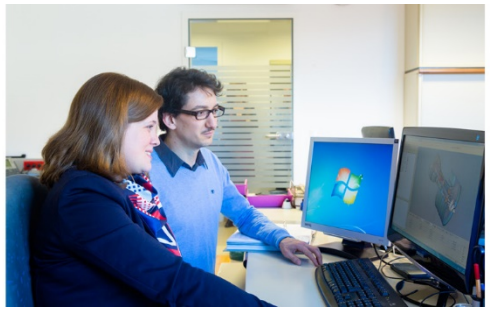
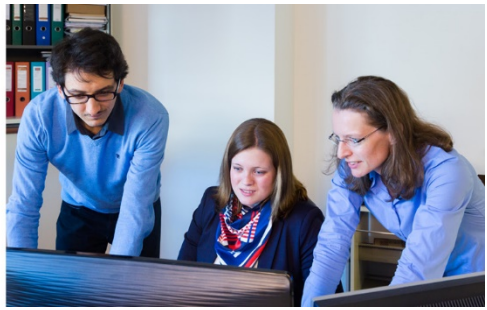



KUNSTSTOFF TECHNIK LEOBEN

KONSTRUIEREN IN KUNST- UND VERBUNDSTOFFEN

Finite element modelling of steel-cable reinforced rubber conveyor belts

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*Semperit Technische Produkte GmbH

Werfenweng, 04.03.2020

SEMPERIT

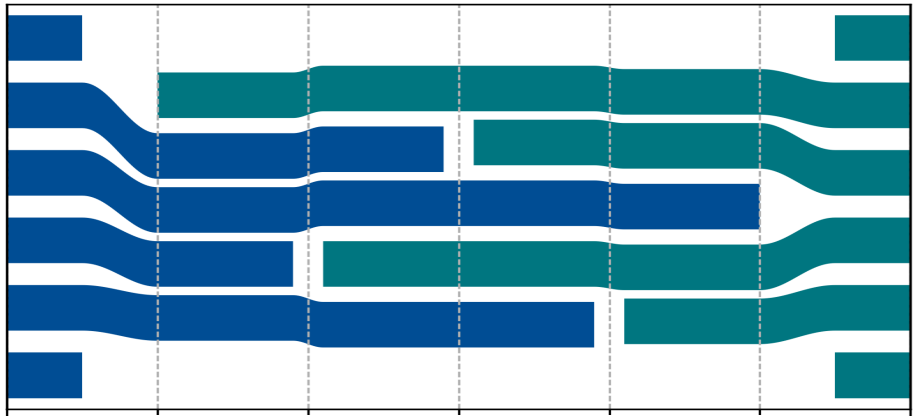
Introduction conveyor belts

- Transport goods over very long distances

- Heavily loaded
  →Steel cable reinforcement

- Consists of several pieces
  - Connected through connection scheme

Conveyor belt in application
Picture by Sempertrans

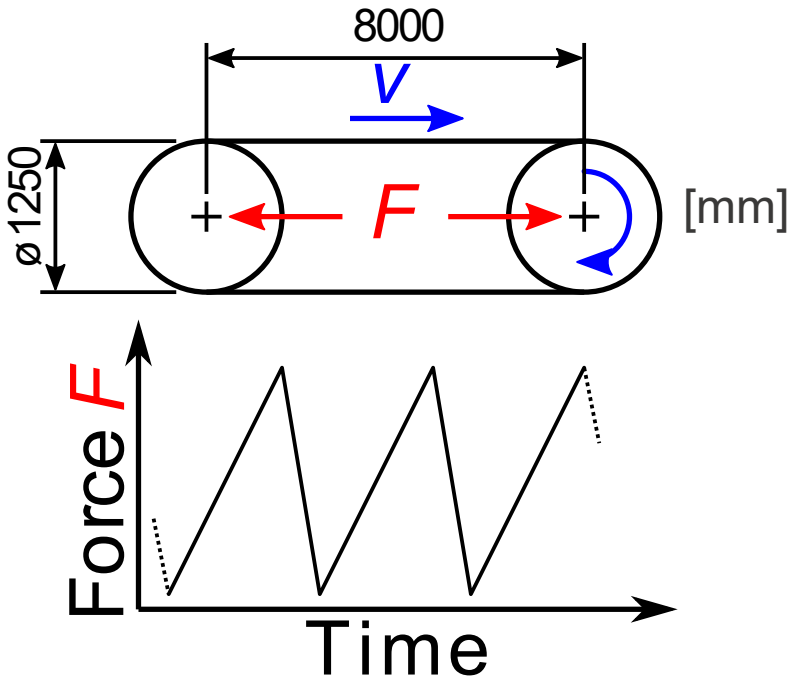


Connection is weakest point

Application ITA test rig

*DIN 22110-3

Testing methods for conveyor belt joints



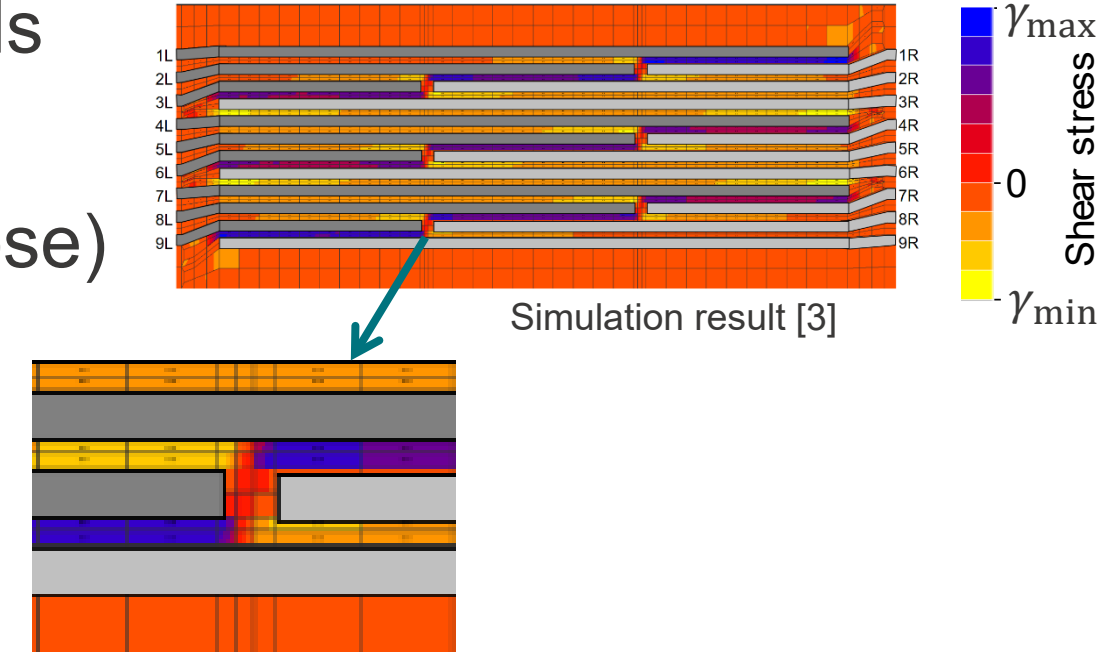
ITA test rig 3500 kN (Hannover) [1]

→ Huge task of modelling belt deformations/stresses

Aim of the project

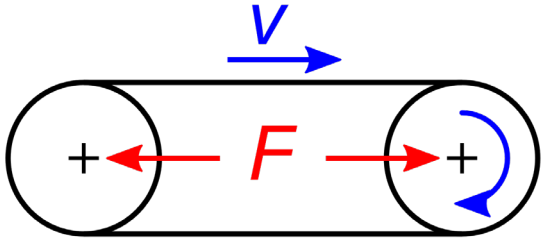
Determine stress and displacement fields

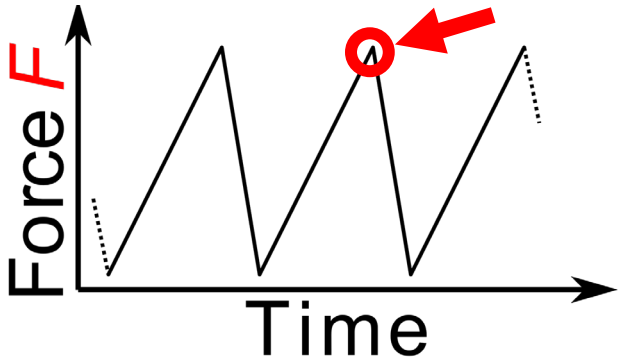
- Existing tension model (Keller & Froböse)



Simulation result [3]

