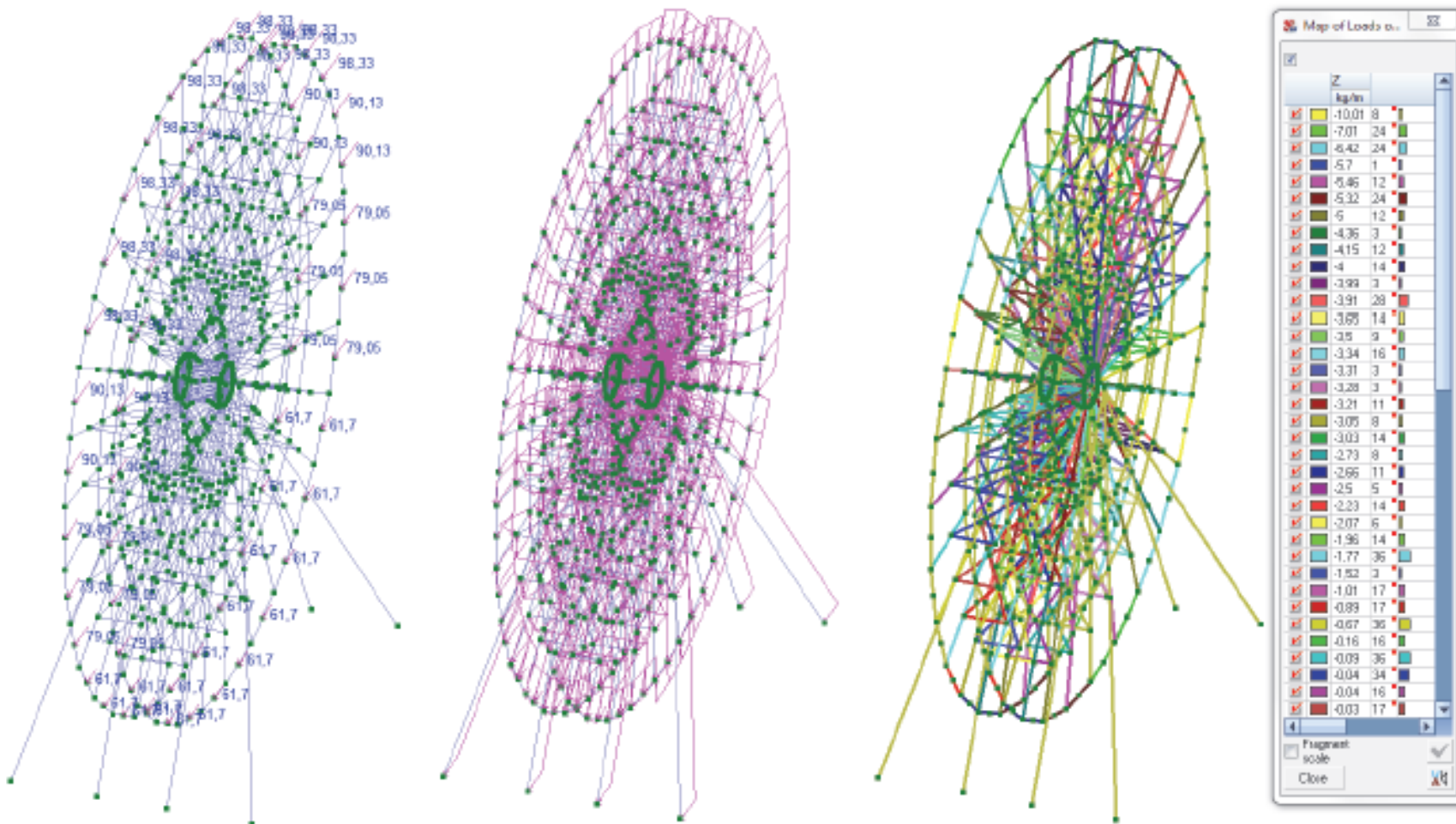




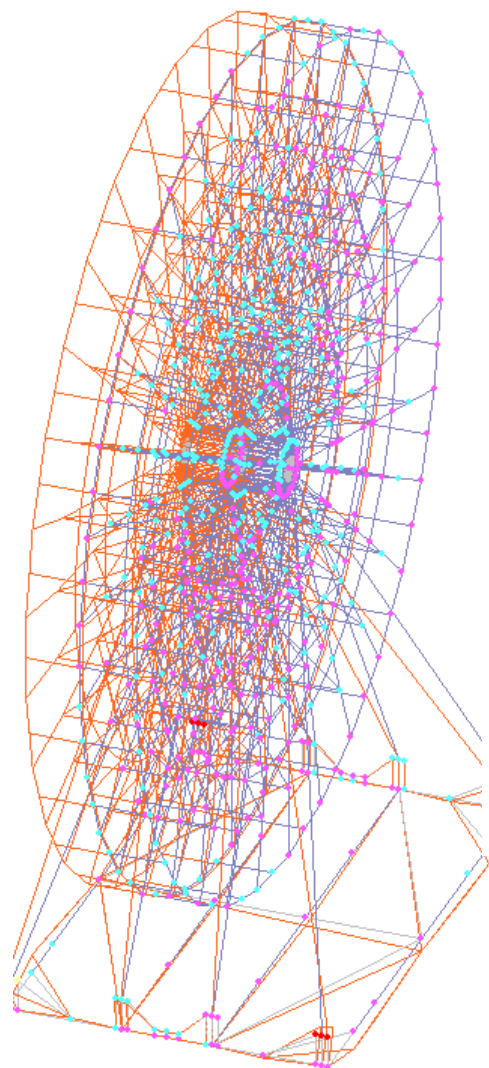
Загрузка №14

Load #14 – Operatin wind load (Y direction)

(kg; kg/m)



Результаты расчета



Перемещения по X

Table 8.4. Ferris wheel design model: extreme values of internal forces for load cases

