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Weight optimization of steel trusses for industrial buildings

Koen Peeters

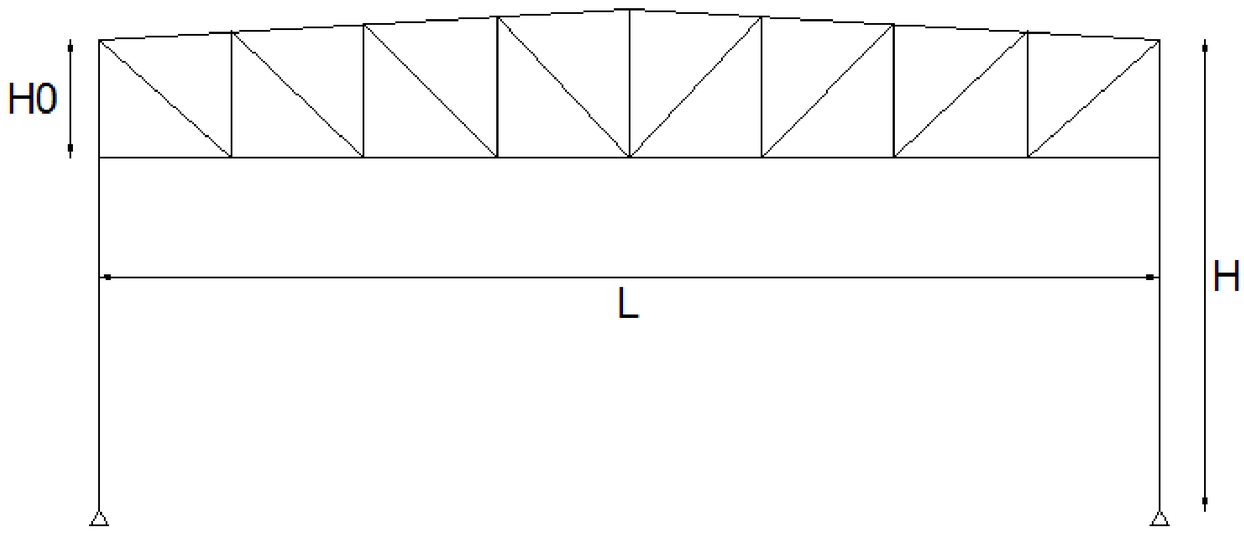
Master IW bouwkunde

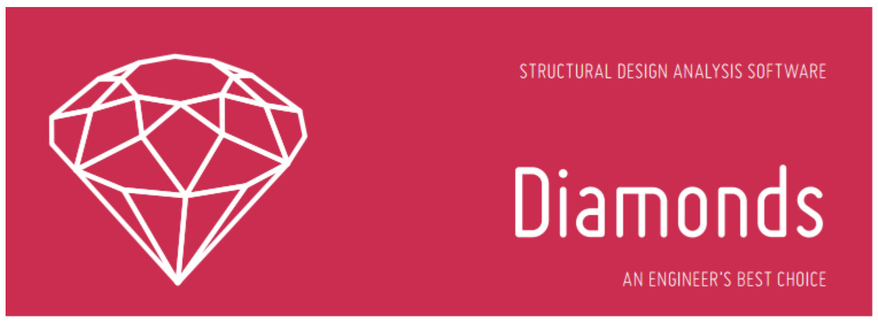
Introduction

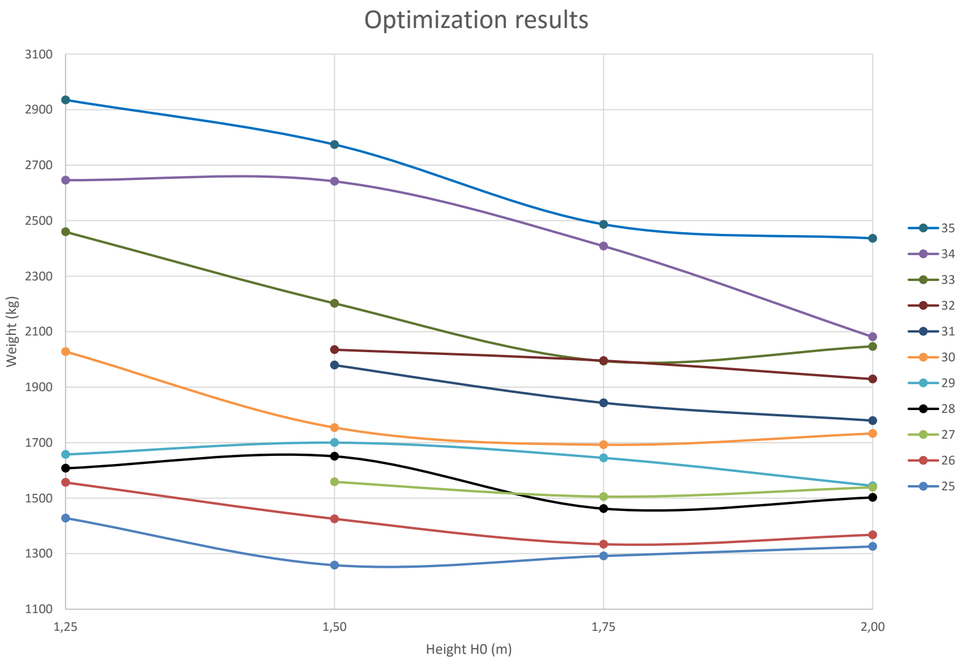
Steel truss structures are a commonly used solution when constructing industrial buildings, more specifically to support the roof. When designing any kind of structure, one always strives to achieve the most economical solution, both for the client and the contractor. One of the main factors of the total cost of a project is the material cost, and in steel construction this cost depends largely on the weight of the structure. In association with the stability bureau AB Associations, the objective of this thesis is the weight optimization of steel trusses, used in industrial portal steel frames, by means of computer aided structural design software.

