

Appendix to report:

SBJ-33-C5-OON-22-RE-019
DESIGN OF CABLE STAYED BRIDGE

Appendix title:

APPENDIX D – ANALYSIS RESULTS

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CONCEPT DEVELOPMENT FLOATING BRIDGE E39 BJØRNAFJORDEN



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1 INTRODUCTION

This appendix includes most of the results from analysis used as a basis for design of the stay-cables.

ULS/SLS of operational phase according to [1]

ALS in operational phase according to [2]

Free standing cable stayed bridge according to [3]

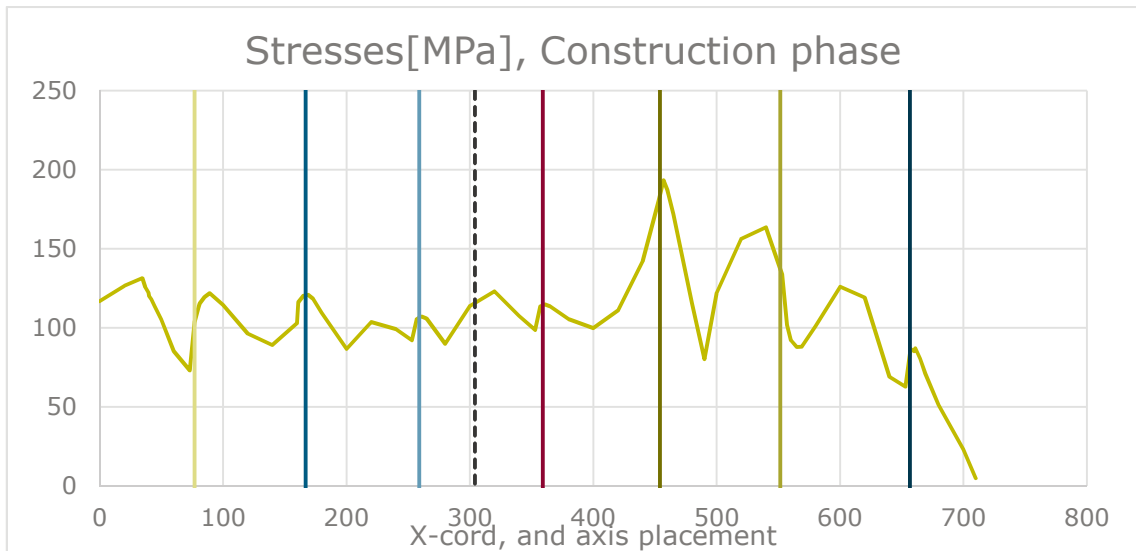
Free standing tower according to [3]

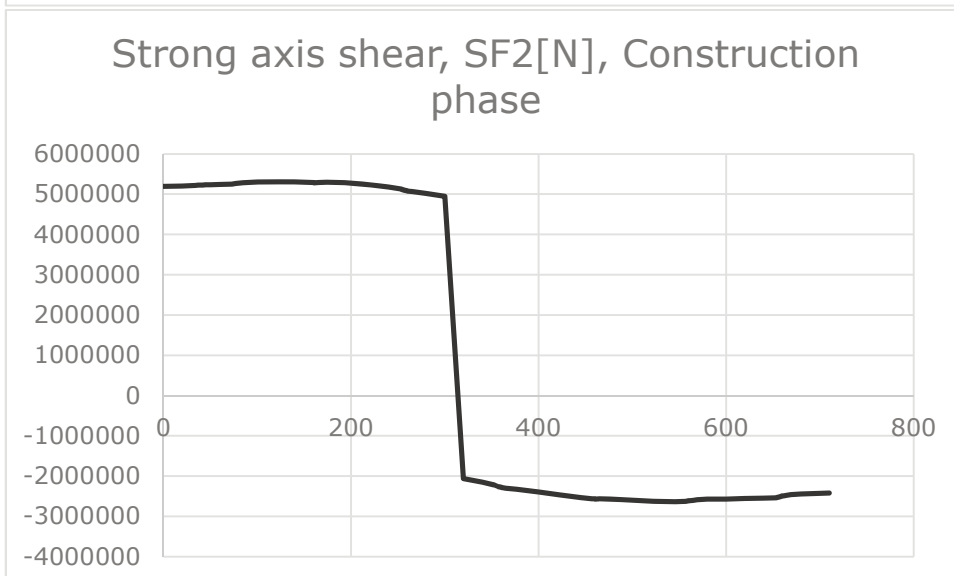
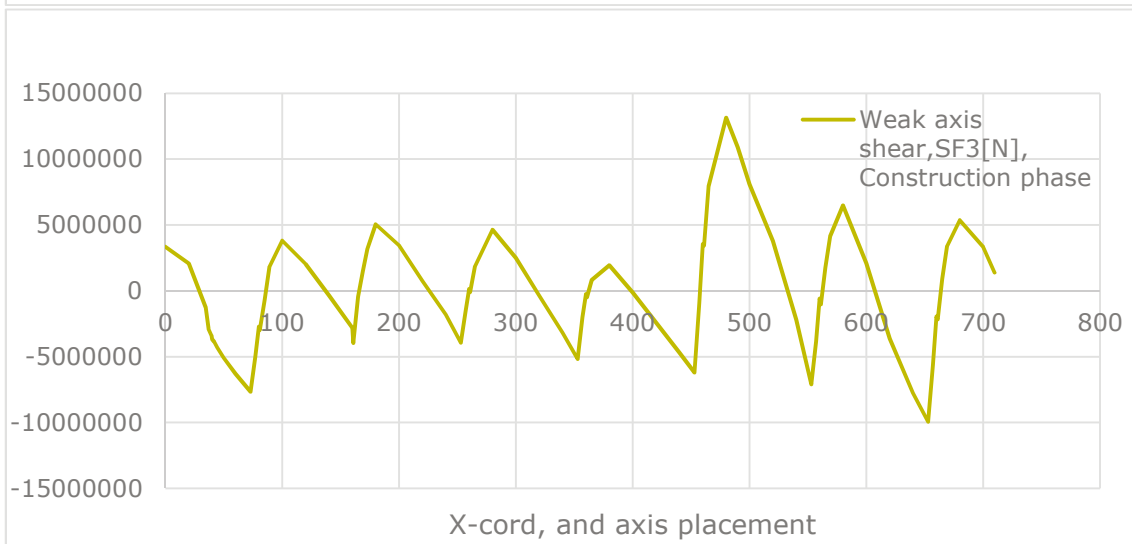
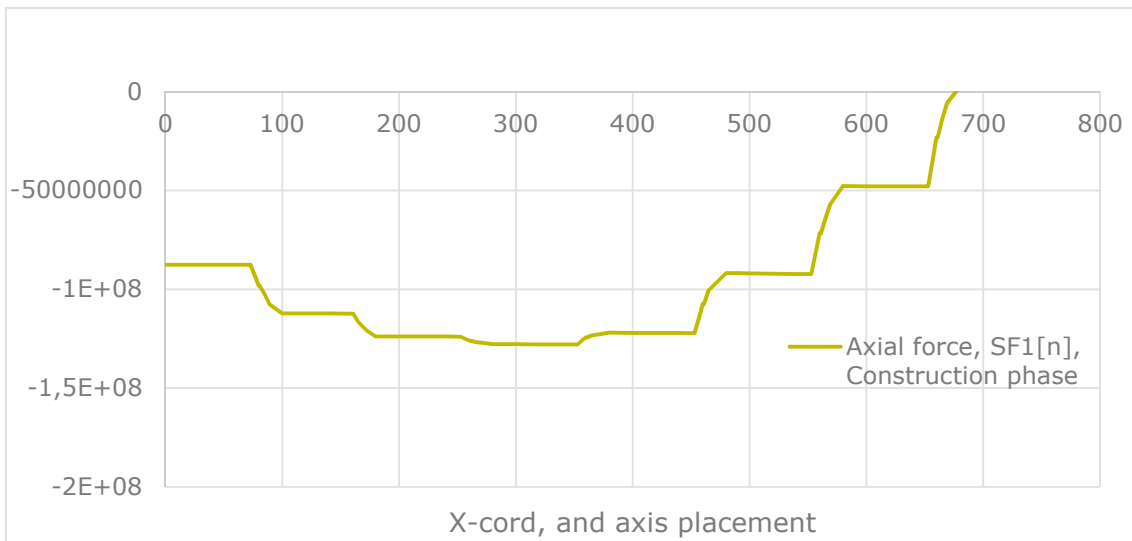
Free standing in construction phase according to [3]

2 GIRDER

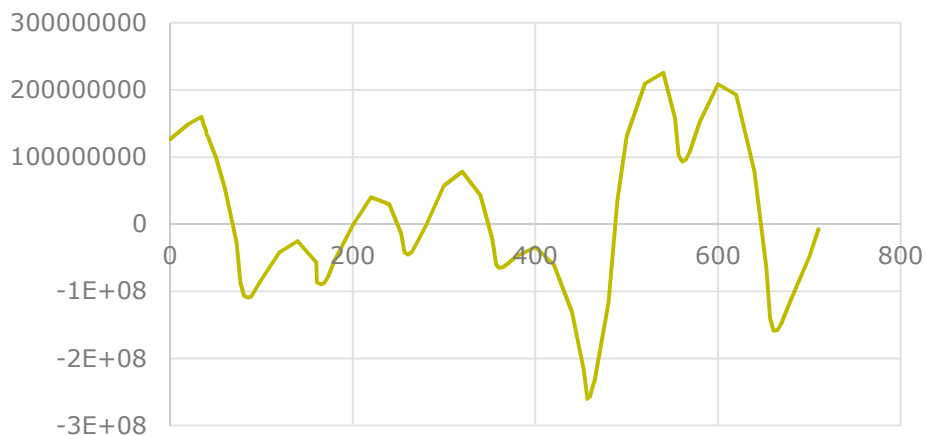
ALS, ULS/SLS of operational phase is not relevant in this report. The design of girder in operational phase is in report [4].