- Full test rig model
  - Quasi-static state at maximum load

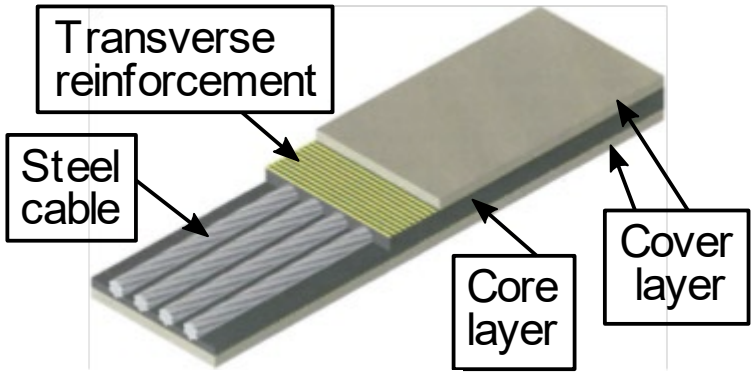




Model Setup

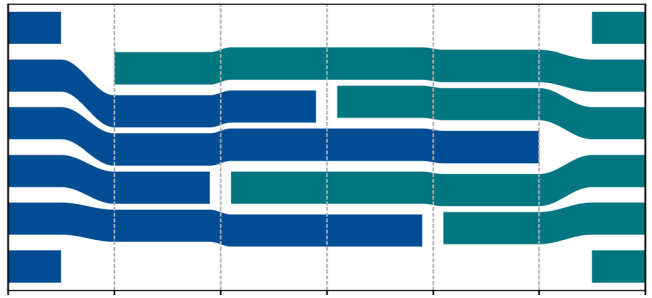
Model requirements

- Cables and materials

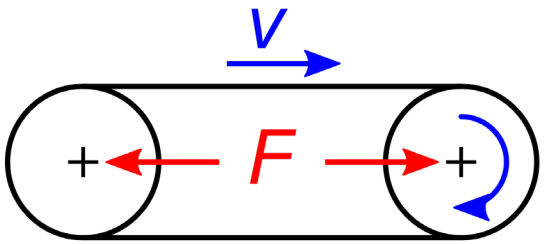


Conveyor belt scheme [2]

- The connection (splice)

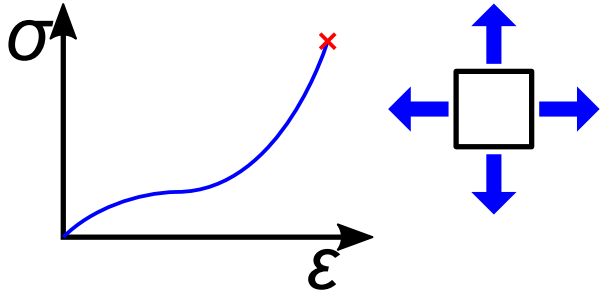


- Test rig kinematics

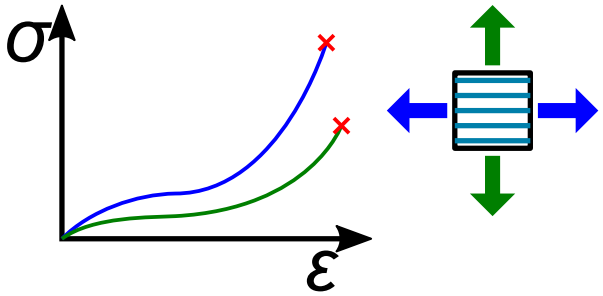


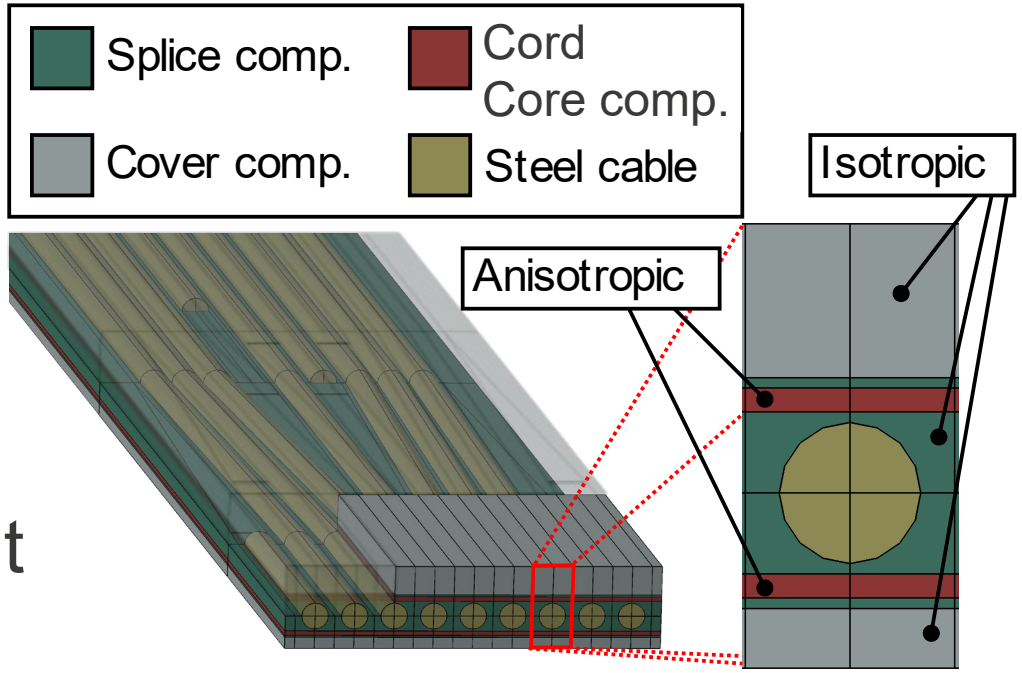
Materials and geometry

- Isotropic hyperelastic rubber



- Anisotropic hyperelastic reinforcement



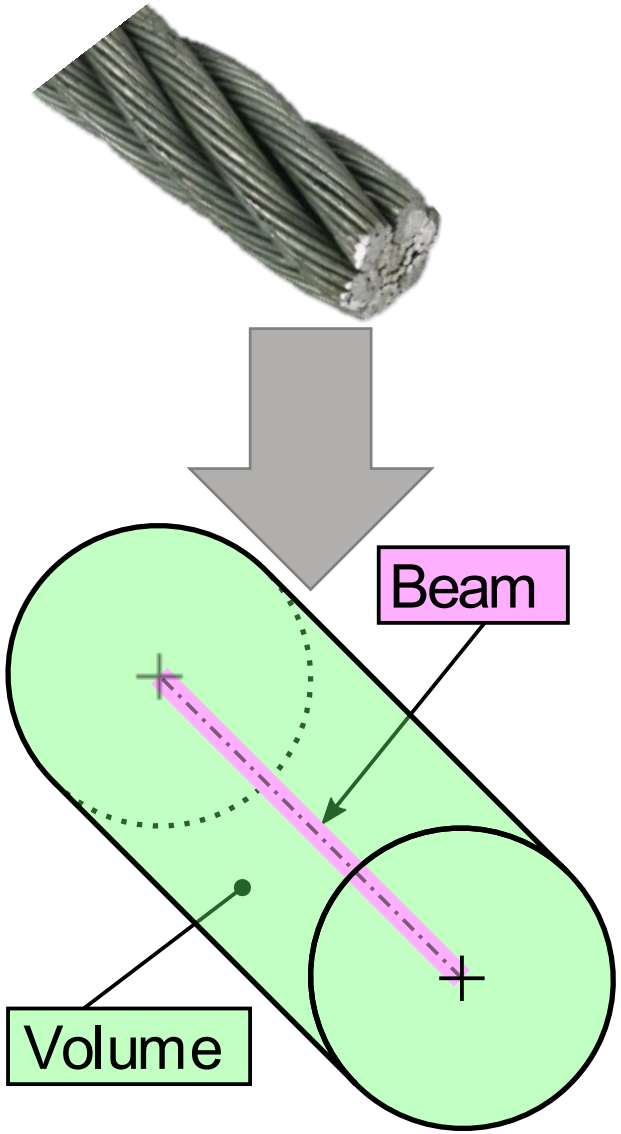


→ Steel cable ?

Steel cables

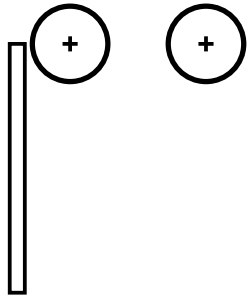
- High tensile stiffness
- Low bending stiffness

- Homogenized model of cable
  - Beam elements (tensile stiffness)
  - Volume elements (bending stiffness)

