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Comparison between direct numerical simulation and homogenization of continuous fiber reinforced woven composites

Anqi Li[1,2], Joris J. C. Remmers[2], Marc G. D. Geers[2] and Thierry J. Massart[1]

[1] Universite libre de Bruxelles (ULB), Building, Architecture & Town Planning, CP 194/2, 1050 Brussels, Belgium, anqi.li@ulb.ac.be, https://batir.ulb.ac.be

[2] Eindhoven University of Technology, Department of Mechanical Engineering PO Box 513, 5600 MB, Eindhoven, The Netherlands, J.J.C.Remmers@tue.nl, www.tue.nl/mechmat

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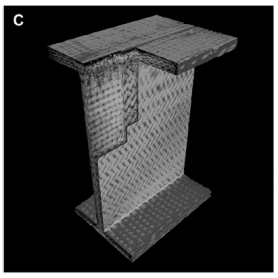
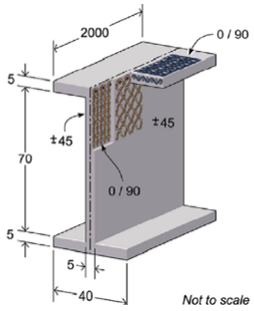
An innovative type of carbon reinforced beams have been developed recently in which the flange and web are connected by continuous fibers [1], shown in Figure 1b. The yarns in the web are weaved into the thickness direction of the flange. Mechanical experiments in [2] have shown that the specific energy absorption is twice higher than for a steel beam.

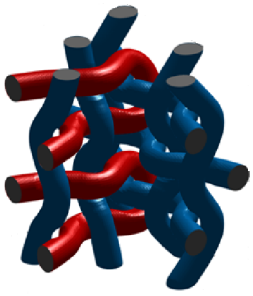
In order to understand these promising experimental results, numerical simulations of such composite structure can be of assistance. Since the geometry of the model is complex, the ideal method is to use computational homogenization to reduce time. In this contribution, we will look at a part of the beam i.e. the junction of the beam where a continuous yarn is weaved from web through the flange. Using the algorithm of Wintiba et. al. [3], a geometry and a finite element mesh of this junction is generated, as shown in Figure 1c and 1d. Both direct numeral simulation (DNS) and simulation with homogenized material properties will be performed and the results will be compared to investigate under which condition the homogenization is valid.



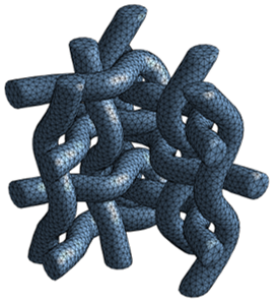
(a) CT scan of an I shped beam [2]



(b) Illustration of the weaving pattern [1]



(c) Geometry of the flange-web junction



(d) Conformal mesh of the flange-web junction

Figure 1: I shaped beam in [2] and the generated geometry and conformal mesh of the junction

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