Supplementary Information

Title of manuscript: *Closing the gap towards super-long suspension bridges using computational morphogenesis*

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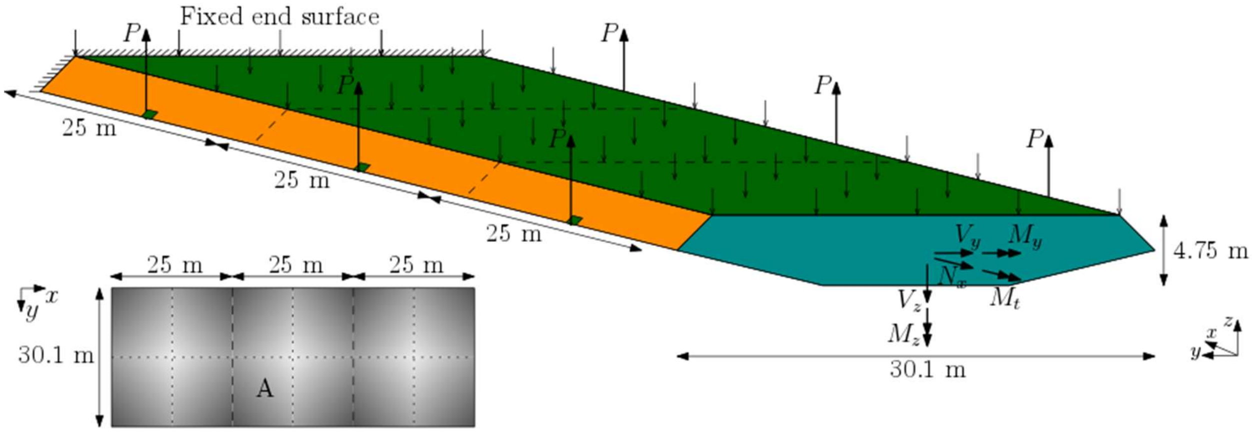
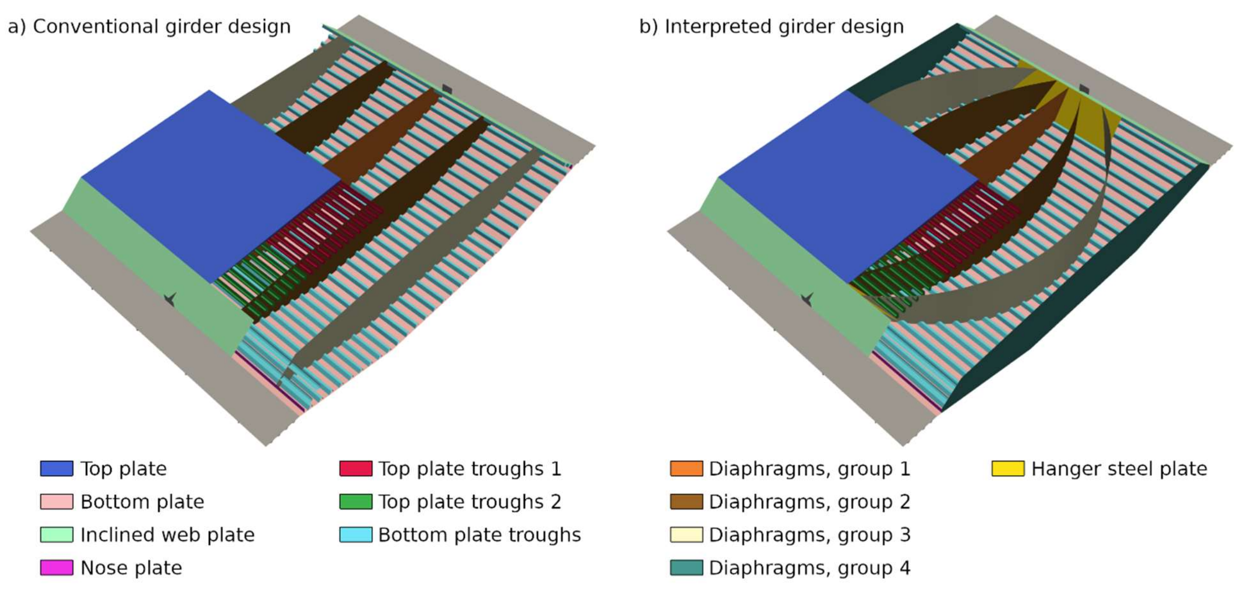
Supplementary Information Items



Supplementary Figure 1 | FE model of the bridge girder. Dimensions, loads, and boundary conditions of the three-section model of a bridge girder. Section forces were applied to the stiff end elements (blue) with $100\ \times$ modulus of elasticity and density $\rho = 1$. Distributed load was applied to the solid top elements (green) and hanger forces P to the solid hanger attachments (green), both with $\rho = 1$. Design domain indicated by orange, $0 \leq \rho \leq 1$. Mapping of the active design domain A to the remaining model is indicated on the inserted illustration by graded color. Here, dashed lines indicate section borders, and dotted lines indicate symmetry lines.



