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Longitudinal supports shape influence on deflection and stresses in solar receiver tubes

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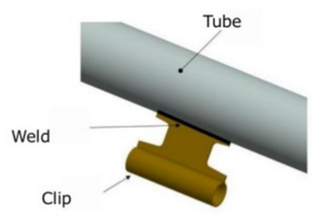
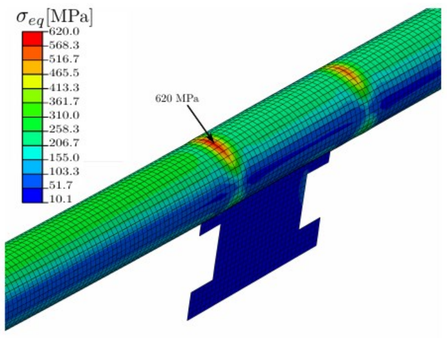
INTRODUCTION

- Longitudinal supports (also called clips) have a key role in solar central receivers, preventing tubes from excessive deflection. In this work, its influence on tube deflection has been studied.
- To carry out the analysis, a new geometry of the metal sheet attached to the receiver tubes has been proposed. With this new shape, different cases have been studied, varying the separation between supports and their size to study its impact on stress and deflection in the tubes.

CONVENTIONAL CLIP GEOMETRIES

- Rigid welds attached to tubes may create stress concentrations when tube bending is remarkable.
- There is no data regarding clip geometries and sizes.

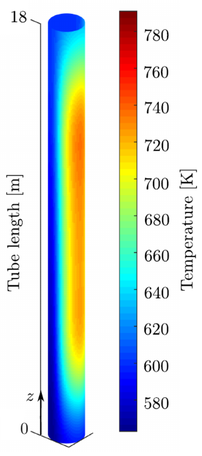


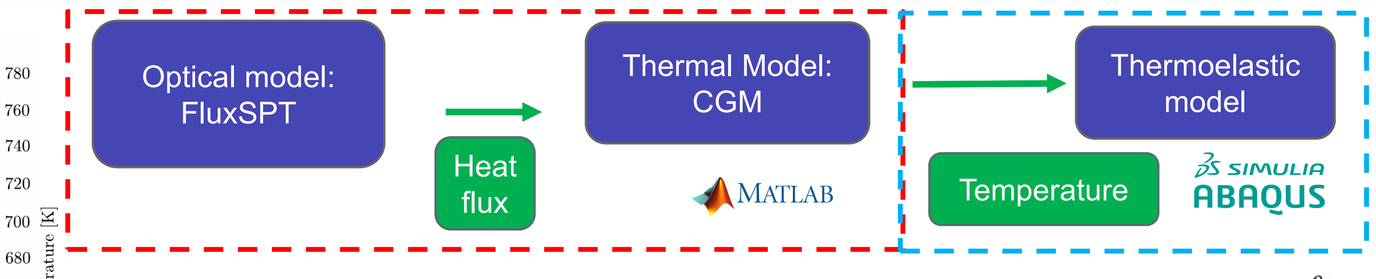


METHODOLOGY

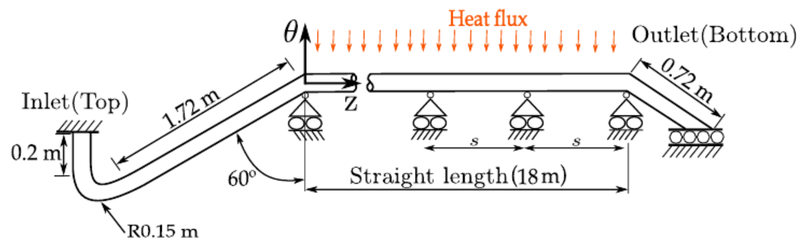
Parameters of the studied solar plant

PARAMETER	VALUE
Number of heliostats	10300
Heliostat dimensions	11.28x10.36 [m]
Latitude	38.24º
Tower height	195 [m]
Receiver length	30.5 [m]
Number of panels	18
Tubes per panel	127
Tubes separation	1.8 [mm]
Tube length	20.3 [m]
Outer tube diameter	22.4 [mm]
Tube thickness	1.2 [mm]
HTF inlet temperature	563 [K]
HTF outlet temperature	838 [K]
Mass flow rate (per tube)	3.98 [kg/s]
Ambient temperature	298 [K]



