An excerpt from INBAR's Technical Report No. 23, Design of Bamboo Scaffolds, Chapter 1 Structural bamboo and bamboo scaffolds

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1.1 Introduction

Timber is regarded as a good natural structural material, and probably, one of the oldest known materials used in construction. A number of design recommendations[1-3] on timber are available, and currently, most of them employ permissible stress design. In a modern structural timber code[4], ultimate limit state design philosophy is adopted and structural adequacy is assessed with characteristic values of both loading and resistance using appropriate partial safety factors. Among many physical properties that affect the strength characteristics of timber, moisture content, density, slope of grain and defects are regarded as the most important ones.

Bamboo is another natural structural material, and there are over 1500 different botanical species of bamboo in the world. Many of them have been used traditionally as structural members in low-rise houses, short span foot bridges, long span roofs and construction platforms in countries with plentiful bamboo resources. Studies have shown bamboo to be an ideal and safe structural material for many construction applications. In general, it is believed that the mechanical properties of bamboo is likely to be at least similar, if not superior, to those of timber. Furthermore, as bamboo grows very fast and usually takes three to six years to harvest, depending on the species and the plantation, there is a growing global interest in developing bamboo as a substitute of timber in construction. The effective use of structural bamboo will mitigate the pressures on the ever-shrinking natural forests in developing countries, and thus, facilitate the conservation of the global environment. However, a major constraint to the development of bamboo as a modern construction material is the lack of design standards for structural bamboo.

Fig. 1.1 Typical bamboo scaffold - Double Layered Bamboo Scaffold (DLBS)

Fig. 1.2 Typical bamboo scaffold - Single Layered Bamboo Scaffold (SLBS)

Fig. 1.3 Typical configuration of a double layered bamboo scaffold

Fig. 1.4 A close-up on the ledger-post connection

Fig. 1.5 Detail of a putlog attaching the post of the outer layer in a DLBS

1.2 Bamboo scaffolds

Bamboo scaffolds have been used in building construction in China for over a few thousand years. It is believed among Chinese that the first bamboo scaffold was built some 5000 years ago while the basic framing systems and the erection methods were established through practice about two thousand years ago. Bamboo scaffolds provide temporary access, working platforms for construction workers and supervisory staff, and also prevents construction debris from falling onto passers-by. In Hong Kong and other parts of the Southern China, bamboo scaffolds are ones of the few traditional building systems which survive by self-improvement through practical experiences of scaffolding practitioners over generations. Nowadays, in spite of open competition with many metal scaffolding systems imported all over the world, bamboo scaffolds remain to be one of the most preferred systems for access in building construction in Hong Kong and the neighbouring areas.

Typical usage of bamboo scaffolds in building construction include:

Single Layered Bamboo Scaffolds (SLBS) for light duty work such as exterior decoration. It is highly adaptable to site conditions with both easy erection and dismantling.

Double Layered Bamboo Scaffolds (DLBS) with working platform for heavy duty work such as masonry work, installation of curtain walls. It provides safe working platforms for complicated operations to be carried out at heights.

Figures 1.1 and 1.2 illustrate some of the typical applications of bamboo scaffolds in Hong Kong. Owing to their high adaptability and low construction cost, bamboo scaffolds can be constructed in any layout to follow various irregular architectural features of a building within a comparatively short period of time. Besides widely erected on construction sites, they are also used in signage erection, decoration work, demolition work and civil work.

used in signage creation, decoration work, demolition work and civil work.
Typical usage of bamboo scaffolds is widely reported to the community of structural engineers[5]. Moreover, industrial guides on safety of bamboo scaffolds are also available[6,7,8].

Figure 1.3 illustrates the typical configuration of a double layered bamboo scaffold, showing the arrangement of posts, ledgers, transoms and diagonals. A close-up on the ledger-post connection is presented in Figure 1.4 while a putlog attaching the post of the outer layer is shown in Figure 1.5.

The major advantages of bamboo as a scaffolding material are high strength-to-weight ratio, simple erection, and easy adaptability to building forms and site conditions. Bamboo culms used for both the standards (vertical members) and the ledgers (horizontal members) in scaffolds range from 40 to 100 mm in diameters and 6 to 8 m in length, and they are light enough for one person to easily handle a single culm at a time. Due to the ease of handling, bamboo scaffolds are easily and efficiently erected and dismantled; compared to steel scaffolds, where installation and dismantling take the same amount of time, bamboo scaffolds can be dismantled in a tenth of the time it takes to install. Machinery, power-driven tools and tightening equipment are not necessary, as simple hand tools and nylon or wire ties suffice to erect the bamboo scaffolds. The typical height of bamboo scaffolds is 15 m and the installation of steel bracket supports at regular intervals allow full coverage of building height up to 100 m (or 30 storeys).

Bamboo scaffolds are traditionally erected by specialized scaffolding practitioners, and thus the safety and effectiveness of the bamboo scaffolds depend primarily on the individual skills of the practitioners. This knowledge is passed on younger workers through an apprentice system, mostly through on-the-job learning. With the natural variations and lack of quality control of bamboo culms, which varies with species, maturity, moisture content, can affect the load bearing properties of culms, and also the strength of the connections.

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