A Novel Mechanical Stress Measurement Method Applied to Wind Turbine Rotor Blades

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Introduction: Rotor blades for wind turbines are made of glass-fiber reinforced compound material (GFRP).

. Length 50m/ 15t weight/ max. speed 300 km/h.

. Permanent dynamic load e.g. centrifugal force.

. They have to withstand the forces of nature such as rain, moisture, temperature change, solar radiation, lightning.

. A continuous blade monitoring system can reduce the repair costs and the downtime periods.

Computational Methods: The simulation method relies on the compound power of COMSOL and SPICE.

. COMSOL Modules: AC/DC and RF.

. COMSOL Solver : MUMPS.

. Using Frequency Domain study.

. Modelling function: Electrical Circuit (cir) & Electromagnetic Wave (emw).

Theoretical background:

. Frequency Domain Reflectometry (FDR).

. TEM Waveguide/ Twisted pair wire.

. Frequency sweep using two discrete frequencies f1 and f2 .

. Figure two shows a block diagram of the measurement method.

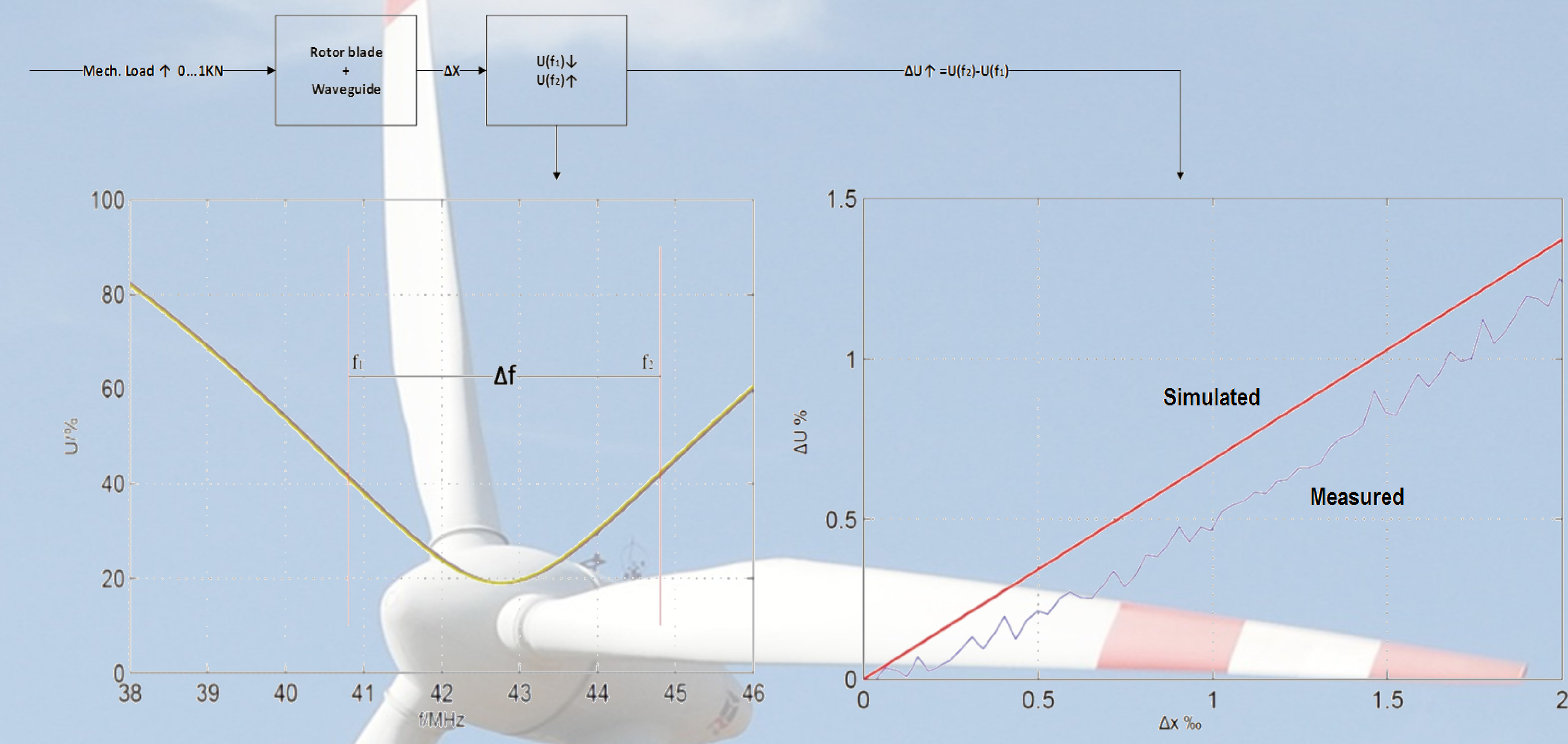

