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LAMINATED WOOD BEAMS AND THEIR APPLICATIONS

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ABSTRACT
Laminated wooden beams are very good for the construction and the combination of different wood structure. The process of producing laminated beams and technology are very flexible since. The glue which we use is important for their durability and quality. The paper will represent both technology production and applications.
Keywords: laminated wood beams, technology, application

1. INTRODUCTION
The use of wood and wooden structures flourished for several reason. Wood is mechanically very high quality building materials, which has a number of advantages and far fewer defects. Wood is orthotropic material. Capacity load parallel to the grain it is large and very cost effective when compared to the weight of the material. The transverse capacity load of wood is much lower, and problematic tensile shear load capacity which should be taken care of in resolving details of timber structures. Wood is also a good sound insulator and thermal insulator. It is increasingly used in residential construction as an environmentally friendly and energy efficient materials. At the same time we must not forget the fact that wood is a healthy material that can easily be recycled.
Today are know all the ways to protect wooden structures and it gives them the advantage of the construction as they have sufficient durability. Finally, although the burning, the wood does not lose the mechanical properties of the fire and, as such, does well in case of fire load. The wood is Self-extinguishing, and this particularly applies to the X-lam plate or large elements of glued laminated beams and the like. The wood industry does not contribute to additional CO_2 emissions.
There are limits to the maximum size of the cross section and length of sawn timber to be used as structural members of the structure for the availability of specific sizes and the presence of natural logs defect occurrence in the tree. These defects can be cut and timber can be reconstructed by applying engineering techniques such as finger jointing in order to obtain greater lengths of lumber of particular strength class or laminating to form a homogeneous section of material.
Combining wood or laminated parts with wooden boards or metal elements are obtained products - engineered wood products (EWPs) whose size is limited only to the limitations in the production, handling and transport. A significant development of these products for structural use with materials such as laminated veneer lumber (LVL), parallel strand lumber (PSL), laminated strand lumber (LSL), prefabricated I-beams, metal web joists and 'massive' or cross-laminated timber (CLT). These EWPs are manufactured by gluing small pieces of wood and laminated (Glulam and CLT or veneer or wood chip (e.g. LVL, LSL and PSL). The size of the wooden components, which are made, influence the characteristics EWPs and application EWPs.

For the production of laminated timber beams are most often used glued laminated timber (Glulam) - Glued solid wood; - Glued laminated timber with long finger connection; - Block glued glulam for use in buildings and bridges, and LVL and CLT.

2. GLUED TIMBER BEAM

Often used EWPs in structures for beams are glulam (glued laminated timber), because with them can provide high quality and unique product of any shape, size and form.

Glued laminated wood is a modern composite material, which has equal or better mechanical properties than the timber in which it is produced.

Glued laminated timber is made of thin lamellas, whose grain is parallel to the surface (the length of the workpiece). The boards are glued with adhesives for structural use, which gives the connection high strength and durability, resistant to the action of water, humidity, high temperature and biological pest.

Glued laminated wood product that is used as a raw material base of spruce, fir or pine (in Canada and the United States and Douglas fir), but can also be made of larch wood and poplar 1 class quality. Today, do research applications hardwood (beech) for the production of this product.

Production of laminated wooden beams should be in accordance with the requirements of EN 14080: 2013. This European Standard sets the performance requirements of the following glued laminated products:

- Glued laminated timber (glulam) which is made from coniferous species listed in this standard or poplar and consists of two or more lamella thickness of 6 mm to 45 mm (including);
- Glued solid timber - which is made of coniferous species listed in this standard or poplar consisting of two to five laminations having a thickness greater than 45 mm and less than or equal to 85 mm;
- Glulam with large finger joints (with a finger length of at least 45 mm);
- Block glued glulam for use in buildings and bridges - which having solid rectangular cross sections.

This European Standard also gives the requirements for glued laminated products treated against biological attack. Glued laminated products treated with fire retardants are not covered.

For the production of glued laminated wood used to glue type I and type II. The lamellae should have a humidity of 8% to 15% depending on the service classes of the future use of the beam, but in the production should be taken care that the moisture difference of each carrier within a depth not greater than 4%.

The usual thickness of the lamellas are 32 mm or 44 mm, a width of lamella are 80 mm to 220 mm. Increased thickness of the lamellas are not recommended because the lamellas in the drying process can distort. Beams are produced in widths of 50 to 300 mm and heights from 100 to 2500 mm.

Glued laminated beams applied in dry, humid and external conditions. Depending on the service classes are made in the following lengths: for 1 and 2 service classes up to 18 m (standard) and for 3 service class up to 50 m (design components). The length of the beam is limited to the requirements of production, handling and transportation.

The combination of different strength and elements (pieces) of wood achieves the desired strength and stiffness of the beam. The structures are commonly used carriers strength classes GL 24, GL 28, GL 32 and GL 36 with references "c" or "h" indicating combination and homogenous form of lamination lay-up respectively).

Depending on the design and constructive solution of the architectural structure, the expected conditions of use (the intensity and type of load, environmental conditions - class service, etc.), wooden laminated beams together to be manufactured as a balanced or unbalanced beams.

