



HOCHSCHULE OSNABRÜCK
UNIVERSITY OF APPLIED SCIENCES

BAMBOO AS A LIGHTWEIGHT MATERIAL IN MOBILE APPLICATIONS USING THE EXAMPLE OF A CITY BIKE





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OUTLINE!

1. Osnabrück – University of Applied Sciences
2. Bamboo as a Lightweight Construction Material
3. Connecting Bamboo Culms
4. Material Tests of Bamboo Culms and Connecting elements
5. Design and Building of the Bike
6. DIN-EN-14764 Tests
7. Conclusion

LOCATION AND DISTANCES TO MAJOR CITIES (AS THE CROW FLIES):

- 57 km to Lingen,
affiliated campus of OS UAS
- 70 km to the Dutch border
- 103 km to Bremen
- 115 km to Hanover
- 167 km to Cologne
- 193 km to Hamburg
- 365 km to Berlin
- 525 km to Munich

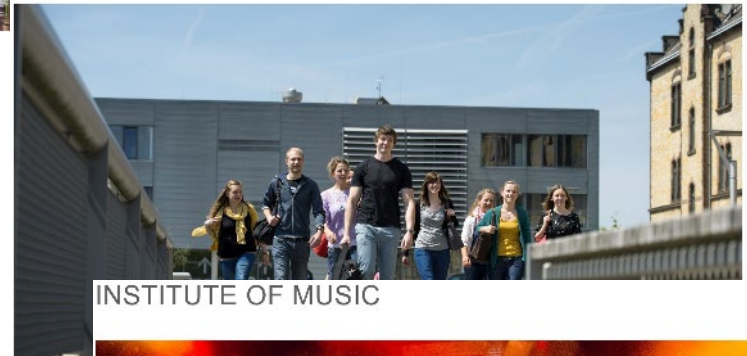




AGRICULTURAL SCIENCES AND
LANDSCAPE ARCHITECTURE



BUSINESS MANAGEMENT AND SOCIAL SCIENCES



INSTITUTE OF MUSIC

13,500 students in 4 faculties
and one institute
3,000 students in Engineering and
Computer Sciences

ENGINEERING AND COMPUTER SCIENCE



MANAGEMENT, CULTURE AND TECHNOLOGY
LOCATION: LINGEN



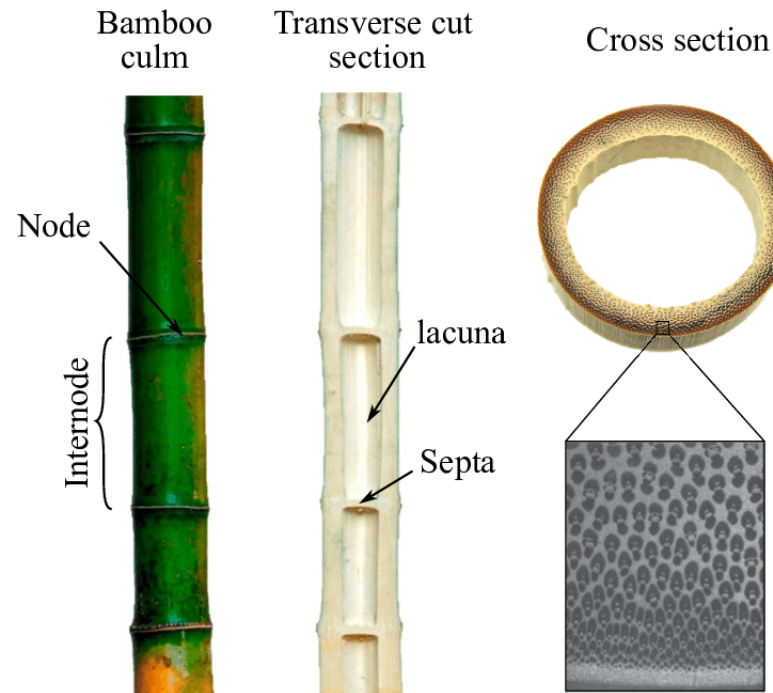
ENGINEERING AND COMPUTER SCIENCE



1. Strong practice-oriented study programs
2. Close research cooperation with regional and international companies
3. Long-standing cooperation with more than 70 partner universities all over the globe

Our students profit from all of it and most of them find an attractive job even before graduating.