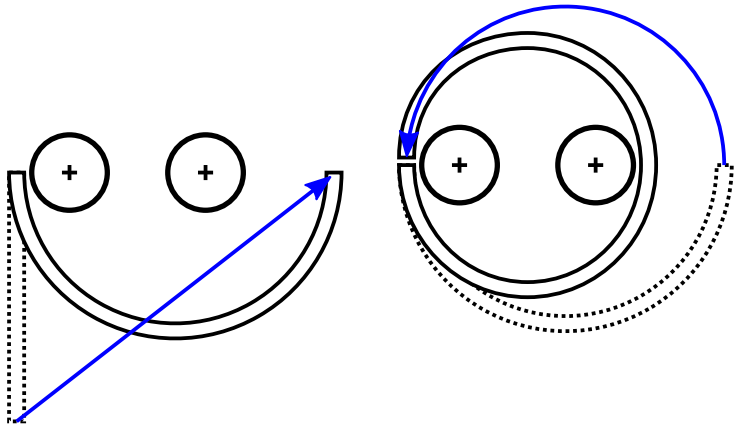


Load history: Full deformation history

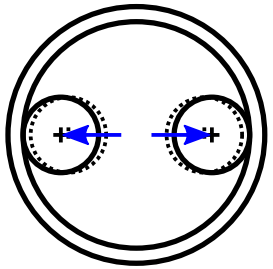
- Start with a straight belt



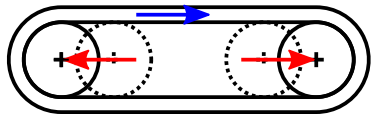
- Bend the belt and connect the ends



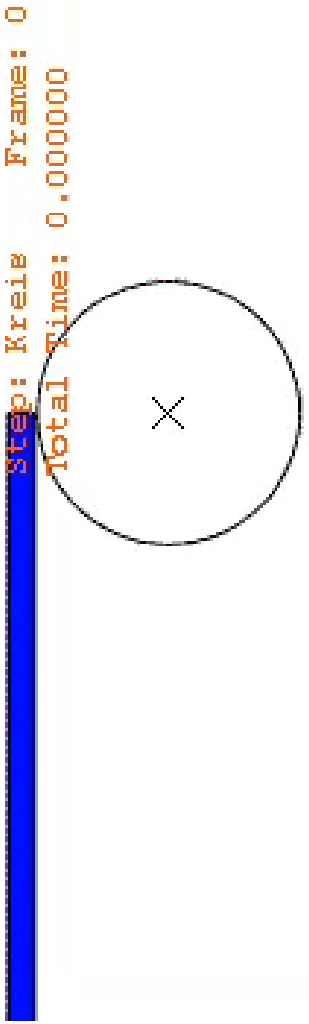
- Bring the drums into contact



- Apply the load and velocity



Load history

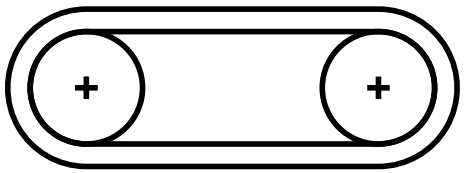


omputation times

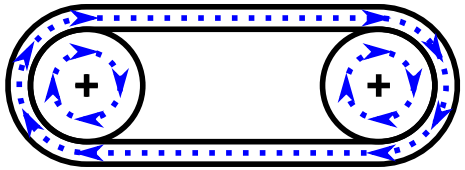
Load history: Start with predeformation

Initial state:

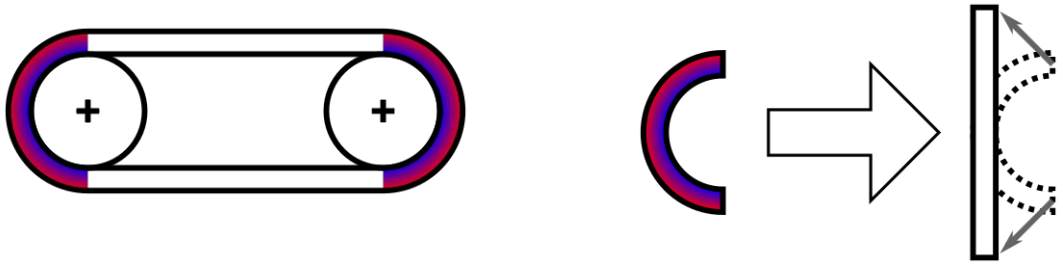
- Drums already in contact



- Apply an initial velocity



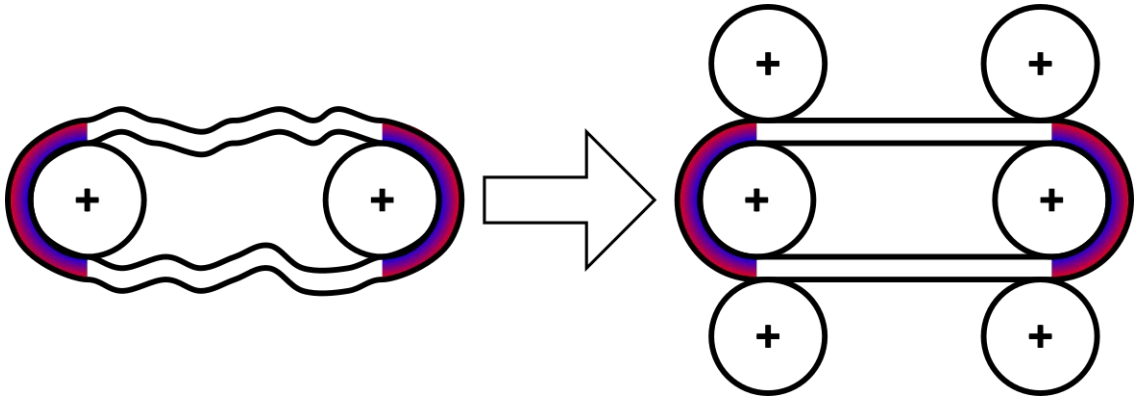
- Apply initial stress in bent region



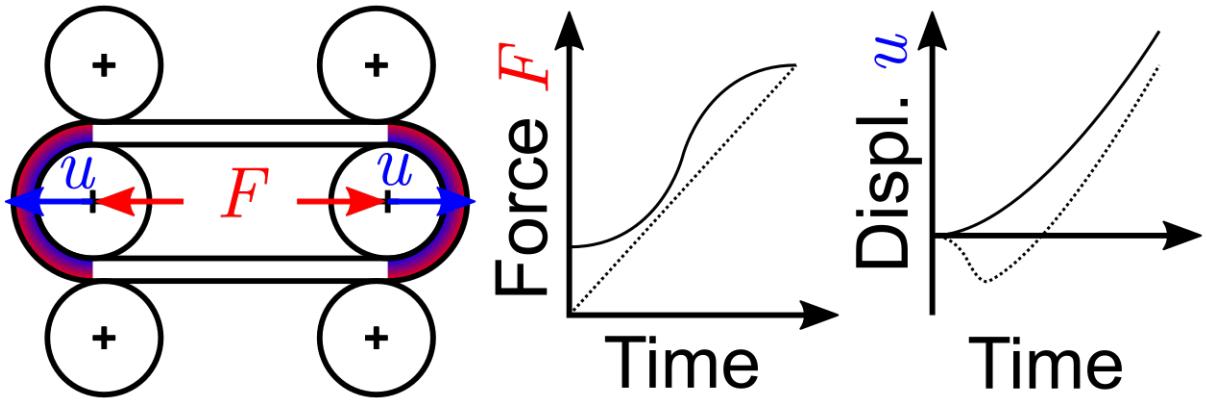
→ Efficient modelling with Abaqus/Explicit