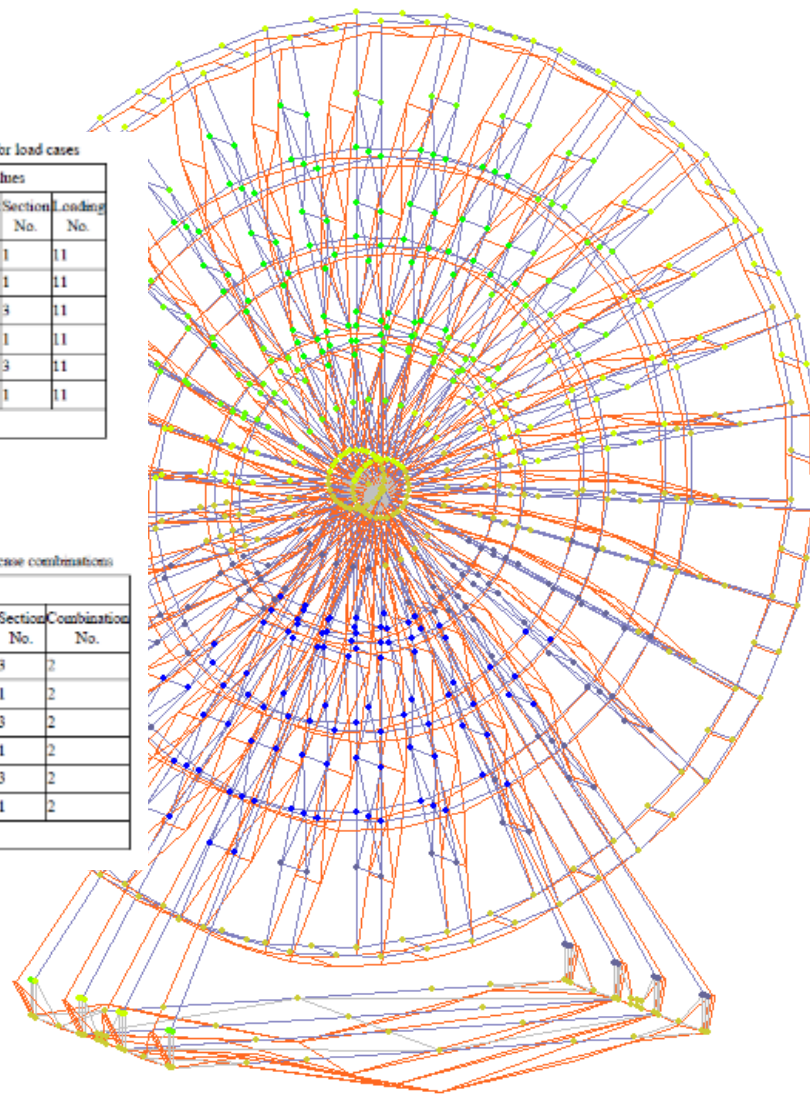
Internal force	Maximum values				Minimum values			
	Value	Element No.	Section No.	Loading No.	Value	Element No.	Section No.	Loading No.
N	41072,886	1	1	11	-41072,776	8	1	11
M _x	6933,06	53	1	11	-6934,177	58	1	11
M _y	58806,195	12	3	11	-58794,937	9	3	11
Q _x	67233,742	12	1	11	-3460,047	1997	1	11
M _z	17559,697	1	3	11	-17551,336	8	3	11
Q _y	992,037	8	1	11	-991,305	1	1	11

Units of measurement: force: kg; length units for force values: m

Table 8.5. Ferris wheel design model: extreme values of internal forces for load case combinations

Internal force	Maximum values				Minimum values			
	Value	Element No.	Section No.	Combination No.	Value	Element No.	Section No.	Combination No.
N	40357,574	5	3	2	-45128,969	4	3	2
M _x	6977,982	53	1	2	-6991,199	57	1	2
M _y	58221,559	12	3	2	-59424,238	9	3	2
Q _x	67218,649	9	1	2	-3783,239	63	1	2
M _z	19055,989	4	3	2	-18769,661	5	3	2
Q _y	1049,793	5	1	2	-1065,063	4	1	2

Units of measurement: force: kg; length units for force values: m



Перемещения по Y



1-я форма колебаний

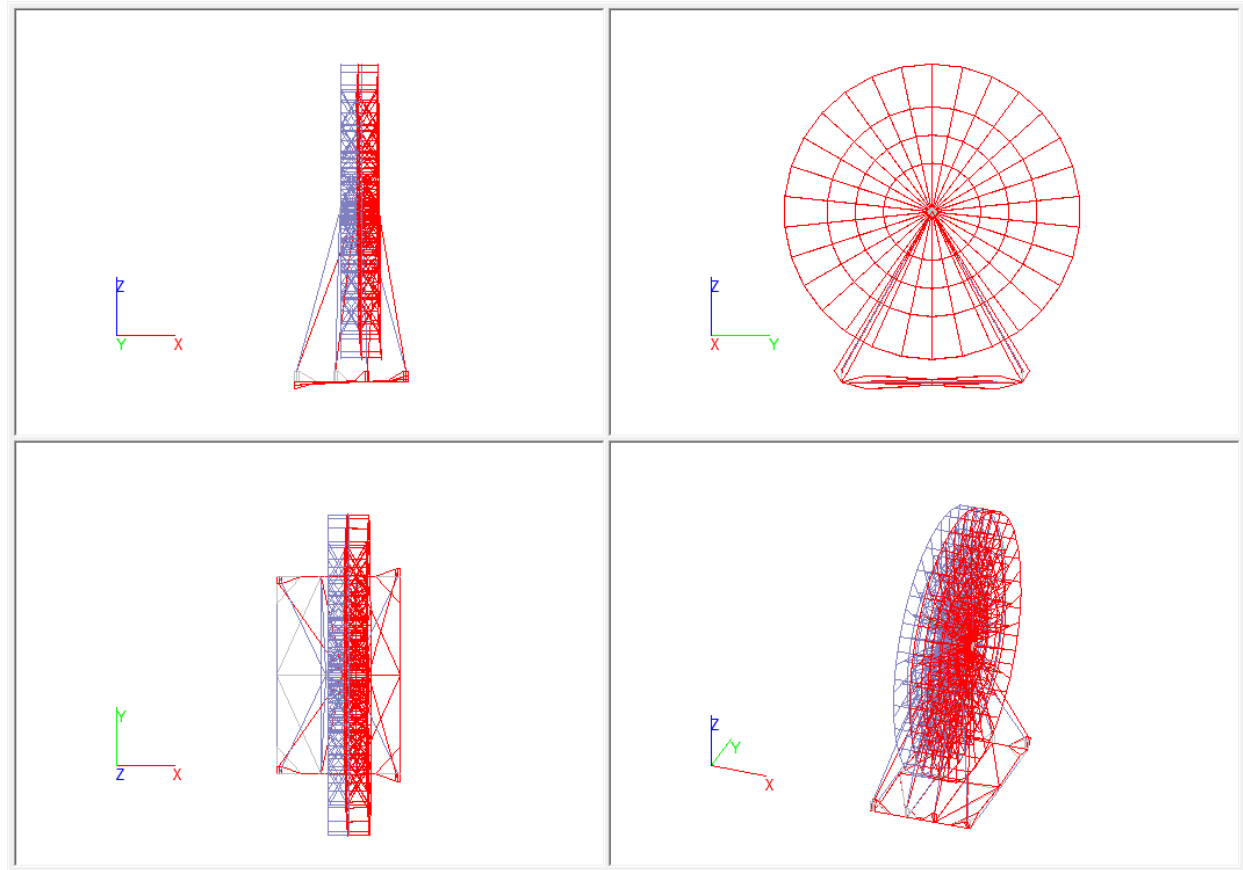
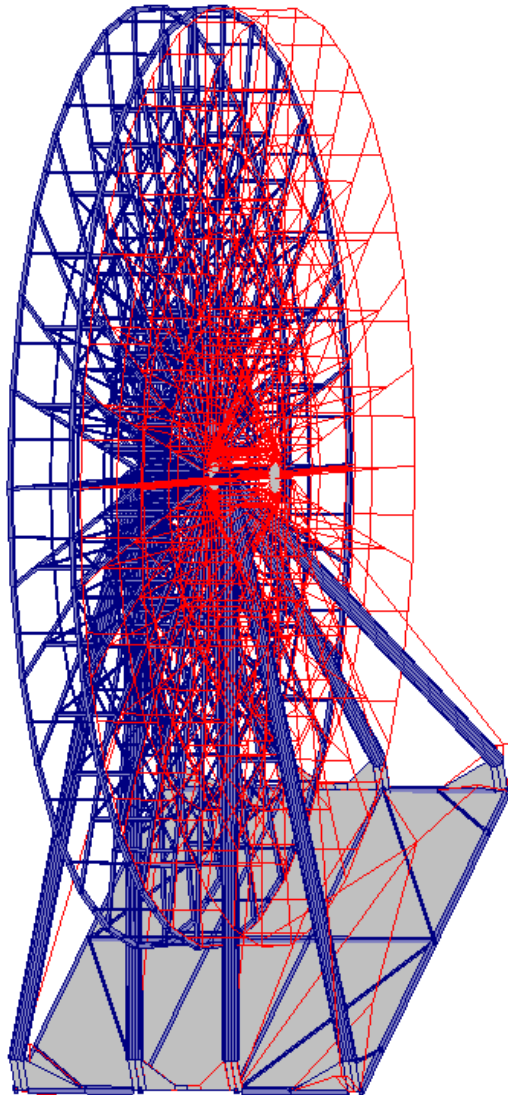