Figure 1) Block diagram of the measurement method

Results: According to the simulation and experiments it is possible with few modifications on rotor blades to monitor its strain circularly. The only modification which should be applied to a conventional rotor in order to measure its mechanical stress is an integrated twisted pair wire. The wire must be integrated during the manufacturing process. Figure 6a shows a cutout of a specimen simulating a rotor blade for laboratory purposes. Figure 6b shows a modified rotor blade to allow the stress measurement.

Conclusion: The applied and described method will revolutionize the rotor blade monitoring. With this method it is now possible to monitor the mechanical stress circularly this reduces the maintenance costs and maximize the operational availability. The mechanical strain Measurement method is applicable to existing rotor blade production units. This makes it easy to adopt it to the production.

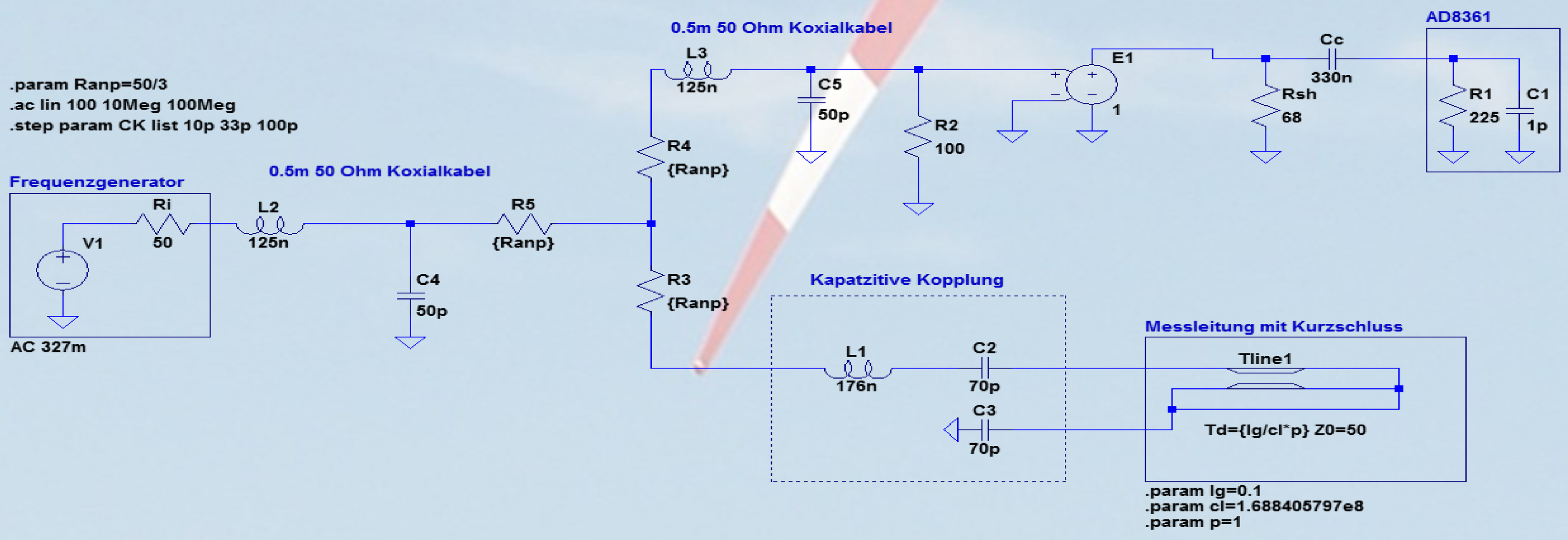

Figure 2) The strain monitoring SPICE Modell.

