

**Guidelines on the
Design and Construction of
Bamboo Scaffolds**



Guidelines on the Design and Construction of Bamboo Scaffolds

A Introduction

1. These guidelines provide good practices for the design and construction of bamboo scaffolds commonly used in Hong Kong. Recommended practices on the design, erection, maintenance and dismantling of bamboo scaffolds are given. Detailed standards of design and construction of some types of simple bamboo scaffold, including double-layered, truss-out and signboard bamboo scaffolds are given in Section 2 of Part B of these guidelines with typical examples for each of these types of bamboo scaffold. When the recommended standards are not followed for the design and construction of these types of simple bamboo scaffold or when other types of bamboo scaffold not covered in Section 2 of Part B of these guidelines are used, the bamboo scaffold should be designed by a design engineer with a performance-based design approach.
2. These guidelines aim to ensure the structural safety and stability of bamboo scaffolds during their lifetime. In this connection, apart from the main frame of the bamboo scaffold, technical requirements for the putlogs, nylon strips, drilled-in anchors and steel brackets are also given. The Buildings Department should be notified whenever bamboo scaffolds are to be erected.
3. For matters relating to labour safety, reference should also be made to the Code of Practice for Bamboo Scaffolding Safety issued by the Labour Department in 2001. The Code of Practice provides practical guidance for the compliance of the requirements under the Factories and Industrial Undertakings Ordinance and Construction Sites (Safety) Regulations regarding structural safety and stability of bamboo scaffolds when workers work in the bamboo scaffolds. If scaffolds in use come under the control of the Construction Sites (Safety) Regulations administered by the Labour Department, requirements as specified in the Code of Practice have to be complied with.
4. Compliance with these guidelines does not confer immunity from relevant legal requirements.

B Design and Construction of Bamboo Scaffolds

1. Material Specification

1.1 Bamboo Members

The commonly used bamboo types are Kao Jue and Mao Jue. They should be 3 to 5 years old and air-dried in vertical positions under indoor condition for at least 3 months before use. The nominal length of both Kao Jue and Mao Jue is 6 m.

All bamboo members should be free from visual defects, and meet the following requirements on the cross-sectional dimensions:

Kao Jue The nominal external diameter should not be less than 40 mm.

Mao Jue The nominal external diameter along the unlapped length should not be less than 75 mm with a nominal minimum thickness of 10 mm.

1.2 Nylon Strips for Knotting

Nylon strips of adequate strength, stiffness and durability should be used for knotting in bamboo scaffolds.

The minimum ultimate strength of the nylon strips should not be less than 50 kgf or 0.5 kN per strip while the nominal width is 5.5 to 6.0 mm with a nominal thickness ranges from 0.85 to 1.0 mm.

All knots should be tightened with at least 5 rounds of nylon strips. The ends of the nylon strips should be crossed and twisted to form a single twisted end which passes through the knot twice to give one round turn for proper anchorage.

1.3 Lateral Restraints

Effective lateral restraints should be provided to the main posts of the outer layer of double-layered bamboo scaffolds.

An effective lateral restraint takes the form of putlog which consists of a metal tie and a bamboo strut. A mild steel bar of at least 6 mm diameter with a yield strength of 250 N/mm² and a minimum elongation of 15% or a bundle of mild steel wires with equivalent tension capacity and mechanical properties should be used. It should be properly anchored to structural elements with the use of an anchor bolt together with a properly installed bamboo strut.

The free-standing portion of bamboo scaffolds at the top should be tied back to the building structure.

1.4 Drill-in Anchor Bolts

High quality drill-in anchor bolts should be used in the installation of steel brackets and putlogs for the construction of bamboo scaffolds. All anchor bolts should be installed onto structural elements. The installation details and procedures of anchor bolts should be in strict accordance with the manufacturer's recommendations.

To ascertain the quality of anchor bolts and their supporting structural elements, representative samples of the installed anchor bolts should be tested. The test load should be 1.5 times the working load and should be maintained for at least 3 minutes. The distance between the reaction legs of the pull-out test equipment and the centre of the bolt should be at least 8 times the bolt diameter to prevent assistance of support reactions against the pull-out test force. No sign of separation or failure in concrete and the bolt should be observed during the test.