LIGHTWEIGHT MATERIAL DEVELOPED BY NATURE OVER THOUSANDS OF YEARS OF EVOLUTION



From Microimaging-informed continuum micromechanics accurately predicts macroscopic stiffness and strength properties of hierarchical plant culm materials
Tarun Gangwara, Dominik Schillingera, Mechanics of Materials January 8, 2019

WORKABILITY



Lathing / Drilling



thread cutting

NATURAL MATERIAL =>

APPLICATION PROBLEMS



Roundness



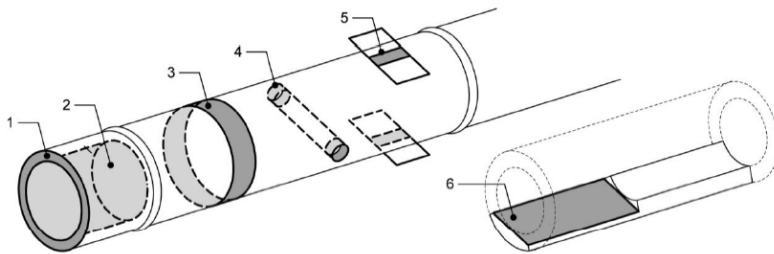
Straightness

Mechanical Properties	
Young's modulus	from 7 473 to 60 000 MPa
tensile strength	from 148 to 389 MPa
Compressive strength	from 39 to 93 MPa
Bending strength	from 76 to 276 MPa
shear strength	about 20 MPa
	the smaller the diameter, the stronger

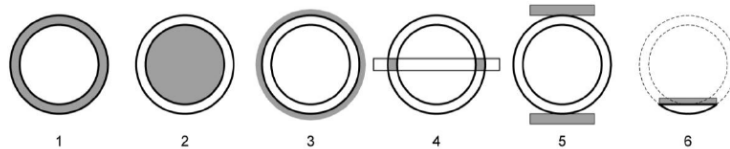
Varying material properties

REQUIREMENTS

- lightweight
- damage to the bamboo stalk as small as possible
- automatable for small series



Connection wrapped with hemp ropes



[1] R. Steffen, Geschossdecken aus Bambus, Gottfried Wilhelm Leibniz Universität Hannover, Hannover, 2017.

principles of connectors

bamboo wheels on the market - heavy nodal points

NEW APPROACH:

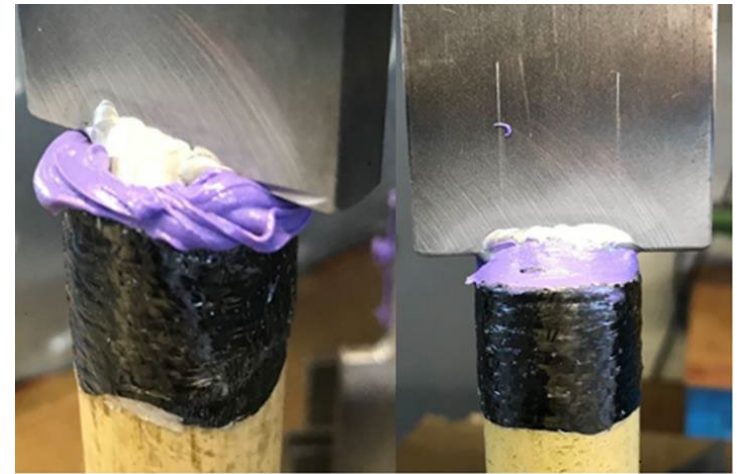
Drill out, glue in metallic connectors, wrap the ends to prevent splitting.