Reducing unwanted dynamic effects

- Add support drums

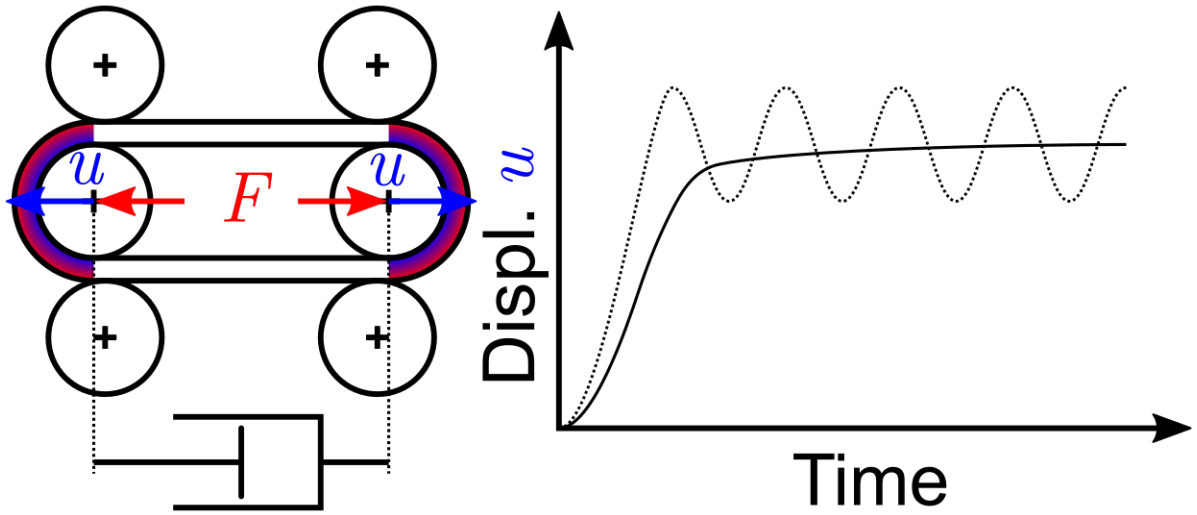


- Smooth load application with initial value



Reducing unwanted dynamic effects

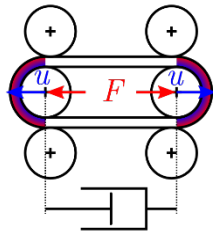
- Apply damping

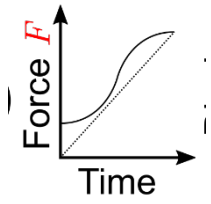


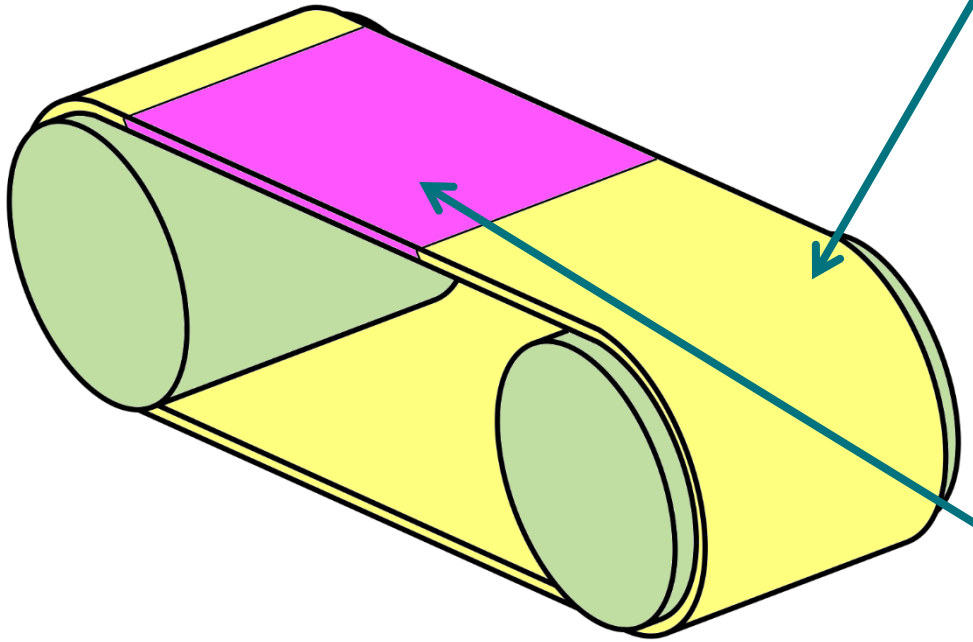
→ Dynamic artefacts under control

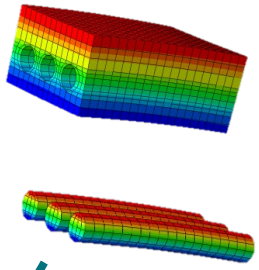
3D Test rig modelling

1. Conveyor belt:
homogeneous material



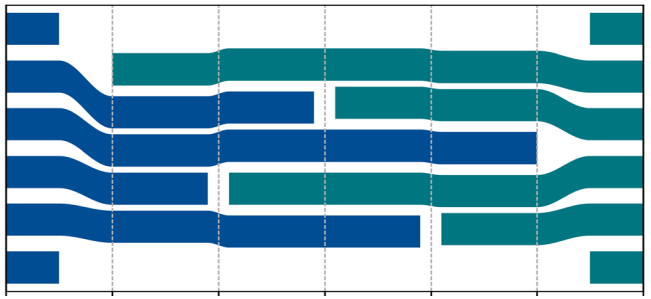