Table 8.3. Ferris wheel design model: frequencies of natural oscillations

Mode	Eigenvalue	Frequency f		Periods T (sec)	Modal masses (%)		
		1/sec	Hz		X	Y	Z
1	0,19	5,267	0,839	1,192	71,905	0	0
2	0,173	5,769	0,919	1,089	0	0	0
3	0,165	6,064	0,966	1,036	0	0	0
4	0,104	9,578	1,525	0,656	0,049	0	0
5	0,066	15,214	2,423	0,413	0,017	0	0



2-я форма колебаний

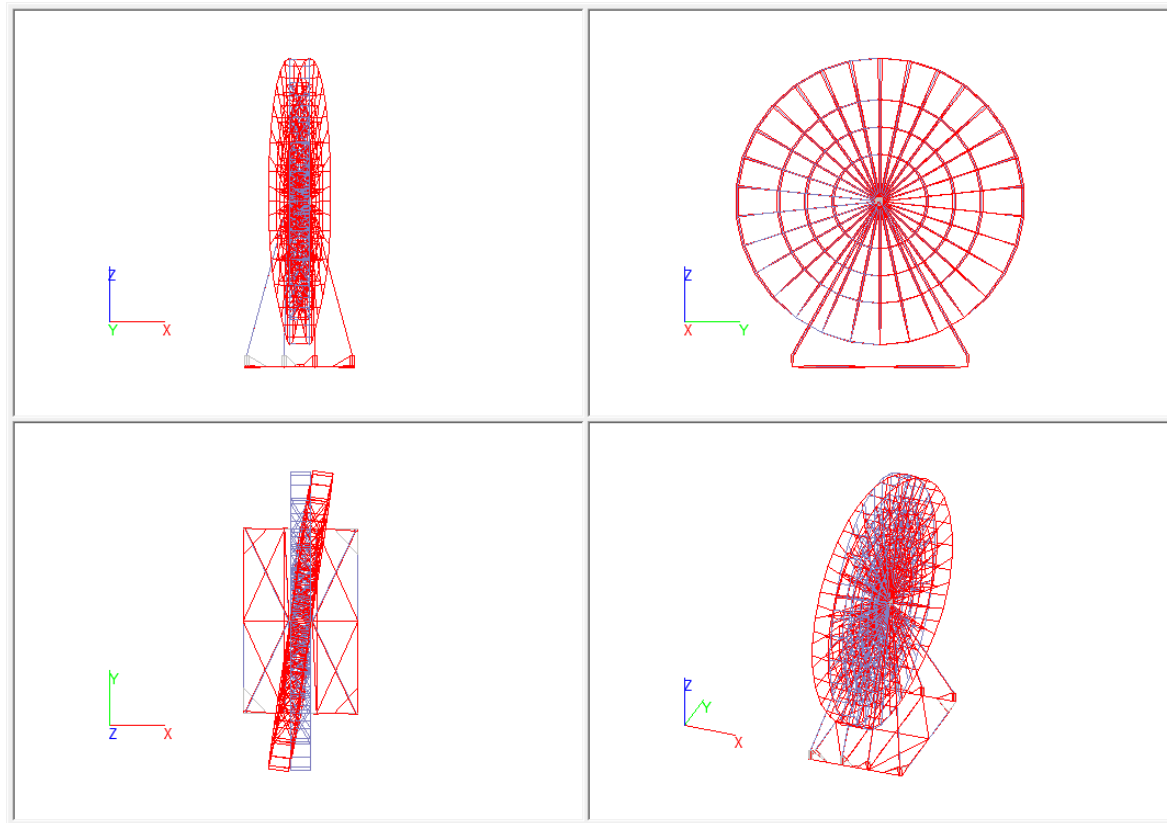
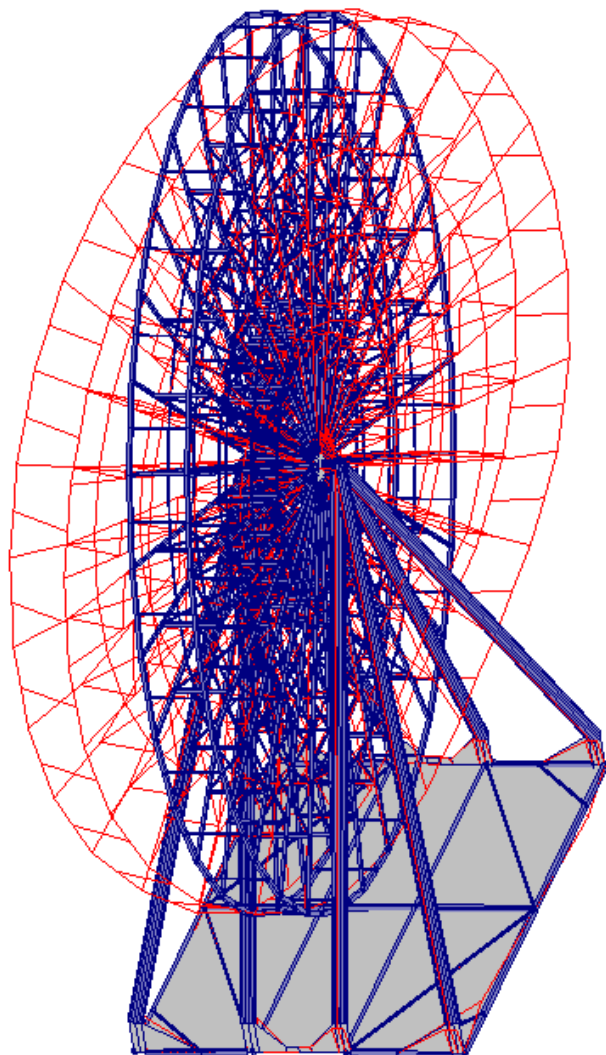


