

New Lightweight Solid Wood Panels for Green Building

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Wood in green buildings

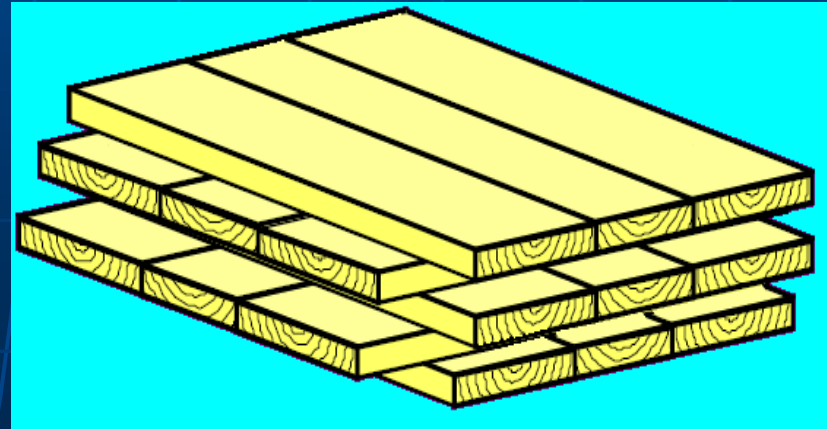
- Wood is an excellent natural renewable material for green building.
- Wood products have some environmental advantages over other building products.
- Manufacture of wood products is a rather simple, clean and low-energy process compared to many other products.
- Wood is a globally available raw material.
- Wood is widely in walls, ceilings, floors, roofs, stairs etc.

Wood in green buildings

- Wood is a user friendly green material effectively used in different structures.
- Inside a wooden house a favorable environment for human life is created.
- There is a wide range of designs for wooden houses. Their choice depends on local traditions, climate, cost and availability of wood, construction time and cost etc.

Massive wooden panels

- Not so long ago in Europe some technologies of industrial production of prefabricated houses from massive wooden panels were developed.
- Massive elements of houses (walls, floors, roofs) are made of cross laminated multi-layer panels in which layers from dry boards are glued or nailed together.



Massive wooden panels

- These panels consist of at least three layers of softwood 19 - 42 mm thick strips where the direction of the grain in adjacent layers is perpendicular to each other. Outer layers form main direction of building elements.



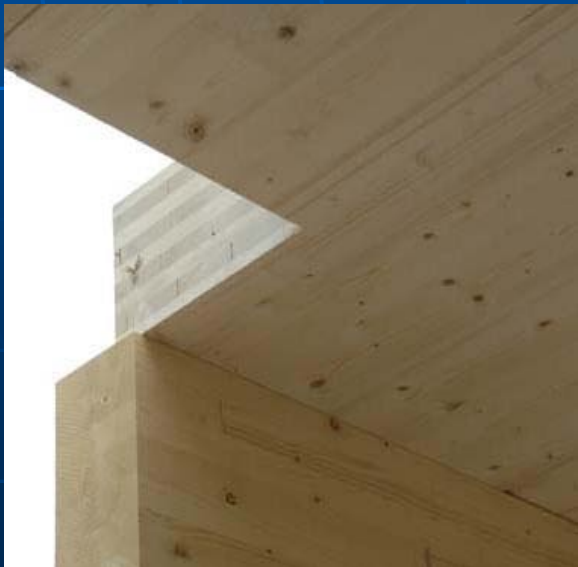
Massive wooden panels

- The panel thickness is determined by the end use for wall, floor, roof and smaller units for any number of custom applications. The thickness of elements is from 60 mm to 400 mm in dimensions of up to 4.80 m x 20 m.



Massive wooden panels

- Each element is prefabricated with given length, width and openings for windows, doors, stairs etc.



Massive wooden panels

- Surfaces of wall, floor and roof elements may be sanded, which gives the rooms a timber look.
- All elements are easily assembled at a building site by a small size mobile crane. The building time is typically short.



Massive wooden panels

- Multi-layer panels are easily individualized for custom applications.



Massive wooden panels

- The panels are dimensionally stable and fire retardant, strong mechanically and low in thermal conductivity.



Massive wooden panels

- Though high cost of panels limits their use in building structures.