2.1 Construction face, coarse adjustment installation

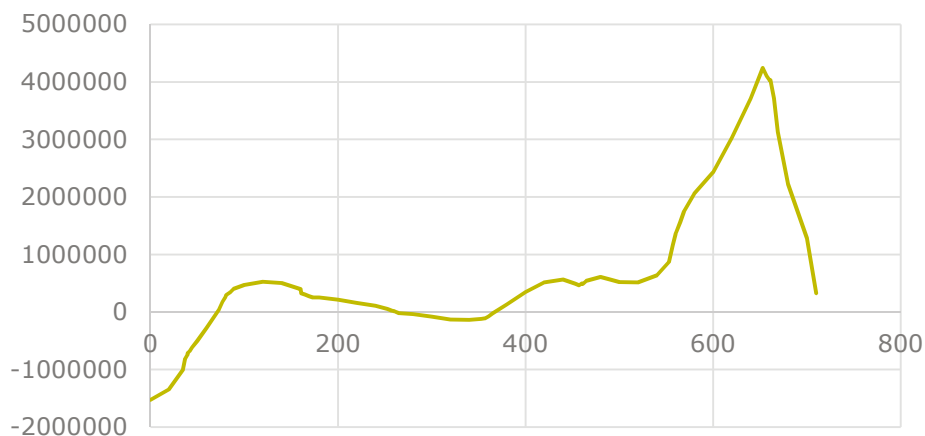




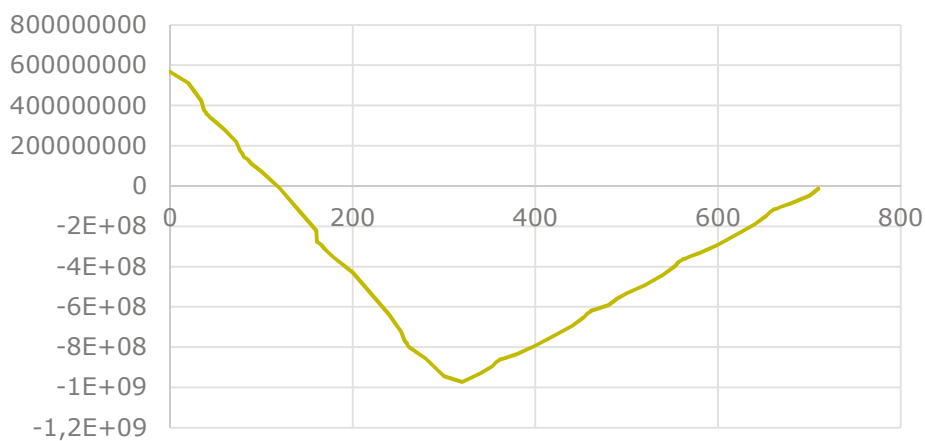
Weak axis bending moment, SM2 [Nm],
Construction phase



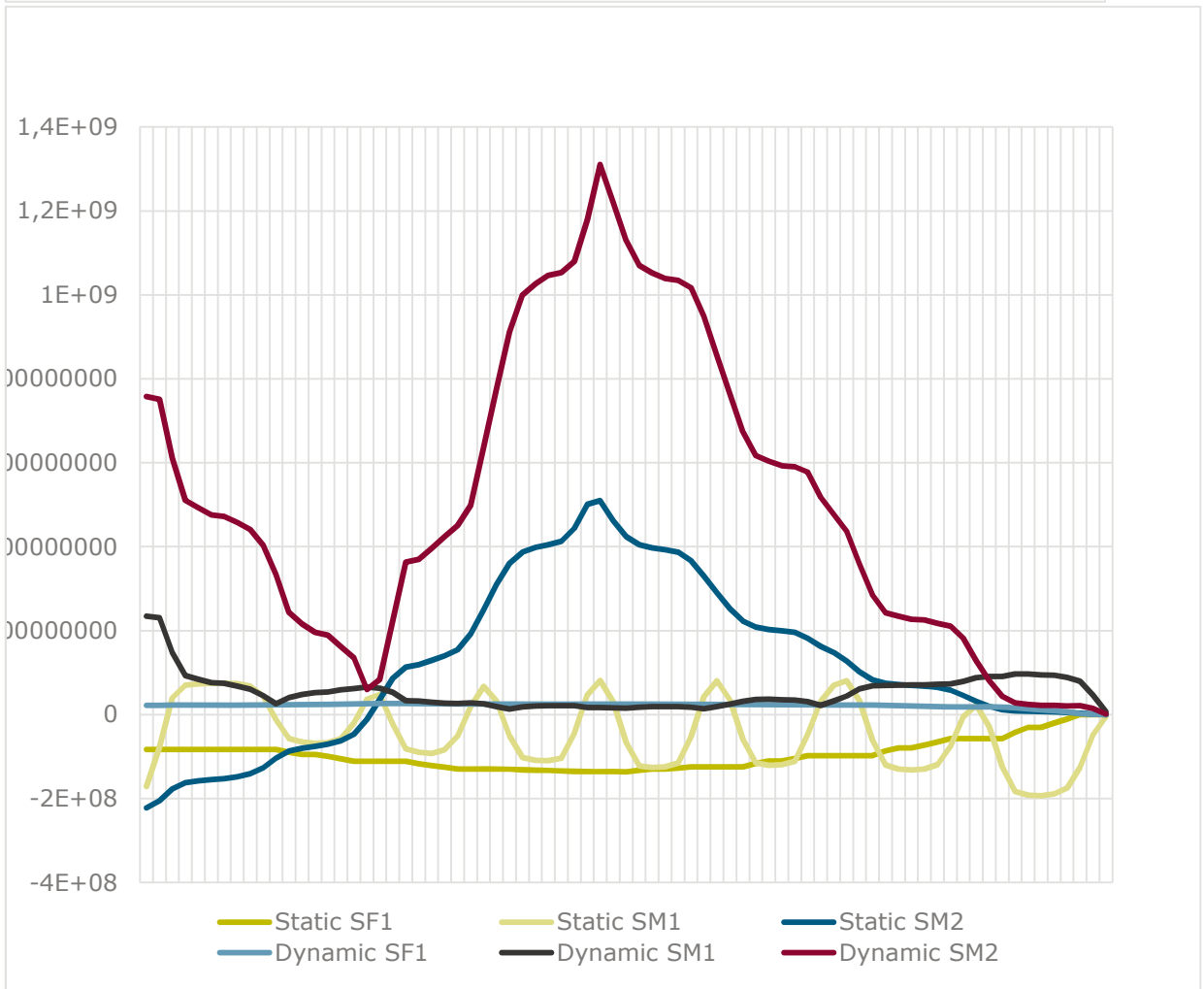
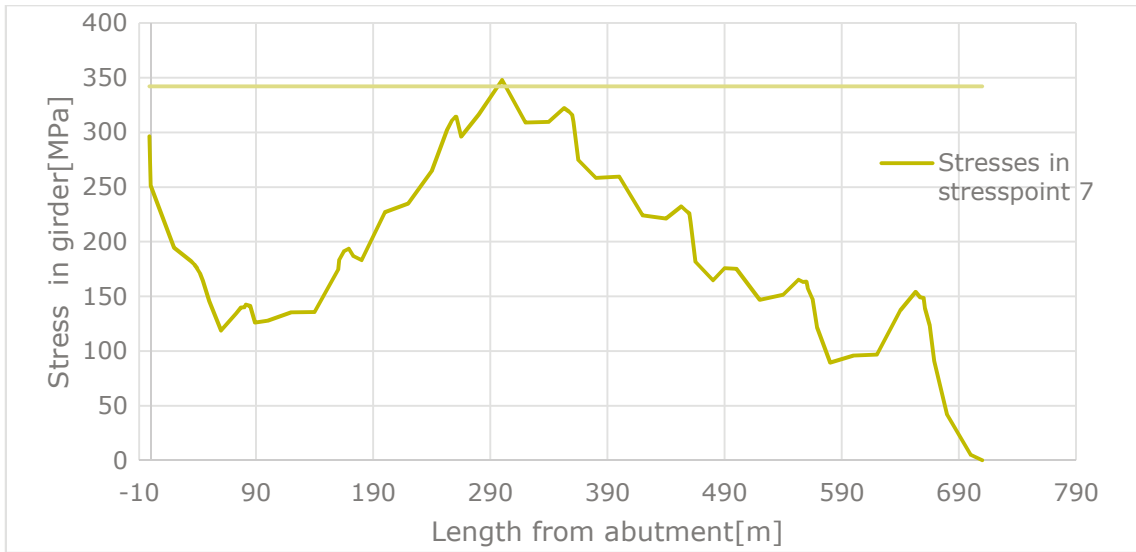
Strong axis bending moment, SM1 [Nm],
Construction phase