Table 8.3. Ferris wheel design model: frequencies of natural oscillations

Mode	Eigenvalue	Frequency f		Periods T (sec)	Modal masses (%)		
		1/sec	Hz		X	Y	Z
1	0,19	5,267	0,839	1,192	71,905	0	0
2	0,173	5,769	0,919	1,089	0	0	0
3	0,165	6,064	0,966	1,036	0	0	0
4	0,104	9,578	1,525	0,656	0,049	0	0
5	0,066	15,214	2,423	0,413	0,017	0	0



3-я форма колебаний

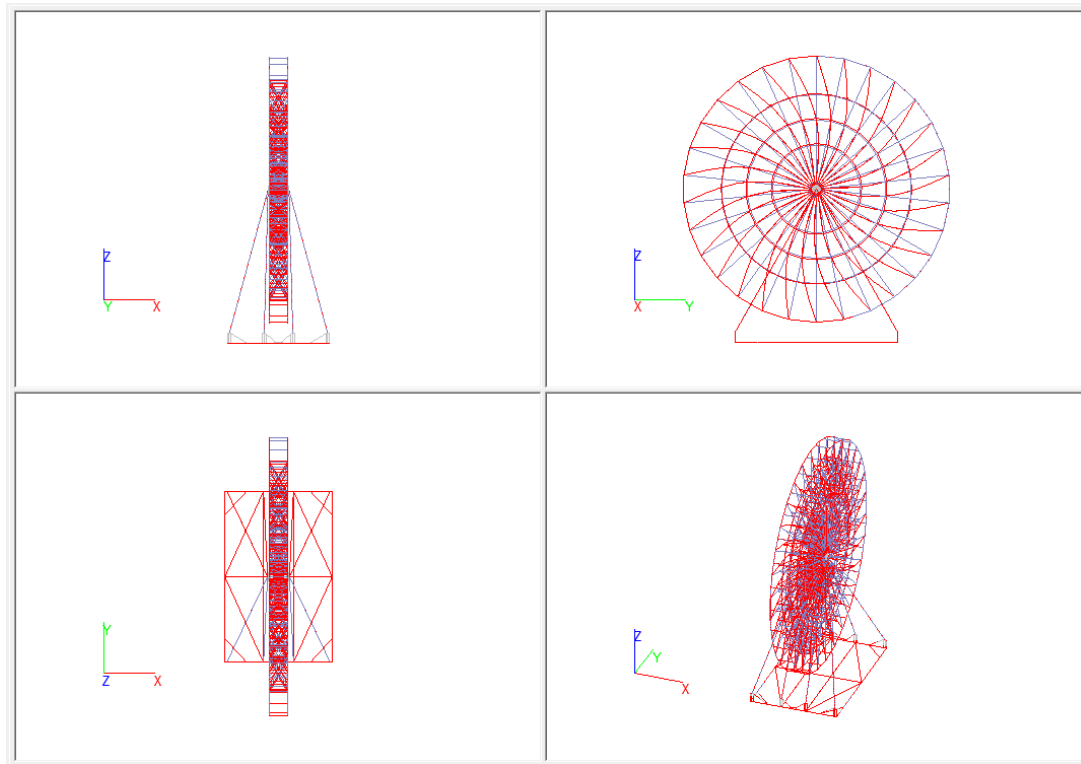
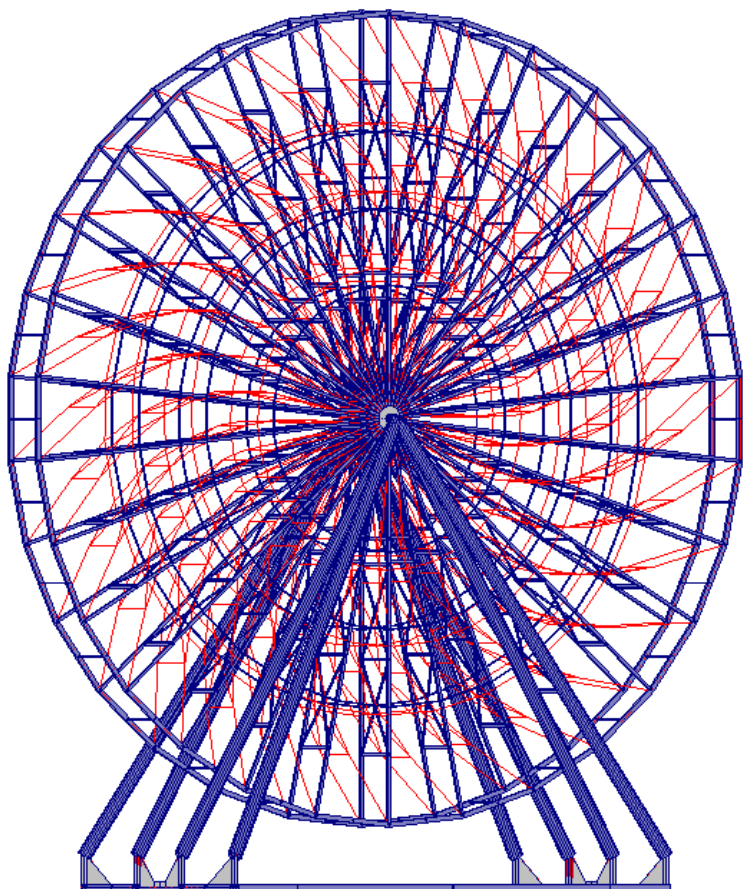