2. Conveyor belt
with steel cables

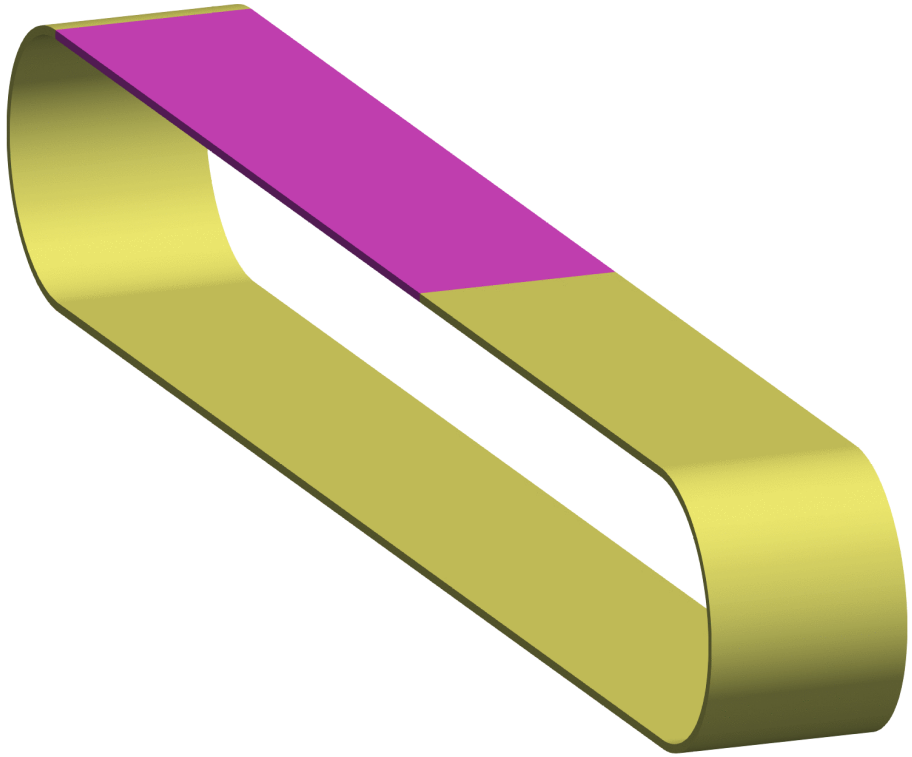
3. Conveyor belt with splice

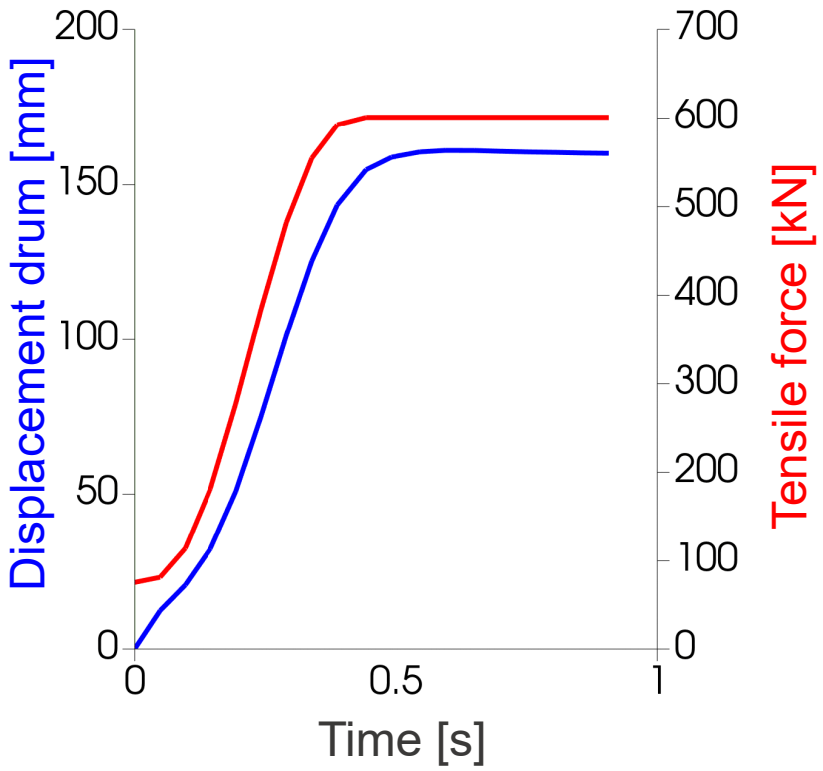


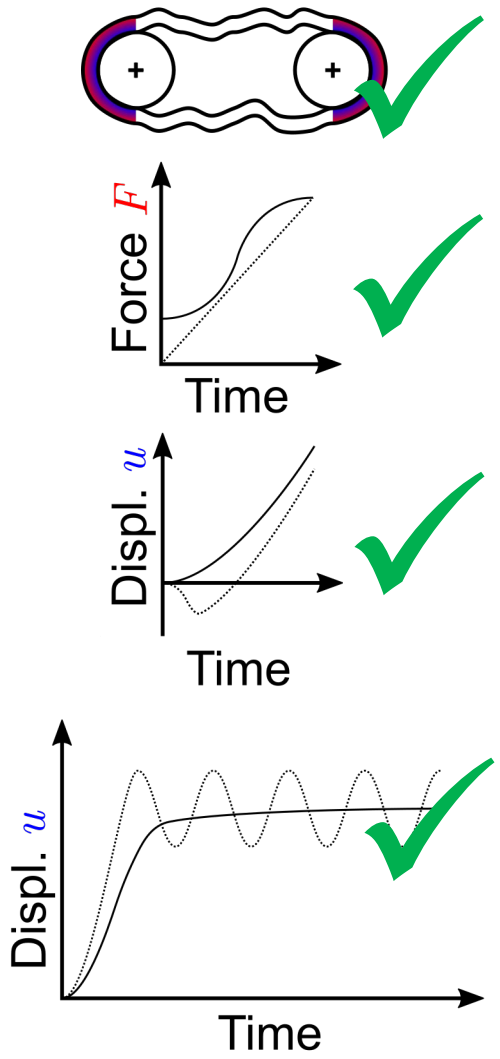
→ Stepwise development is finished

Results

Applying the load

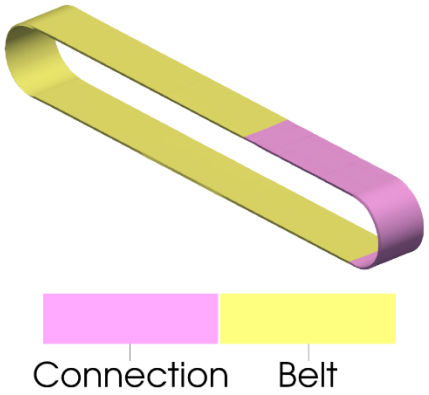




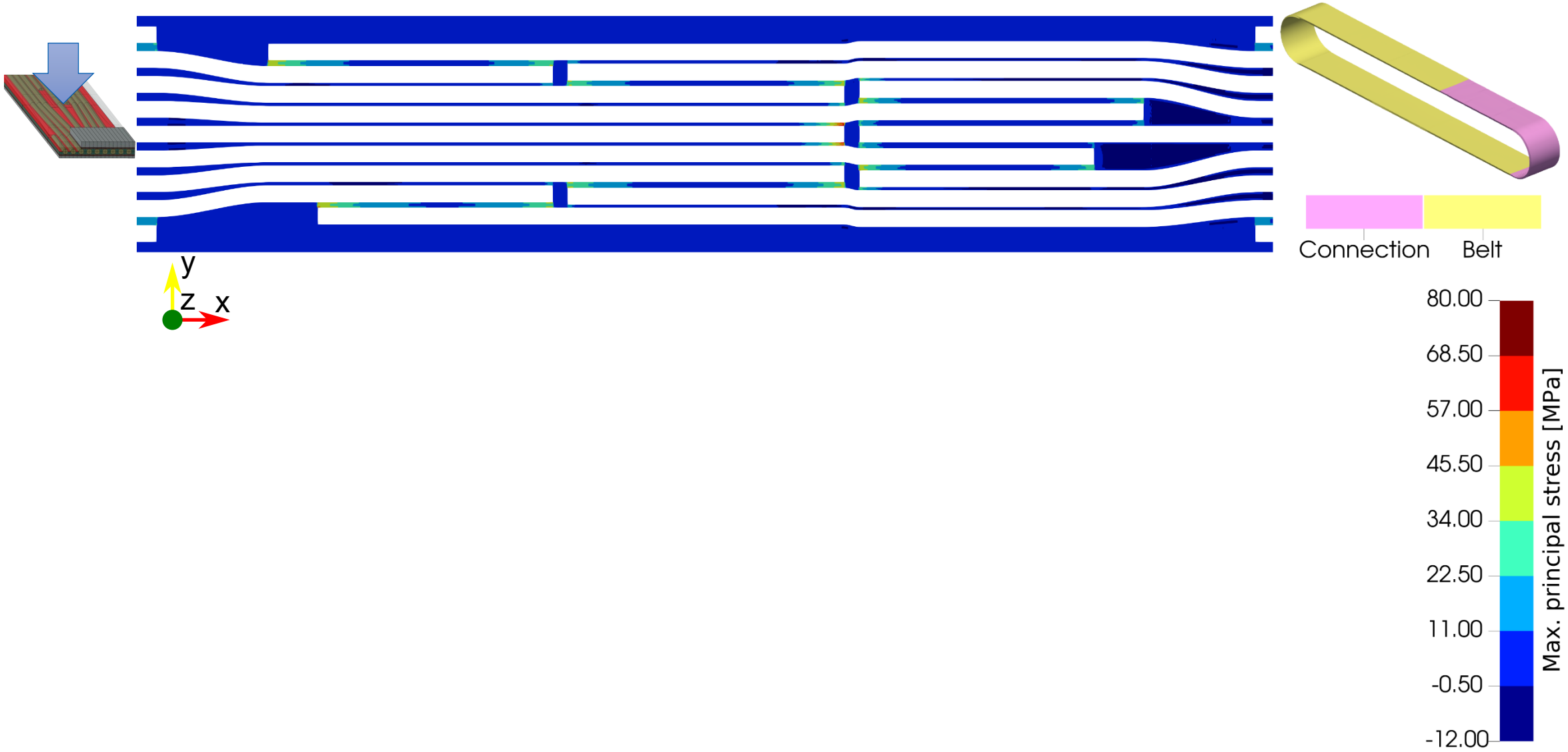


→ Smooth load history is reached

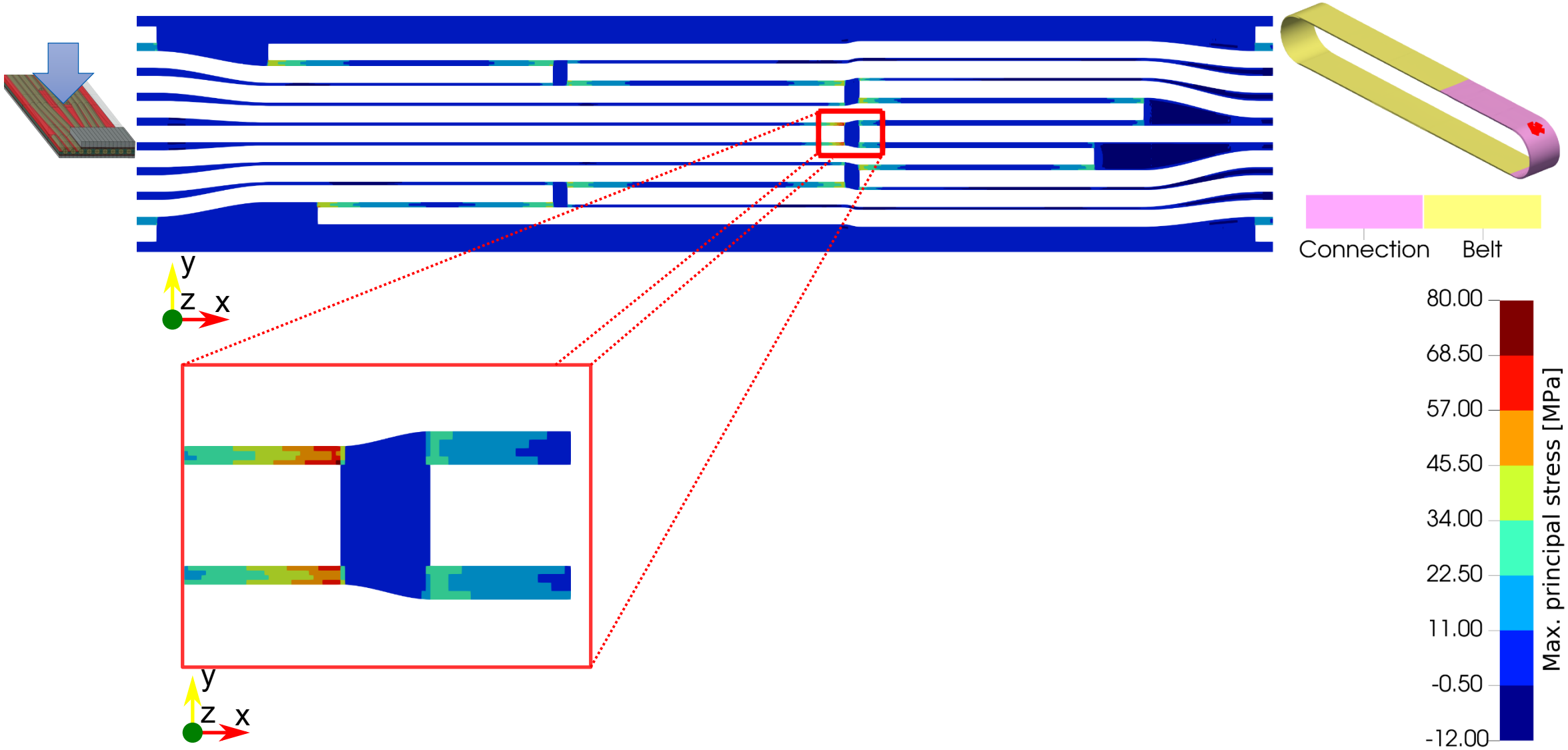
Evaluation of stresses in belt



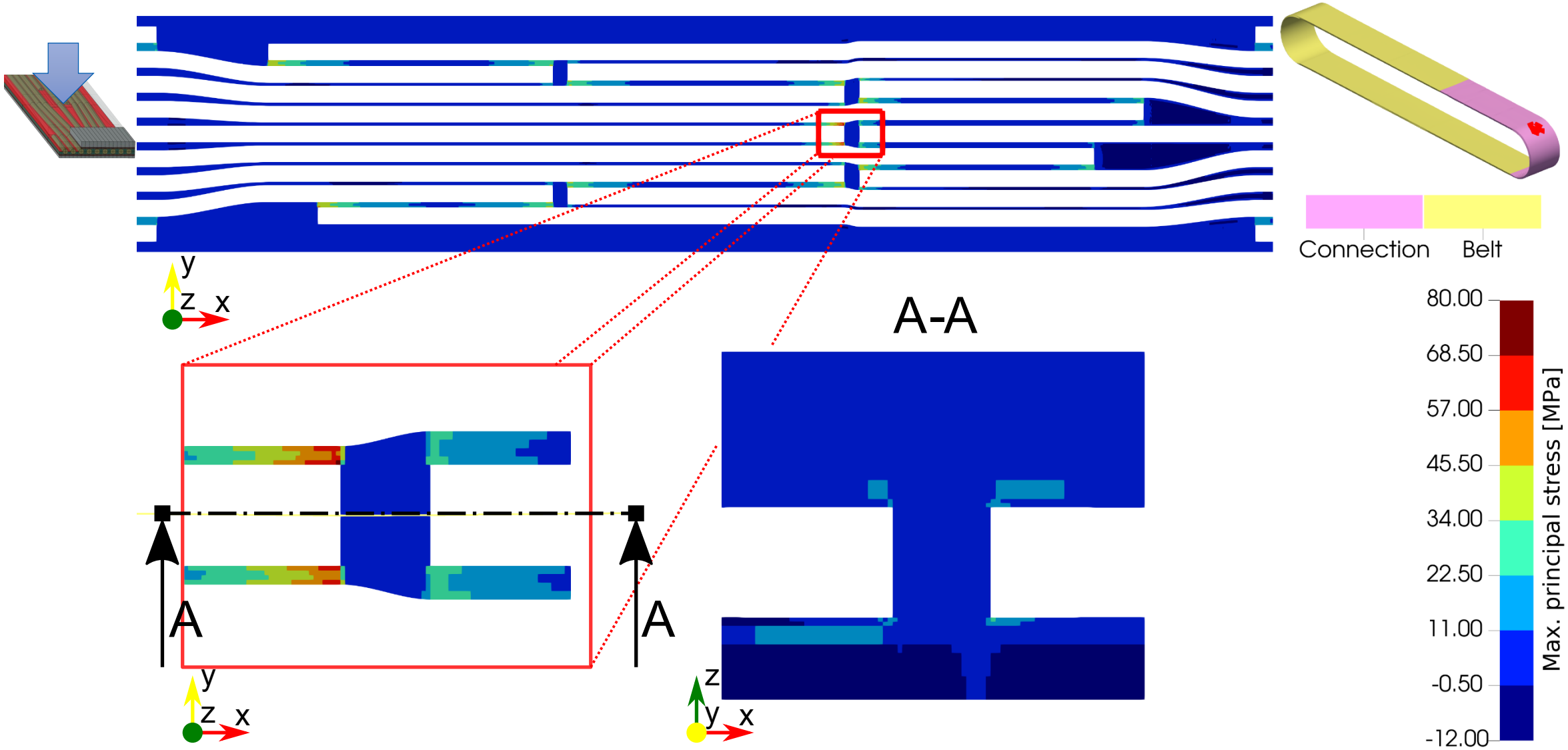
Visualisation