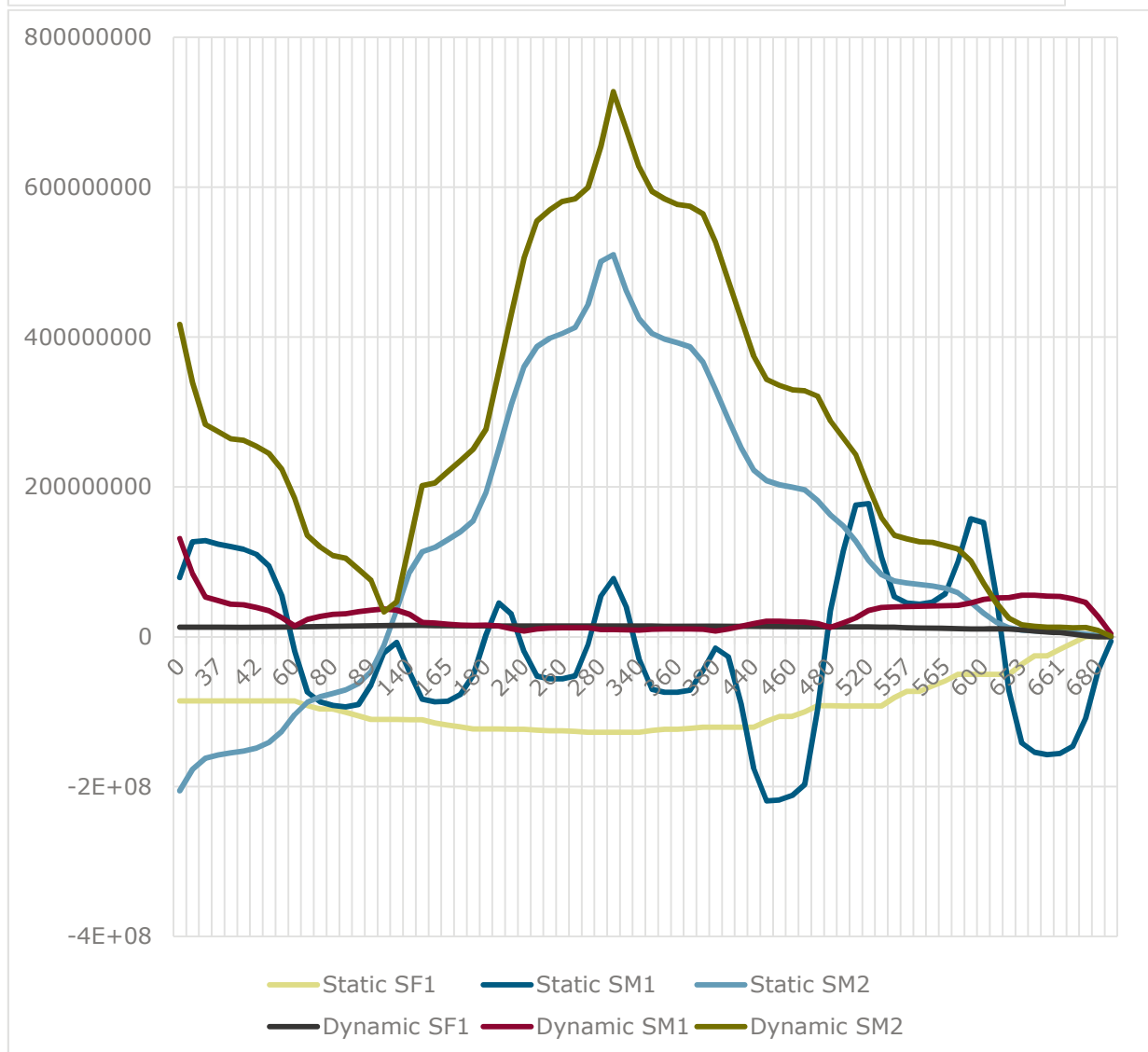
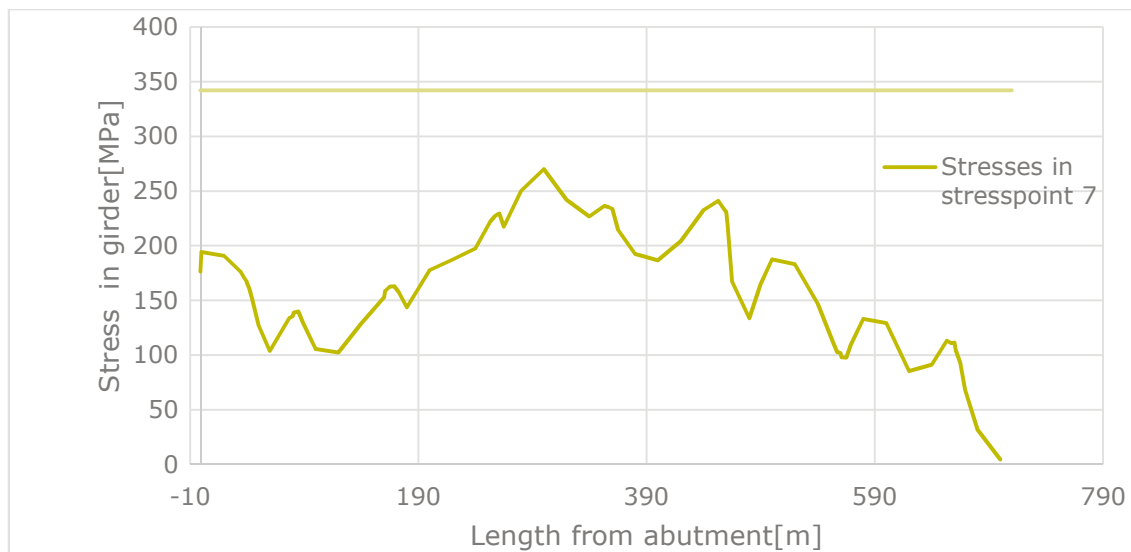
Torsional moment, SM3 [Nm],
Construction phase



2.2 50- Year return period wind



2.3 10-year summer storm + ballast



3 CABLE FORCES

Cable name[Cableplane; CablePackage; runningnr]	Self-Weight[n]	ULS[n]	Construction phase, with installation force[n]	Construction phase with wind force[n]	FreeStanding, 50-year wind[n]	ALS[n]	Design force[n]
111	1.38E+07	9.11E+06	1.06E+07	1.05E+07	1.05E+07	111	1.21E+07
211	1.38E+07	9.14E+06	1.01E+07	9.65E+06	1.05E+07	211	1.21E+07
112	1.28E+07	8.19E+06	8.85E+06	8.26E+06	9.56E+06	112	1.10E+07
212	1.28E+07	8.20E+06	9.02E+06	8.56E+06	9.57E+06	212	1.10E+07
113	1.24E+07	7.75E+06	8.31E+06	7.65E+06	9.13E+06	113	1.05E+07
213	1.24E+07	7.76E+06	9.20E+06	9.19E+06	9.14E+06	213	1.05E+07
114	1.22E+07	7.41E+06	8.33E+06	7.93E+06	8.90E+06	114	1.02E+07
214	1.22E+07	7.43E+06	8.07E+06	7.46E+06	8.91E+06	214	1.02E+07
115	1.22E+07	7.27E+06	8.09E+06	7.56E+06	8.86E+06	115	1.01E+07
215	1.22E+07	7.28E+06	7.84E+06	7.11E+06	8.87E+06	215	1.01E+07
121	6.77E+06	3.68E+06	4.33E+06	4.84E+06	4.51E+06	121	6.11E+06
221	6.82E+06	3.69E+06	4.09E+06	4.41E+06	4.53E+06	221	6.15E+06
122	5.43E+06	2.65E+06	3.31E+06	3.86E+06	3.36E+06	122	4.87E+06
222	5.48E+06	2.65E+06	3.06E+06	3.42E+06	3.38E+06	222	4.90E+06
123	5.52E+06	2.53E+06	3.15E+06	3.72E+06	3.36E+06	123	4.87E+06
223	5.58E+06	2.53E+06	2.96E+06	3.40E+06	3.38E+06	223	4.90E+06
124	6.56E+06	2.98E+06	3.38E+06	3.85E+06	4.10E+06	124	5.69E+06
224	6.64E+06	2.98E+06	3.69E+06	4.42E+06	4.13E+06	224	5.74E+06
125	6.56E+06	2.87E+06	3.31E+06	3.88E+06	4.06E+06	125	5.67E+06
225	6.65E+06	2.87E+06	3.68E+06	4.53E+06	4.08E+06	225	5.72E+06
131	7.64E+06	2.87E+06	3.63E+06	5.23E+06	5.18E+06	131	6.78E+06
231	7.82E+06	2.87E+06	3.33E+06	4.71E+06	5.26E+06	231	6.87E+06
132	5.91E+06	1.82E+06	2.26E+06	3.42E+06	3.76E+06	132	5.21E+06
232	6.05E+06	1.82E+06	2.37E+06	3.61E+06	3.83E+06	232	5.28E+06

133	5.77E+06	1.62E+06	2.45E+06	3.94E+06	3.66E+06	133	5.05E+06
233	5.93E+06	1.62E+06	2.09E+06	3.30E+06	3.72E+06	233	5.13E+06
134	6.59E+06	1.90E+06	2.47E+06	3.89E+06	4.32E+06	134	5.73E+06
234	6.79E+06	1.90E+06	2.55E+06	4.06E+06	4.42E+06	234	5.84E+06
141	6.01E+06	1.90E+06	2.28E+06	3.34E+06	3.83E+06	141	5.37E+06
241	6.26E+06	1.90E+06	2.42E+06	3.59E+06	3.93E+06	241	5.51E+06
142	4.79E+06	1.16E+06	1.52E+06	2.42E+06	2.87E+06	142	4.26E+06
242	5.01E+06	1.16E+06	1.44E+06	2.29E+06	2.94E+06	242	4.38E+06
143	4.96E+06	1.22E+06	1.62E+06	2.58E+06	3.05E+06	143	4.39E+06
243	5.19E+06	1.22E+06	1.70E+06	2.72E+06	3.10E+06	243	4.53E+06
144	6.48E+06	2.16E+06	2.48E+06	3.50E+06	4.36E+06	144	5.77E+06
244	6.78E+06	2.16E+06	2.51E+06	3.58E+06	4.44E+06	244	5.95E+06
151	7.20E+06	2.49E+06	2.94E+06	4.40E+06	4.98E+06	151	6.50E+06
251	7.51E+06	2.49E+06	2.91E+06	4.34E+06	5.19E+06	251	6.67E+06
152	5.71E+06	1.31E+06	1.86E+06	3.32E+06	3.75E+06	152	5.08E+06
252	6.00E+06	1.31E+06	1.76E+06	3.16E+06	3.89E+06	252	5.25E+06
153	5.47E+06	9.93E+05	1.31E+06	2.64E+06	3.59E+06	153	4.83E+06
253	5.78E+06	9.95E+05	1.46E+06	2.91E+06	3.71E+06	253	5.01E+06
154	6.47E+06	1.41E+06	2.08E+06	3.90E+06	4.46E+06	154	5.72E+06
254	6.83E+06	1.42E+06	1.95E+06	3.65E+06	4.63E+06	254	5.93E+06
161	9.03E+06	5.25E+06	5.64E+06	5.51E+06	6.75E+06	161	8.08E+06
261	9.38E+06	5.25E+06	5.89E+06	5.97E+06	6.94E+06	261	8.28E+06
162	7.69E+06	4.22E+06	4.77E+06	4.56E+06	5.64E+06	162	6.78E+06
262	8.03E+06	4.23E+06	4.67E+06	4.38E+06	5.84E+06	262	6.98E+06
163	7.63E+06	4.20E+06	4.64E+06	4.05E+06	5.63E+06	163	6.65E+06
263	8.00E+06	4.20E+06	4.95E+06	4.59E+06	5.85E+06	263	6.86E+06
164	9.31E+06	5.58E+06	6.36E+06	5.45E+06	7.13E+06	164	8.08E+06
264	9.77E+06	5.59E+06	6.12E+06	5.01E+06	7.41E+06	264	8.34E+06
171	1.11E+07	6.75E+06	7.64E+06	7.30E+06	8.77E+06	171	9.78E+06