Table 8.3. Ferris wheel design model: frequencies of natural oscillations

Mode	Eigenvalue	Frequency f		Periods T (sec)	Modal masses (%)		
		1/sec	Hz		X	Y	Z
1	0,19	5,267	0,839	1,192	71,905	0	0
2	0,173	5,769	0,919	1,089	0	0	0
3	0,165	6,064	0,966	1,036	0	0	0
4	0,104	9,578	1,525	0,656	0,049	0	0
5	0,066	15,214	2,423	0,413	0,017	0	0

4-я форма колебаний

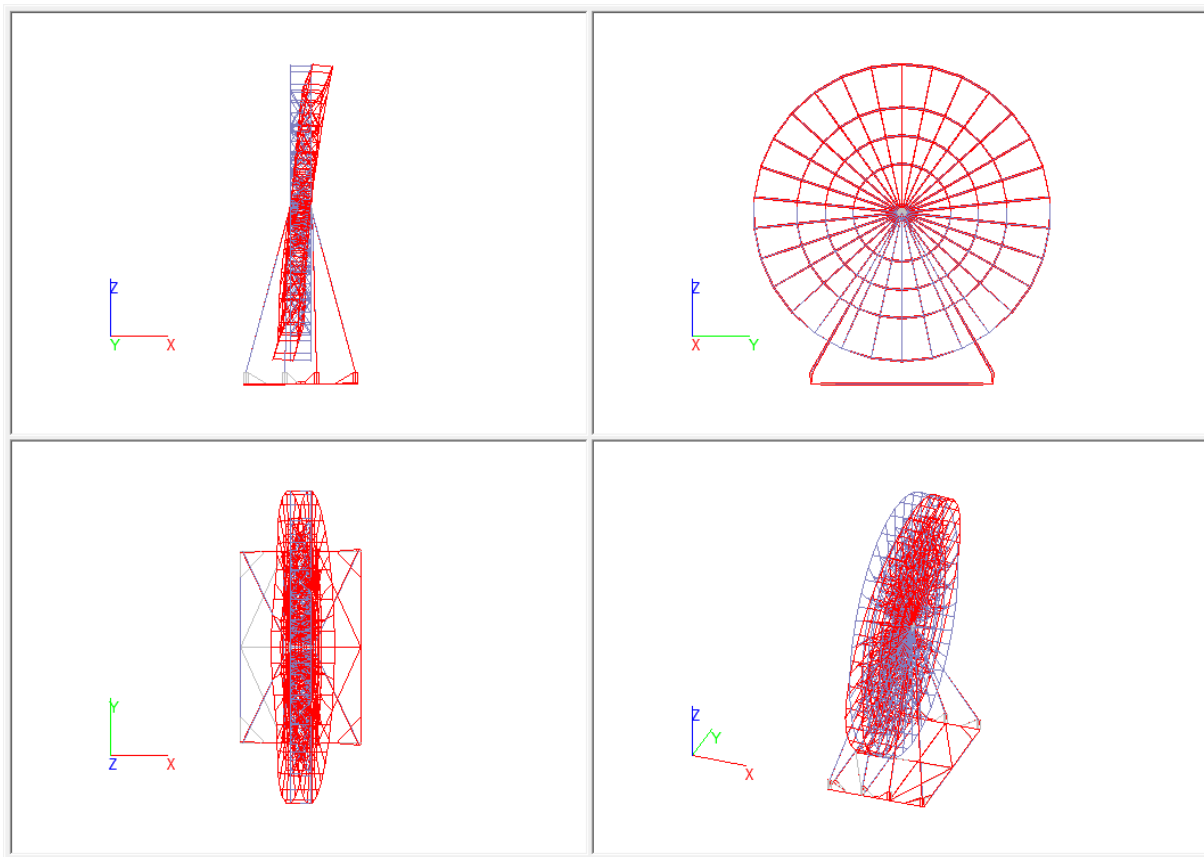
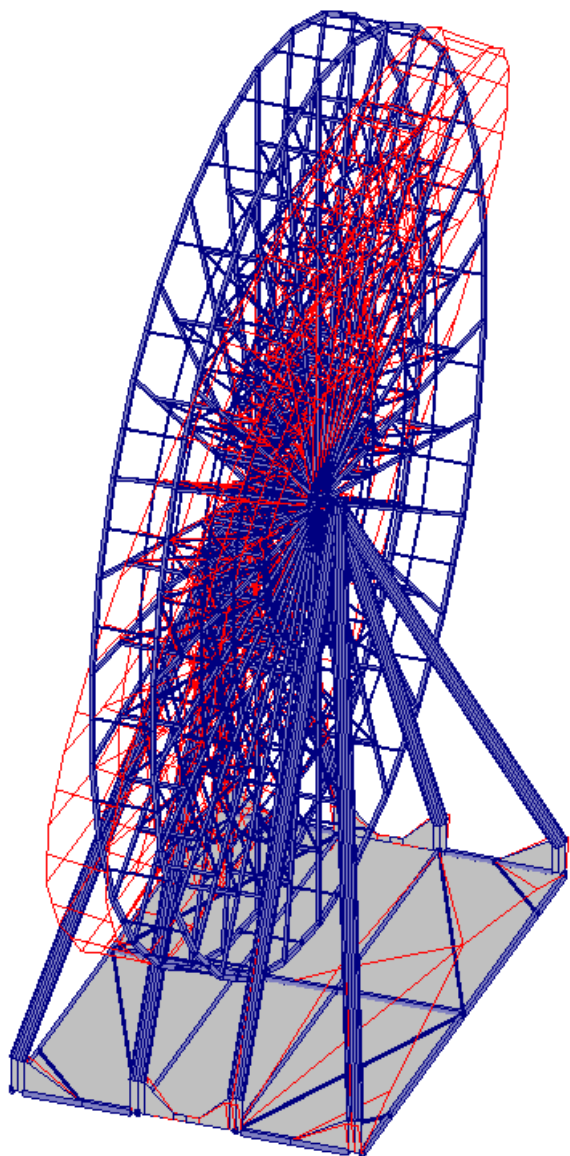


Table 8.3. Ferris wheel design model: frequencies of natural oscillations

Mode	Eigenvalue	Frequency f		Periods T (sec)	Modal masses (%)		
		1/sec	Hz		X	Y	Z
1	0,19	5,267	0,839	1,192	71,905	0	0
2	0,173	5,769	0,919	1,089	0	0	0
3	0,165	6,064	0,966	1,036	0	0	0
4	0,104	9,578	1,525	0,656	0,049	0	0
5	0,066	15,214	2,423	0,413	0,017	0	0



