

Short description of the laboratory

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Main topics relevant to COST Action E24	Examples of activities	Number of scientists
Glued laminated timber	Properties of glued laminated beams from mixed species; Energy dissipation in glued laminated beams	2
Fire resistance	Behaviour of glued laminated beams exposed to fire: effects of intumescent paints on the fire resistance of loaded beams:	1
Mechanical joints	Glued in steel-wood longitudinal joints	2

Main equipment: MTS testing machine (195 kN); INSTRON TTK25 ton testing machine; 3 large climatic chambers (2 with two climates); Horizontal and vertical fire resistance testing oven; Fire performance testing facilities; Ultrasonic and densitometric NDT test devices.

Activities related to the field of COST Action E 24

Properties of glued laminated beams from mixed species (del Senno, Paganini)

Laminated timber is a material of both structural and aesthetic value, with various applications in the field of building components and of timber structures of big and small spans. The technological development of glulam makes for continuous evolution; industries, but above all researchers, are now starting to consider the possibility of using a wider range of wood species; interest is increasingly being shown in fast growing species which could stimulate the establishment of specialized non-forest plantations. The use of these by themselves or in combination with the traditional ones for the production of laminated timber could be an answer to the increasing demand for cheaper and disposable raw material. At the moment the use of glulam obtained from a combination of different wood species is quite widespread, but with different end uses rather than structural ones.

At ITL particular attention has been paid to eucalyptus, which shows interesting mechanical properties, and to poplar, which, due to short cultivation cycles (10 –12 years), is, for the time being, one of the few renewable sources of wood raw material manageable in the medium term. The possible uses of the latter for structural purposes have been investigated in previous research studies (Castro and Paganini 1993; Castro and Paganini 1997; Pedrotti et al. 1997) carried out on small sized laminated beams as well as on structural sized beams which have shown a very favourable shear behaviour in terms of strength and rigidity, hence suggesting a convenient use in short span beams and, close to the neutral axis area, in mixed species glued laminated beams.

Combining the wood of different species seemed potentially very interesting, bearing in mind the importance of the similarity of shrinkage coefficients of the species involved (big moisture content variations in the wood induce stresses in the glue lines which can produce, in the case of mixed wood species, a greater increase in glue line delamination if the difference between shrinkage coefficients is of particular note).

The scope of the work is then to investigate possible drawbacks in mixing the wood species and to find the combination which would produce optimum structural efficiency.

Energy dissipation in glued laminated beams (del Senno, Paganini)

Another sector of the investigation has been focused on the bending behaviour of combined glulam both in terms of energy dissipation and of deformation in the elastic field and up to the ultimate load. In particular a possible correlation between the pseudo-ductile behaviour found in a previous research study (Paganini and del Senno 2000) and physical-mechanical properties of species involved, beam composition criteria, dimension and distribution of defects in outer laminations, are being studied.

In this context a verification of the mechanical behaviour of mixed species glued laminated timber at repeated load cycles beyond elastic region has also to be done.

Effects of intumescent paints on the fire resistance of loaded beams: (del Senno, Piazza¹)

The effectiveness of an intumescent system in improving the fire resistance of a timber structural element has been shown to depend on its swelling and insulating characteristics, but also on its ability to adhere, once swollen, to the wooden surface.

Investigations have been carried out aiming in the first place to establish a relationship between the spread rate of an intumescent system and the fire resistance improvement of a glued laminated beam.

The actual performances have been experimentally evaluated by measuring the deflection variations at failure in four loaded points tests of simply supported beams, and working out, on the basis of the residual cross sections, the stresses corresponding to the ultimate bending moment.

These last data have been utilised to perform a critical evaluation of the main design criteria for fire resistant timber elements, namely the residual cross section and the effective cross section method, in order to establish correlations between these approaches and more sophisticated numerical evaluation methods, supported by numerical simulations with a high discretization degree.

Glued in steel-wood longitudinal joints (del Senno, Piazza¹)

Recent investigations have provided a substantial amount of information on the behaviour of axial joints utilising glued-in steel rods. This joint type does not resort to a poor property of timber, such as shear resistance, and does not involve risks of embedding, providing at the same time both high joint stiffness and protection from fire for the steel connector and the resin. Tests have been carried out on norway spruce blocks and threaded steel bars, using different epoxy resin formulations and hole / bar diameter ratios. The bar diameters ranged from 8 to 12 mm, and a 1 mm and 2 clearances were left between bar and hole wall.

After a first phase, in which the smallest diameter bars and 1 mm clearance had been taken into consideration, the resin range has been limited to two. Afterwards, an investigation on the effects of 1 mm and 2 mm clearance confirmed the results of the first investigation, that is: 1) the system has proved to be highly efficient, for both failure (and therefore permissible) load and joint stiffness, 2) the joint stiffness allows a steel - like approach to the joint design. So far a 240 pieces sample has been evaluated.

Selected References

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