271	1.15E+07	6.76E+06	7.33E+06	6.74E+06	8.79E+06	271	1.00E+07
172	9.01E+06	5.05E+06	5.89E+06	5.68E+06	6.95E+06	172	7.85E+06
272	9.36E+06	5.05E+06	5.53E+06	5.05E+06	6.97E+06	272	8.05E+06
173	7.95E+06	4.19E+06	5.12E+06	5.11E+06	6.06E+06	173	6.90E+06
273	8.27E+06	4.20E+06	4.99E+06	4.86E+06	6.08E+06	273	7.09E+06
174	8.02E+06	4.20E+06	4.69E+06	4.38E+06	6.18E+06	174	7.00E+06
274	8.35E+06	4.21E+06	5.06E+06	5.02E+06	6.21E+06	274	7.19E+06
175	9.66E+06	5.27E+06	5.75E+06	5.35E+06	7.73E+06	175	8.47E+06
275	1.00E+07	5.28E+06	6.12E+06	5.99E+06	7.75E+06	275	8.71E+06
181	1.22E+07	7.68E+06	8.17E+06	8.41E+06	9.84E+06	181	1.10E+07
281	1.26E+07	7.65E+06	8.50E+06	9.04E+06	9.84E+06	281	1.12E+07
182	1.04E+07	6.04E+06	6.60E+06	7.09E+06	8.31E+06	182	9.31E+06
282	1.07E+07	6.03E+06	6.98E+06	7.76E+06	8.33E+06	282	9.51E+06
183	9.24E+06	5.05E+06	5.52E+06	6.09E+06	7.40E+06	183	8.36E+06
283	9.54E+06	5.03E+06	6.39E+06	7.60E+06	7.57E+06	283	8.55E+06
184	8.78E+06	4.54E+06	5.36E+06	6.35E+06	7.27E+06	184	8.04E+06
284	9.07E+06	4.51E+06	5.09E+06	5.91E+06	7.33E+06	284	8.25E+06
185	9.24E+06	4.61E+06	5.59E+06	6.95E+06	8.00E+06	185	8.60E+06
285	9.62E+06	4.57E+06	5.98E+06	7.62E+06	8.08E+06	285	8.90E+06

4 CONNECTION, GIRDER TOWER

	50-year wind	Installation phase
Load in bearing[MN]	15.87	2.9

5 TOWER

The tower in ULS/SLS/ALS is reported in ShellDesign appendix D.

5.1 Tower in free standing stay-cable phase

Lasttilfellet 1 – Free standing stay cable bridge 50-year wind						
Vertical coordinate[m]	SM1[NM]	SM2[NM]	SM3[NM]	SF1[N]	SF2[N]	SF3[N]
0	1.19E+09	1.39E+09	2.28E+07	-2.51E+08	1.57E+07	-3.39E+07
17	1.05E+09	8.60E+08	2.21E+07	-2.32E+08	1.38E+07	-3.00E+07
33	3.83E+08	3.88E+08	2.24E+07	-2.09E+08	1.07E+07	-2.63E+07
50	3.10E+08	-1.39E+08	2.21E+07	-1.94E+08	9.76E+06	-2.34E+07
60	2.55E+08	-1.61E+08	2.21E+07	-1.77E+08	8.60E+06	-4.09E+06
83	-2.57E+08	-2.09E+08	2.22E+07	-1.58E+08	7.22E+06	-2.88E+05
100	-3.68E+08	-1.88E+08	2.24E+07	-1.44E+08	6.23E+06	2.73E+06
117	-4.77E+08	-1.19E+08	2.26E+07	-1.31E+08	5.34E+06	5.34E+06
133	-5.58E+08	-1.21E+07	2.27E+07	-1.20E+08	4.46E+06	7.65E+06
150	-6.12E+08	1.37E+08	2.28E+07	-1.10E+08	-4.54E+06	9.63E+06
Tower topp 216	-1.45E+05	-1.28E+05	-8.97E+02	-2.79E+06	1.38E+05	-1.27E+06
213	-7.85E+05	-1.16E+07	-2.46E+03	-2.26E+07	3.70E+05	-7.73E+06
211	-2.02E+06	-3.77E+07	-5.18E+03	-4.08E+07	6.05E+05	-1.16E+07
208	-3.86E+06	-7.51E+07	-8.73E+03	-5.85E+07	8.46E+05	-1.38E+07
206	-6.31E+06	-1.19E+08	1.25E+04	-7.66E+07	1.09E+06	-1.36E+07
203	-9.40E+06	-1.64E+08	1.59E+04	-9.46E+07	1.32E+06	-1.11E+07
201	-1.30E+07	-1.99E+08	1.93E+04	-1.07E+08	1.53E+06	-9.36E+06
198	-1.72E+07	-2.27E+08	2.29E+04	-1.16E+08	1.74E+06	-7.61E+06
196	-2.19E+07	-2.47E+08	2.67E+04	-1.26E+08	1.96E+06	-6.20E+06
193	-2.71E+07	-2.59E+08	3.09E+04	-1.37E+08	2.18E+06	8.42E+06
191	-3.29E+07	-2.59E+08	3.51E+04	-1.50E+08	2.39E+06	1.38E+07
188	-3.92E+07	-2.47E+08	4.01E+04	-1.63E+08	2.60E+06	1.48E+07
186	-4.60E+07	-2.29E+08	4.57E+04	-1.74E+08	2.80E+06	1.65E+07
183	-5.33E+07	-2.04E+08	5.15E+04	-1.84E+08	3.02E+06	1.88E+07

181	-6.63E+07	2.19E+08	6.65E+04	-1.98E+08	3.34E+06	2.30E+07
176	-7.84E+07	2.81E+08	7.23E+04	-2.11E+08	3.66E+06	2.41E+07
173	-8.77E+07	3.28E+08	7.94E+04	-2.21E+08	3.88E+06	2.61E+07
171	-9.77E+07	3.79E+08	8.66E+04	-2.31E+08	4.11E+06	2.82E+07
169	-1.06E+08	4.25E+08	-9.34E+04	-2.46E+08	4.29E+06	3.03E+07
Tower leg 2 0	1.21E+09	-1.17E+09	-1.66E+07	-2.93E+08	1.59E+07	2.83E+07
17	9.87E+08	-7.19E+08	-1.59E+07	-2.74E+08	1.40E+07	2.53E+07
33	7.66E+08	3.46E+08	-1.59E+07	-2.54E+08	1.23E+07	2.24E+07
50	6.07E+08	1.52E+08	-1.59E+07	-2.38E+08	1.09E+07	2.03E+07
60	4.42E+08	1.30E+08	-1.58E+07	-2.21E+08	9.34E+06	1.83E+06
83	-3.18E+08	1.44E+08	-1.56E+07	-2.02E+08	7.47E+06	-1.06E+06
100	-3.14E+08	1.12E+08	-1.54E+07	-1.88E+08	6.03E+06	-2.98E+06
117	-2.95E+08	4.94E+07	-1.53E+07	-1.75E+08	4.65E+06	-4.65E+06
133	-2.68E+08	-4.97E+07	-1.54E+07	-1.64E+08	3.35E+06	-6.01E+06
150	-2.37E+08	-1.59E+08	-1.57E+07	-1.54E+08	-3.13E+06	-7.06E+06