5-я форма колебаний

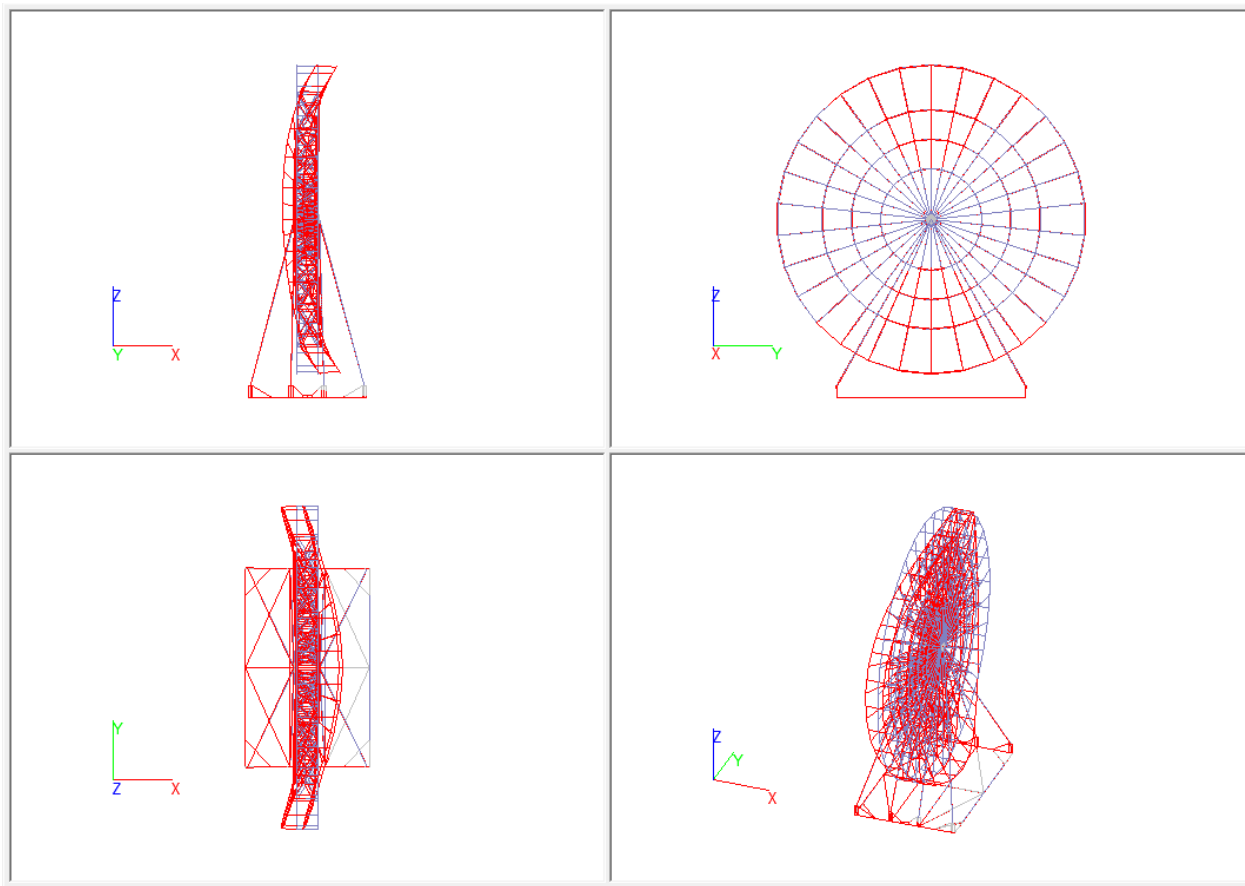
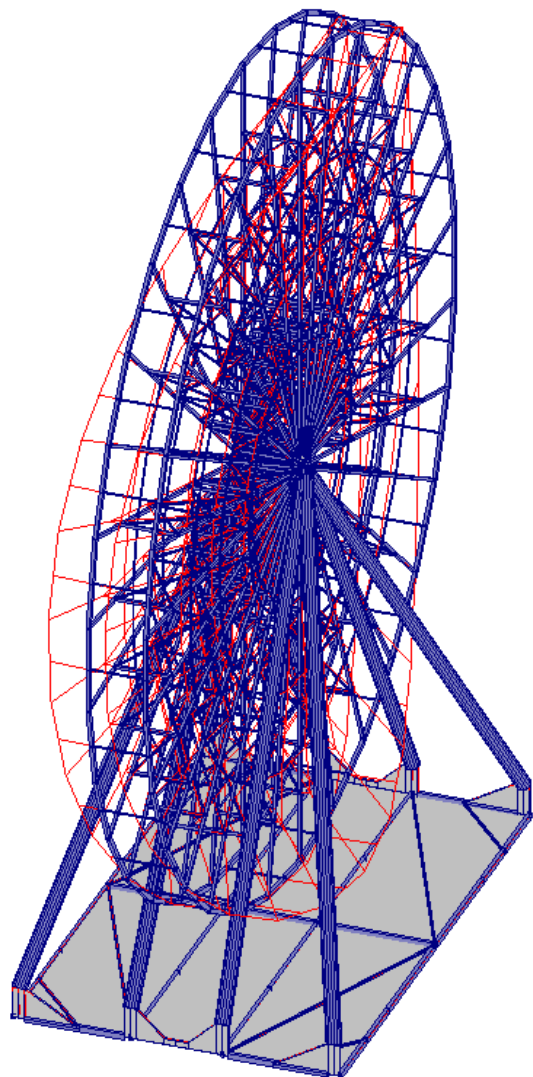
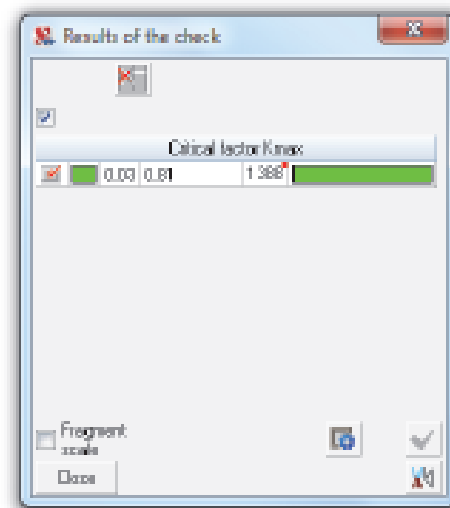
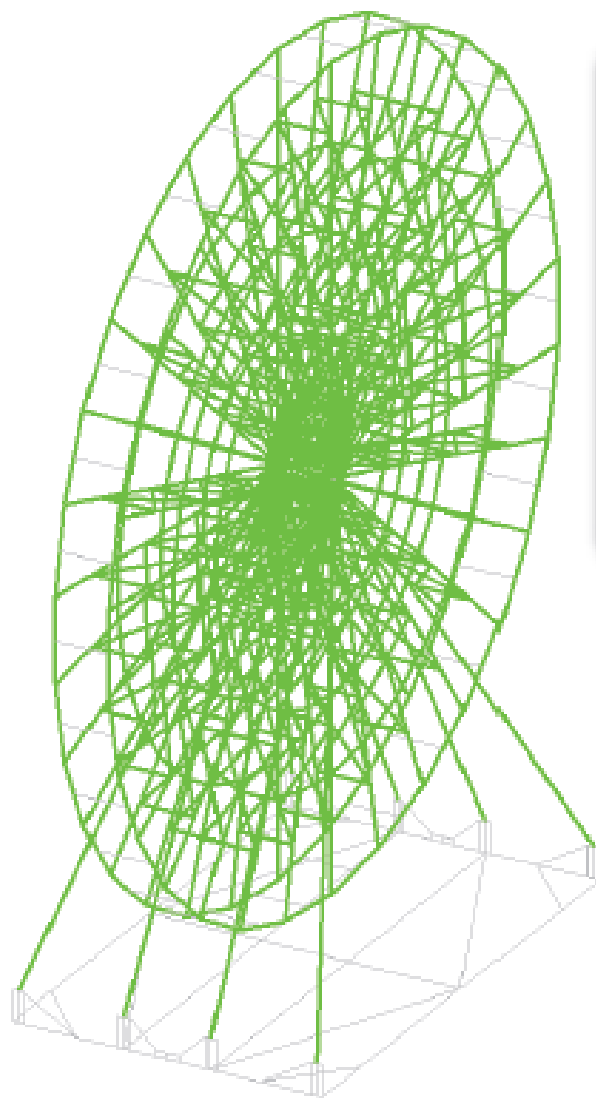