Supplementary Figure 2 | Design variables in parametric optimization. Indication of design variables during parametric optimization (steel plate thicknesses) on a single girder section.

Supplementary Table 1 | Performance of the conventional and interpreted designs. Weighted compliance of the five load cases (LC) included during the optimization and the in total 14 load cases, respectively. Furthermore, average of the maximum von Mises stresses for the five load cases is shown. Relative improvements and changes are compared to the conventional design.

Design	Weighted compliance 5 LC [J]	Improvement	Weighted compliance 14 LC [J]	Improvement	Average of max von Mises stress [MPa]	Change
Conventional design	264.6	-	655.6	-	225.4	-
Interpreted design	231.0	12.7%	574.8	12.3%	248.6	10.3%
Interpreted design - parametric optimization	189.6	28.4%	473.9	27.7%	199.2	-11.6%

Supplementary Table 2 | Total quantities of steel, concrete, and CO_2 for the entire bridge. Estimated material quantities calculated by knock-on effects from the savings in girder self-weight. The CO_2 calculations only take account of material quantities, hence disregarding construction methods.

Design	Steel [ton]	Savings [ton]	Concrete [m^3]	Savings [m^3]	CO_2 [ton]	Savings [ton]
Conventional design	69,000	-	175,000	-	233,000	-
Interpreted design	63,000	6,000	162,000	13,000	213,000	20,000
Interpreted design - parametric optimization	56,000	13,000	146,000	29,000	190,000	43,000

Supplementary Table 3 | Loads applied to the FE model. Load case 1-12: global, load case 13-14: local. *Only distributed load on half of the top surface and average hanger force due to skew load.

Load case	N_x [MN]	M_y [MNm]	M_z [MNm]	V_y [MN]	V_z [MN]	M_t [MNm]	Distributed load [kN per m^2]	Hanger force [MN]
1	9.3	65.6	8.5	0.2	0.6	-23.1	-6.8	2.3
2	-16.6	-99.6	52.2	-0.1	0.5	47.8	-12.4	3.7
3	-2.1	-247.3	-18.7	-0.2	1.4	-26.4	-12.5	3.5
4	4.7	169.3	6.0	0.0	0.5	-34.3	-7.5	2.3
5	0.1	28.8	-818.2	4.6	1.1	-10.0	-7.8	2.3
6	-1.3	-20.8	403.0	5.4	0.3	24.4	-8.8	2.5
7	0.1	-13.1	-344.2	-5.3	0.3	-7.9	-7.8	2.3
8	-1.3	-20.8	403.0	5.4	0.3	24.4	-8.8	2.5
9	6.1	-36.7	-5.9	-0.1	1.3	55.3	-9.2	3.0
10	-13.4	-125.1	-25.6	0.0	-0.7	-47.4	-11.6	2.5
11	-0.1	-13.5	226.5	0.2	1.0	-170.8	-11.4	3.4
12	-2.2	-18.4	-235.8	-0.2	1.0	165.5	-11.0	3.2
13	-	-	-	-	-	-	-5.0	1.6
14*	-	-	-	-	-	-	-5.0	0.8

Supplementary Table 4 | Steel plate thicknesses in conventional and interpreted designs. Steel plate thickness of the various girder parts are shown for the conventional design, and the interpreted design, before and after parametric optimization, respectively. All values are given in millimeters.

Design	Top plate	Bottom plate	Inclined web plate	Nose plate	Top plate troughs 1	Top plate troughs 2
Conventional design	14.0	9.0	12.0	10.0	7.0	8.0
Interpreted design	14.0	9.0	12.0	10.0	7.0	8.0
Interpreted design - parametric optimization	12.0	14.5	25.4	4.9	4.0	4.0

Design	Bottom plate troughs	Diaphragms, group 1	Diaphragms, group 2	Diaphragms, group 3	Diaphragms, group 4	Hanger steel plate
Conventional design	6.0	10.0	10.0	10.0	-	-
Interpreted design	6.0	6.9	6.9	6.9	6.9	8.3
Interpreted design - parametric optimization	4.0	8.3	6.3	5.9	6.3	8.8