Sampling rates for testing anchor bolts are recommended as follows:- (whichever is the greater)

- a. for steel bracket (at each layer): 10% and not less than 5
- b. for putlog: 5% and not less than 5

The anchor bolts should be heavy-duty type with at least 12 mm diameter and a minimum tensile capacity of 7 kN.

1.5 Steel brackets

Steel brackets for bamboo scaffolds in construction sites should be made of 80×80×6 Grade S275 Equal Angle with a minimum unit weight of 7.34 kg/m while those for truss-out bamboo scaffolds should be made of 50×50×5 Grade S275 Equal Angle with a minimum unit weight of 3.79 kg/m or suitable size of steel brackets. The steel angles should be welded with 5 mm fillet welds. The steel brackets are preferably galvanized or painted with 2 layers of red lead primer.

2. General Forms of Bamboo Scaffolds

This section provides detailed standards of design and construction of some typical types of single bamboo scaffold, including double-layered, truss-out and signboard bamboo scaffolds.

When the recommended standards given in this section are not followed or when other types of bamboo scaffold not covered in this section are used, they should be designed by a design engineer. For a bamboo scaffold for demolition works, irrespective of its size, the design engineer should also ensure the bamboo scaffold is capable to withstand the increased wind load acting on the plastic sheeting.

2.1 Double-layered Bamboo Scaffolds

The inner layer, at about 200 – 250 mm from the building face, is known as the finishing scaffold. The outer layer, at about 600 mm from the inner layer, is called the working scaffold. Working platforms are erected between the inner and outer layers.

For the outer layer, Mao Jue or firs are erected as the main vertical posts at a maximum distance of about 1.3 m apart. They are rested on either solid ground or steel brackets. The posts are connected with horizontal ledgers for fixing their position. Kao Jue are erected between two Mao Jue or firs as standards at a distance of about 650 mm. Standards are vertical members overhung by the bottom ledgers which are made of Mao Jue. The vertical distance between two ledgers is about 600 to 750 mm. Two pieces of Kao Jue fixed in an 'X' shape at an angle of 45° to 60° are the bracings for keeping lateral stability. Each bracing must be tied to the posts, standards and ledgers of the scaffold. This forms the basic configuration of a double-layered bamboo scaffold.

For the inner layer, all posts, standards and ledgers are Kao Jue. Bracings should be provided. Transoms are erected to connect the inner and the outer layers. These transoms are also used to support the working platform.

Alternatively, posts may be spaced at a distance of 2.6 m. Such an arrangement should be substantiated by a design engineer. Diagram 1 indicates this alternative arrangement for reference.