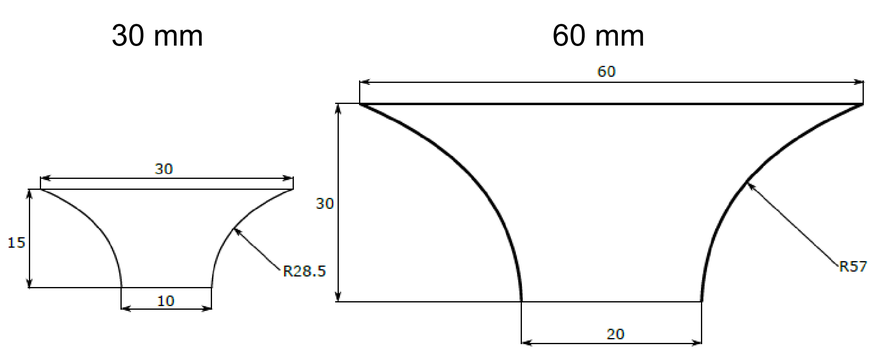


- 2D thermal model solves the temperature in the whole receiver.
- Thermal stress and tube deflection are calculated using a FE model.
- Clips are uniformly spaced along the tube straight length each 2 m.

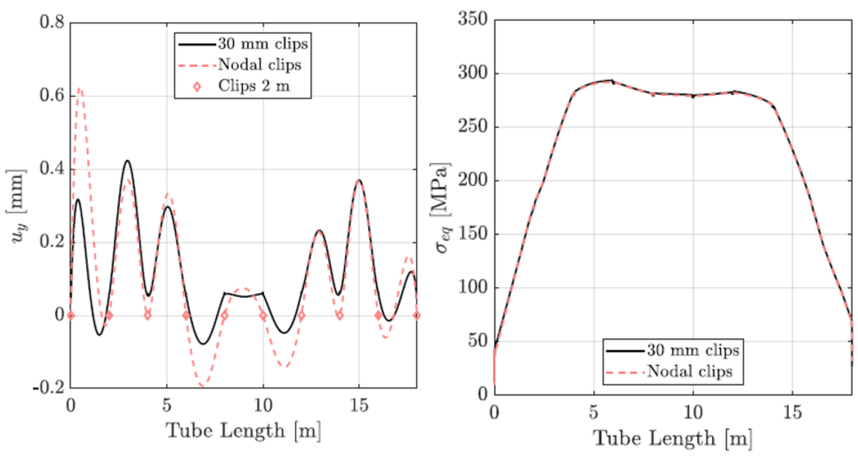


RESULTS AND DISCUSSION

New clip weld geometry proposed in two sizes:

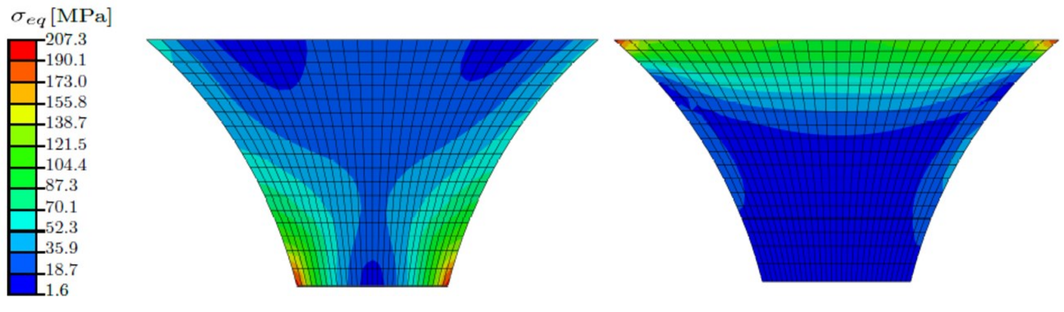


Displacement and stress distribution along the tube: Comparison between clips model (30 mm clips) and no clip model (nodal clips):