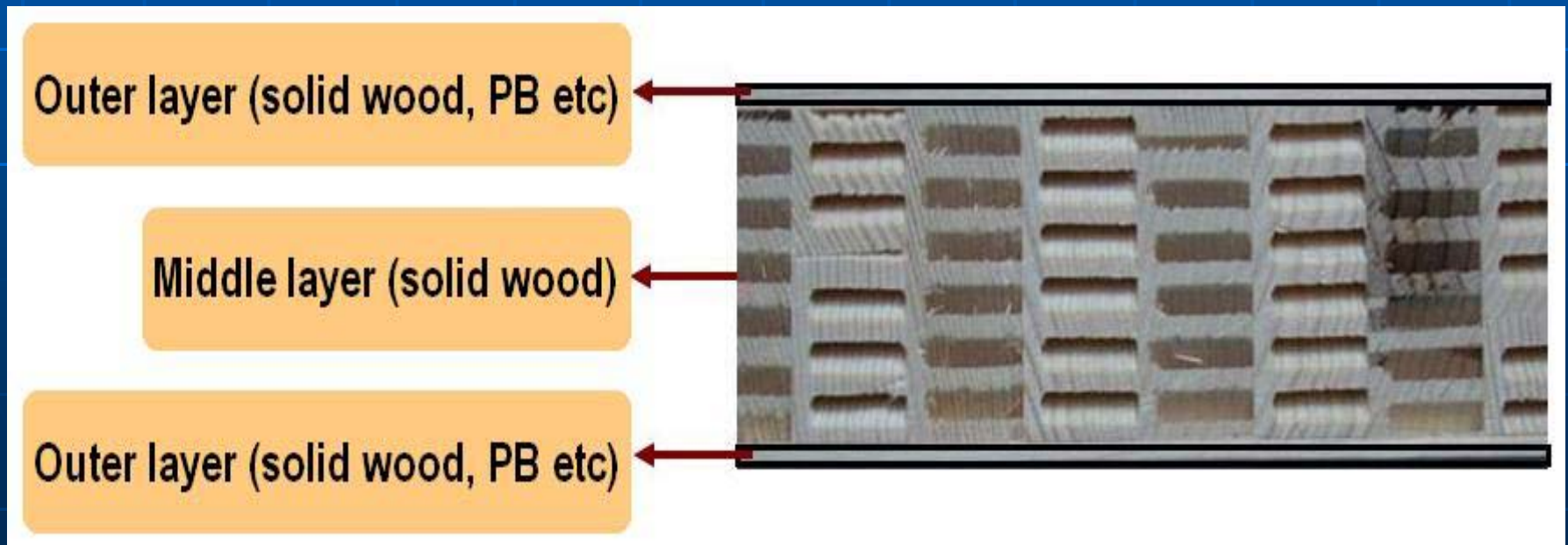
Solid wood lightweight panels

- Recently complete new solid wood lightweight panels with good mechanical and technological characteristics named Dendrolight ® (DendroSolutions GmbH, Euratsfeld, Austria) were developed.



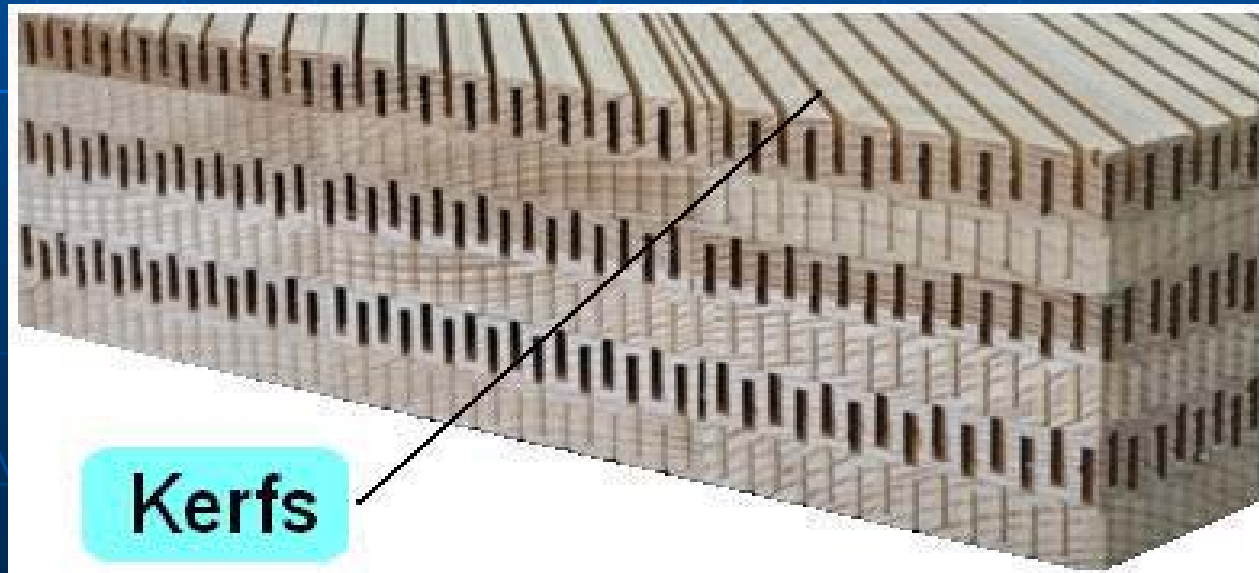
Solid wood lightweight panels

- This is a three-layered panel. Thin outer layers providing basic stiffness to the panel consist of solid wood, particle board (PB) etc.



Solid wood lightweight panels

- The middle layer of the panel consists of cross aligned boards with longitudinal kerfs, which are glued to the surface layers at an angle of 45° . The kerfs form multitude of small cells with webs inclined at an angle of 45° .



Solid wood lightweight panels

- The panels have low bulk density (300 - 400 kg/m³). Their weight depends on panel thickness and top layer material.
- They have high strength and dimensional stability, a very good heat insulation factor (better than solid wood) and fire resistance factor.
- The panel thickness varies from 24 mm to 240 mm (including top layers), width – up to 2075 mm and length of up to 6000 mm.