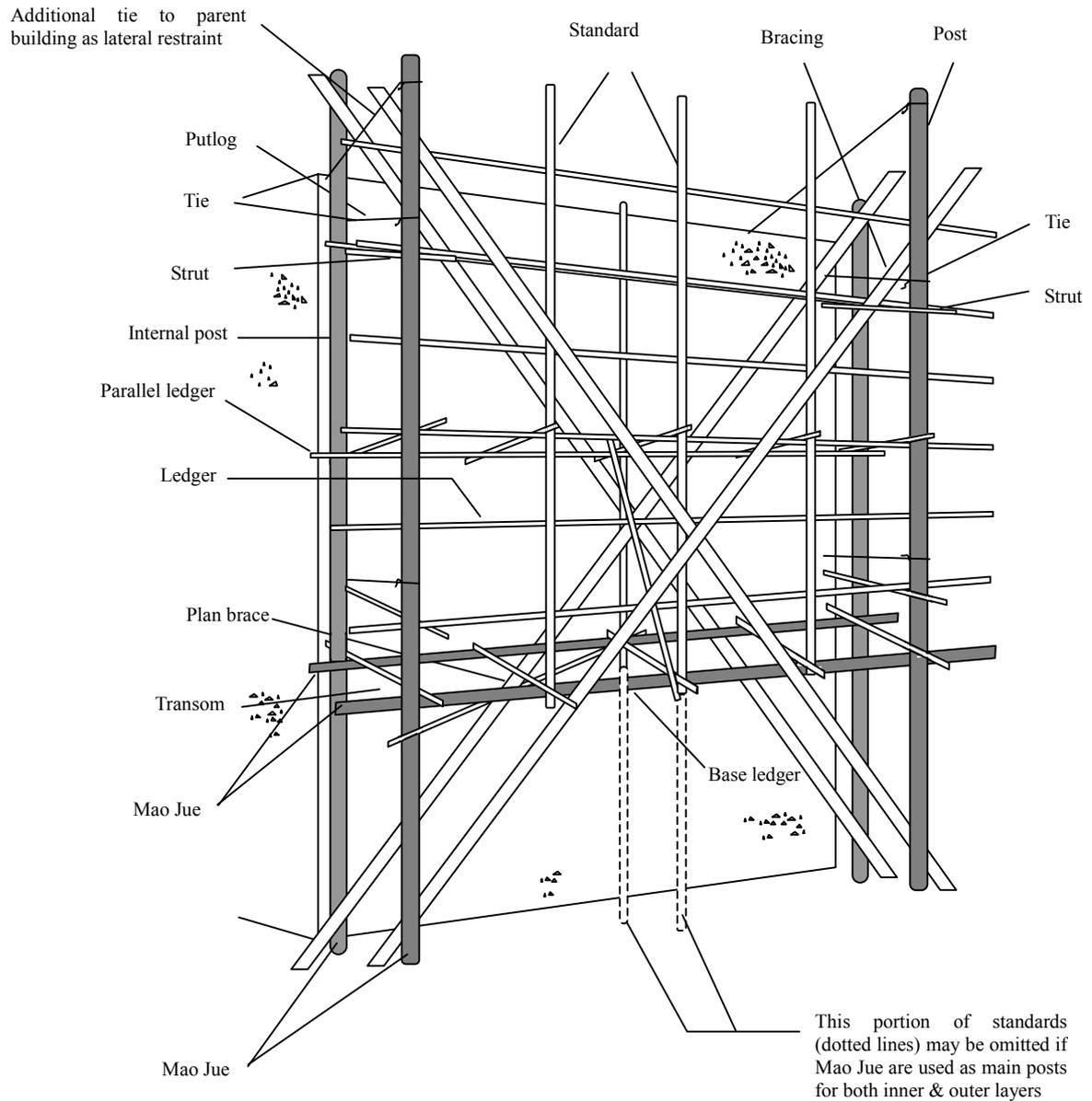


Diagram 1 – Alternative arrangement for double-layered bamboo scaffold

Diagram 2 shows the details of putlog and catch-fan. The putlog should be fixed to the post at the outer layer at one end and to the structural element of a building at another end with the use of a 6 mm diameter mild steel bar pre-fixed to the structural elements with the use of an anchor bolt. Catch-fans should be provided at 15 m vertical intervals and are connected to the working platforms. The span length of the catch-fan should not be less than 1.5 m from the outer layer of the scaffold. The outer edge of the catch-fan should be tied with

a 6 mm diameter steel guy wire at a spacing of not more than 2.6 m. The steel guy wire should be tied securely onto the main posts. The catch-fans must be covered with galvanized zinc sheets for debris collection and removal. For a huge catch-fan, additional ties such as hang pole and raker are required.

To safeguard structural stability of bamboo scaffolds under extreme weather conditions, putlogs should be provided at a horizontal spacing not greater than 3.0 m. At a height less than 100 m above ground, the vertical spacing of putlogs should not be greater than 6.3 m while at a height of 100 m or more, the vertical spacing should not be greater than 4.2 m.

The spacing between the vertical posts may be increased to 3 m in case it is properly designed by a design engineer. Diagram 3 shows for the design engineer's reference the layout of a 15 m high double-layered bamboo scaffold with a post spacing of 3 m.

For a scaffold greater than 15 m in height, it should be designed by a design engineer. Diagram 4 shows for the design engineer's reference the layout of a 19 m high double-layered bamboo scaffold with a post spacing of 3 m.