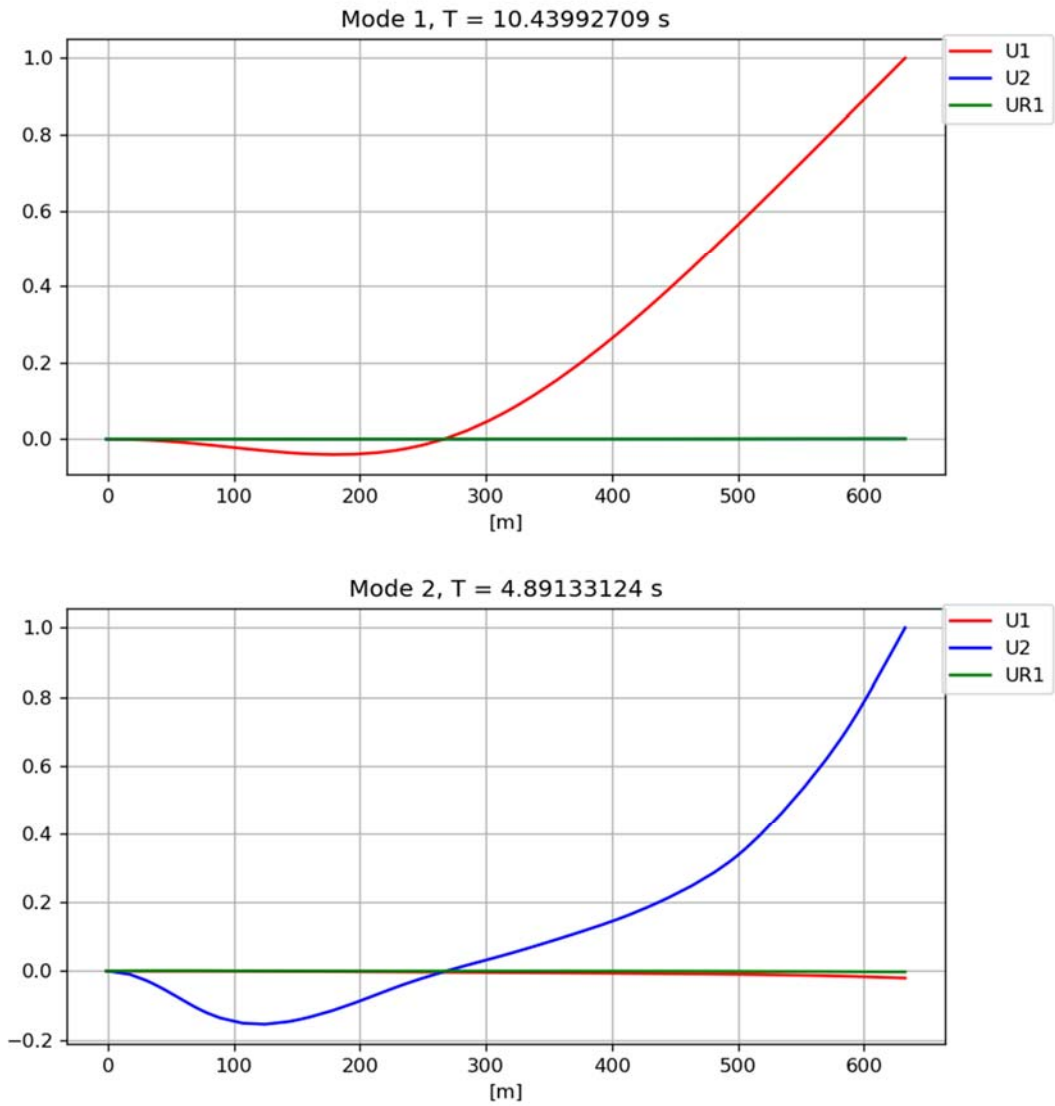
Ballasting with 10-year summer storm

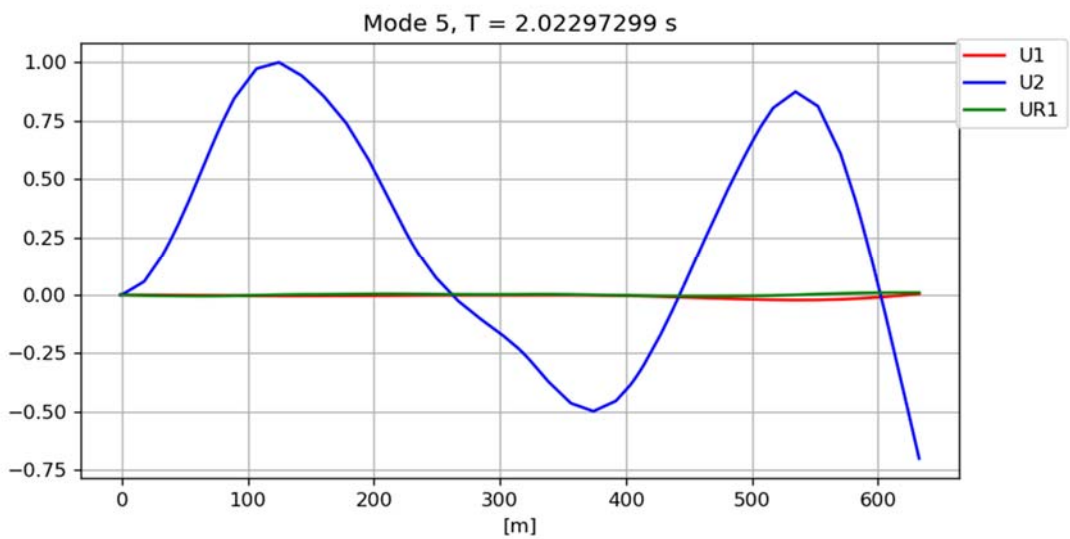
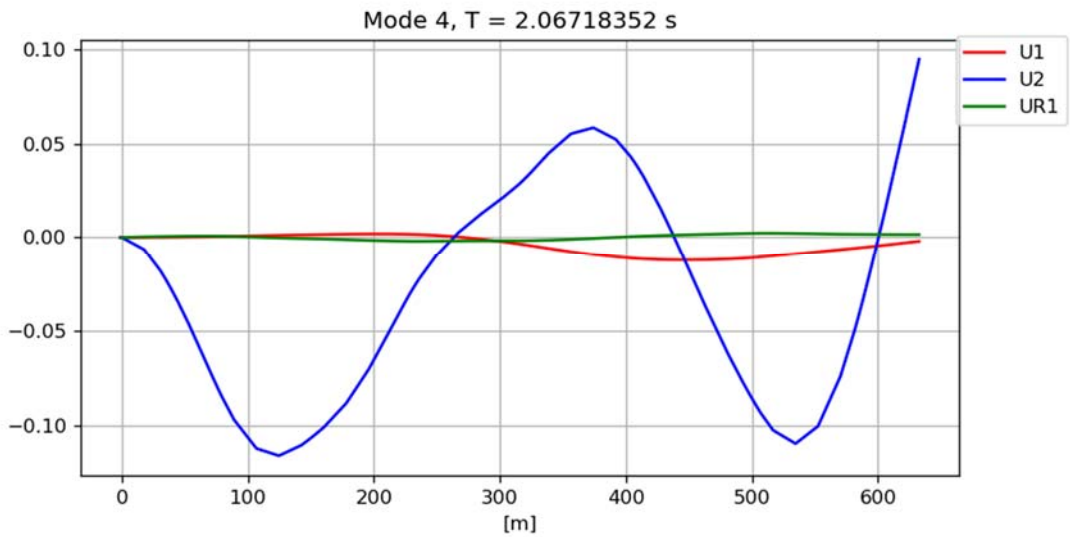
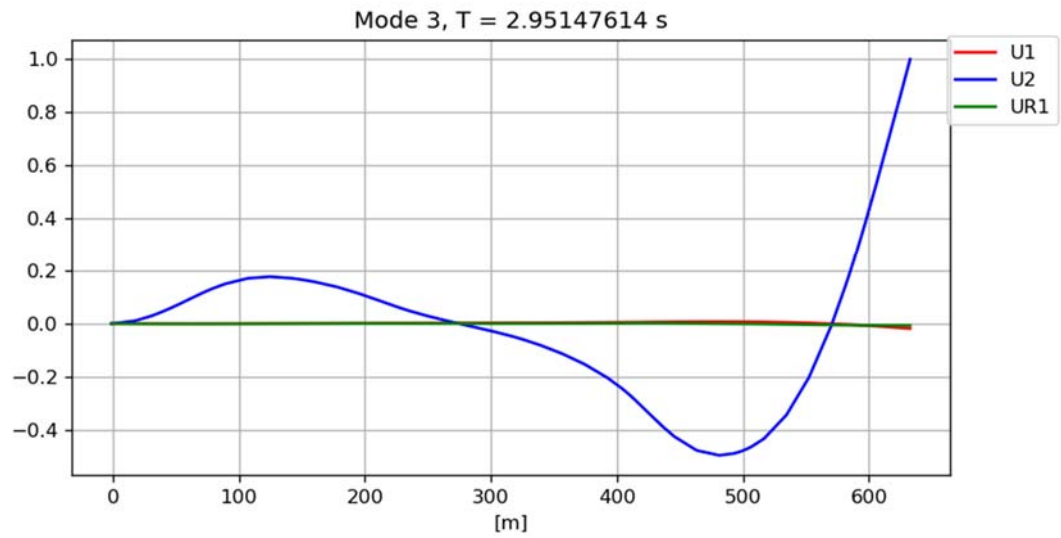
Vertical coordinate[m]	SM1[NM]	SM2[NM]	SM3[NM]	SF1[N]	SF2[N]	SF3[N]
Tower leg 1 0	-5.0E+08	7.2E+08	2.2E+07	-1.1E+08	4.7E+06	-1.7E+07
17	-5.5E+08	4.6E+08	2.2E+07	-1.0E+08	3.9E+06	-1.5E+07
33	-2.8E+08	2.1E+08	2.3E+07	-9.1E+07	2.3E+06	-1.4E+07
50	-3.1E+08	-6.8E+07	2.2E+07	-8.4E+07	2.0E+06	-1.2E+07
60	-3.3E+08	-7.1E+07	2.2E+07	-7.7E+07	-2.2E+06	-1.9E+06
83	-3.5E+08	-9.3E+07	2.2E+07	-6.9E+07	-3.0E+06	-2.1E+05
100	-3.6E+08	-8.5E+07	2.2E+07	-6.3E+07	-3.7E+06	1.1E+06
117	-3.7E+08	-5.6E+07	2.2E+07	-5.8E+07	-4.3E+06	2.3E+06
133	-3.7E+08	-9.1E+06	2.2E+07	-5.3E+07	-4.8E+06	3.4E+06
150	-3.5E+08	5.7E+07	2.2E+07	-4.9E+07	-5.2E+06	4.3E+06
Tower topp 216	8.2E+04	-7.3E+04	5.1E+02	1.5E+06	-7.8E+04	-7.2E+05