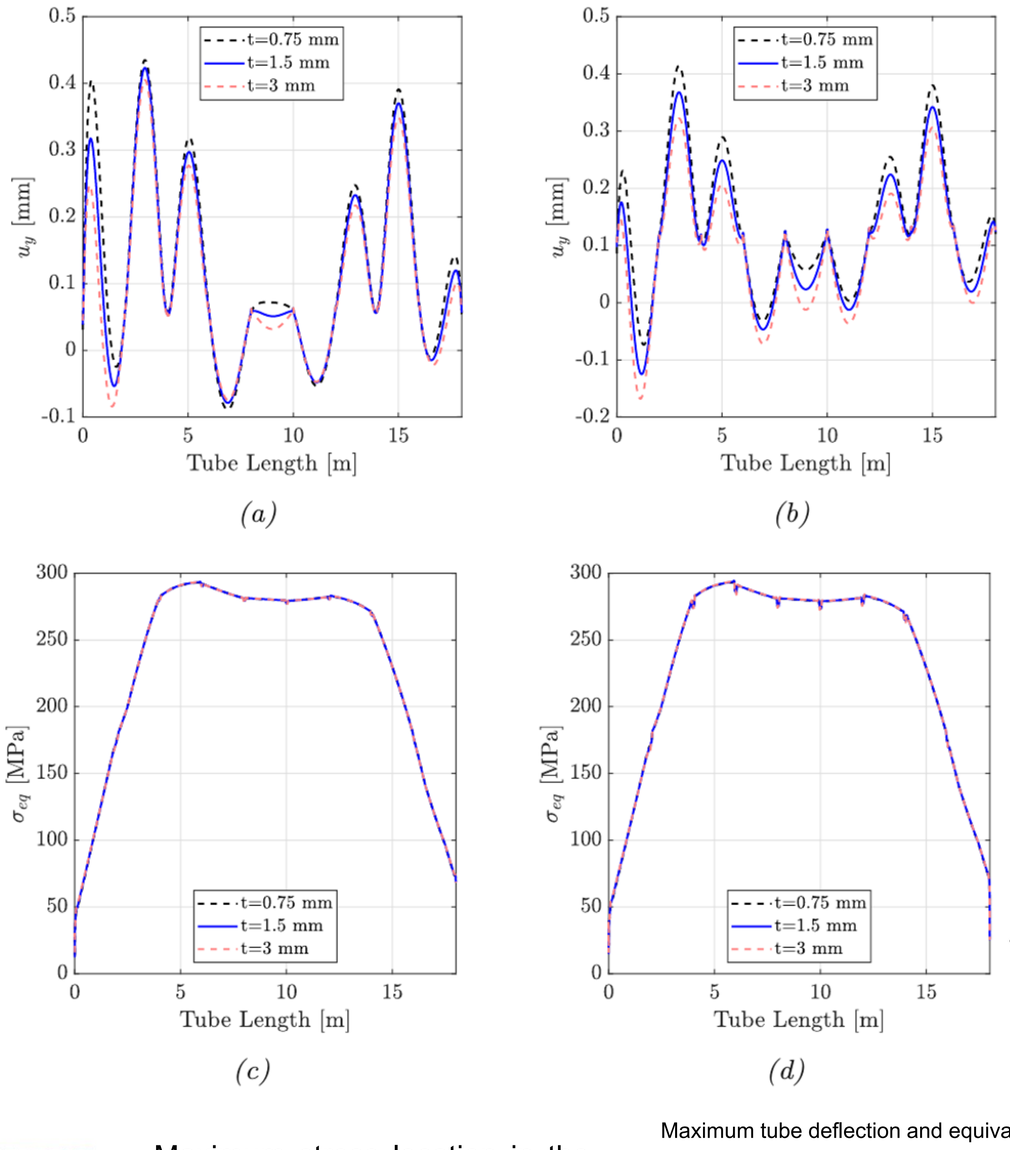
- Clip geometry does not cause stress concentrators.
- Tube deflection is lower when clip geometry is considered.

Stress distribution in the clip welds:

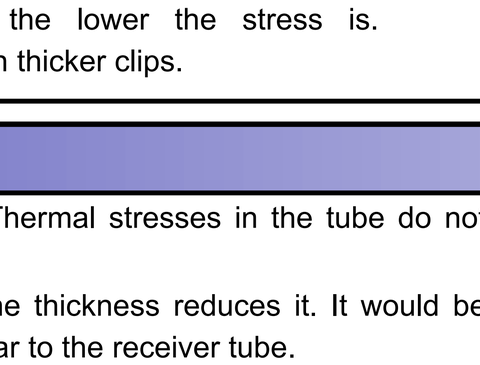


- Maximum stress location in the weld changes according to the clip position along the tube.
- In clips close to the tube ends max. stress is located closer to the guiding rod. In middle clips max. stress is located in the tube union.

Influence of clip size and thickness in stress and deflection



- Cip size has certain influence in tube deflection, although the reduction is not proportional to the increment in clip size.
- Thermal stress in the tube do not present significant changes with different clip sizes. There are no stress concentrators in the max. stress area.



- There are stress concentrators due to the simplified modelling of the union between tube and weld.

Maximum tube deflection and equivalent stress in the metal sheets of the clips

	30 mm Clips		60 mm Clips	
t [mm]	u_y [mm]	σ_{eq} [mm]	u_y [mm]	σ_{eq} [mm]
0.75	0.44	252.8	0.41	303.9
1.5	0.421	207.3	0.37	254.3
3.	0.41	150.6	0.32	183.5

- Stress in the clips increases with its size, while the thicker the clip is, the lower the stress is. Deflection is lower with thicker clips.

CONCLUSIONS

- When clips are modelled tube deflection changes, but thermal stress does not present significant changes.
- Max. stress location in clips geometry changes according to the clip position along the tube, due to the higher tube rotation at the ends.
- Clip size has certain influence in tube deflection. Thermal stresses in the tube do not present changes.
- Clip size increases stress in the clip itself, while the thickness reduces it. It would be recommended to use small clips with thickness similar to the receiver tube.

ACKNOWLEDGMENTS

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