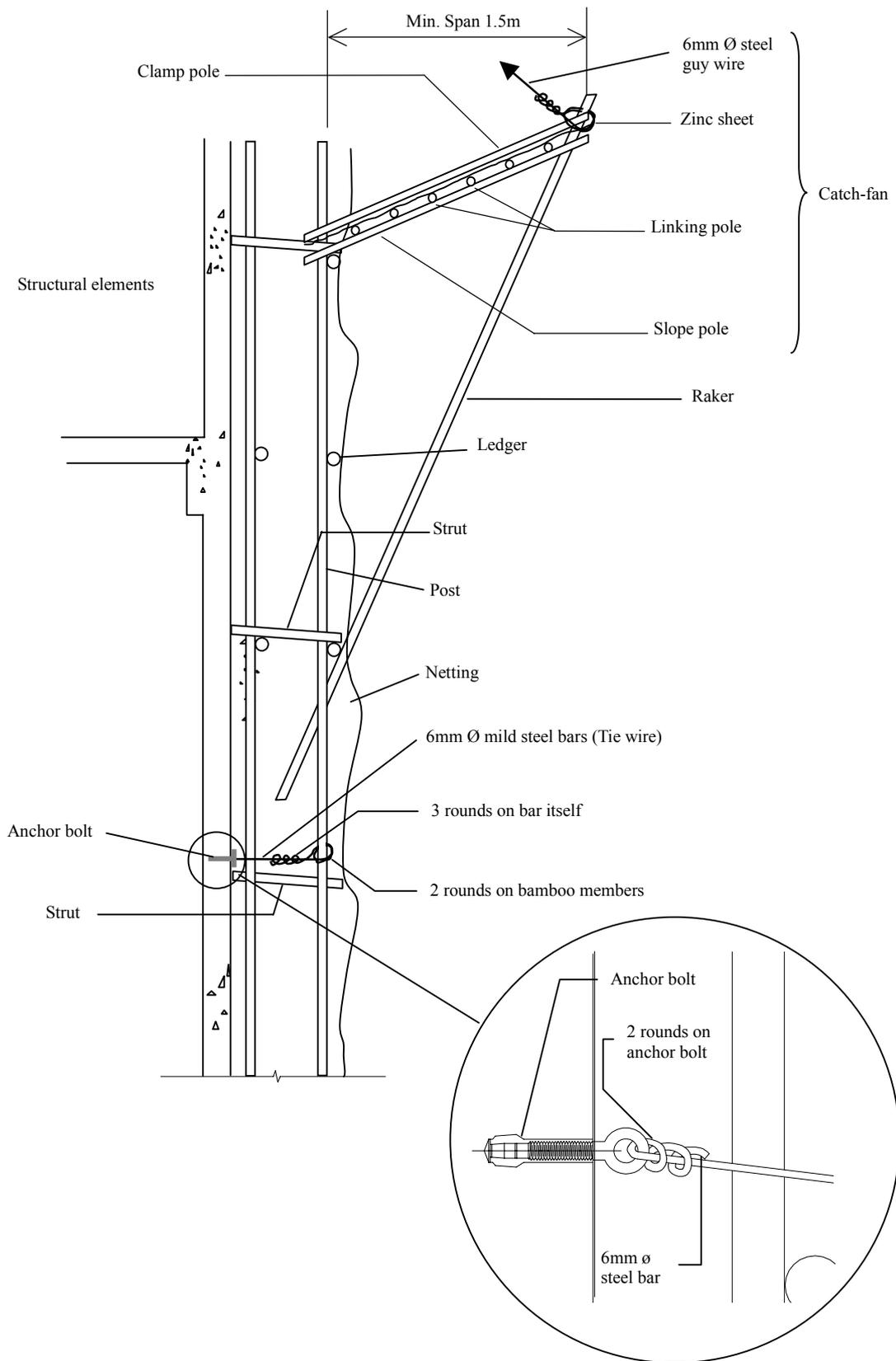


Diagram 2 – Details of putlog and catch-fan for double-layered bamboo scaffold

One loaded platform (See Table 1)

