



# DRESL

Diagnosi rinforzo di elementi strutturali in legno

## **Research project on diagnosis and reinforcement of wooden structural elements and systems. Development of a supporting software named HyperDresl**

The project stems from the primary need to identify for timber and ancient structures, a methodology of investigation and intervention as objective and effective as possible. Secondly, to contribute to the establishment of a reference database that allows to consider "ancient" timber as "modern", namely a construction material with a known variability to which statistically reliable performance characteristics can be associated.

In the case of interventions on ancient wood structures, it is necessary to take into account the peculiarities that distinguish the wood, first of all its wide variability that make the approach to conservation not immediately transferable from the one used for other construction materials. Experience shows that each wooden structure is different from the others, as is every element within the same structure; for this reason it is essential to always precede the design with an accurate and reliable diagnostic investigation, in order to obtain objective feedback on the performance and the conservation status of each element and to limit the intervention to what is strictly necessary.

The activities carried out in the project have well demonstrated that the combined use of diagnostic techniques based on scientific criteria and already consolidated in practice, with more advanced techniques already widely tested on new wood, allows us to obtain in a reliable way, the qualitative and quantitative information necessary to perform an optimal planning of the future intervention.

With regards to the interventions, given its excellent mechanical properties, adaptability to surfaces and minimal invasiveness, the attention was mainly focused on carbon fibers, in the form of fabric rather than laminate as in current applications. The reason is that we wanted to evaluate their applicability for the restoration and reinforcement of structural elements in place, with particular regard to elements broken by bending and / or degraded by the attack of xylophagous insects, a circumstance that frequently occurs in real cases.

The use of this technique would make it possible to avoid dismantling and replacing the original bearing element, with cost savings and the advantage of preserving the authenticity of the element itself.

The experimentation carried out as part of the project allowed us to verify its effectiveness also for the reinforcement of elements not degraded but particularly defective, therefore characterized by low or insufficient performance levels up to the complete non-suitability, a circumstance that often occurs in ancient structures and that often involves their replacement. Tests have shown that the use of carbon fiber fabrics for the reinforcement of ancient and degraded beams is feasible in practice even on elements with irregular surface, resulting in a significant increase in both stiffness and bending strength, and a good “plastic” behavior during breakage. Higher-weight carbon fibers (1000 g/m<sup>2</sup>) were used for this purpose.

By using a double layer of fabric, it is even possible to repair (restore) broken elements. The tests carried out have shown that the reinforcement not only restores but in some cases, even increases the original bearing capacity and gives the elements greater ductility and stiffness.

As a tool to improve the diagnostic investigation procedure, a supporting application software was developed and tested in the field. For the moment it is specifically dedicated to simple structures and its main purpose is to collect the data in a single container (database) which is also available remotely, it can be updatable and it is equipped with the possibility to automatically perform structural verification calculations, which are useful for evaluating the possible need for structural reinforcements in the first instance.

Further advantages in the use of the software are:

- facilitate and accelerate the on-site collection of data (useful for the preparation of inspection reports)
- the possibility of creating a digitized database that can also be used by third parties
- facilitate communication between the various phases of the work (from inspection to structural verification, to the design and the carrying out the intervention).

The project, financed by the Tuscany Region with European funds POR FESR Tuscany 2014-2020, lasted two years and involved partners from the business and research world.

In particular, the group of companies formed by:

**C-Six srl** – Leading company in the production of carbon fiber fabrics, with an eye to new applications and experimentation. It has been successfully operating for over 10 years in the field of structural reinforcements thanks to its reinforcement system consisting of C-TEX ECO (carbon fiber fabric) C-RESIN (resin)

**[www.c-six.it](http://www.c-six.it)**

**LegnoDOC srl**– Thanks to its twenty-year experience, it is one of the most important Italian companies as for diagnostic and consulting services in the field of conservation of existing wooden structures, especially as far as cultural heritage is concerned. The company has up-to-date equipment for the non-destructive testing of wood in the structural field and is therefore able to satisfy any request regarding the technological characterization and assessment of the conservation status of wood elements and structures, both on site and disassembled.

[www.legnodoc.com](http://www.legnodoc.com)

**Impresa Aliberto Saccenti sas** – A construction company specialized in ordinary and extraordinary maintenance, renovation, consolidation, building recovery and conservative restoration. For over 60 years it has been working on the existing building stock, pursuing a conservative philosophy and adopting traditional techniques alongside innovative systems and products

and as service providers:

**CNR-IBE - Istituto per la Bioeconomia (former IVALSA)**, Important Italian research center in the forest-wood sector, basically the only institute at a scientific and technical level for the sector of wood and timber products, in their varied and multiform fields of application.

IBE has planned and conducted all testing activities relating to:

- physical-mechanical characterization of ancient timber
- assessment of reinforcement systems for wood elements
- verification of resistographic profiles and support activities for the development of the software – Hyperdresl

[www.ibe.cnr.it](http://www.ibe.cnr.it)

**Coopolis SPA**, Italian company leader in the development of software, specialized in providing services and IT solutions to the highest quality standards and capable of enhancing its skills, with a propensity to technological innovation.

Coopolis Spa conducted in particular the following activities:

- creation and development of the software called "HyperDresl".

[www.coopolis.it](http://www.coopolis.it)

All the activities were carried out both at the suppliers and at the companies' offices.

The project was an excellent example of synergies between business partners and public research institutes. Each party involved contributed to a profitable exchange of experiences and knowledge, with its experience in its field of activity, with suggestions, ideas, materials and operational activities and this, in addition to the results of the project, has been one of the main added value of this collaborative experience.

N.B.: The development of the project according to the standards of the Bando B 2014- POR CreO FESR Toscana 2014-2020' was carried out with the support of the external party PIN S.c.r.l. [www.pin.unifi.it](http://www.pin.unifi.it)