Wooden beams reinforcement and prothesis.

IS IT:

- [ ] *Product*
- [X] *Technology*
- [ ] *Equipment*

APPLICABLE FOR:

- [X] *Restoration*
- [X] *Rehabilitation*
- [ ] *New Construction*

APPLICABLE ON:

- [ ] *1. Foundations and underground structures*
- [ ] *2. Vertical structures*
- [X] *3. Horizontal structures and vertical connections*
- [X] *4. Roof and terraces*
- [ ] *5. Façade and building envelope*
- [ ] *6. Finishes and completion elements*
- [ ] *7. Integrated services*
- [ ] *8. General strategies for building recovery*

Related companies: *No companies; university research; structural study.*

DESCRIPTION

During the rehabilitation or restoration interventions, a specific work is often required to consolidate wooden beams, trusses and generally some parts of wooden structures. In these cases the goal is twofold: to secure the beams of a floor or roof and significantly improve the aesthetic aspects, mitigating the effects of decay.

These operations of consolidation of wooden floors and roofs, are always particularly delicate and complex.

This technique is used when it is only the end part of a wooden beam that is degraded or damaged (in the wooden beams of a floor the portion inside the wall beams, in a truss the end portion of the rod-tie beam and sometimes also of the strut).

It is therefore essential to know through analytical examination the degraded part to be removed and the healthy one instead to which it can be easy to anchor the new wooden prosthesis, in order to minimize the impact of the intervention.

The least invasive possible and structural rehabilitation interventions must be carried out. In this regard, the grafts of wooden prostheses take on characteristics of particular precision and delicacy.

It must be refer to the situations in which water, humidity, prolonged exposure to atmospheric agents and the wear and tear of time, have perhaps only partially damaged the heads of wooden beams of floors, roofs or trusses.

In this case, not the entire wooden beam is replaced, but special care is taken only on the most damaged parts when it is inserted into the wall.

WHY TO USE

In structural restoration interventions it happens very often to find situations of decay of wooden structures, which however for various reasons it is not possible to replace or consolidate with conventional methods.

The consolidation system by reconstructing the damaged part with prosthesis made on site and using with pieces of beams of similar size and steel reinforcements, allows to solve the majority of these rehabilitation cases.

HOW TO USE AND APPLY

In the past, the degraded area was rebuilt with a cast of "epoxy grout", but this technique is now outdated due to the excessive cost of the rehabilitation intervention and its very limited compatibility with wood.

It is therefore preferred to make a prosthesis in solid or laminated wood (the choice depends on the possibility of finding wood with humidity below 18%) and connect it with bars and sheets glued with epoxy resin.

In the absence of sufficient sections in seasoned solid wood, the prosthesis is reconstructed as if it were a "lamellar portion of beam made on site", placing boards side by side and gluing them together.

The union of the prosthesis to the surviving wooden part of the beam is carried out by means of stainless steel bars with improved adhesion, or in composite material, glued precisely with thixotropic epoxy adhesive that does not drip, positioning the bars in specially made seats both in the prosthesis and in the portion of residual beam and close to it, positioning them parallel to the wood fiber and then covering them with a wooden strip of adequate thickness that does not make the intervention too visible and camouflages it (usual thickness of at about 3-5 cm); this allows the wood fibers to be stressed in the best possible way.

The insertion of the bars parallel to the wooden fibres allows to improve the compatibility between the two materials: a bar inserted transversely with respect to the fibers would counteract the shrinkage and swelling of the wood, generating alternating shear stresses on the gluing.

In wooden trusses, the strut is often degraded only in a limited area of contact with the wooden tie-rod beam, in correspondence with the interlocking indentation; in this case it is sufficient to restore the joint by eliminating the degraded part and inserting a piece of harder wood (e.g.: oak).

THE INTERVENTION IS DIVIDED INTO SEVERAL AND CO-RELATED SUCCESSIVE PHASES:

- introduction of supporting beams at the intrados of the floor beam or truss for safety during subsequent work. The beam must be suitably shored in order to facilitate the cutting of the damaged part;
- removal of the degraded and terminal part of the wooden beams to be restored by cutting with a chainsaw (usually the cut is made on an inclined

plane of 60 ° with respect to the horizontal one), using two nailed boards as a guide. If necessary, the cutting surface can be leveled with an electric plane;

- creation in the remaining part of the original wooden beam of a special shape for the insertion of the new part of wooden prosthesis;
- drilling of the original wooden beam with a core drill in order to create one-two or more housings for threaded fiberglass or stainless steel bars;
- creation of the wooden prosthesis with the same essence and the same dimensions as the original, or prosthesis in harder wood or laminated wood; also in this element two or more holes will be created at the same distance and with the same diameter of the part in place, for its entire length;
- insertion of suitable epoxy resin possibly pigmented to reproduce the shades of the existing wood between the surfaces in contact;
- injection of suitable resin inside the holes, positioning of the threaded bar that will come out from the head of the wooden beam; a special care must be taken that the whole bar is perfectly wrapped in the adhesive;
- positioning of the metal counter-steel plate and tensioning of the two bars in order to tension the elements thus reconstructed;
- reconstruction of the side face of the wooden beam by means of wooden strips useful for camouflaging the intervention and treated with paint like the pre-existing parts of the beam.