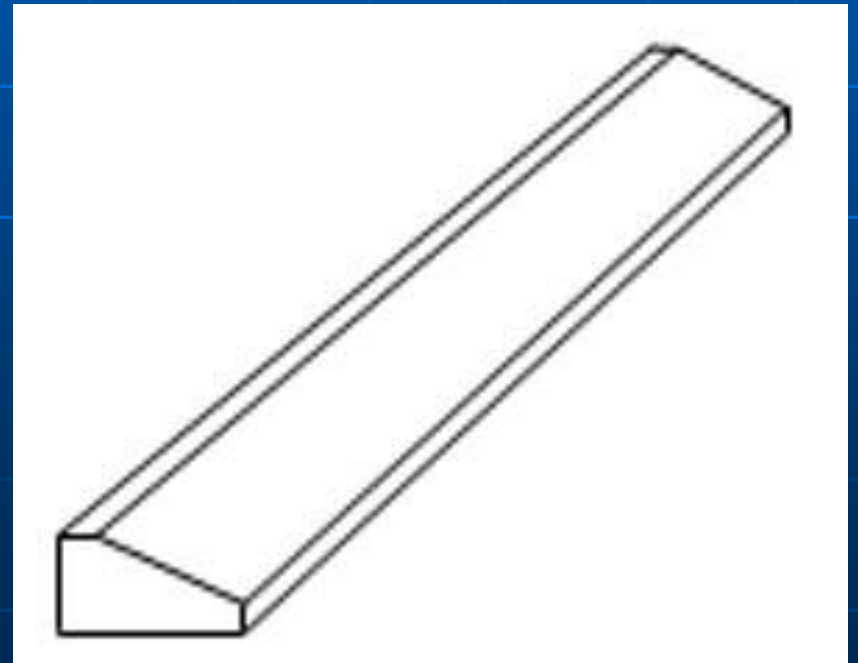
Solid wood lightweight panels

- Unfortunately, high level of wastes in production of the panels limits their application. When producing the kerfs in the center layer, about 50 percent of the raw material goes into sawdust which adds to the total amount of sawdust in the process. Using the extra sawdust produced for fuel (wood pellets), as some suggest, is not a viable option as it requires additional investment into a new process.



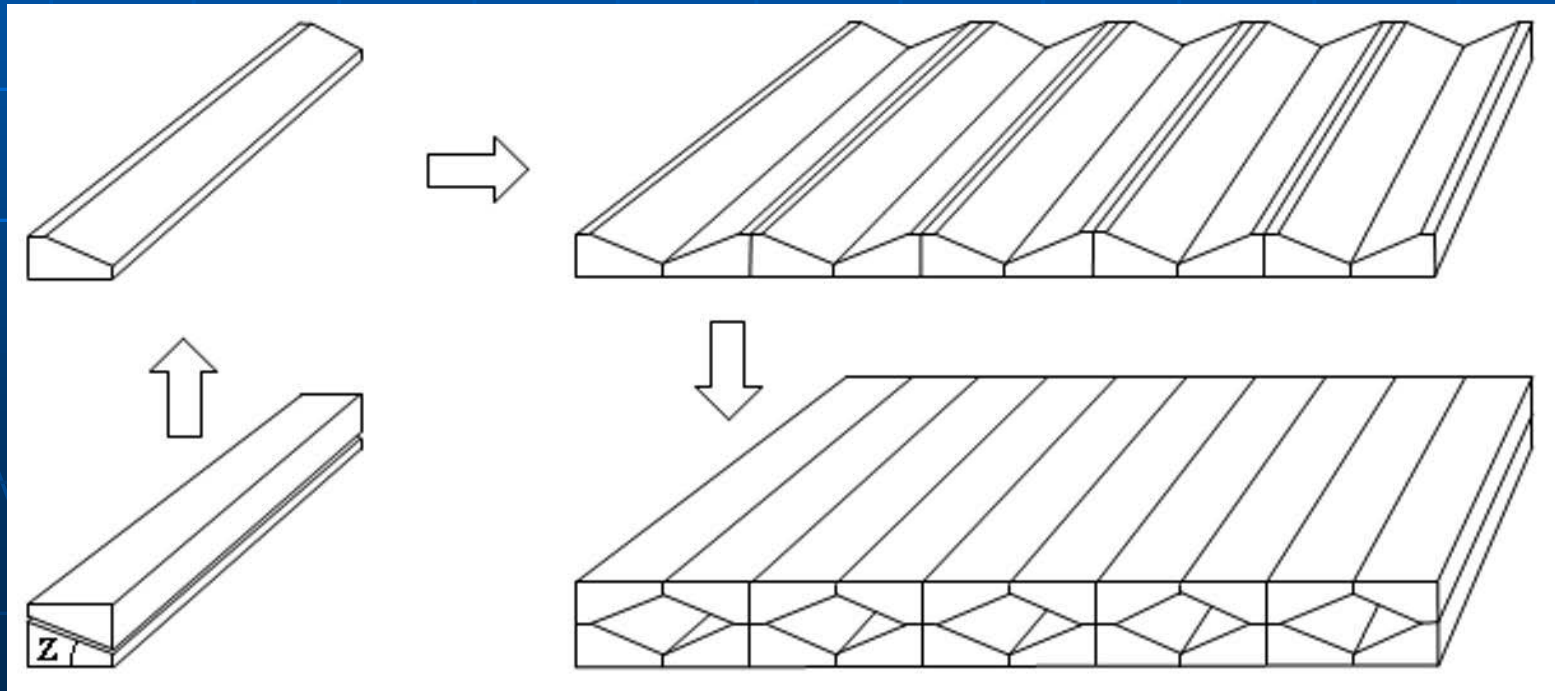
New solid wood lightweight panels

- New lightweight solid wood panels, which do not generate much waste in production, are presented below. The panel (patented, Skuratov 2010) consists of several layers.
- Each layer consists of strips, which are trapezoid in section.