Optimization procedure

- Objective function
  - Minimize $W(A_i) = \sum_{i=1}^{n} A_i L_i \gamma$
- Variables
  - Shape optimization
    - Length: 25m - 35m
    - Height H_0: 1,25m - 2,00m
  - Size optimization
    - Cross-sections
      - Columns: IPE
      - Chords: HEA
      - Web members: SHS (80/4, 60/4, 100/5)
- Constraints
  - Geometry: Frame spacing 6m
  - Loads
    - Wind: 0,591 kN/m^2
    - Snow: 0,4 kN/m^2
    - Roof: 0,25 kN/m^2
    - Self-weight: 77 kN/m^3
  - Limit states
    - SLS: deflection, lateral displacement
    - ULS: cross-sectional resistance, buckling





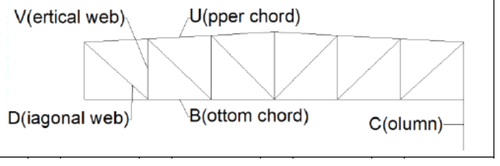


Optimization results Truss & Columns

H0 \ L	25	26	27	28	29	30	31	32	33	34	35
1,25	C IPE 330 U HEA 120 B HEA 120 D SHS 60/4 V SHS 60/4	C IPE 330 U HEA 140 B HEA 100 D SHS 80/4 V SHS 60/4		C IPE 360 U HEA 140 B HEA 100 D SHS 80/4 V SHS 60/4	C IPE 360 U HEA 140 B HEA 100 D SHS 80/4 V SHS 60/4	C IPE 360 U HEA 160 B HEA 120 D SHS 80/4 V SHS 60/4			C IPE 400 U HEA 160 B HEA 120 D SHS 100/5 V SHS 80/4	C IPE 400 U HEA 180 B HEA 140 D SHS 80/4 V SHS 80/4	C IPE 450 U HEA 180 B HEA 140 D SHS 100/5 V SHS 80/4
1,50	C IPE 330 U HEA 120 B HEA 100 D SHS 60/4 V SHS 60/4	C IPE 330 U HEA 140 B HEA 100 D SHS 60/4 V SHS 60/4	C IPE 330 U HEA 140 B HEA 100 D SHS 80/4 V SHS 60/4	C IPE 360 U HEA 140 B HEA 100 D SHS 80/4 V SHS 60/4	C IPE 360 U HEA 140 B HEA 100 D SHS 80/4 V SHS 60/4	C IPE 360 U HEA 140 B HEA 100 D SHS 80/4 V SHS 60/4	C IPE 360 U HEA 160 B HEA 120 D SHS 80/4 V SHS 60/4	C IPE 360 U HEA 160 B HEA 100 D SHS 80/4 V SHS 60/4	C IPE 400 U HEA 160 B HEA 120 D SHS 80/4 V SHS 80/4	C IPE 400 U HEA 180 B HEA 140 D SHS 80/4 V SHS 60/4	C IPE 450 U HEA 180 B HEA 120 D SHS 80/4 V SHS 80/4
1,75	C IPE 330 U HEA 120 B HEA 100 D SHS 60/4 V SHS 60/4	C IPE 330 U HEA 120 B HEA 100 D SHS 60/4 V SHS 60/4	C IPE 330 U HEA 140 B HEA 100 D SHS 60/4 V SHS 60/4	C IPE 360 U HEA 120 B HEA 100 D SHS 60/4 V SHS 60/4	C IPE 360 U HEA 140 B HEA 100 D SHS 60/4 V SHS 60/4	C IPE 360 U HEA 140 B HEA 100 D SHS 60/4 V SHS 60/4	C IPE 360 U HEA 140 B HEA 100 D SHS 80/4 V SHS 60/4	C IPE 360 U HEA 140 B HEA 120 D SHS 80/4 V SHS 60/4	C IPE 400 U HEA 140 B HEA 100 D SHS 80/4 V SHS 80/4	C IPE 400 U HEA 180 B HEA 120 D SHS 60/4 V SHS 60/4	C IPE 450 U HEA 160 B HEA 120 D SHS 80/4 V SHS 80/4
2,00	C IPE 330 U HEA 120 B HEA 100 D SHS 60/4 V SHS 60/4	C IPE 330 U HEA 120 B HEA 100 D SHS 60/4 V SHS 60/4	C IPE 330 U HEA 140 B HEA 100 D SHS 60/4 V SHS 60/4	C IPE 360 U HEA 120 B HEA 100 D SHS 60/4 V SHS 60/4	C IPE 360 U HEA 120 B HEA 100 D SHS 60/4 V SHS 60/4	C IPE 360 U HEA 140 B HEA 100 D SHS 60/4 V SHS 60/4	C IPE 360 U HEA 140 B HEA 100 D SHS 60/4 V SHS 60/4	C IPE 360 U HEA 140 B HEA 120 D SHS 60/4 V SHS 60/4	C IPE 400 U HEA 140 B HEA 100 D SHS 80/4 V SHS 60/4	C IPE 400 U HEA 160 B HEA 120 D SHS 60/4 V SHS 60/4	C IPE 450 U HEA 160 B HEA 100 D SHS 80/4 V SHS 80/4

Wind load: $v_{b,0}$ = 25 m/s
Terrain category III
H = 8m
Snow load: 0,4 kN/m²
Roof load: 25 kg/m²

Steel: S235



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