Drilled out culm



Connector & culm wetted
with adhesive



Excess adhesive with filled chamber

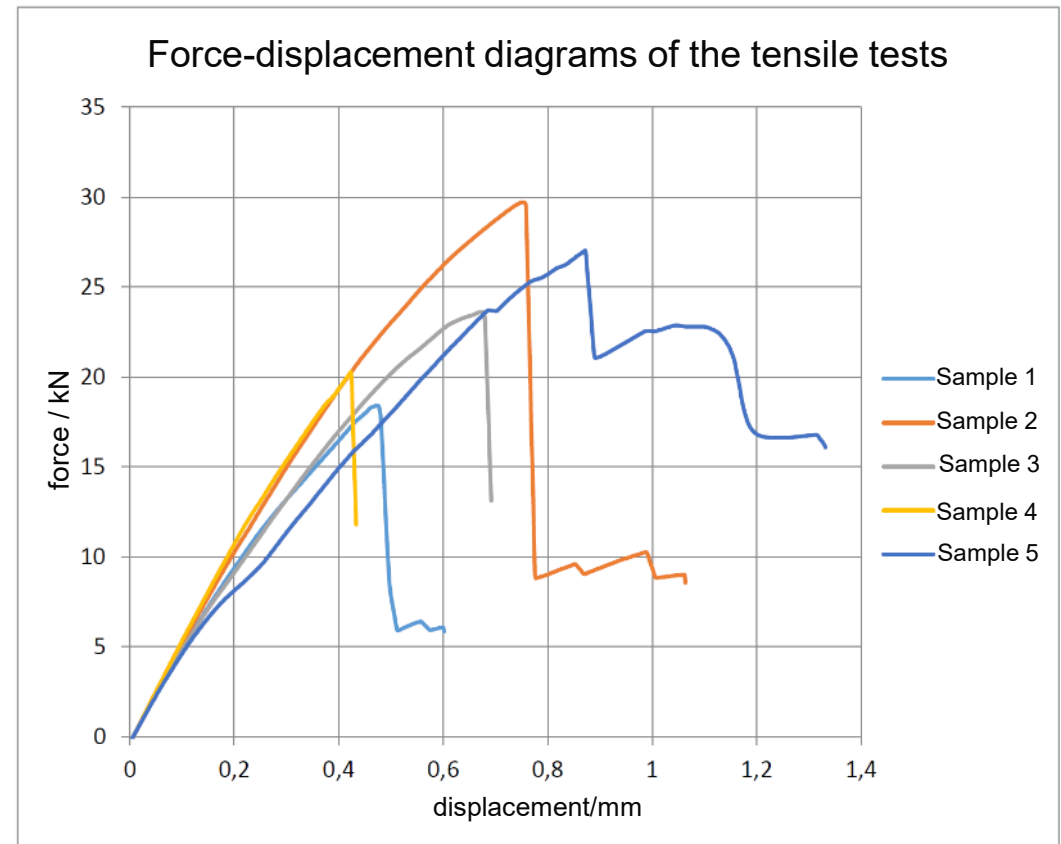
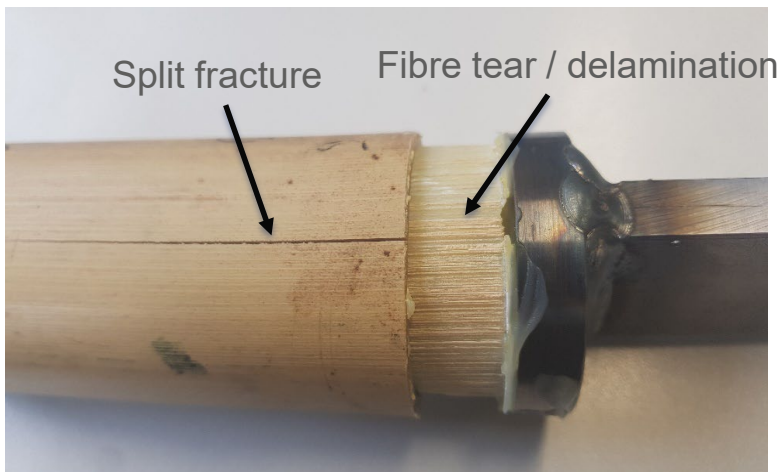
TENSILE TESTS OF THE CALMS