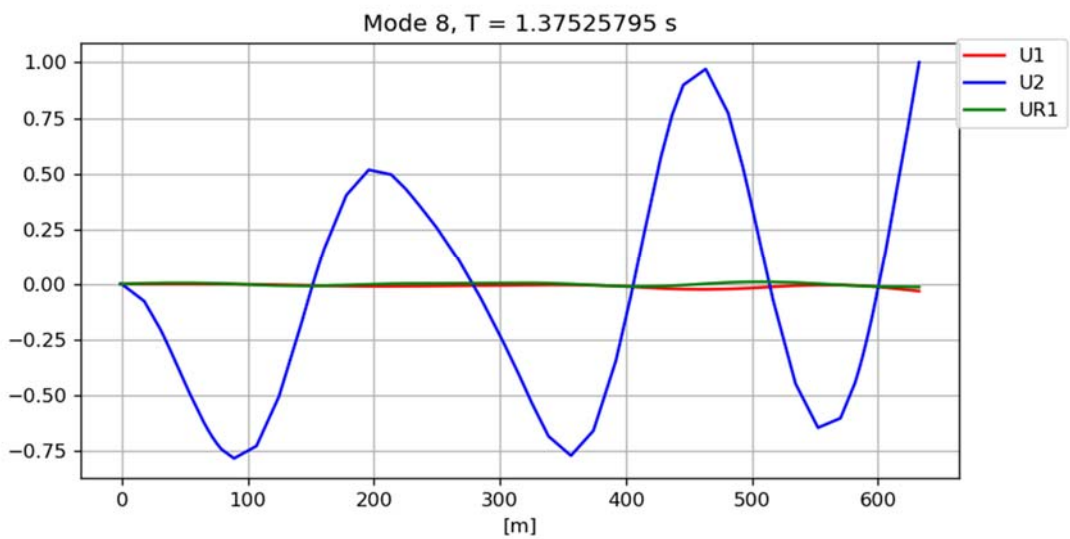
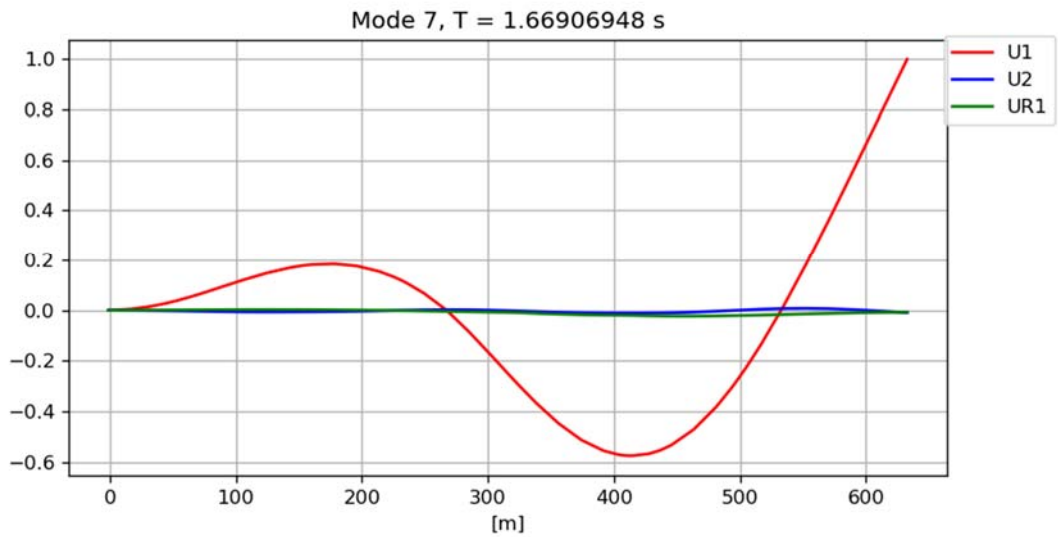
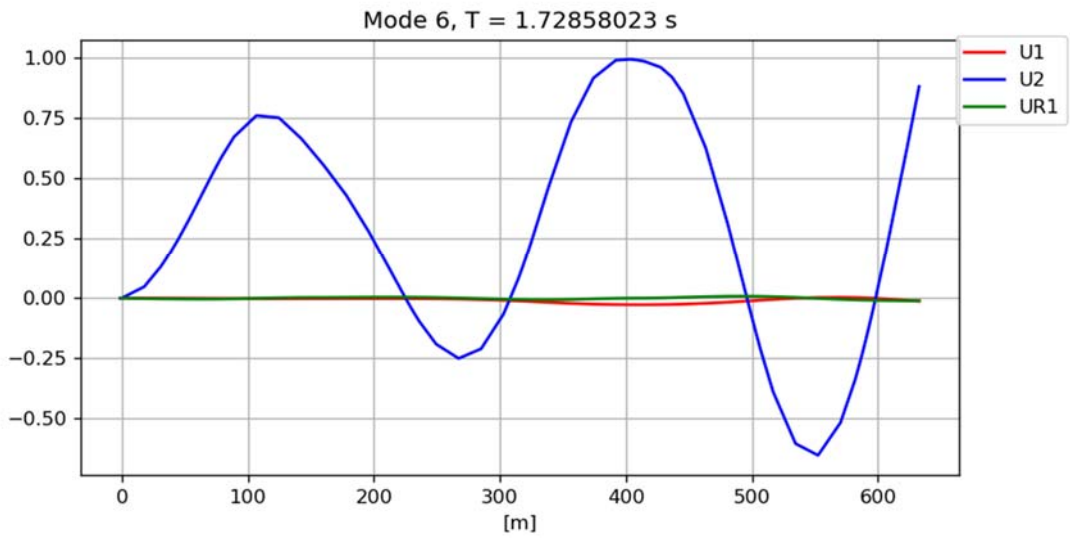
213	4.4E+05	8.5E+06	1.4E+03	1.2E+07	-2.1E+05	5.9E+06
211	1.1E+06	2.9E+07	2.9E+03	2.1E+07	-3.4E+05	9.4E+06
208	2.2E+06	5.9E+07	4.9E+03	3.1E+07	-4.8E+05	1.2E+07
206	3.6E+06	9.6E+07	-7.1E+03	4.0E+07	-6.2E+05	1.3E+07
203	5.3E+06	1.4E+08	-9.0E+03	5.0E+07	-7.4E+05	1.4E+07
201	7.4E+06	1.7E+08	-1.1E+04	5.6E+07	-8.7E+05	1.2E+07
198	9.7E+06	2.1E+08	-1.3E+04	6.1E+07	-9.9E+05	9.8E+06
196	1.2E+07	2.3E+08	-1.5E+04	6.6E+07	-1.1E+06	8.0E+06
193	1.5E+07	2.5E+08	-1.7E+04	7.2E+07	-1.2E+06	5.7E+06
191	1.9E+07	2.5E+08	-2.0E+04	7.9E+07	-1.4E+06	-5.6E+06
188	2.2E+07	2.5E+08	-2.3E+04	8.6E+07	-1.5E+06	-9.1E+06
186	2.6E+07	2.3E+08	-2.6E+04	9.1E+07	-1.6E+06	-1.2E+07
183	3.0E+07	2.1E+08	-2.9E+04	9.6E+07	-1.7E+06	-1.5E+07
181	3.8E+07	1.6E+08	-3.8E+04	1.0E+08	-1.9E+06	-1.8E+07
176	4.4E+07	1.1E+08	-4.1E+04	1.0E+08	-2.1E+06	-1.8E+07
173	5.0E+07	-1.4E+08	-4.5E+04	1.1E+08	-2.2E+06	-1.9E+07
171	5.5E+07	-1.8E+08	-4.9E+04	1.1E+08	-2.3E+06	-2.0E+07
169	6.0E+07	-2.1E+08	5.3E+04	1.1E+08	-2.4E+06	-2.0E+07
Tower leg 2 0	-5.0E+08	-6.0E+08	-1.9E+07	-1.3E+08	4.8E+06	1.4E+07
17	-5.1E+08	-3.8E+08	-1.9E+07	-1.2E+08	4.0E+06	1.3E+07
33	-4.9E+08	2.0E+08	-1.9E+07	-1.2E+08	3.2E+06	1.1E+07
50	-4.7E+08	7.4E+07	-1.9E+07	-1.1E+08	2.6E+06	1.1E+07
60	-4.3E+08	5.2E+07	-1.9E+07	-1.0E+08	-2.5E+06	6.3E+05
83	-3.8E+08	5.6E+07	-1.8E+07	-9.4E+07	-3.1E+06	-5.3E+05
100	-3.3E+08	4.2E+07	-1.8E+07	-8.8E+07	-3.5E+06	-1.3E+06
117	-2.7E+08	1.6E+07	-1.8E+07	-8.3E+07	-3.9E+06	-1.9E+06
133	-2.0E+08	-2.5E+07	-1.8E+07	-7.8E+07	-4.1E+06	-2.4E+06
150	-1.4E+08	-6.9E+07	-1.8E+07	-7.4E+07	-4.3E+06	-2.8E+06

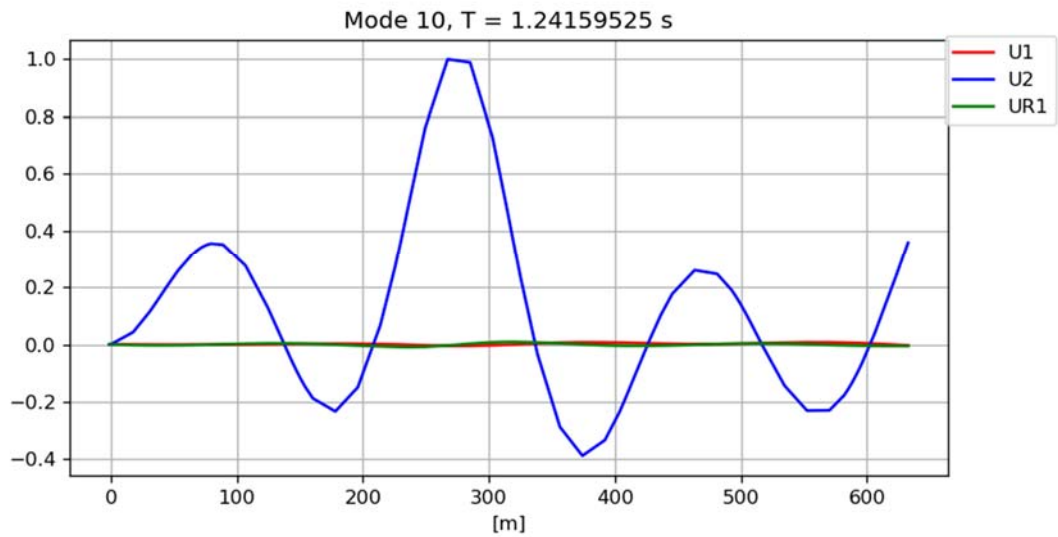
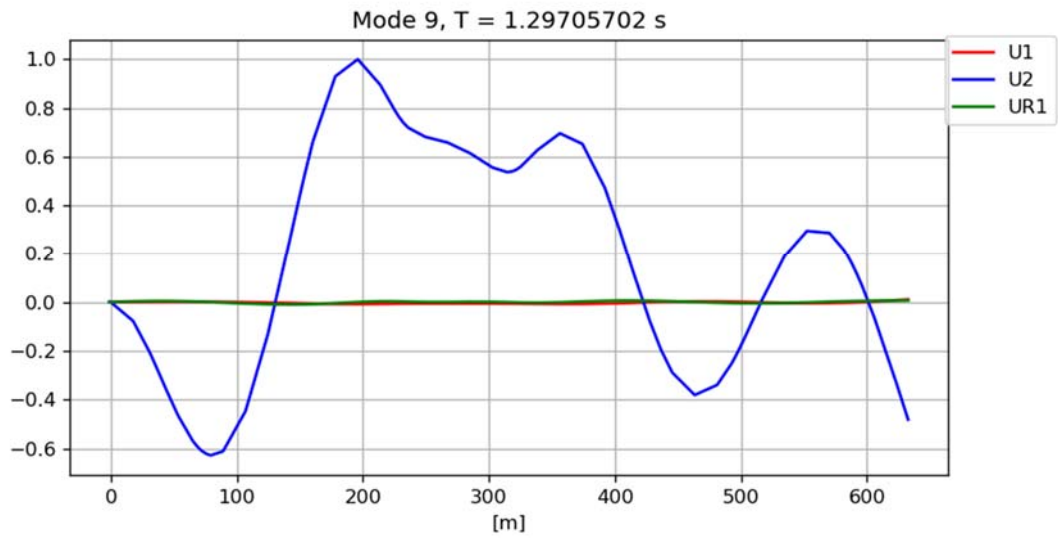
6 MODAL PROPERTIES