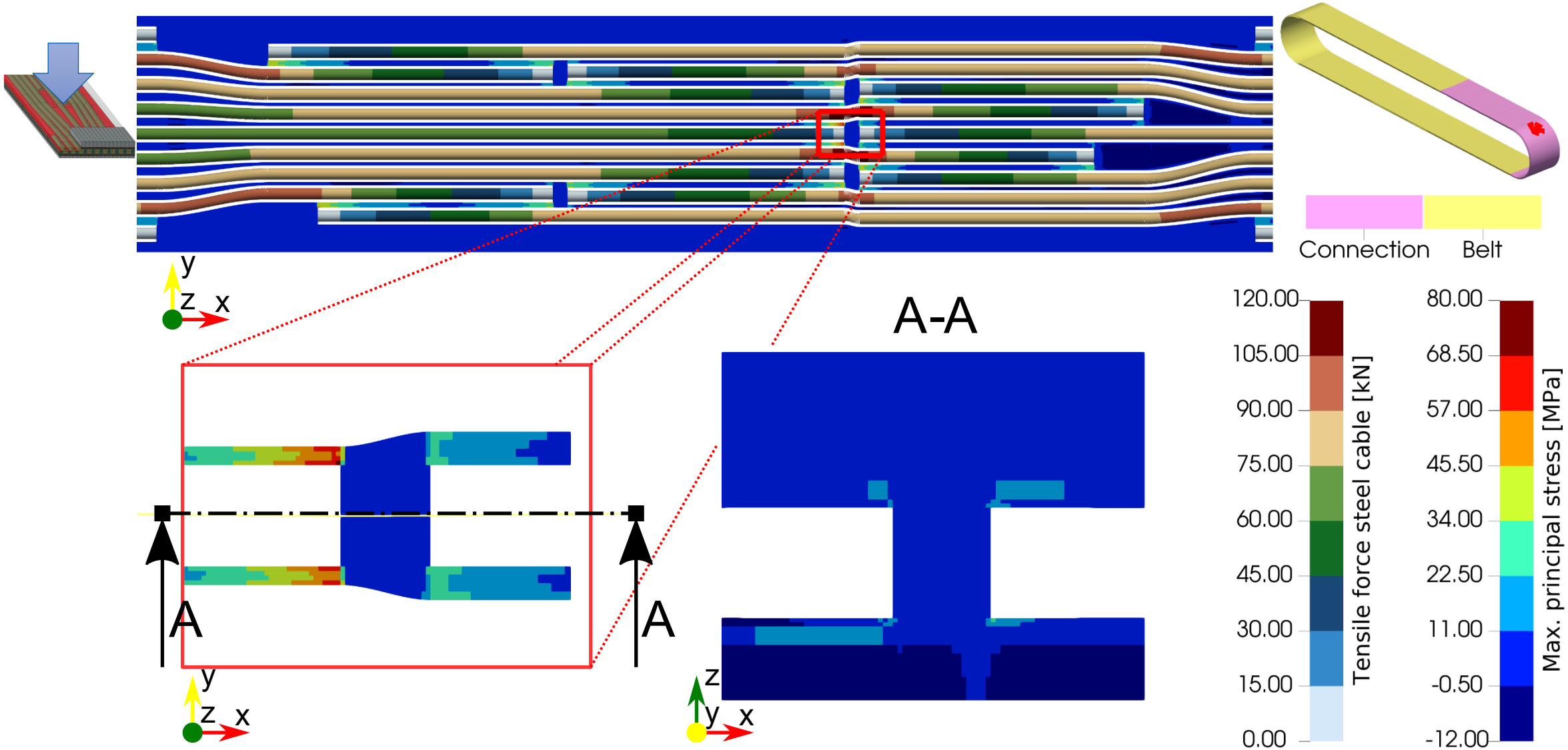
Visualisation



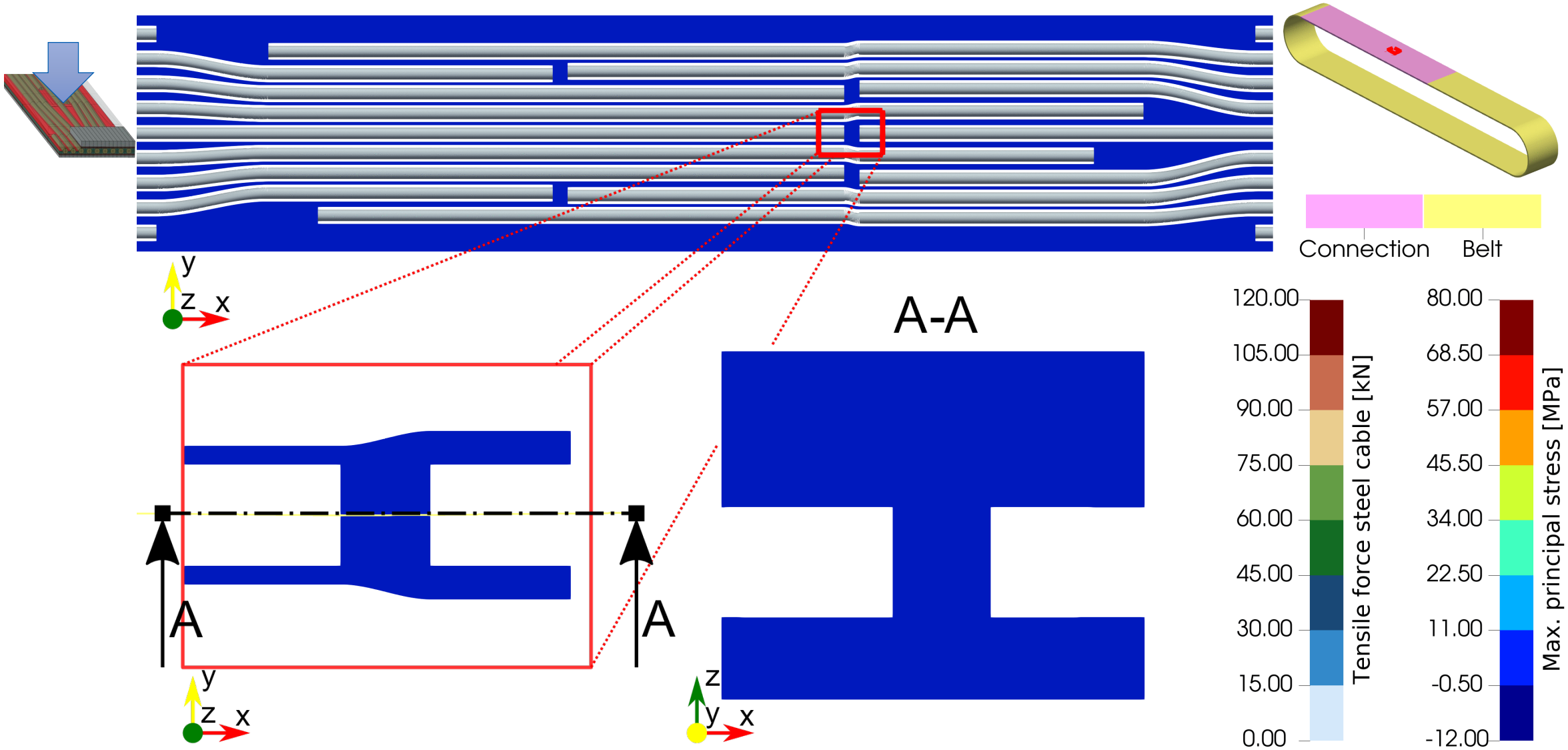
Visualisation



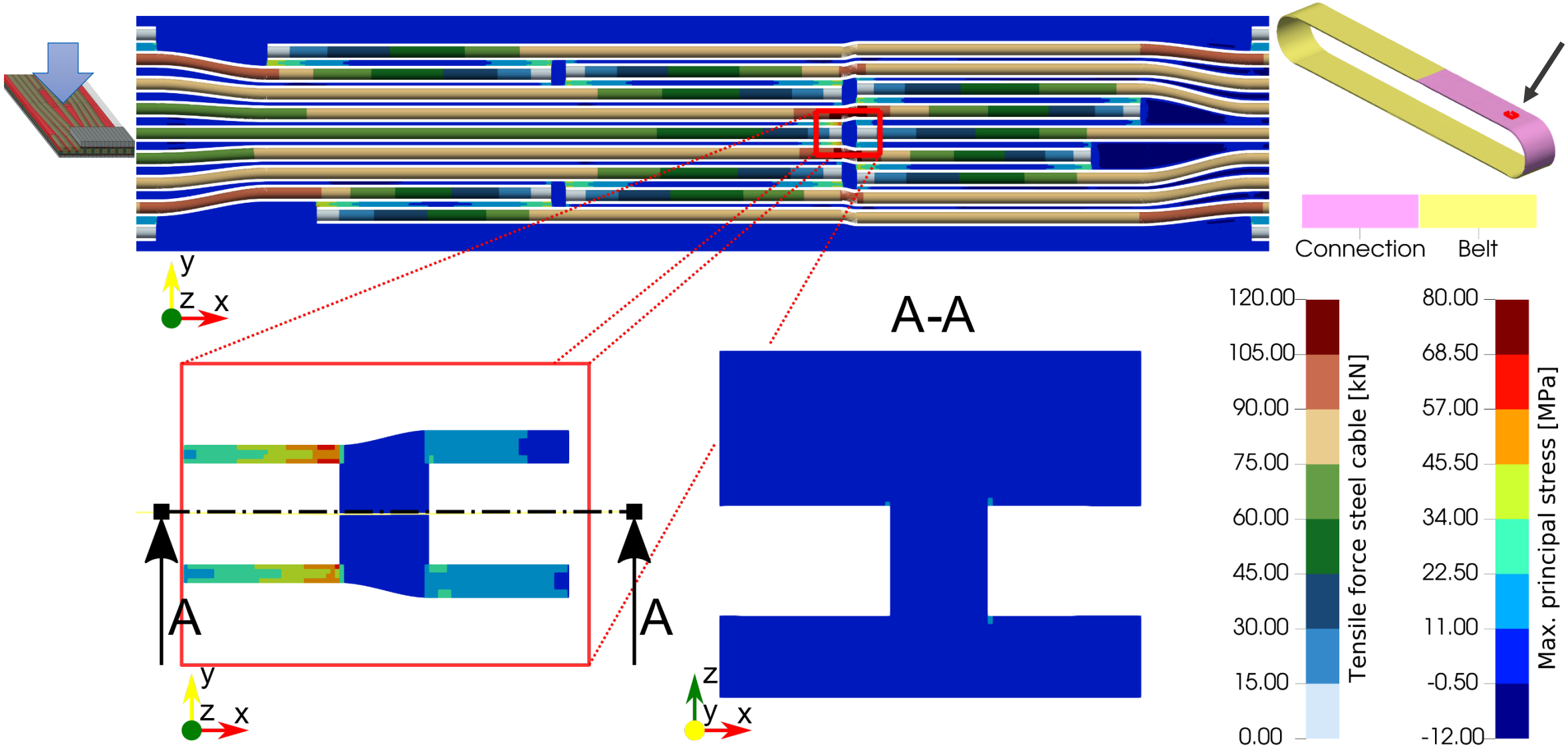
Visualisation



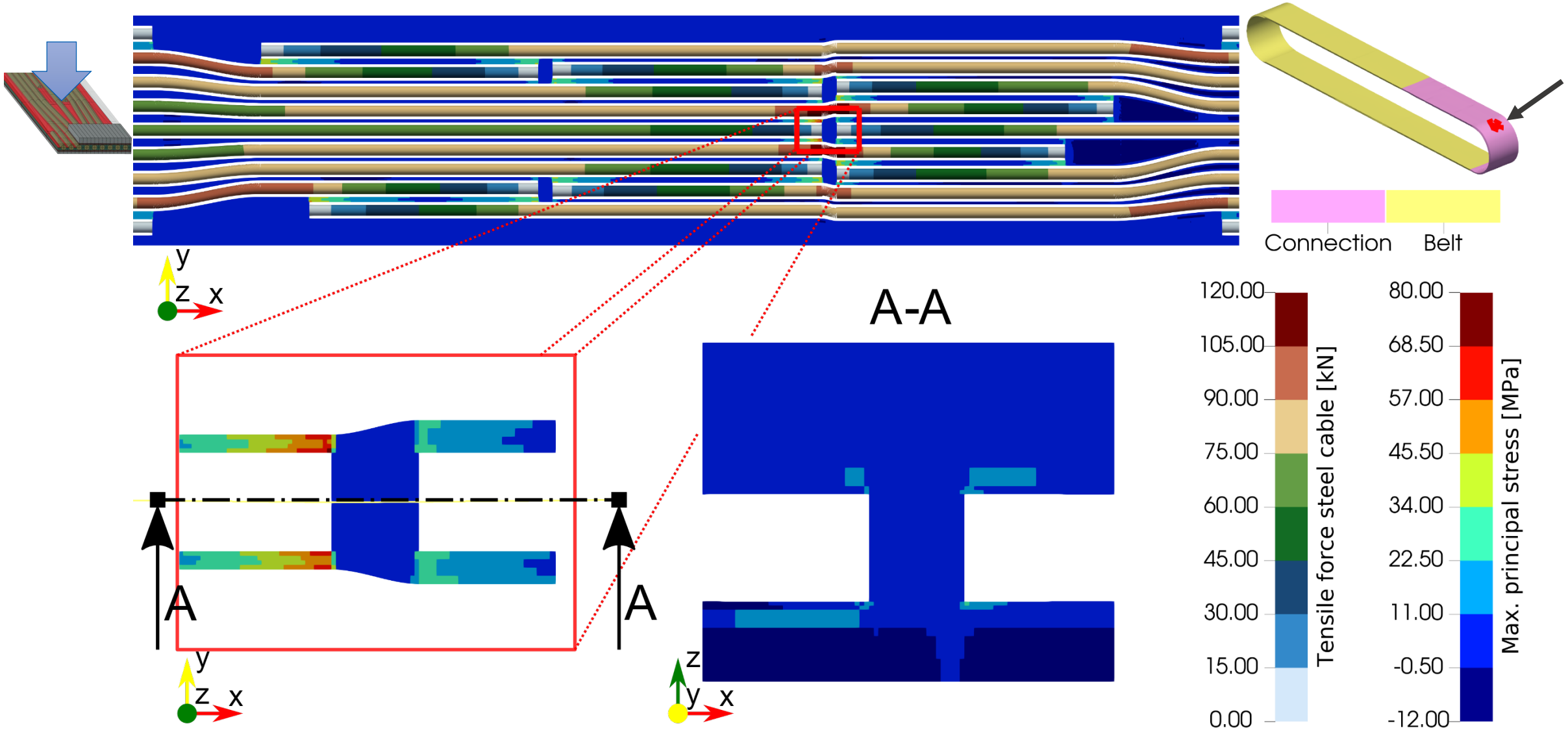
Running belt



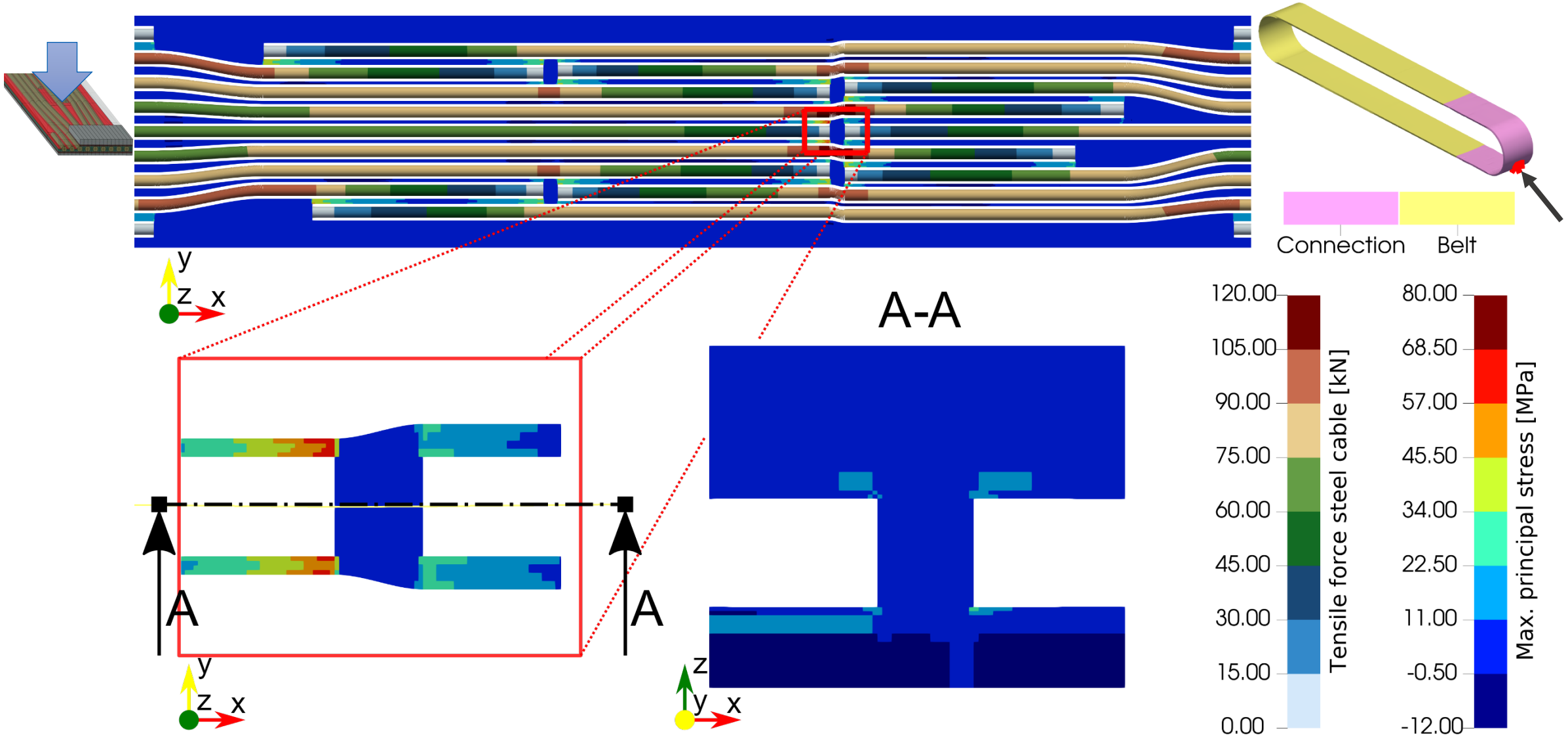
Detail in front of the drum



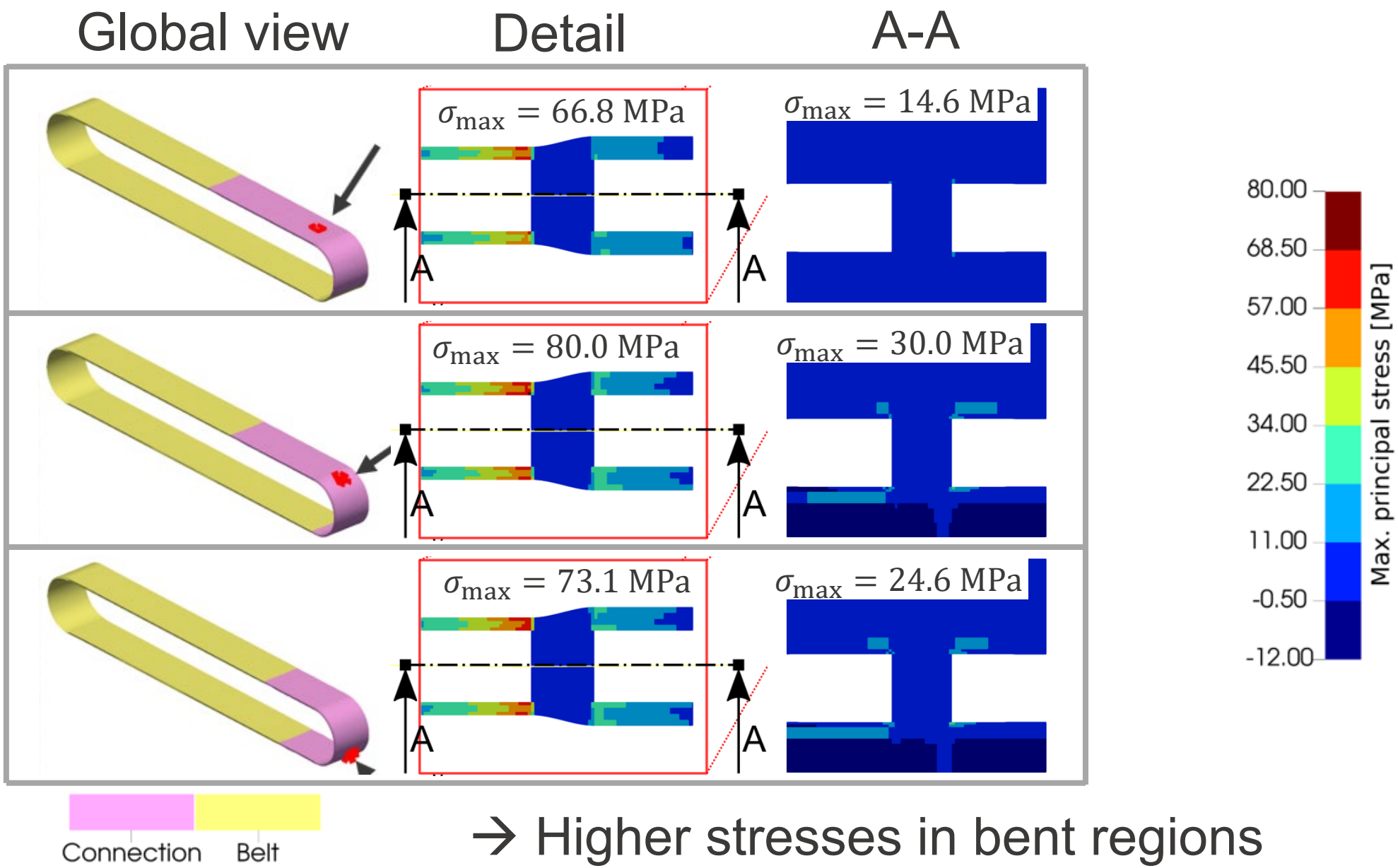
Detail on the drum (P1)



Detail on the drum (P2)



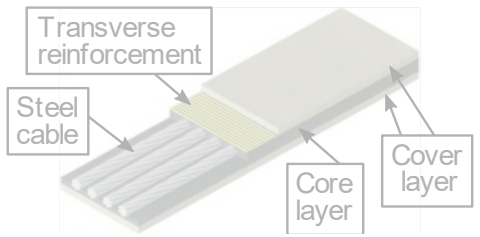
Detail comparisation



→ Higher stresses in bent regions

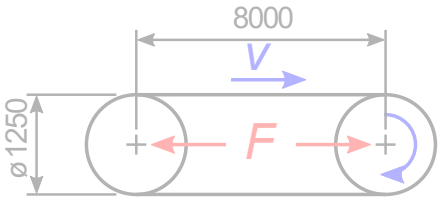