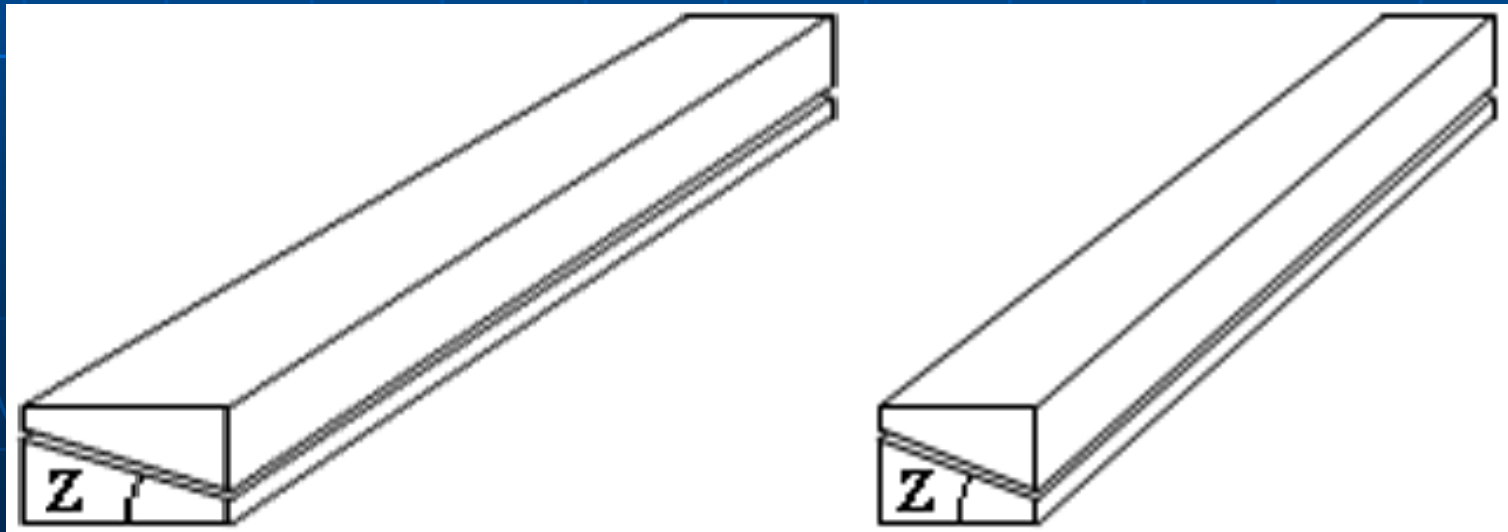
New solid wood lightweight panels

- Strips had been produced by cutting surfaced boards at a fixed angle Z and the subsequent planing of sharp-angled edges. The simplest panel is glued from two layers with identical grain orientation.



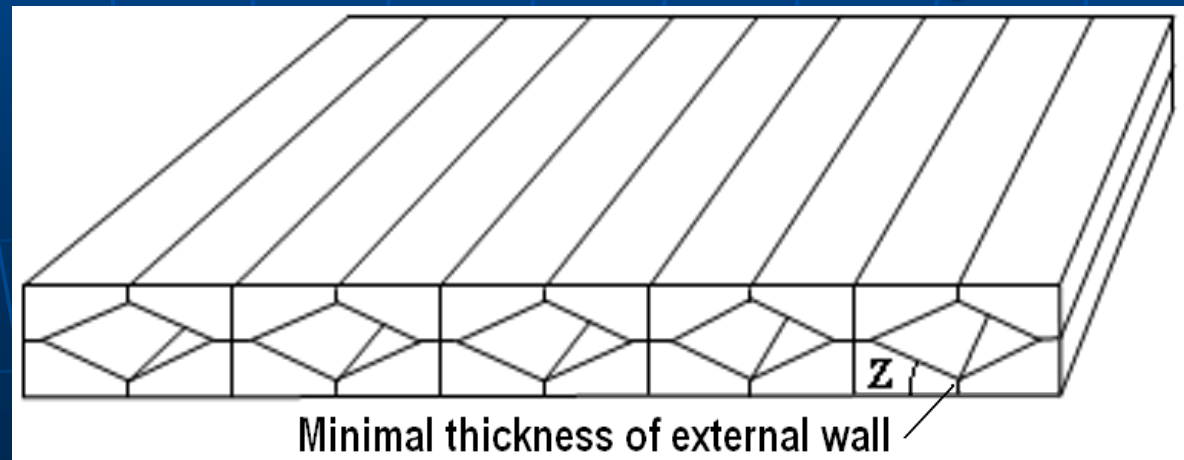
New solid wood lightweight panels

- The angle Z depends on the cross section of the board and it defines the structure of the panel itself. The larger is the angle Z , the higher is the thickness of the panel and the lower is the minimal thickness of external wall of the panel.



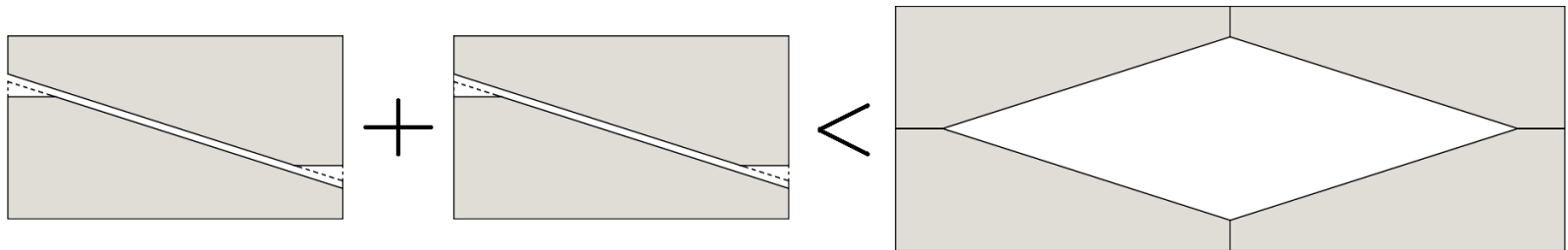
New solid wood lightweight panels

- Minimal thickness determines to a great extent the stiffness and other mechanical properties of the panel. Outer layers of panels which are exposed to external mechanical impact should have a stiffness property to withstand the impact. To accommodate that property the angle Z should be smaller. For internal layers the angle Z can be larger and this thickness smaller.



