BY Ar Dr ELEENA JAMIL

DETAILING BAMBOO IN BUILDINGS

GROUND CONNECTIONS

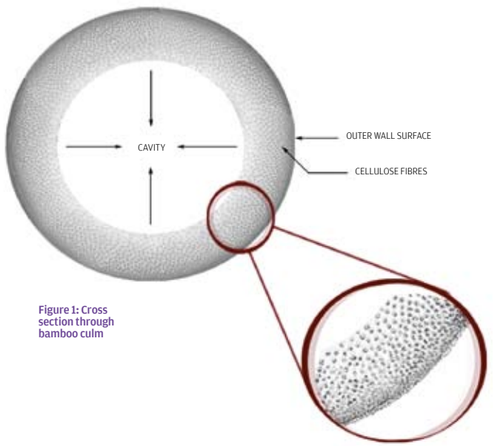


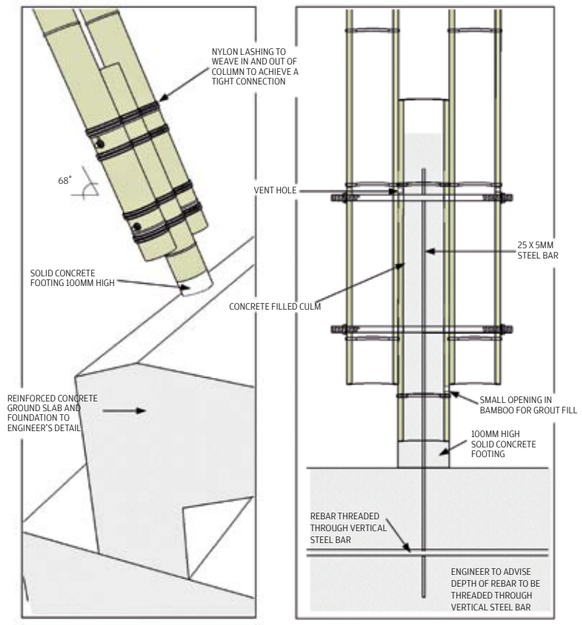
Figure 1: Cross section through bamboo culm

Bamboo is a remarkably strong material for building structures, and this is convincingly demonstrated by looking at informal structures such as scaffolding for tall buildings in Hong Kong, large vernacular edifices in Indonesia and bridges in parts of rural Southeast Asia. Bamboo's cylindrical shape with a hollow interior means that their connection details are very different from that of timber, and the fact that it is sensitive to moisture means that special care is required when using it as structural elements.

Bamboo is a natural building material. When exposed to moisture – for example, soil moisture – it tends to split and become prone to fungal attack and decay. As a general rule, bamboo culms are to be fully and slowly dried to maintain their structural properties before they can be used in construction. Hence, one of the key design strategies to ensure durability is to avoid direct contact with the ground.

When in contact with water for prolonged periods, dry culms start to deteriorate as moisture is constantly absorbed along their cellulosic vessels. The cellulose fibres in a bamboo culm contain vessels running longitudinally along its length (see Figure 1).

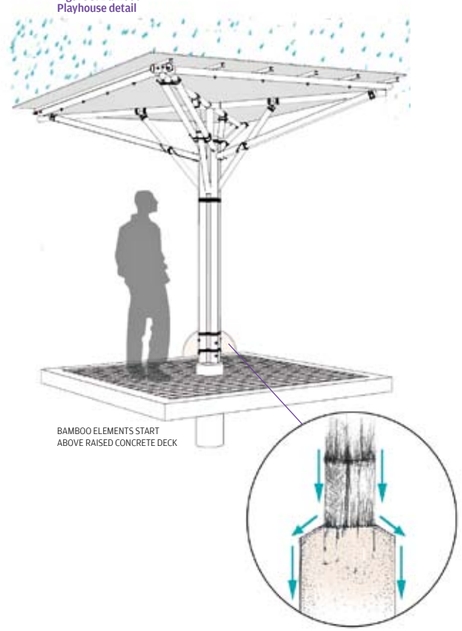
Figure 2: The Millennium School detail



3D PERSPECTIVE VIEW

CROSS SECTION

Figure 3: Bamboo Playhouse detail



In fresh culms, these vessels move water and nutrients through the plant. According to Janssen, the cellulose performs like "reinforcement, similar to steel bars in reinforced concrete or glass fibre in fibre-reinforced plastic."[1] This concentration of cellulose near the outside of the bamboo culm creates stiffness that allows it to resist bending and increases its shear strength.

There are many approaches to detailing bamboo connections in a way that avoids ground contact yet anchors culms securely to the base of a building. Examples can be seen in our previous bamboo projects – the Millennium School and the Bamboo Playhouse – where whole tube-like culms are used as structural members.

In the Millennium School project, the bamboo columns sit 500mm above ground on a raised concrete deck (see Figure 2). Here, slim metal bars are cast into the deck, of which 550mm is left protruding out at a pre-determined angle, ready to receive the culms. Once the culms are lowered onto the bars, bolts are threaded horizontally through both the bamboo and metal. Mortar is then injected into the cavity of the culms to create strong connections with the ground deck.

A power drill is usually used to make small holes near the base of the culms from which mortar is injected through. It is essential to note that pouring wet mortar into a culm causes it to swell, and sometimes, split upon drying and may result in a weak joint. It is unclear why some culms split and others don't, and when they do, the culms will need to be replaced.

When the mortar is dry, the culms are lashed using nylon strings to keep them together. Lashing is a traditional method of connecting bamboo that relies on the friction between the surface of the culm and string, rope or twine.

A similar approach can be seen in the Bamboo Playhouse. Here, all bamboo elements are located above the elevated concrete decks, so the possibility of absorbing ground moisture is highly unlikely. In fact, the bamboo columns sit on circular concrete stumps that rise from the middle of each deck, further protecting the culms from any moisture that may pond on the deck floor. In addition to this, the top of the stumps has been profiled to slope downwards along the edges, to throw off rainwater (see Figure 3). As in the Millennium School detail, metal bars are cast into the concrete stump, with approximately 500mm protruding upwards, ready to receive the culms. Culms lowered onto the bars are then grouted and lashed to create a strong and stable connection with the floor deck.

There is a host of other methods of connecting structural bamboo. They range from simple lashings to nut and bolt connections, and from adhesive techniques to complex steel connections. The choice of connections depends very much on structural detailing, technical experience and also the desired aesthetics. ■

[1] Janssen, Jules J.A., Designing and Building with Bamboo, Technical Report No. 20, International Network for Bamboo & Rattan 2000, pp. 16.