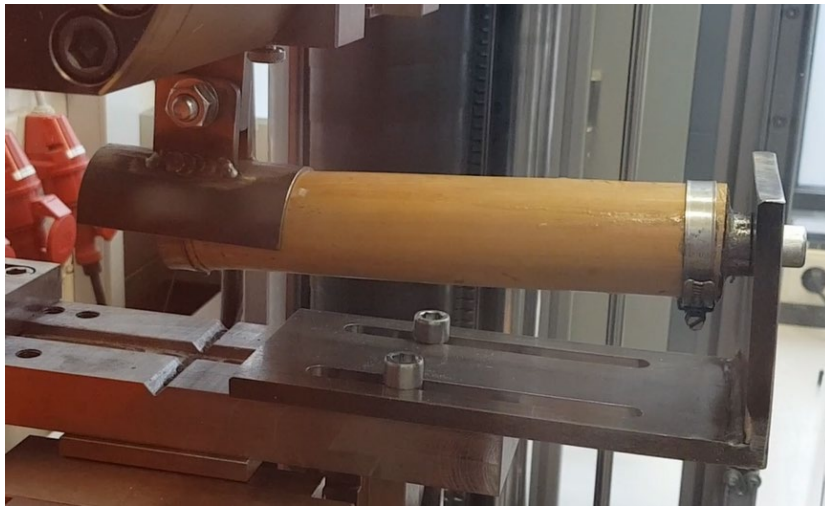
clamped sample

Nr.	D [mm]	d [mm]
1	45,1	36,25
2	45,75	36,85
3	46,4	36,9
4	44,85	36,3
5	46,65	37,7