New solid wood lightweight panels

- New panels need less wood in production compared to traditional cross laminated multi-layer panels. Simple geometrical calculations show that from 1 cu m of surfaced boards it is possible to produce up to 1.2 - 1.3 cu m of panels.

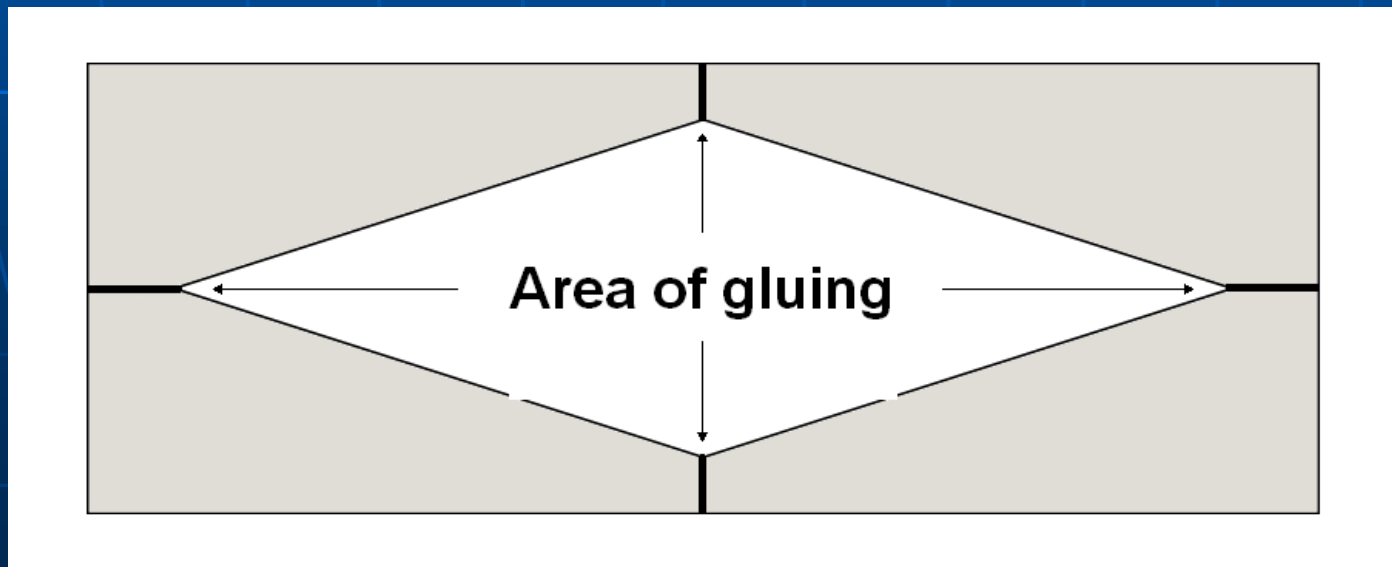


New solid wood lightweight panels

- Bulk density of softwood panels is equal to 300 - 350 kg/m³ (60 – 70% of common density of wood).
- Thickness of panels, depending on board size and quantity of layers, can be from 40-50 mm up to 300-400 mm.
- Length and width of panels are defined by the press dimension.

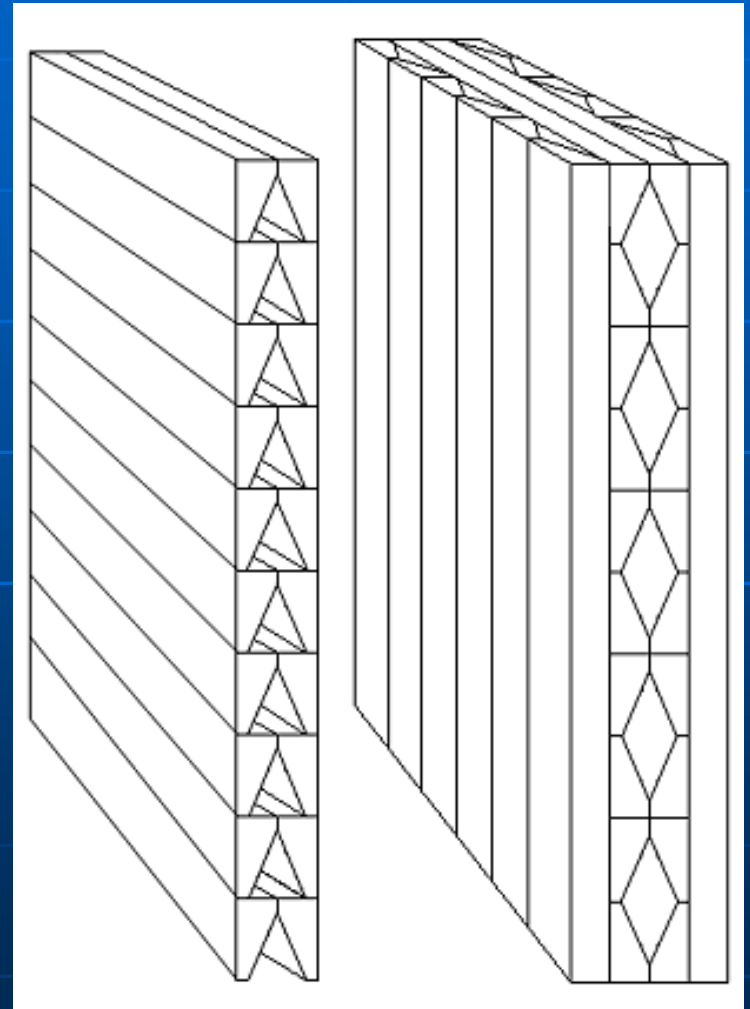
New solid wood lightweight panels

- The area of gluing at assembly of layers is equal only to 20 – 25 % of the panel area therefore for gluing of panels the press with rather low capacity is needed.
- The glue charge will also be low.



