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Design and optimization of lattice structures for aerospace applications

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Contents

Contents iii

List of Figures v

List of Tables v

1 Enriching the classic TTO formulation with advanced mechanical constraints 1
- 1.1 Local buckling and kinematic compatibility constraints . . . 1
  - 1.1.1 Local and topological buckling constraints . . . 1
  - 1.1.2 Kinematic compatibility constraints . . . 1
  - 1.1.3 Minimum slenderness constraints . . . 1
- 1.2 Optimization formulation and solving strategy . . . 2
  - 1.2.1 Optimization strategy . . . 2
  - 1.2.2 First step: SLP optimization . . . 2
  - 1.2.3 Handling local minima: reinitialization strategy . . . 2
  - 1.2.4 Second step: NLP optimization . . . 2
- 1.3 Numerical application . . . 2
  - 1.3.1 Ten-bar truss . . . 2
  - 1.3.2 2D cantilever beam . . . 2
  - 1.3.3 Simply supported 3D beam . . . 2
  - 1.3.4 Ten-bar truss with multiple load cases . . . 2
- 1.4 Conclusion . . . 2

List of Figures

1.1 todo 34 38 56 79 2

List of Tables

1.1 todo 2

Enriching the classic TTO formulation with advanced mechanical constraints

1

1.1 Local buckling and kinematic compatibility constraints 1
1.2 Optimization formulation and solving strategy . . 2
1.3 Numerical application . 2
1.4 Conclusion 2

Introduction

1.1 Local buckling and kinematic compatibility constraints

1.1.1 Local and topological buckling constraints

1.1.2 Kinematic compatibility constraints

1.1.3 Minimum slenderness constraints

As precedently seen, one of the limit of the tto is that is based on truss model. so we cannot trust the results if the model is outside of his limits. For that reason in section we have already set the limit to 15. th focus of this section is to introduce an upper bound on the cross sectional area design variable to deal with that

we first formely introduce the slenderness of a bar as:

$$\lambda = \frac{\ell}{R_{\mathrm{g}}} \tag{1.1}$$

remembering that $R_{\mathrm{g}} = \sqrt{I/a_j}\; I = \pi r_j^4/4\; a_j =$

$$R_{\mathrm{g}} = r/2 \tag{1.2}$$

The minimum slenderness limit constraints g_{slend} are stated as:

$$a_j \leq \frac{4\pi\ell_j^2}{\lambda_{\max}}, \quad \forall j \in [1, \ldots, N_{\mathrm{el}}] \tag{1.3}$$

we re run the optimization on the l shape beam of section XX using formulation and adding only the slenderness constraints. in image the results of st = 1,08,03,02. we see how the same load is repartitioned on multiple bars. we active more bars because there is un upper imit on the area (and then the force) that they can bear.

We compared the results with the olds . we see that the number of active bars increase, as the colaulation time, but the volume stays almost the same, indicating that there are plenty of solutions with almost the same volume

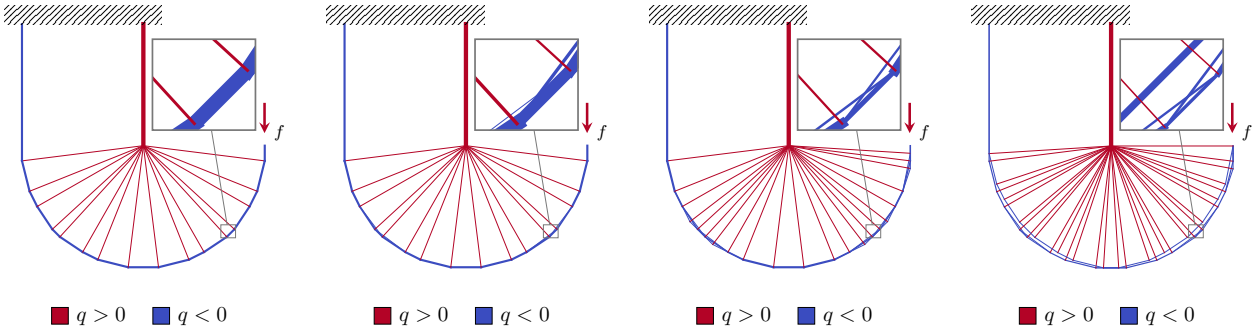

Figure 1.1: todo 34 38 56 79

Table 1.1: todo

σ_L	V_f	Min λ	$V_{f,sl}$	Min λ_{sl}	$V_{f,sl}/V_f$	$N_{el,sl}/N_{el}$	t_{sl}/t
1.0	6.21 %	15.8	6.21 %	15.8	1.0000	1.00	1.02
0.9	6.90 %	15.0	6.90 %	15.0	1.0000	1.00	1.03
0.8	7.76 %	14.1	7.76 %	15.0	1.0001	1.12	2.27
0.7	8.87 %	13.2	8.87 %	15.0	1.0001	1.12	2.21
0.6	10.35 %	12.2	10.35 %	15.0	1.0002	1.12	1.12
0.5	12.42 %	11.2	12.42 %	15.0	1.0003	1.12	1.07
0.4	–	–	15.53 %	15.0	–	–	–
0.3	–	–	20.71 %	15.0	–	–	–
0.2	–	–	31.06 %	15.0	–	–	–

1.2 Optimization formulation and solving strategy

1.2.1 Optimization strategy

1.2.2 First step: SLP optimization

1.2.3 Handling local minima: reinitialization strategy

1.2.4 Second step: NLP optimization

1.3 Numerical application

1.3.1 Ten-bar truss

1.3.2 2D cantilever beam

1.3.3 Simply supported 3D beam

1.3.4 Ten-bar truss with multiple load cases

1.4 Conclusion