diameter of the samples



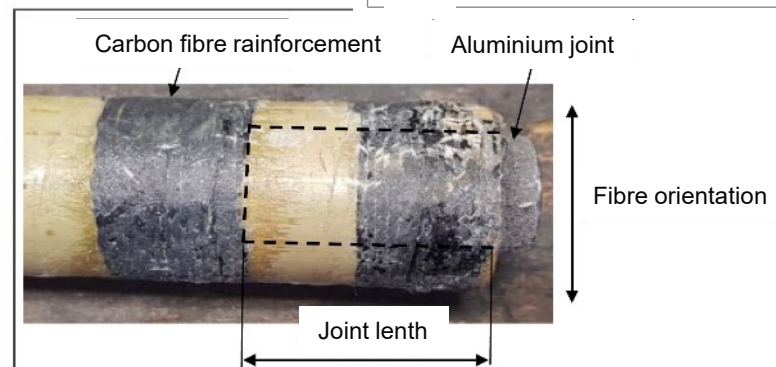
BENDING TESTS OF THE CALMS



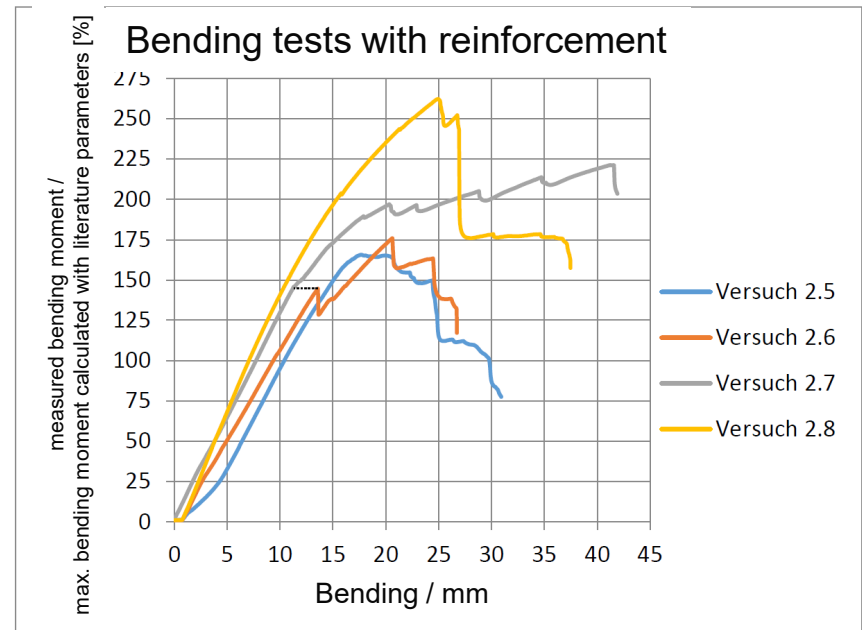
2-point bending test rig