Structural glued laminated timbers are permitted to be laid up with lumber grades placed symmetrically or asymmetrically about the neutral axis of the member. Timbers with symmetric lay-ups are referred to as “balanced” and have the same design values for positive and negative bending. Timbers with asymmetric lay-ups are referred to as “unbalanced” and have higher design stresses for positive bending (tension on bottom) than negative bending. Unbalanced lay-ups are generally used for simple, single-span beams, while balanced lay-ups are used for continuous or cantilevered beams. However, for most residential applications where cantilever lengths are relatively short, a stock unbalanced glulam can be used. Cantilevered roof overhangs of up to 20% of the main span can be accommodated using an unbalanced beam without special lay-ups. For longer length cantilevers, balanced beams should be specified. The topside of unbalanced beams is required to be marked “TOP” by the manufacturer to ensure proper installation. Balanced beams use the same grades in the top half of the beam as in the bottom half. The upper and lower halves are mirror images of each other. Unbalanced beams use higher grades in the bottom half than in the top half.

In recent years, fiber reinforced polymer (FRP) materials have been used for external reinforcement of glulam timber beams (Plevris and Triantafillou 1992; Fiorelli and Dias 2006; Dempsey and Scott 2006). However, the use of FRP materials for reinforcement is still very much limited due to the relatively high cost and rather complicated fabrication processes (Lopez and Xu 2002). For civil engineering infrastructure applications, glulam panels reinforced with hybrid FRP had been experimentally and analytically evaluated for bridge deck construction (Lopez and Xu 2002). Several computational models of glulam timber beams have been developed and reported in a number of researches (Lindenberg 2000; Romani and Blab 2001; Lopez and Xu 2002; Fiorelli and Dias 2003, 2006). A semi-probabilistic model based on the Monte Carlo approach to determine the strength and stiffness of glulam beams was developed by Lindenberg (2000). A simple beam analyzed linearly and non-linearly based on a moment-curvature model had been proposed to respectively compute structural properties and to predict ultimate load (Lopez and Xu 2002). Design models for moment of rupture had been developed and compared with experimental results (Romani and Blab 2001; Fiorelli and Dias 2003, 2006). Furthermore, various approaches to improve post elastic responses of glulam timber beams under bending had been experimentally investigated by Tomasi et al. (2009).

3. SOME EXAMPLES OF APPLICATION OF LAMINATED WOOD BEAMS

Laminated beams are designed and manufactured in accordance with the desired appearance (design) and the requirements for using the aforementioned beams. The following figure shows some examples of using laminated beam and specific requirements of use.

		
Figure 1. Glued laminated beams construction which need very high quality of beams	*Figure 2. Special roof construction which include different types of glued laminated beams in certain parts*	*Figure 3. Big sport hall with a roof from glued laminated beams produced based on certain design*
		
Figure 4. Innovative solution structure of the tower that requires very specific wooden beams	*Figure 5. Very special construction from glued laminated beams*	*Figure 6. Special construction of a bridge from glued laminated beams*

From the above examples it is clear that each individual beam requires a certain specific technology of production. Also each individual type of require and test of stress in the beam, and according to the results and production of the beam.

Design the most appropriate beam girders that form a gable roof surface, but these beams have the greatest problems with regard to the transverse tensile stresses. The maximum shear stress is in the middle zone. On the chart below to see the stress state of transverse stresses in the gable-beam girders and the possibility of taking over these stresses by using built-in threaded rods through middle section.

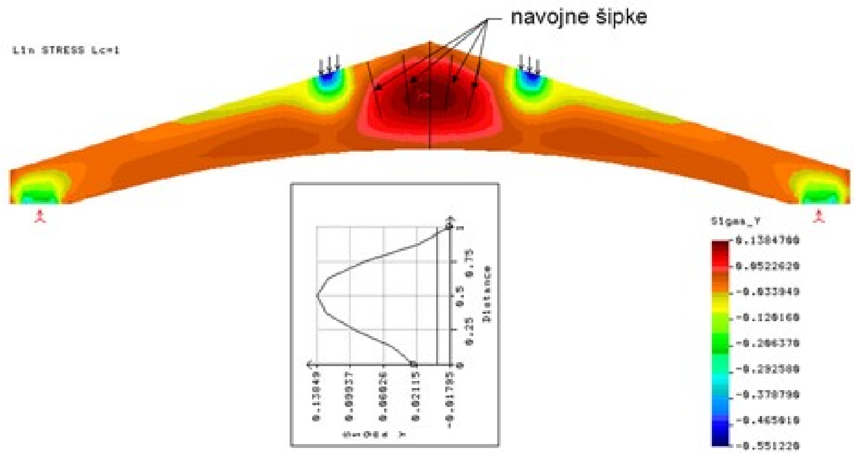

Figure 7. Stress state of transverse stresses in the gable-beam

In the design and manufacture of construction it is necessary to strive for rational use of materials for making them. For example, when making rational wooden structures laminated wood is consumed 0.05 to 0.12 m3 / m2-shaped, while normal steel consumption of 3 to 6 kg / m2 floor plan. All construction shall be tested.

4. CONCLUSIONS

The modern design and construction which include glued laminated beams require high quality of products implemented in all construction. For that we decided to point certain matters in this field.

1. The first application of glued laminated beams comes as very good matter for the special construction, where natural material is required.
2. Since it is a natural material constructed where gluing process is included, it is very important to quality control in production process and after.
3. But other composite natural building material offers the physical strength, toughness and durability of the material as well produced glued laminated beams.
4. Each carrier requires individuality design and development to meet the requirements in terms of mechanical properties, durability and looks carriers.
5. Quality of material built into the bracket and the quality of manufactured carrier must be tested.
6.Tehnologija to produce laminated wooden structures should be flexible in order to meet the desired requirements.

5. LITERATURE

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