Conclusion

- Conveyor belts: Necessary to model cables

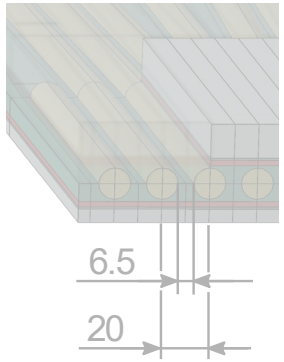


Conveyor belt scheme [2]

- Small features / big belt: Huge amount of elements

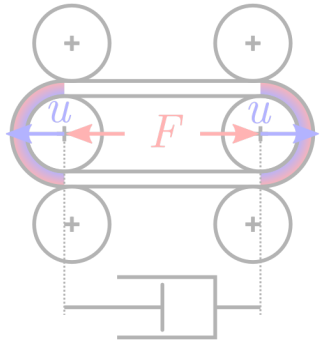


4.5E6 Elements

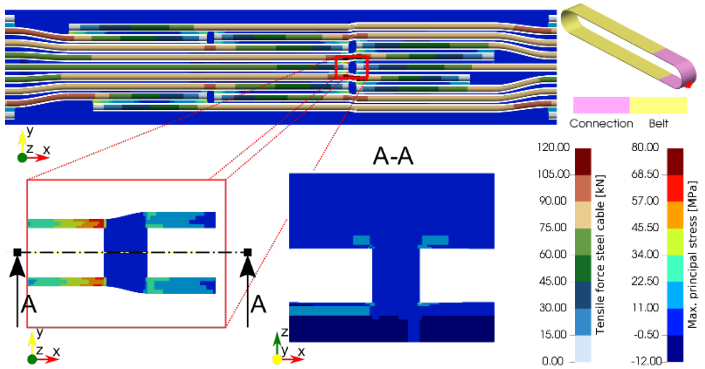


[mm]

- Simulation tricks were necessary



→ But we did it ☺



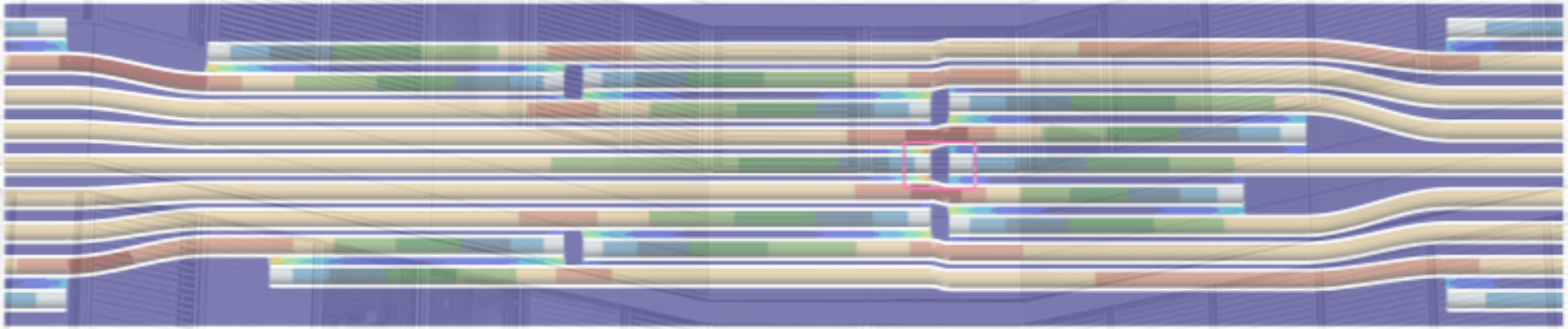
56 Cores
10 Days

References

[1] **Hötte, Daniel; Lotz, Christoph; Froböse, Tobias; Overmeyer, Ludger:** Trends in der frühzeitigen Schadensanalyse von Fördergurtverbindungen während der Umlaufprüfung, 20. Fachtagung Schüttgutfördertechnik 2015 „Schüttguthandling im Zeitalter von Industrie 4.0, 2015

[2] **Tobias, Froböse:** Verfahren zur Ermittlung der Materialparameter für die Auslegung von Stahlseil-Fördergurtverbindungen mit Hilfe der FEM, Berichte aus dem ITA Band 01/2017, 2017

[3] **Markus, Keller:** Zur Optimierung hochfester Stahlseilgurtverbindungen, Dissertation, Hannover, 2001



Thank you for your attention