split without reinforcement

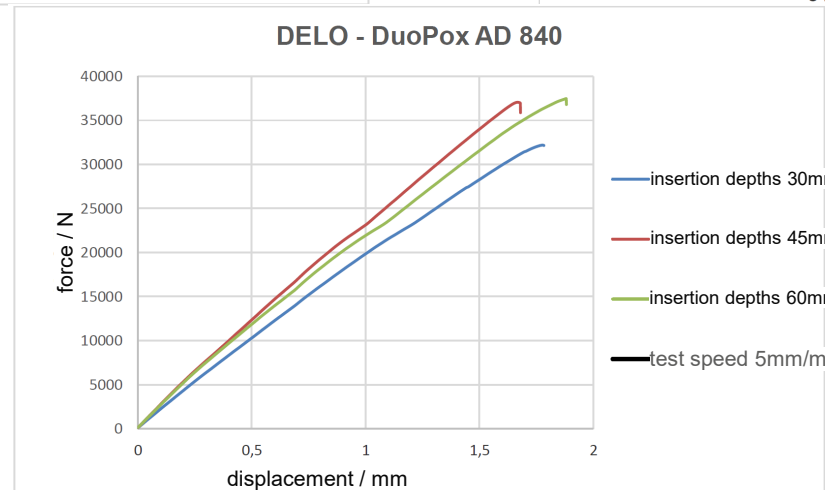
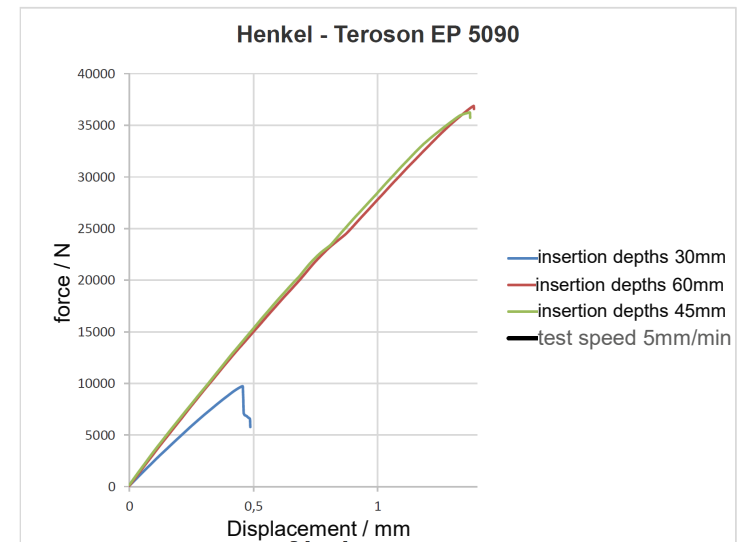
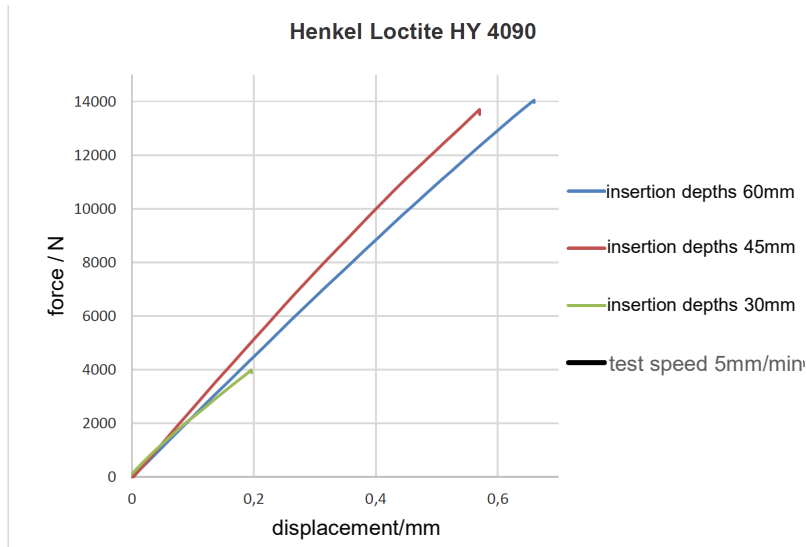