TECHNICAL CHARACTERISTICS

It is possible to reconstruct the rotten wooden part without necessarily dismantling the floor or the roof where the affected beam is placed.

The intervention can in fact be carried out with the structures fully loaded. Furthermore, the intervention, once finished, will be contained in the original dimensions of the beam itself and will allow us to leave the structure exposed without excessively noticing the reconstruction intervention.

The prosthesis is also to be preferred over other consolidation interventions because, being made of wood, it undergoes the same physical variations that the rest of the beam has.

RECOMMENDATIONS AND OTHER INFORMATION

N/A

EXAMPLES

Fig.1: Head part of a damaged wooden beam.
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Fig.2: Cutting of the residual portion of the wooden truss tie-rod beam, useless to insert the wooden prosthesis to be connected by matching.
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Fig.3: Making a hole with a drill to insert the adhesion bar of the existing part of the wooden truss to the newly built wooden prosthesis.
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Fig.4: Cutting for making prosthesis in a wooden truss tie-rod beam.
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WEBSITE OF THE COMPANY

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IMAGES AND CAPTIONS

Fig.5: Introduction of supporting beams at the intrados of the floor beam or truss for safety during subsequent work. The beam must be suitably shored in order to facilitate the cutting of the damaged part. *©Mario Li Castri*

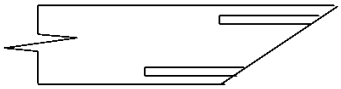
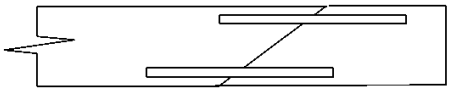
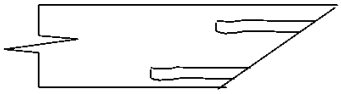
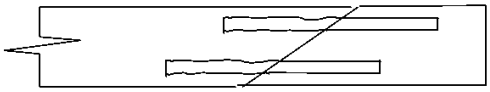
Fase	Descrizione	Schema
0	Corrisponde allo stato delle cose al momento iniziale.	
1	Fase di preparazione dell'intervento. Nel caso specifico la trave viene lavorata in modo da poter poi posizionare la protesi	
2	Effettuazione dell'intervento	
3	Fase di rimozione della protesi	
4	Riesecuzione dell'intervento con procedure e modalità analoghe a quelle della fase 2	

Fig.6: Descriptive table of the construction phases to be carried out for the rehabilitation intervention. *©Mario Li Castri*

Fig.7: Construction site phase of the wooden prosthesis in some wooden floor beam. *©Mario Li Castri*

Fig.8: Reconstruction of the side face of the wooden beam by means of wooden strips useful for camouflaging the intervention and treated with paint like the pre-existing parts of the beam. *©Mario Li Castri*

Fig.9: Injection of suitable resin inside the holes, positioning of the threaded bar that will come out from the head of the wooden beam; a special care must be taken that the whole bar is perfectly wrapped in the adhesive. *©Private archive*