6.1 Full free-standing stay-cable bridge without asphalt

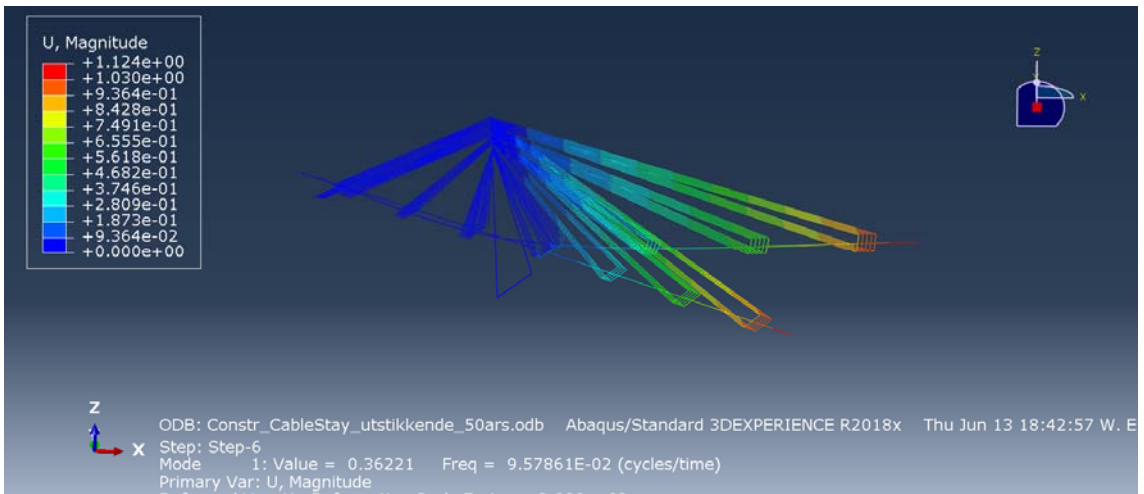




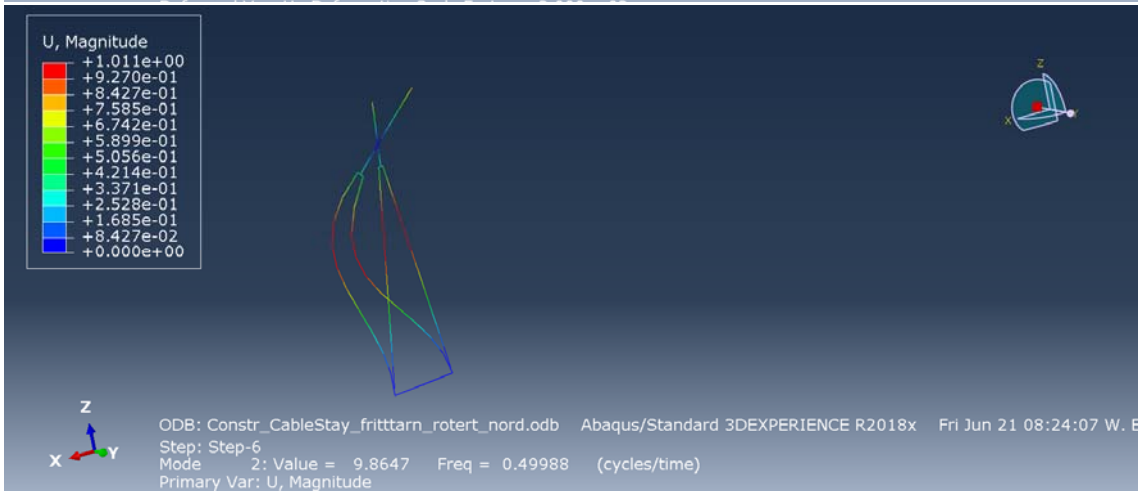
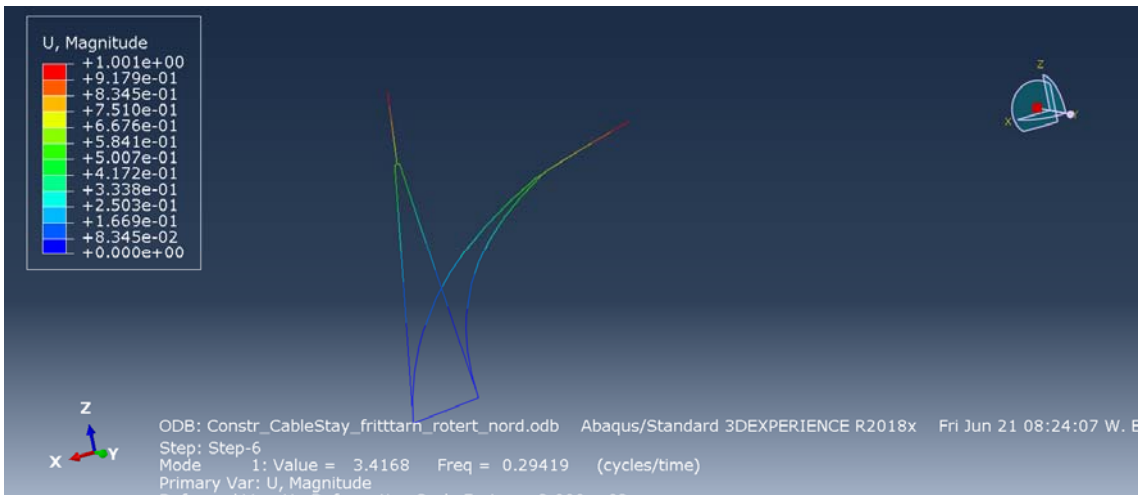


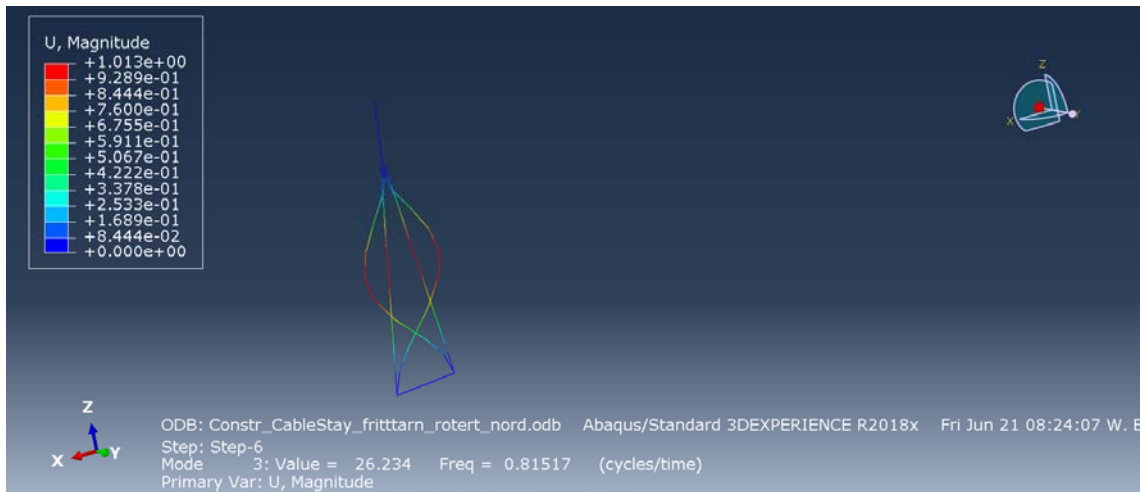


Mode	Frequency[hz]	AngularFrequency	Period[s]	Modal mass[kg]
1	0.09578611	0.60184188	10.43992709	2451587
2	0.20444332	1.28455527	4.89133124	1313486
3	0.33881351	2.12882809	2.95147614	988782
4	0.48374999	3.03949080	2.06718352	13752538
5	0.49432197	3.10591655	2.02297299	3816483
6	0.57850945	3.63488208	1.72858023	3438952
7	0.59913623	3.76448398	1.66906948	2433173
8	0.72713631	4.56873220	1.37525795	3855885
9	0.77097613	4.84418587	1.29705702	2919794
10	0.80541545	5.06057453	1.24159525	1618204

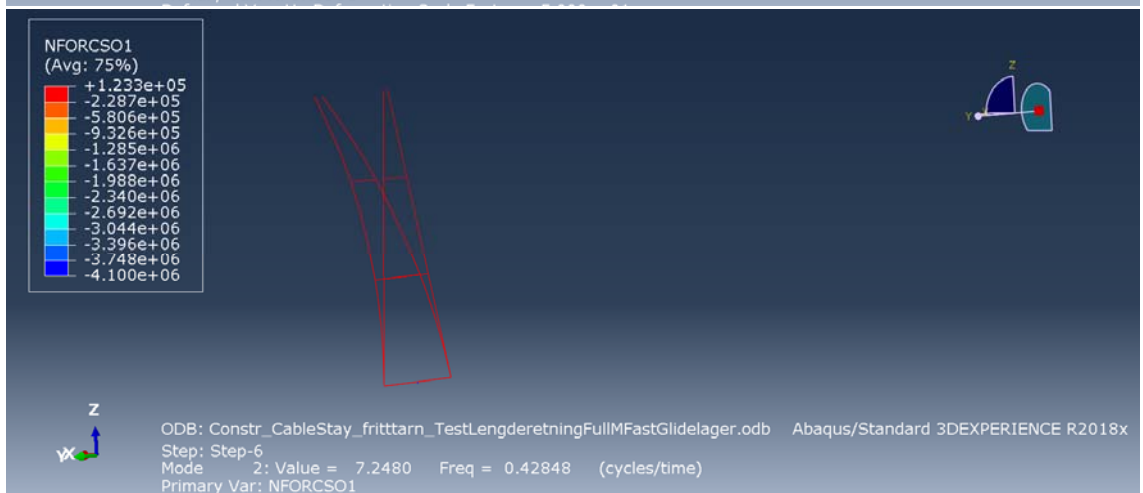
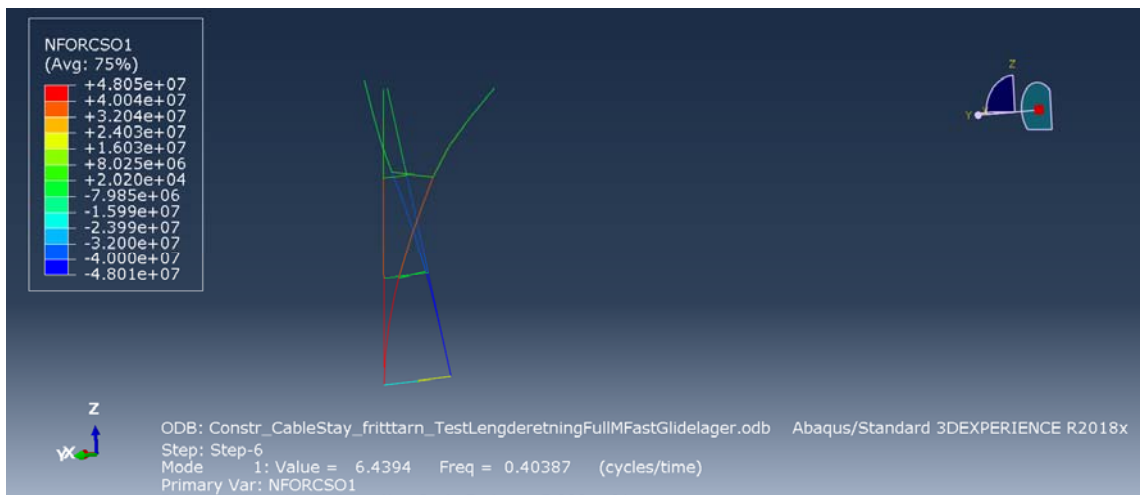


