Investigations on the Impact of the Chip Geometry and of Wood Species on the Properties of Raw-density-reduced Chipboards Manufactured from Them, in the Context of Applying Lightweight Filler Materials

Project Leader: Dipl.-Ing. Tino Schulz
In-charge: Dipl.-Ing. Tino Schulz
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Initial Situation and Objective

For quite some time, the reduction of weight in the furniture industry has increasingly come into the focus of manufacturers, retailers and consumers for economic reasons (transport and assembly cost reduction), for ecological reasons (resource conservation) and for ergonomic reasons (simpler handling, enhanced functionality). Especially the ever growing expenditure for fossil fuels requires comprehensive activities to reduce transport weights. Also the competing situation between the material and energetic uses of wood resources plays a more and more important role.

The furniture industry is an essential field for applying lightweight solutions. Industrial furniture and interior design prefer to use chipboards and MDF. The main structural material are chipboards of raw densities between 600 kg/m³ and 650 kg/m³, which are too heavy for quite a number of applications. Moreover, such weights involve high efforts regarding personnel and finance when processing, handling and assembling the chipboards. In addition, there is the high cost for transporting the boards to the furniture manufacturers and for the transport of finished products to retailers/consumers.

Before that background, the objective of this R&D project consisted in reducing the raw density of chipboards. A predecessor project was able to prove that, by applying lightweight filler materials in the middle layer, the raw density of chipboards can be reduced, whereas the standard requirements of the mechanical properties of 480 kg/m³ can be met. Lightweight filler materials, such as cork granulate and unexpanded polystyrene that expands during panel manufacture only, proved especially beneficial.

The R&D project investigated correlations between the application of lightweight filler materials (cork, unexpanded polystyrene) in the middle layer of chipboards, changes in the chip geometry (chip lengths and thicknesses) and wood species (spruce, pine, birch poplar) of the chips used in the middle layer of the boards.

It was tested to what extent the combination of lightweight filler material and modified chip geometry and wood species results in positive changes in the mechanical and physical properties of the

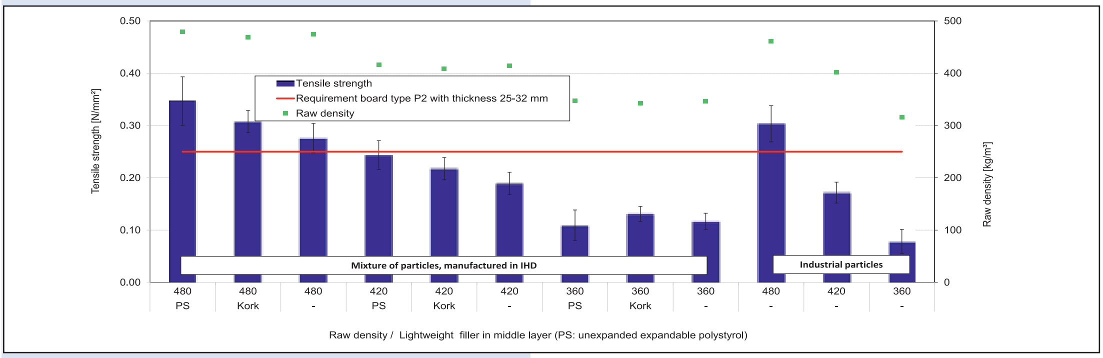

Fig. 1: Transverse tensile strength of chipboards, with varied raw densities and using a chip mix of spruce and lightweight materials in the middle layer, compared to industrial chips

Fig. 2: Coated chipboard samples with chip mixes of chips from cutting and chipping (spruce), density 480 kg/m³, with polystyrene (top), cork (second from top), without filler material (middle) compared to a chipboard of industrial middle-layer chips without filler material of a board density of 480 kg/m³ (second from bottom) and 600 kg/m³ (bottom)

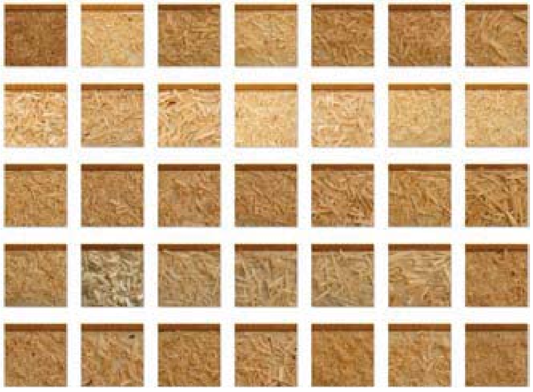

Fig. 3: Chip variants produced (selection)

chipboards manufactured. It was derived from that as to what extent the raw density of the chipboards could be reduced by meeting standard requirements at the same time. It was the objective to make chipboards of reduced raw densities and of property levels sufficiently suitable for their use in furniture.

Approach

Chipboards were made by varying the kind of chip used, the wood species, the lightweight filler materials, the raw density and the press diagram. The chipboard variant made of industrial chips and without filler materials in its middle layer served as a referential variant. Generally, regarding the variation in the chip geometry and wood species, the middle-layer chip material was taken into account only. Industrial chips were used in all variants as surface layer material. Wood chips in the middle layer of the chipboard were substituted by lightweight filler materials at a share of 10 % of the mass. The application of lightweight filler materials served the objective to fill the cavities that emerged by reducing the amount of wood in the wood chip matrix with lightweight, therefore, voluminous materials, thus improving adhesion among the particles themselves. The filler materials used were unexpanded expandable polystyrene and cork particles.

Regarding the variation of the middle-layer wood chips, chips from cutting of varied chip lengths (three settings) and of varied chip thicknesses (two settings) as well from chipping, varying in chip thickness (two settings), were made at the IHD.

Regarding the wood species, spruce and pine were used as coniferous wood, and birch and poplar as deciduous wood. All chip variants were comprehensively characterised.

Results

The investigations showed that the application of lightweight filler materials substituting wood chips in the middle layer of triple-layered chipboards in combination with chips of modified chip geometries led to improvements in the board properties. The results varied depending on the wood species applied and on the respective lengths and thicknesses of the chips. It was proven that the chipboards of raw densities of up to 420 kg/m³ can be reproducibly manufactured, still meeting standard requirements.

Compared to the corresponding variants whose middle layers consisted of industrial chips without any filler material, partly higher transverse tensile and bending strengths were achieved by the raw-density-reduced chipboard variants.

Further investigations on coating, testing the screw extraction resistance, creep behaviour and surface soundness also yielded improvements as compared to the referential variants.

The results obtained represent a possible alternative and a considerable raw-material-saving potential as compared to the manufacture of standard chipboards of raw densities of approx. 600 kg/m³ to 650 kg/m³.