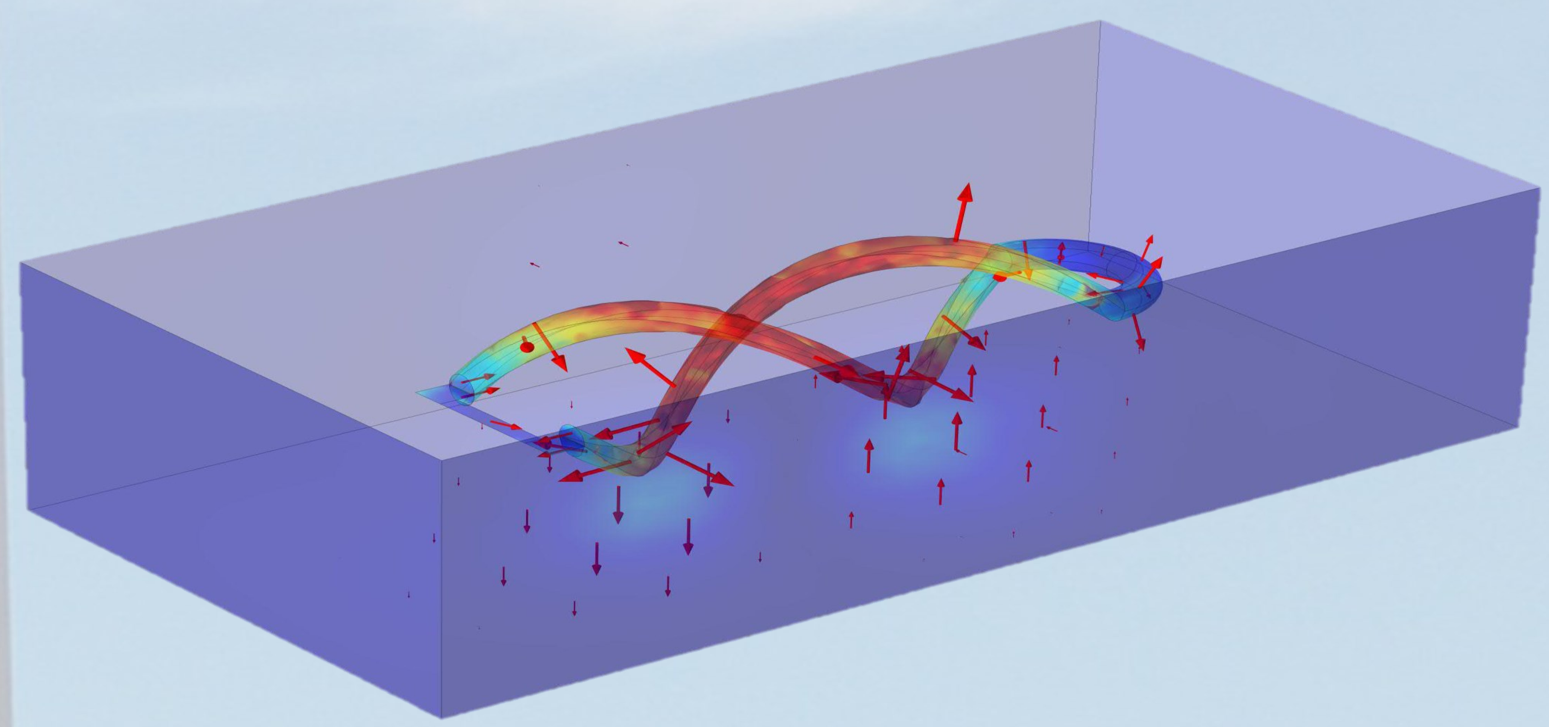

Figure 3) A 3-D COMSOL model of the GFRP material with integrated twisted pair cupper wire