Table 8.3. Ferris wheel design model: frequencies of natural oscillations

Mode	Eigenvalue	Frequency f		Periods T (sec)	Modal masses (%)		
		1/sec	Hz		X	Y	Z
1	0,19	5,267	0,839	1,192	71,905	0	0
2	0,173	5,769	0,919	1,089	0	0	0
3	0,165	6,064	0,966	1,036	0	0	0
4	0,104	9,578	1,525	0,656	0,049	0	0
5	0,066	15,214	2,423	0,413	0,017	0	0



Проверка сечений металлопроката



Проверка сечений металлопроката

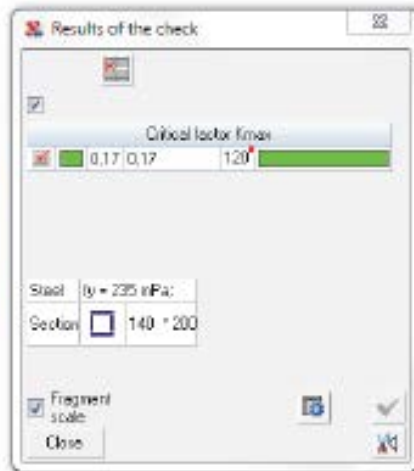
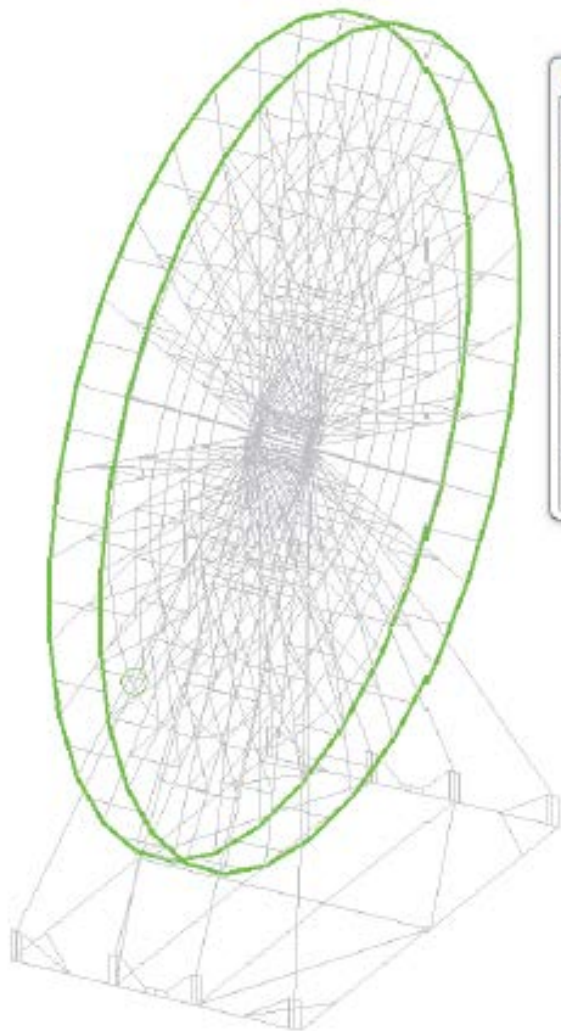
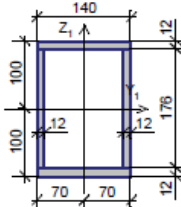


Table 8.8. Results of verifications of wheel rim “Banana” structural members of the Ferris wheel in accordance with the requirements of EN 1993-1-1 (for member No. 1305)

Results of analysis	Check	Utilization Factor
Steel: With yield point $f_y=235$ mPa	Section	
Length of the element 1,85 m		
Importance factor 1		
Inelasticity is forbidden		
Effective length factor in the X_1OZ_1 Plane 1		
Effective length factor in the X_1OY_1 Plane 1		
Sec. 6.2.3 (EN1993-1-1)	Tensile strength of the member subject to axial force N	0,09
Sec. 6.2.4 (EN1993-1-1)	Compression strength of the member subject to axial force N	0,06
Sec. 6.2.5 (EN1993-1-1)	Bending strength of the member subject to bending moment My	0,08
Sec. 6.2.5 (EN1993-1-1)	Bending strength of the member subject to bending moment Mz	0,07
Sec. 6.2.6 (EN1993-1-1)	Shear strength of the member subject to shear force Vz	0,01
Sec. 6.2.6 (EN1993-1-1)	Shear strength of the member subject to shear force Vy	0,01
Sec. 6.29 (EN1993-1-1)	Bending strength of the member subject to bending moment My taken into account axial force N	0,17
Sec. 6.2.8-6.2.10 (EN1993-1-1)	Bending strength of the member subject to bending moments My and Mz taken into account axial force N and shear forces Vz and Vy	0,17
Sec. 6.3.1.1, 6.3.1.2, 6.3.1.3 (EN1993-1-1)	Buckling strength of the member subject to flexural buckling relating to axes y-y due to axial force N	0,06
Sec. 6.3.1.1, 6.3.1.2, 6.3.1.3 (EN1993-1-1)	Buckling strength of the member subject to flexural buckling relating to axes z-z due to axial force N	0,06
Sec. 6.3.1.1, 6.3.1.2, 6.3.1.4 (EN1993-1-1)	Buckling strength of the member subject to torsional and torsional-flexural buckling due to axial force N	0,06
Sec. 6.3.3(4) (EN1993-1-1)	Buckling strength of the member subjected to axial force and bending moments	0,12

