Bamboo in building construction: study of a reversible joint for bamboo space frame structure
by Simone Cantoni
Tutor: Nuccia Maritano Comoglio
Co-tutor: Crescentino Bosco

Every day bamboo is used for different purposes by more than half the world's population.
Thanks to its fast growth which allows a plant to be complete in less than a year, bamboo is a highly renewable natural resource, with no or very little impact on the environment. Due to its underground root system it helps to limit the erosive process due to water and wind in poor soils.
In spite of these exceptional characteristics bamboo is practically not used in building in western countries with strict technical rules.
To understand its actual potential in an European context, it is extremely important to know the material, its physical and chemical properties, its strength and mechanical behaviour; for this purpose it is extremely important to know its anatomical structure.
The bamboo culm is mostly a hollow cylinder divided into segments (the internodes), separated by a diaphragm (the nodes) which, together with the hard and thick walls give the culm great mechanical resistance.
We can say that the bamboo culm is a natural iron pipe.
In Asia it is used to set up the scaffoldings used even for big building constructions like skyscrapers.
Although ideal for the realization of reticular structures for temporary use it still has same weak points:

• 	it easily splits vertically
• 	being a natural material it has irregular sizes and shapes

which make the making of joints between two or more elements very difficult.
In the reticular structures the connections between culm and node must:
on one hand ensure the complete transmission of strain between two elements, therefore be stable and strong enough so as to have a safe and efficient connection;
on the other be practical and functional so as to allow a simple and quick assembly.

A study of different connections systems already realized by experts in the field has underlined that the most evident limit is the total or partial irreversibility of the joint-culm-joint system. In case one or the other element is damaged both are lost.
My work has tried to find a solution to this problem taking into account structural requirements like the minimal design strength of the joint and, above all, the irregular dimensions of the bamboo culm.
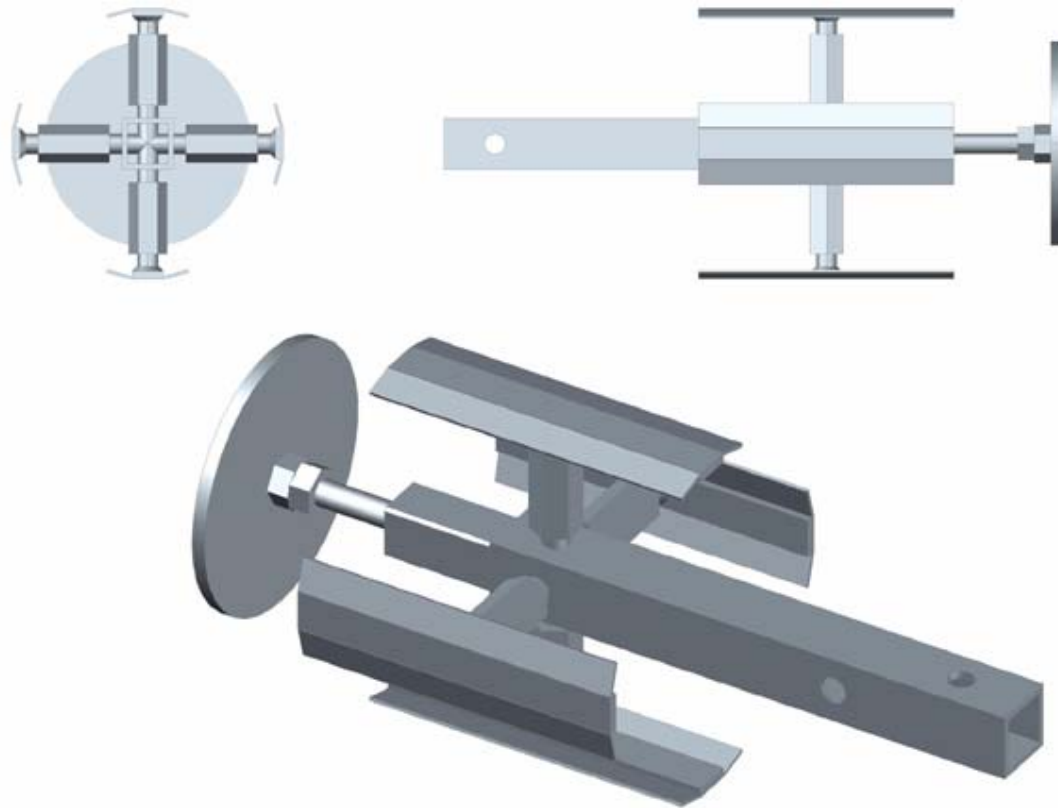
A connection system has been developed which is suited to the different diameters of the culms and does not require any kind of adjustment like holes or cuts.
The joint consist of a central pin connected with side plates which expanding produce a pressure against the internal walls of the ends of the culm where the joint is placed.
The internal pressure is controlled by applying an external metal strip around the ends corresponding with the pressure points.

The system is thus completely reversible, so joint and culm are independent one from the other. Once the structure is dismantled the joints are taken away from the culms, and both can be reused to realize the same or a different structure.
Thanks to the cooperation between the Università di Architettura of the Politecnico di Torino and the Municipality of the town a bamboo pavilion using this reversible joint has been realized.
The joint system has been patented.

Mechanical tests on the bamboo culms used carried out with the collaboration of the material testing laboratory of the Politecnico di Torino, under the supervision of Ingegner Bosco Crescentino have proved that the mechanical strength of the material was greater than required.

Because of the sizes of the elements that make up the joint and the diameters of the culms there are limits to the maximum strengths of the system which make it suitable only for certain uses where the loads are not very big as in the case of temporary pavilions or light roof systems for exhibition halls.

For further information, e-mail:
Simone Cantoni: simonecantoni78@hotmail.com