Scientific research on the dynamic and static properties of hybrid flax-carbon bicycle racing frames

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Bicycle design has become a state of the art technology since the need for better bicycles for race applications at professional level is growing with the years. This improvement includes also the evolution of the bicycle frame material. Nowadays, mainly aluminum, titanium alloys and fibre reinforced polymers (FRP) are used (mainly carbon fibre). The use of FRP fulfils many needs of the demanding professional bicyclist since it is possible to design a lightweight and stiff frame. Surprisingly, there is less scientific research on how the bicycle frame can be improved on both static and dynamic level. FRP give designers the opportunity to find an optimum balance between weight, stiffness, strength, durability and geometry of the frame and riding comfort for the bicyclist (cfr. the damping capability of the bicycle). By searching for the best material and fibre orientation it is possible to find a good compromise between all these issues.

The research described here combines all these aspects. An important novelty is the use of flax fibre as reinforcement fibre instead of the common carbon fibre. *Museeuw Bikes* is the first to implement flax fibre in bicycle frames. Flax fibre is in this research looked for its possibilities to improve both static and dynamic properties of the bicycle. Full carbon FRP frames as well as hybrid flax-carbon FRP frames are considered here. To determine the static properties, the bicycle can be reduced to the frame itself since this defines the stiffness of the bicycle mostly. In the same way the durability of the bicycle is investigated, here the frame has the largest influence also. The dynamic behaviour however is more complex. Since shock absorption is not only determined by the frame itself, it is necessary to take the whole bicycle-rider system into account. The approach here is through field tests riding ourselves with an instrumented bicycle to determine the dynamic behaviour of the bicycle.

The static frame stiffnesses can be measured on a test setup which allows for different loading conditions. To gain more insight into these results, also the mechanical properties of flax, carbon and hybrid flax-carbon test samples are assessed from tensile testing. The same test setup also allows for fatigue testing conform the European Norm. Moreover, small adjustments of the test setup enable a more realistic force pattern on the frame and thus a better prediction of the durability is possible (Figure 1). The analysis of the experimental data from field tests is supported by modelling the bicycle-rider system with computer software. Analogue to the static frame tests, at material level the damping constant of the frame materials is assessed.

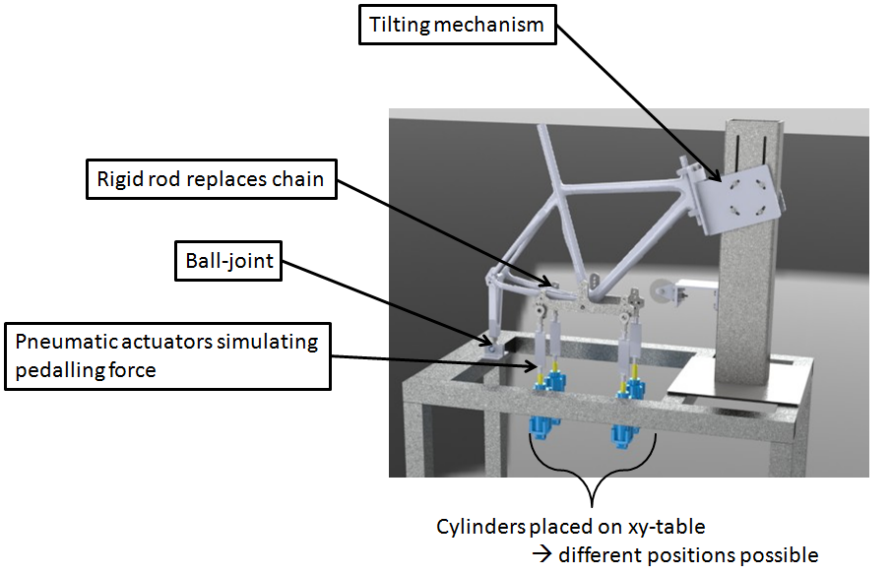

Figure 1: Fatigue test setup

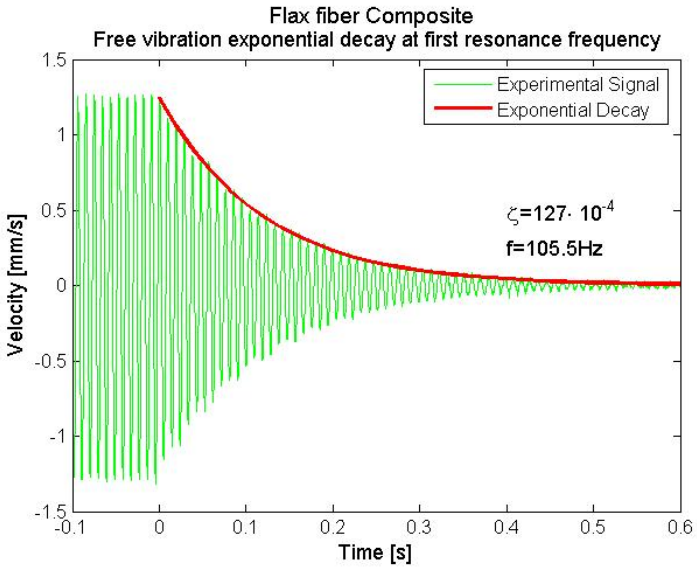

Figure 2: Experimental result from damping measurements

All of the test setups have passed the design phase, from now on building up has started and results are expected within a few months. Experimentally measuring damping in a proper way is already a fact as established in Figure 2.