New solid wood lightweight panels

- The order of stacking of strips and orientation of grain in panel layers can be different.
- In practice, for each specific application it is possible to make a panel with needed mechanical properties and stability.

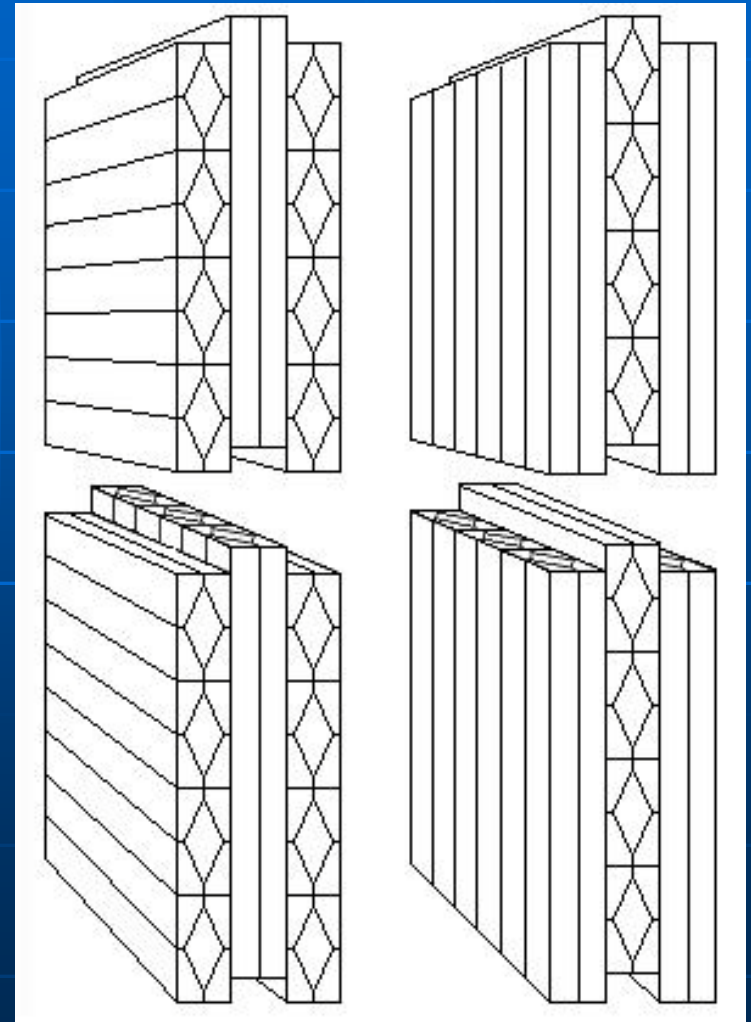


New solid wood lightweight panels

- Abundance of hollow sections in the structure of panels reduces heat conductivity of new panels by 25-30 % against standard panels of solid wood. It makes them suitable for use in external walls, floors and roofs, which do not have to be thick even in a cold climate.
- Additional benefit of hollow channeled structure is the capacity to host wires and pipes.

New solid wood lightweight panels

- Connecting tongues and grooves for panel fixing can be made by simple movement of layers in pressing.



New solid wood lightweight panels

- Panel appearance depends on quality of wood of external layers. When boards of 1 and 2 grades are used, surfaces can be sanded and painted. For inner layers low quality boards can be used.

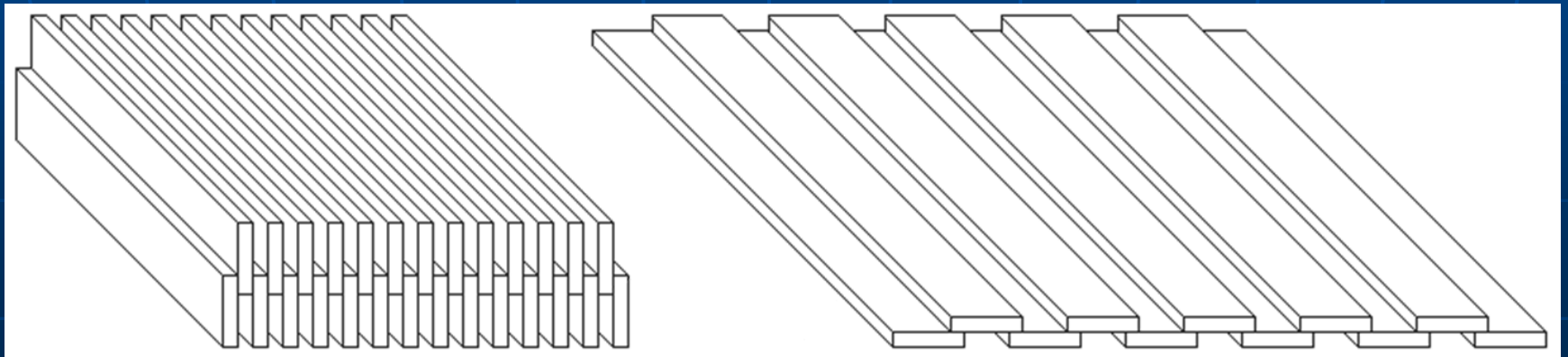


New core layer for lightweight panels

- Use of core layer with cellular structure reduces the weight and wood consumption in production of three-layer panels.
- New material for inner lightweight layer used in making solid wood panels (patent pending) is described below.
- The core layer is also a stratified structure in its own right.

