BAMP! | SP4

Building with paperboard!

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Abstract

The aim of the LOEWE*-Research Cluster BAMP! is to qualify paper for use in the construction industry. As a renewable raw material, it can make a significant contribution to sustainable construction. At PtU, research is being conducted into the production of large-area components such as facade elements or roof shingles by using forming processes. For this purpose, the Single Point Incremental Forming process (SPIF for short) with paper and vulcanized fiber materials was investigated. This process offers high geometrical flexibility with favorable local forming zones and economical tooling.

*LOEWE – State Offensive for the Development of Scientific and Economic Excellence

Project description

Within the LOEWE focus “BAMP! – Building with Paper”, a unique consortium consisting of seven departments at three universities (see Figure 1) has come together to qualify paper as a material for the challenges in the construction industry. The competencies of the disciplines from architecture, civil engineering, paper technology, chemistry and forming technology are bundled and used in the best possible way in interdisciplinary cooperation. The aim is to investigate the sustainable and versatile material paper with regard to its stability, shape and weather resistance. The design of connecting elements between individual components is just as much a part of the project content as the architectural design of entire buildings or components and chemical treatment to comply with fire protection guidelines. Within subproject 4, the PtU is concerned with the production of three-dimensionally shaped, large-area components that can be used, for example, as facades, roof coverings or cladding.

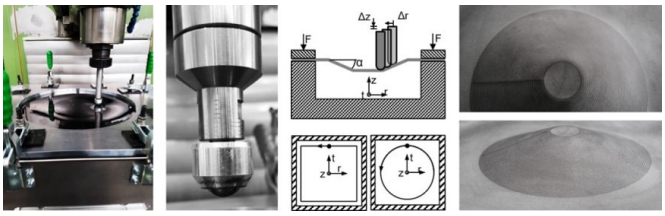
Results

The focus of subproject 4 is on the process development for the production of three-dimensionally shaped, large-area components. The application in the construction industry requires that components should be formed as individually as possible. A manufacturing process for the production of small quantities is thus aimed at. In recent years, the process of Single Point Incremental Forming (SPIF) on paper has been adapted and further developed. SPIF is characterized by the fact that almost any geometry can be formed from a clamped, flat semi-finished product without the need for form-specific tools. Thus, individually shaped components can be produced at low cost. The materials used are industrially produced paper, cardboard and vulcanized fibre.

Figure 1 shows on the left side the test stand and the CNC guided, spherical tool that comes into contact with the semi-finished product. The process principle is shown in the middle: A firmly clamped semi-finished product is formed by a tool layer by layer. The tool path per forming plane defines the final geometry of the component. On the right, a conical component made of vulcanized fiber is shown.

After examining the process on the test stand, a 3-axis portal system and an associated component clamping system were designed and put into operation. With a forming zone of 800 mm x 1200 mm, this offers the possibility of forming even larger components. In addition, a linear laser has been installed in the system to measure and control the forming process. (see Fig. 2)

In addition to process development, BAMP! also carries out investigations on non-destructive component testing. The principle of Acoustic Emission (AE) has proven to be very promising. By recording acoustic signals, which are generated as vibrations in the material during the forming of fibre materials, new insights into the forming mechanisms on fibre levels could be gained. Specific shaping mechanisms could be assigned to individual frequencies of the AE signals.



[1] SPIF test stand and tool (left), SPIF process principle (middle), component made of vulcanized fibre using SPIF (right)

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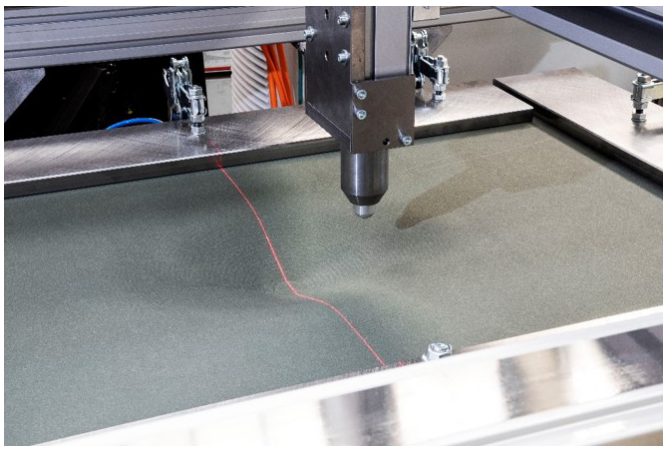

[2] 3-axis-portal system with laser measurement

Acknowledgement

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