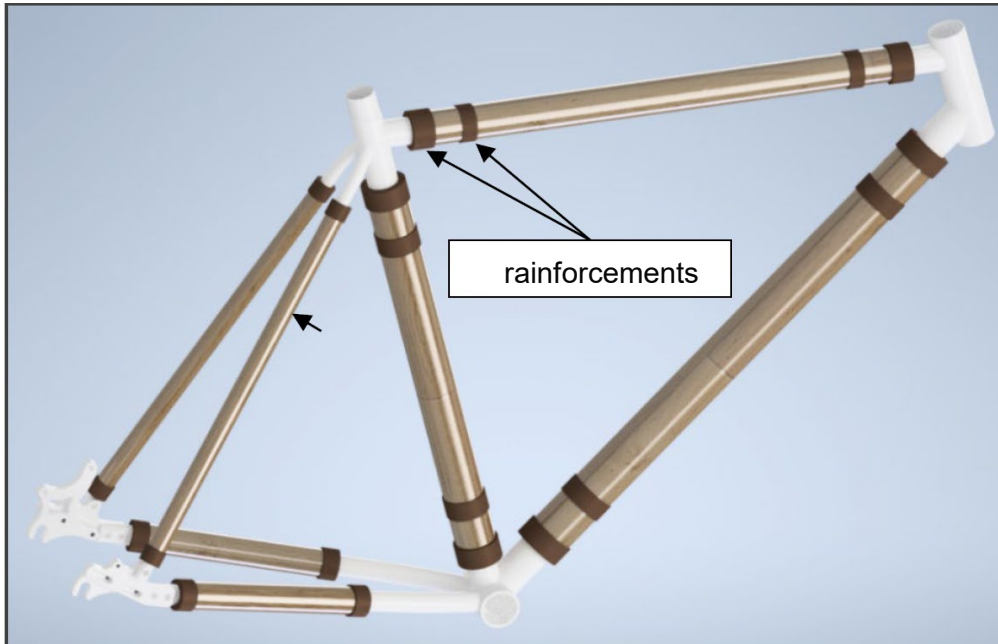
Reinforced tube end



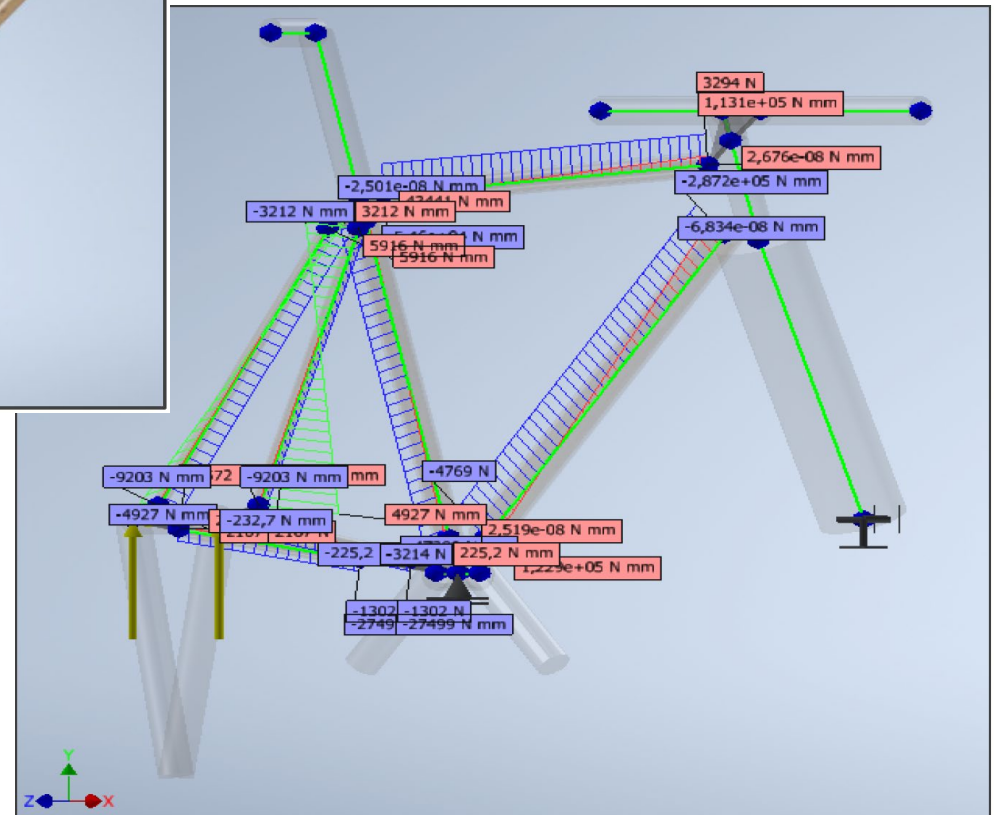
TENSILE TESTS OF THE ADHESIVE JOINT

Experiments with different adhesives and insertion depths of the tubes (outer calm diameter: about 30 mm)





Calculation of the stress on the culms



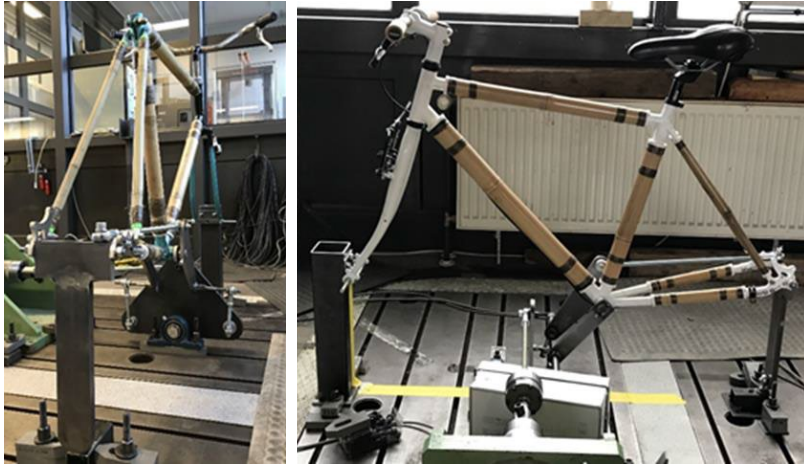
design

BUILDING



The finished frame weighs 3,140 g.
The mass share of bamboo is 908 g,
the steel connectors make up 2,060 g
of the weight





Examination setup swayback



Test with a vertical force on the saddle mount



Impact test

7. CONCLUSIONS



- Experimental tests showed that bamboo possesses and exceeds the strength and lightweight construction properties described in the literature
- The tests provide a basis for the design and strength calculation of a bamboo calm construction.
- The developed method for joining bamboo tubes offers high strength and flexible options for joining bamboo tubes.
- It allows the transmission of high forces and moments
- It is automatable for small batch production and transferable to other constructions





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THANK YOU FOR YOUR ATTENTION!