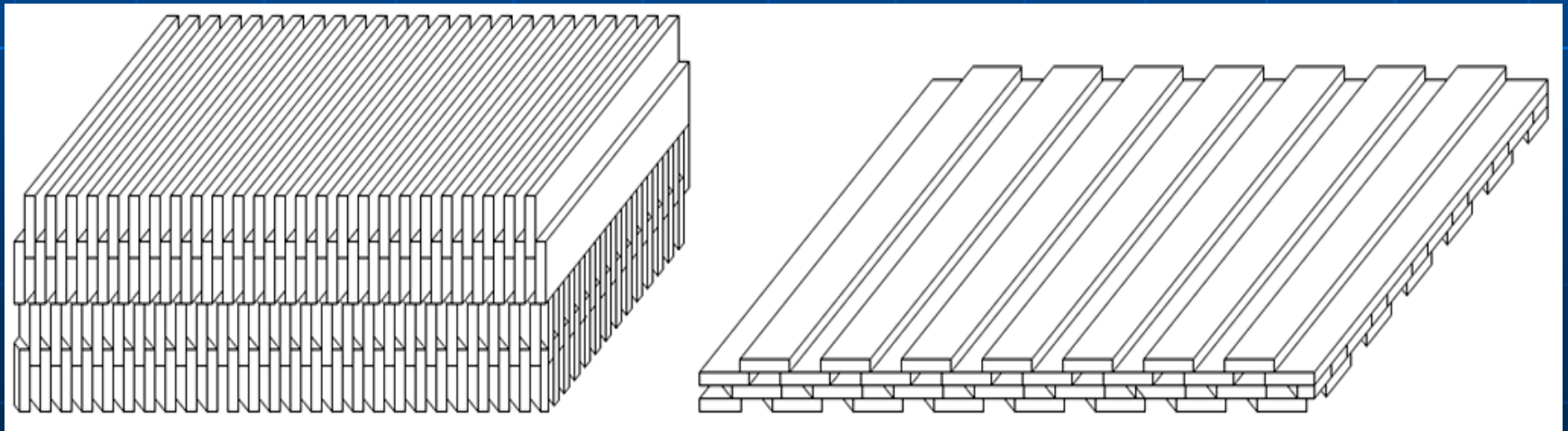
New core layer for lightweight panels

- The strata are formed by gluing thin strips of wood in an overlapping manner along the edges. The width of gluing zones should be not less than 3 – 4 mm. The arrangement of strips in layers can be vertical or horizontal. Optimal thickness of strips is equal to 7 – 8 mm and width 20 – 25 mm.