Проверка сечений металлопроката

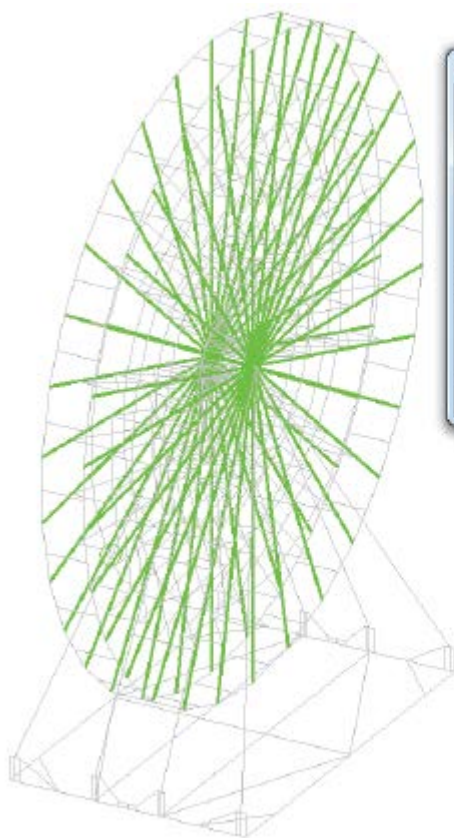


Table 8.12. Results of verifications of spoke F1 structural members of the Ferris wheel in accordance with the requirements of EN 1993-1-1 (for member No. 86)

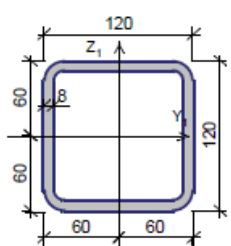
Results of analysis	Check	Utilization Factor
Steel: With yield point $f_y=235$ mPa	Section	
Length of the element 4,13 m		
Importance factor 1	Profile: Square Hollow Sections GOST P 54157-2010 120x80	
Inelasticity is forbidden		
Effective length factor in the X_1OZ_1 Plane 1		
Effective length factor in the X_1OY_1 Plane 1		
Sec. 6.2.3 (EN1993-1-1)	Tensile strength of the member subject to axial force N	0,11
Sec. 6.2.4 (EN1993-1-1)	Compression strength of the member subject to axial force N	0,22
Sec. 6.2.5 (EN1993-1-1)	Bending strength of the member subject to bending moment My	0,08
Sec. 6.2.5 (EN1993-1-1)	Bending strength of the member subject to bending moment Mz	0,5
Sec. 6.2.6 (EN1993-1-1)	Shear strength of the member subject to shear force Vz	0,01
Sec. 6.2.6 (EN1993-1-1)	Shear strength of the member subject to shear force Vy	0,05
Sec. 6.2.9 (EN1993-1-1)	Bending strength of the member subject to bending moment My taken into account axial force N	0,52
Sec. 6.2.8-6.2.10 (EN1993-1-1)	Bending strength of the member subject to bending moments My and Mz taken into account axial force N and shear forces Vz and Vy	0,52
Sec. 6.3.1.1, 6.3.1.2, 6.3.1.3 (EN1993-1-1)	Buckling strength of the member subject to flexural buckling relating to axes y-y due to axial force N	0,41
Sec. 6.3.1.1, 6.3.1.2, 6.3.1.3 (EN1993-1-1)	Buckling strength of the member subject to flexural buckling relating to axes z-z due to axial force N	0,41
Sec. 6.3.1.1, 6.3.1.2, 6.3.1.4 (EN1993-1-1)	Buckling strength of the member subject to torsional and torsional-flexural buckling due to axial force N	0,22
Sec. 6.3.3(4) (EN1993-1-1)	Buckling strength of the member subjected to axial force and bending moments	0,72



Photo 1.



Photo 3.



Photo 2.



Photo 4.



Photo. 5.



Photo. 7.



Photo. 6.



Photo. 8.



Photo. 9.

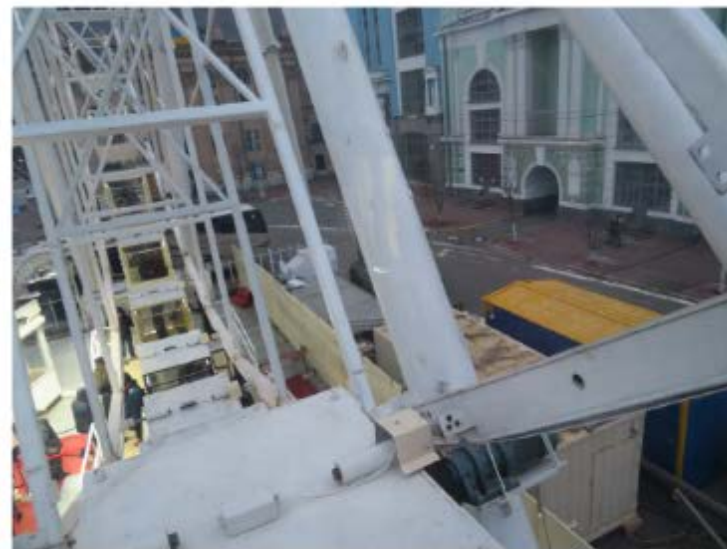


Photo. 11.



Photo. 10.

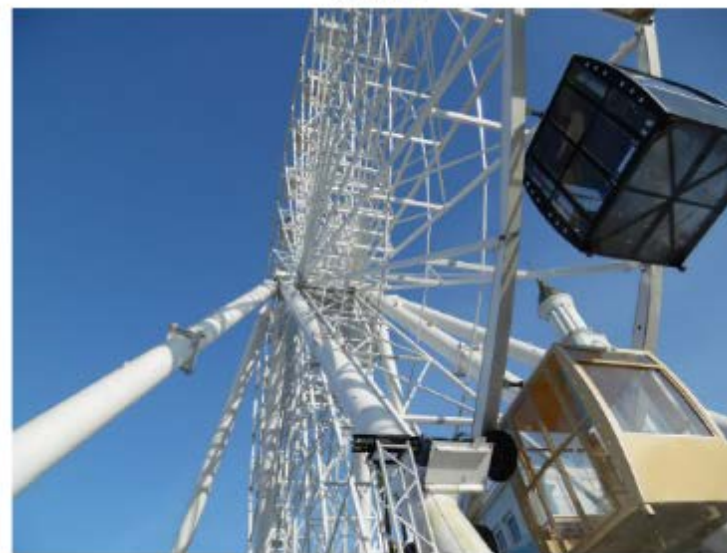


Photo. 12.



Photo. 13.



Photo. 15.



Photo. 14.



Photo. 16.



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