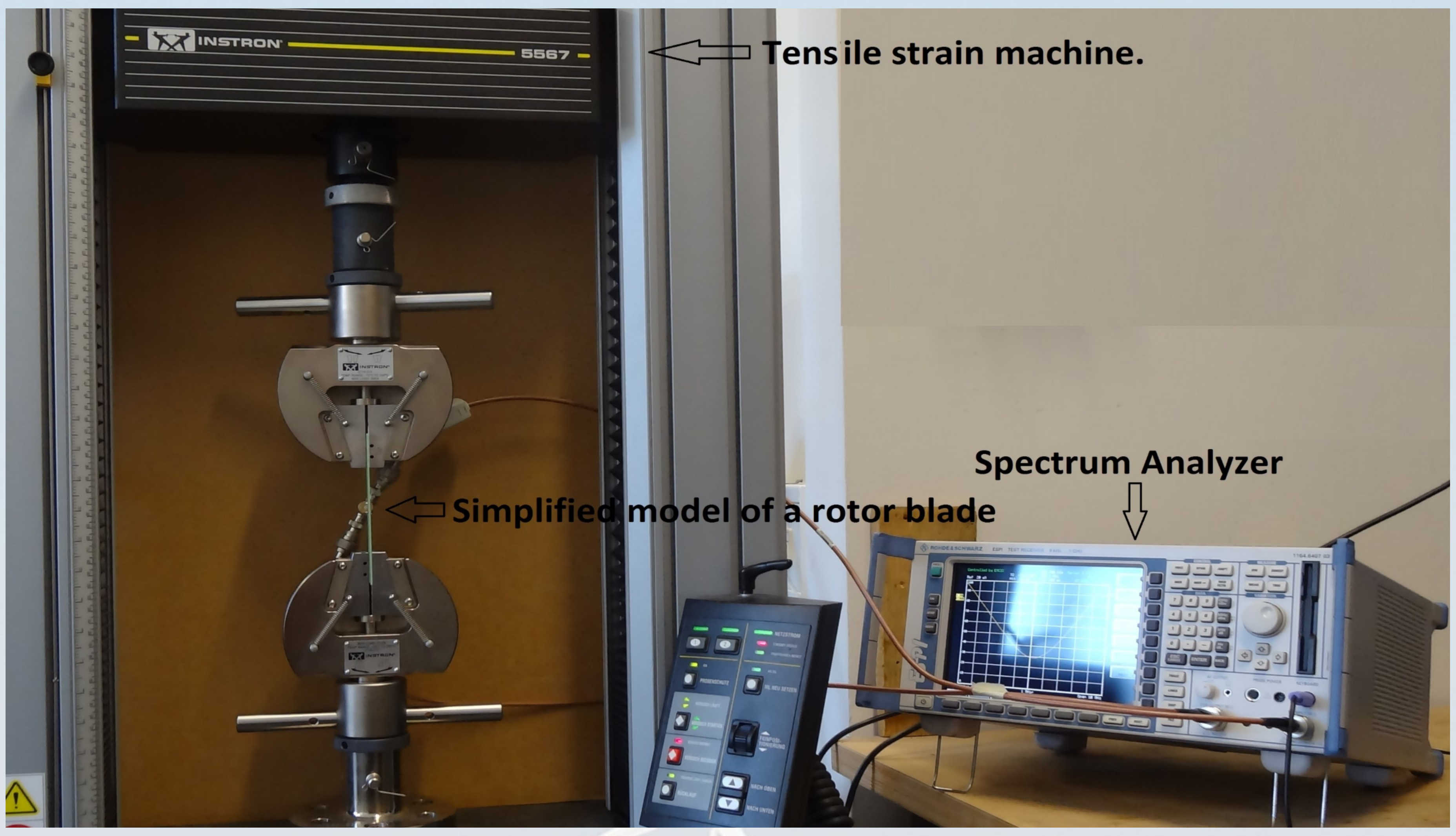

Figure 4) Measurment setup

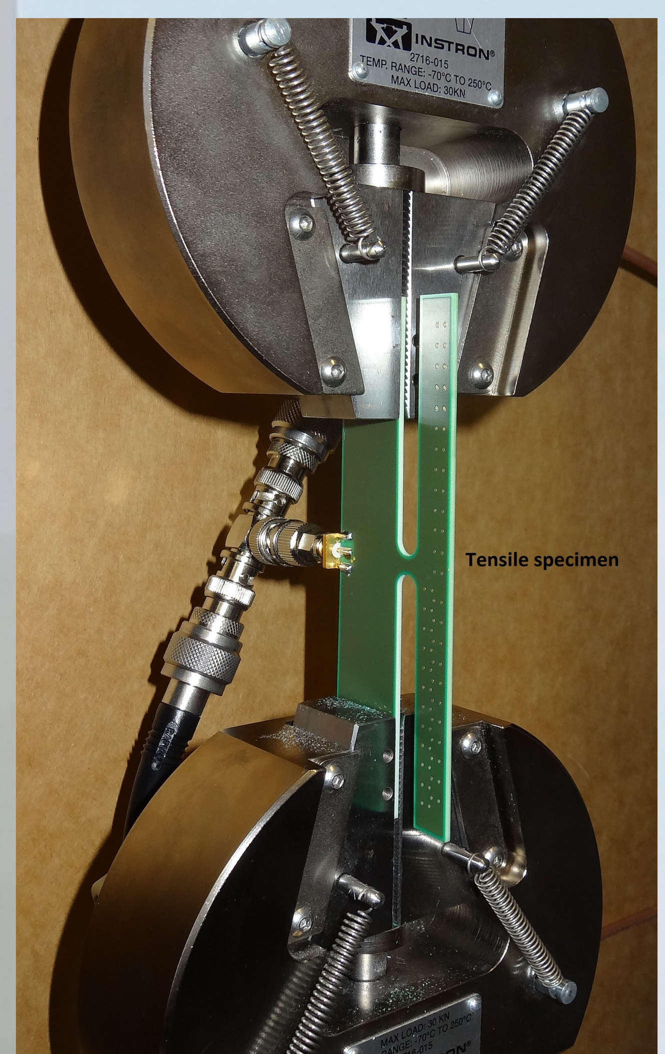

Figure 5) Tensile specimen

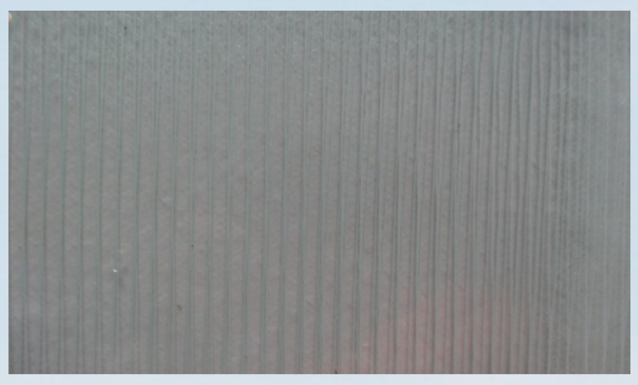

Figure 6a)

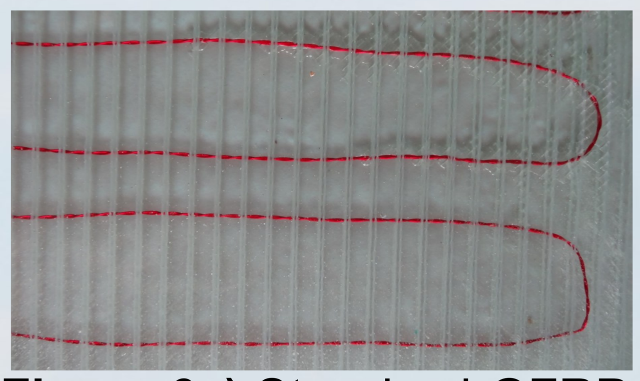

Figure 6a) Standard GFRP specimen, **6b)** modified GFRP specimen

References: **[Background Image]**, http://de.m.wikipedia.org/wiki/Datei:Wind_turbine_with_observation_deck_bruck_an_der_leitha.jpg, 01-08-2013