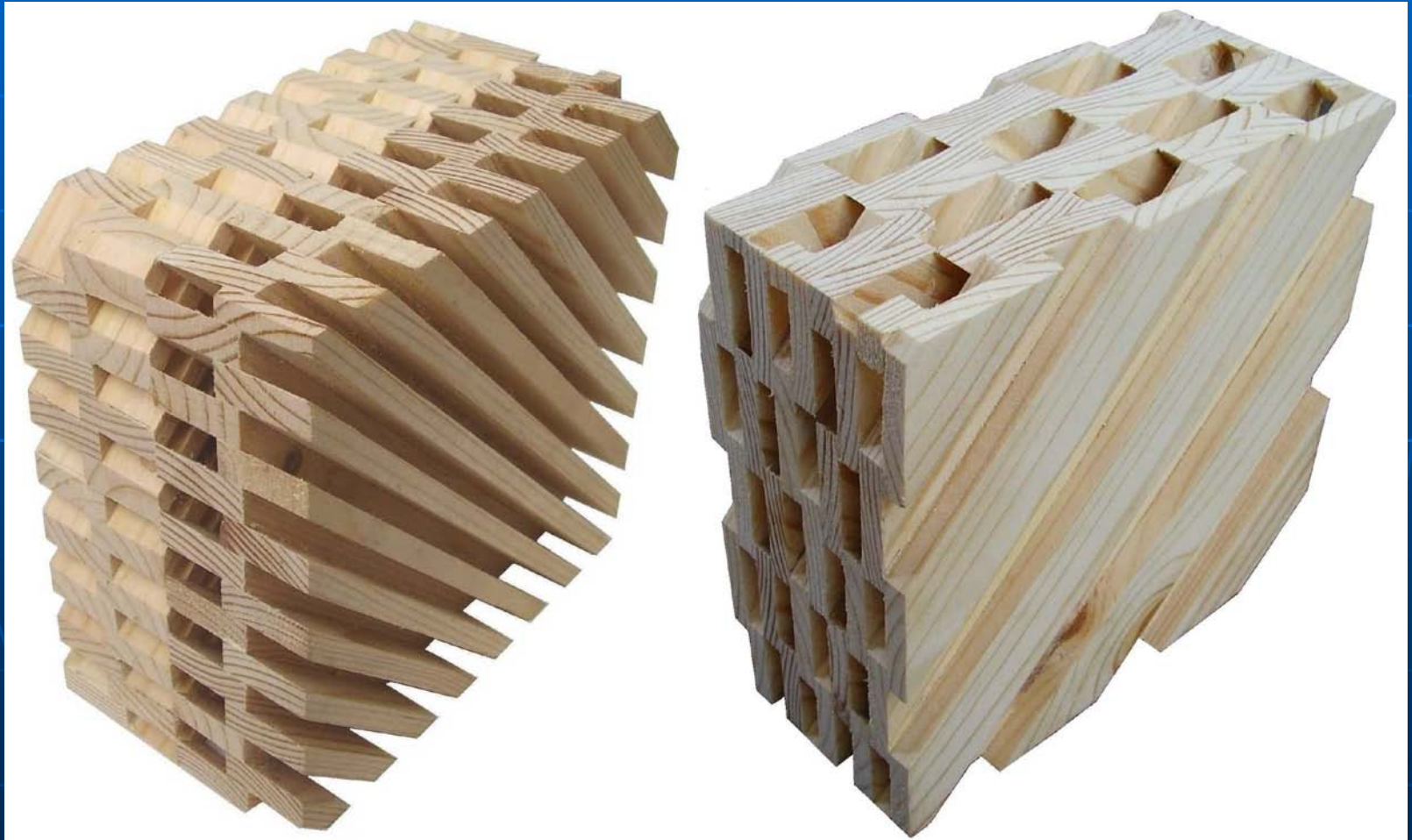
New core layer for lightweight panels

- Fibers in the strips of adjacent layers are differently oriented, but the same angle is maintained in relation to one of the axes of the unit. For symmetry of the structure this angle should be at 45° . Slight deviation is allowed.



New core layer for lightweight panels

- Orientation of layers in the structure of the new unit.

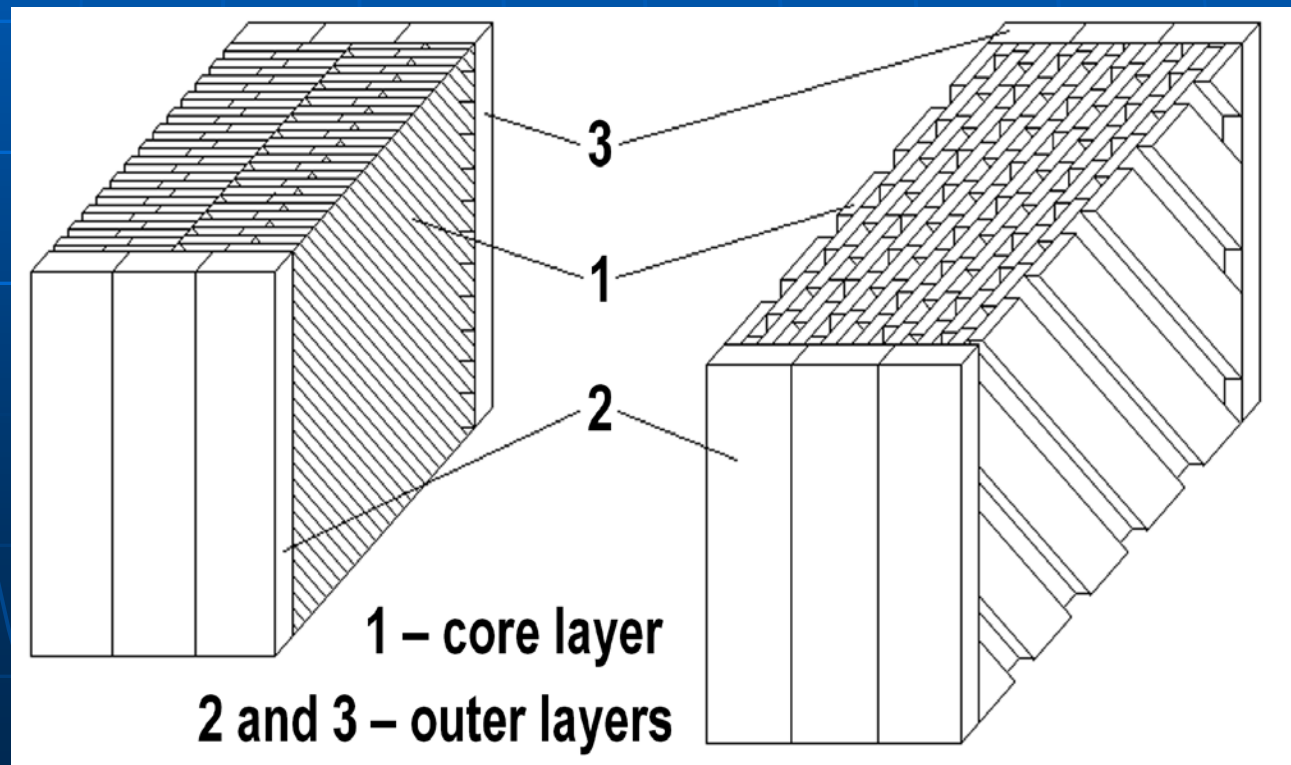


New core layer for lightweight panels

- The unit is low in wood and glue consumption. From 1 cu m of surfaced boards it is possible to produce about 1.05 - 1.15 cu m of the new element. At density of coniferous wood of 500 kg/m³ bulk density of the material will be equal only to 270 – 320 kg/m³.
- Wide area of gluing of strips with each other and cross arrangement of layers provides for high strength and stability to the element.
- Calculated factor of heat conductivity of the element is about 0.09 – 0.10 W/mK, 30 – 40% less than of massive wood.

New core layer for lightweight panels

- This material as a core layer of three-layer panels can be applied successfully in construction of external walls of wooden houses. As outer layers of wall panels, wood of different species, chipboard, MDF, OSB etc can be used.



Conclusion

- Use of new panels and elements of structure saves wood, reduces weight and price of products making housing more accessible.
- Further it is supposed to define panel and material characteristics and specify field of their effective application.

Thank you!