6.2 Free standing tower

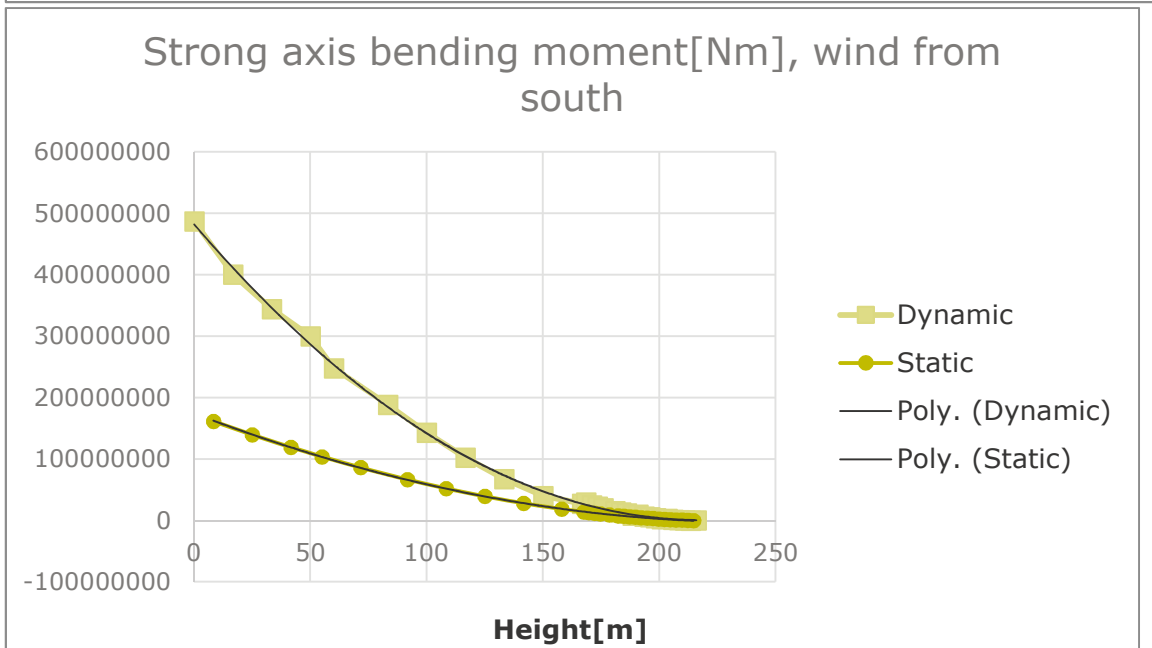
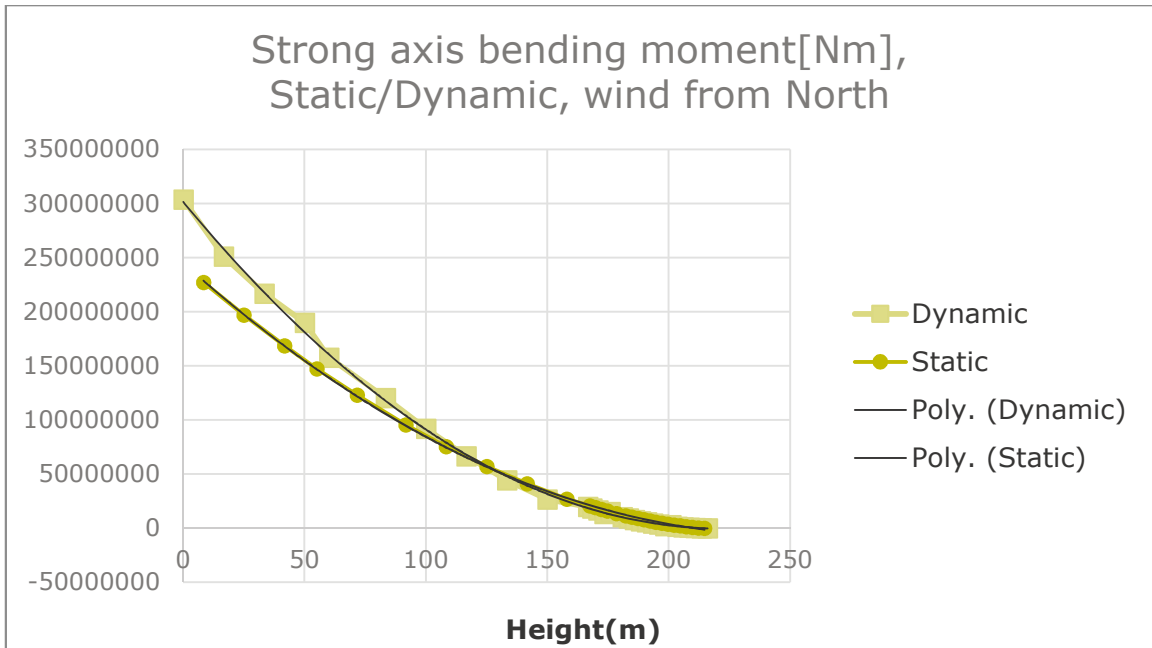


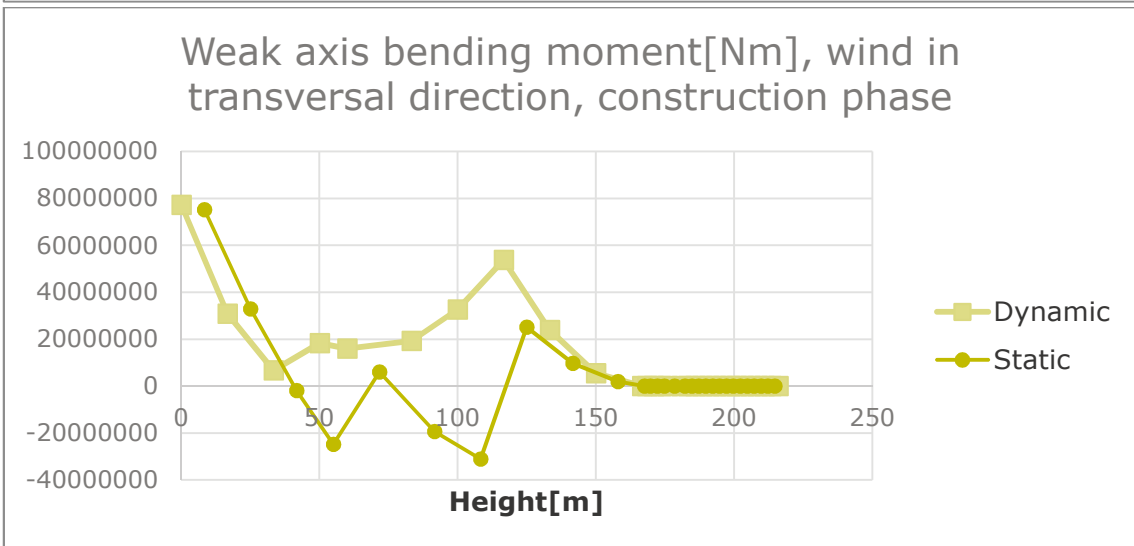
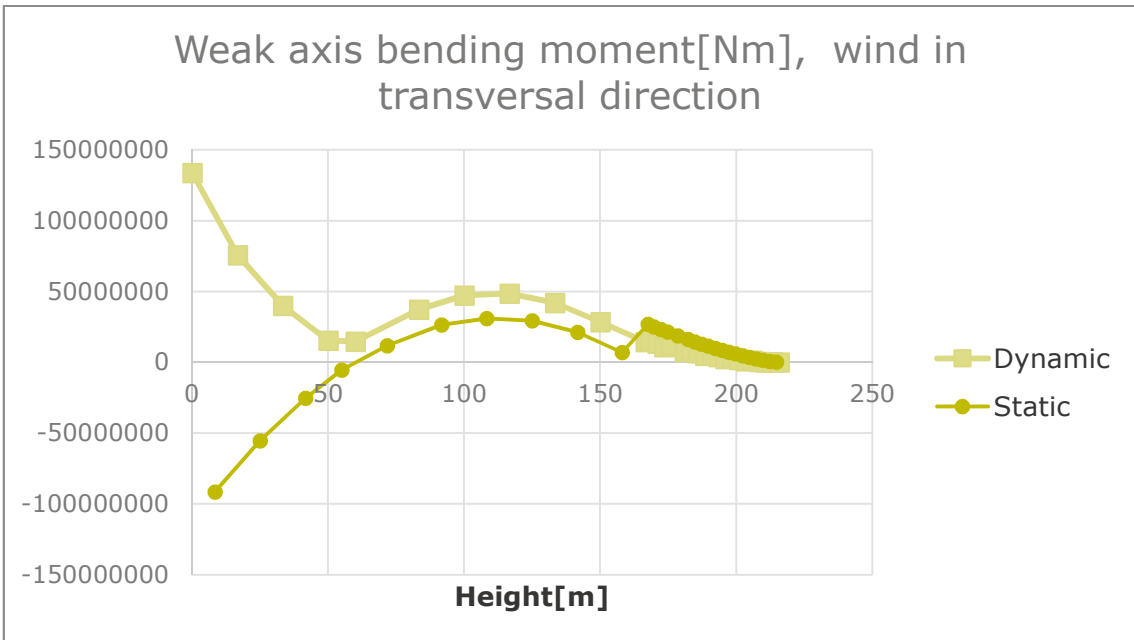


6.3 Free standing tower in construction phase



6.4 Dynamic/Static wind calculation freestanding tower





	Direction	Aproximated moment of tower leg[MNm]	Scaling factor mean wind
Free standing tower, construction	North	N/A	3.6*
Free standing tower, construction	South	N/A	2.5**
Free standing tower, construction	East/West	115	2.25
Free standing tower	North	550	2.23
Free standing tower	South	662	3.6
Free standing tower	East/West	225	2.5

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