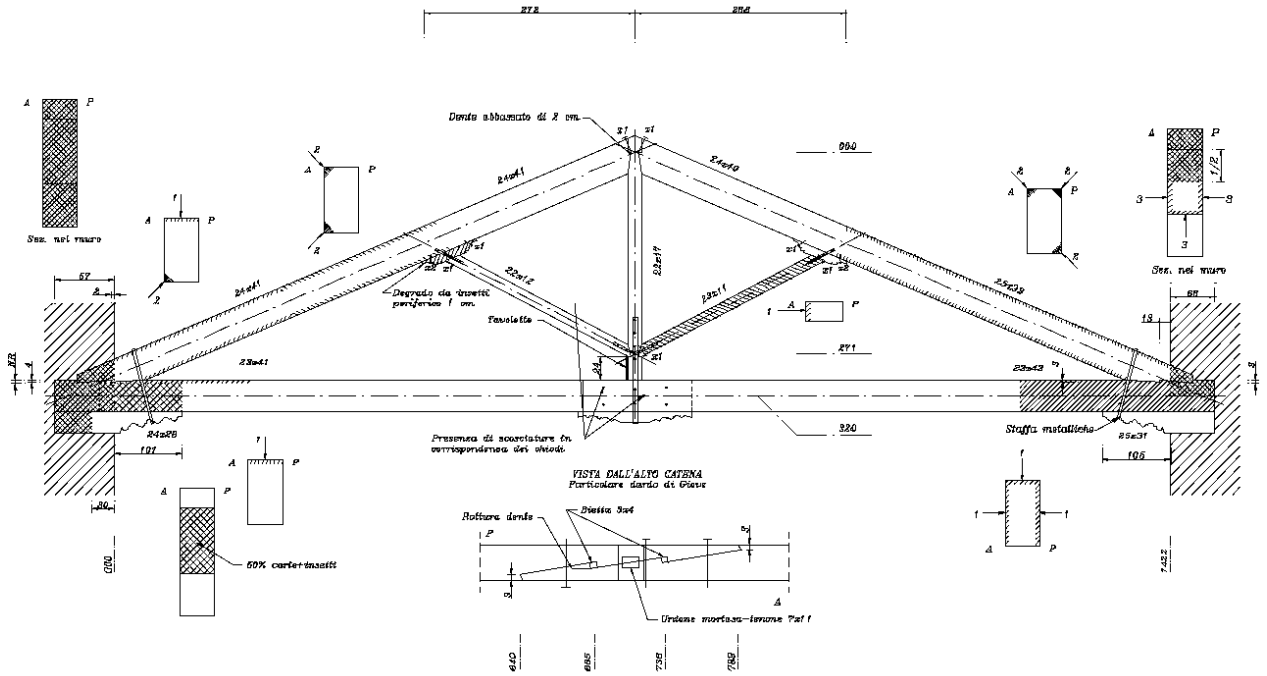


Fig.10: Wooden truss, the strut is often degraded only in a limited area of contact with the wooden tie-rod beam, in correspondence with the interlocking indentation; in this case it is sufficient to restore the joint by eliminating the degraded part and inserting a piece of harder wood. *©Mario Li Castri*

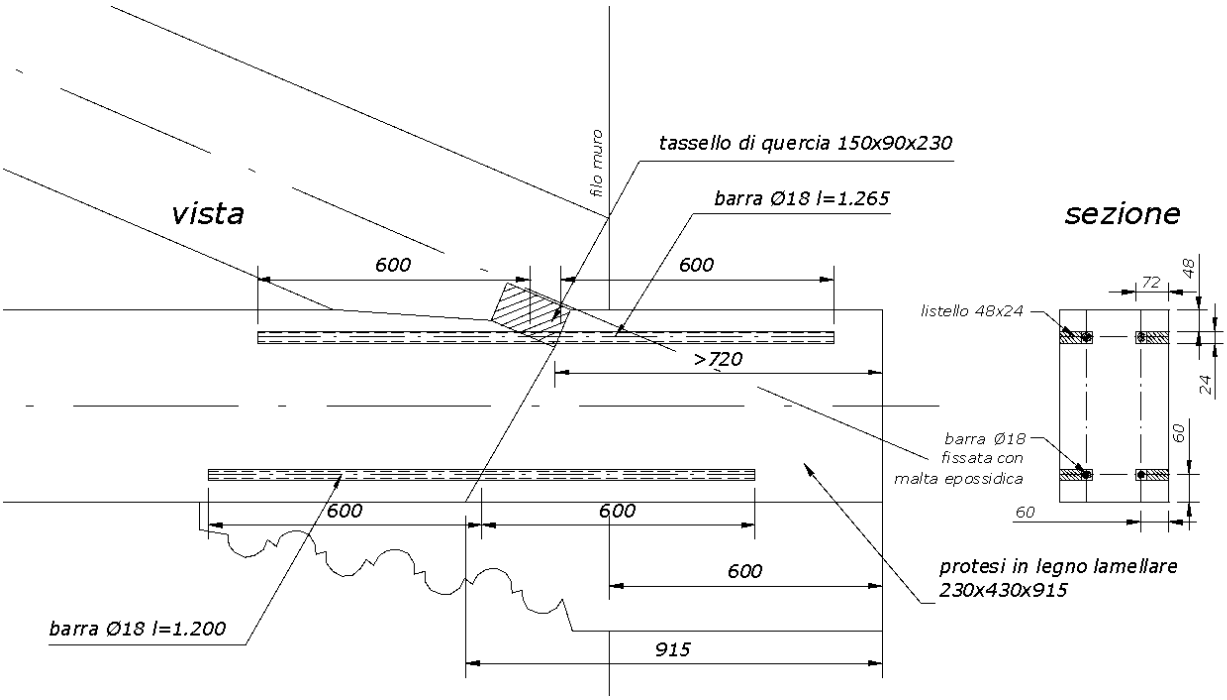


Fig.11: Wooden truss, the strut is often degraded only in a limited area of contact with the wooden tie-rod beam, in correspondence with the interlocking indentation; in this case it is sufficient to restore the joint by eliminating the degraded part and inserting a piece of harder wood. *©Mario Li Castri*

Fig.12-13: Wooden truss, the strut is often degraded only in a limited area of contact with the wooden tie-rod beam, in correspondence with the interlocking indentation; in this case it is sufficient to restore the joint by eliminating the degraded part and inserting a piece of harder wood. *©Mario Li Castri*