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# Application of the Material Point Method as a New Fast Simulation Technique for Textile Composites Forming and Material Handling

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**Abstract :** The excellent strength to weight ratio of woven fabric composites, along with their high formability, is one of the primary design parameters defining their increased use in modern manufacturing processes, including those in aerospace and automotive. However, for emerging automated preform processes under the smart manufacturing paradigm, complex geometries of finished components continue to bring several challenges to the designers to cope with manufacturing defects on site. Wrinklinge. g. is a common defectoccurring during the forming process and handling of semi-finished textile composites. One of the main reasons for this defect is the weak bending stiffness of fibers in unconsolidated state, causing excessive relative motion between them. Further challenges are represented by the automated handling of large-area fiber blanks with specialized gripper systems. For fabric composites forming simulations, the finite element (FE)method is a longstanding tool usedfor prediction and mitigation of manufacturing defects. Such simulations are predominately meant, not only to predict the onset, growth, and shape of wrinkles but also to determine the best processing condition that can yield optimized positioning of the fibers upon forming (or robot handling in the automated processes case). However, the need for use of small-time steps via explicit FE codes, facing numerical instabilities, as well as large computational time, are among notable drawbacks of the current FEtools, hindering their extensive use as fast and yet efficient digital twins in industry. This paper presents a novel woven fabric simulation technique through the application of the material point method (MPM), which enables the use of much larger time steps, facing less numerical instabilities, hence the ability to run significantly faster and efficient simulationsfor fabric materials handling and forming processes. Therefore, this method has the ability to enhance the development of automated fiber handling and preform processes by calculating the physical interactions with the MPM fiber models and rigid tool components. This enables the designers to virtually develop, test, and optimize their processes based on either algorithmicor Machine Learning applications. As a preliminary case study, forming of a hemispherical plain weave is shown, and the results are compared to theFE simulations, as well as experiments.

**Keywords :** material point method, woven fabric composites, forming, material handling
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