$L = 3.0 \text{ m}$; $h = 2.1 \text{ m}$

Height (H) = 14.8 m or $6@2.1 + 2.2$

Inner layer KJ + MJ

Covered area per putlog = $3 \times 2.1 \times 3 = 18.9 \text{ m}^2$

Transoms not shown for clarity

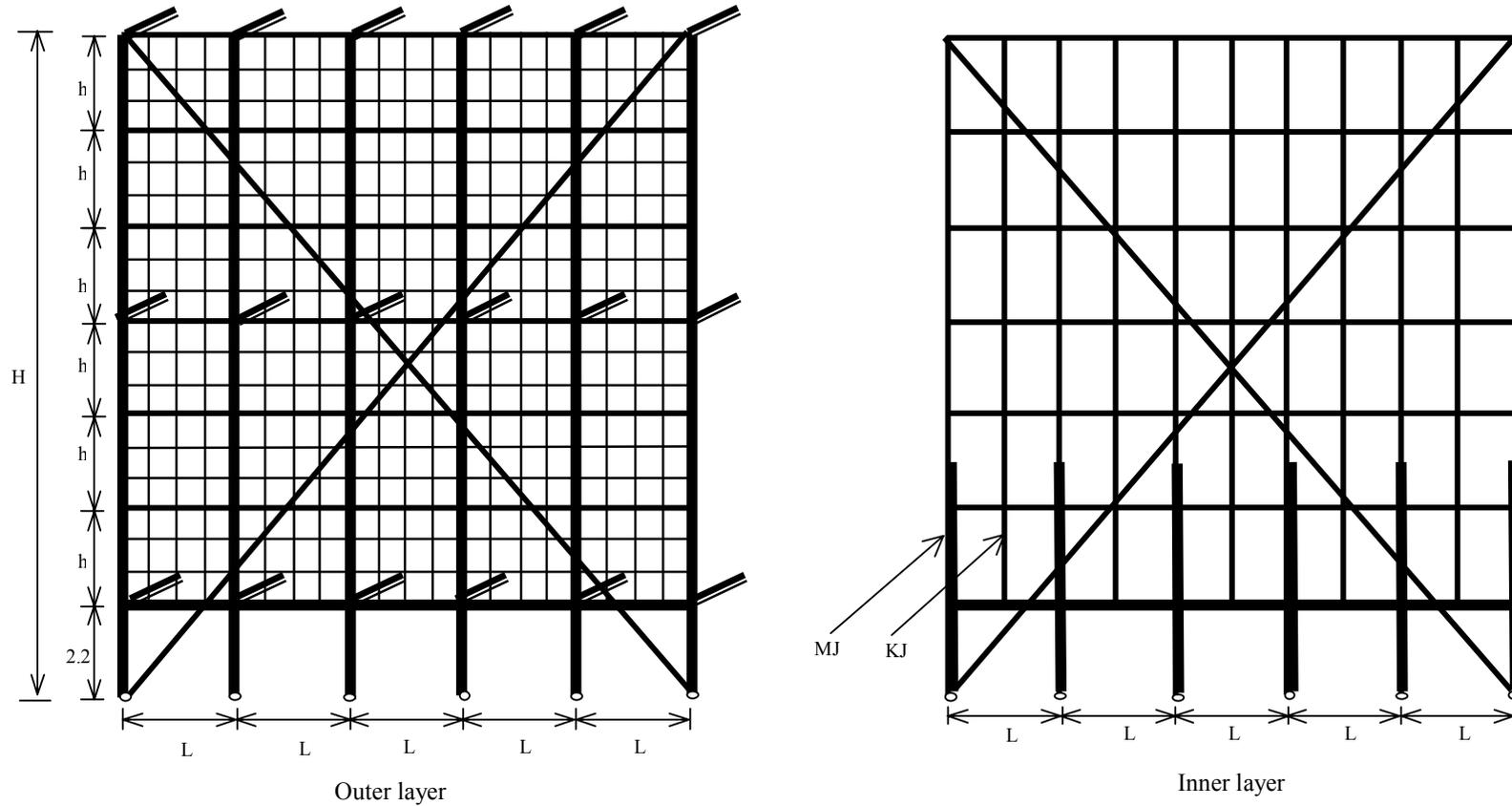


Diagram 3 –Configuration for double-layered bamboo scaffold with a height of 15m (for reference only)

One loaded platform (See Table 1)

$L = 3\text{m}$; $h = 2.1\text{m}$

Height (H) = 19.0m or $8 @ 2.1 + 2.2$

Inner layer KJ + MJ

Covered area per putlog = $3 \times 2.1 \times 3 = 18.9\text{ m}^2$

Transoms not shown for clarity

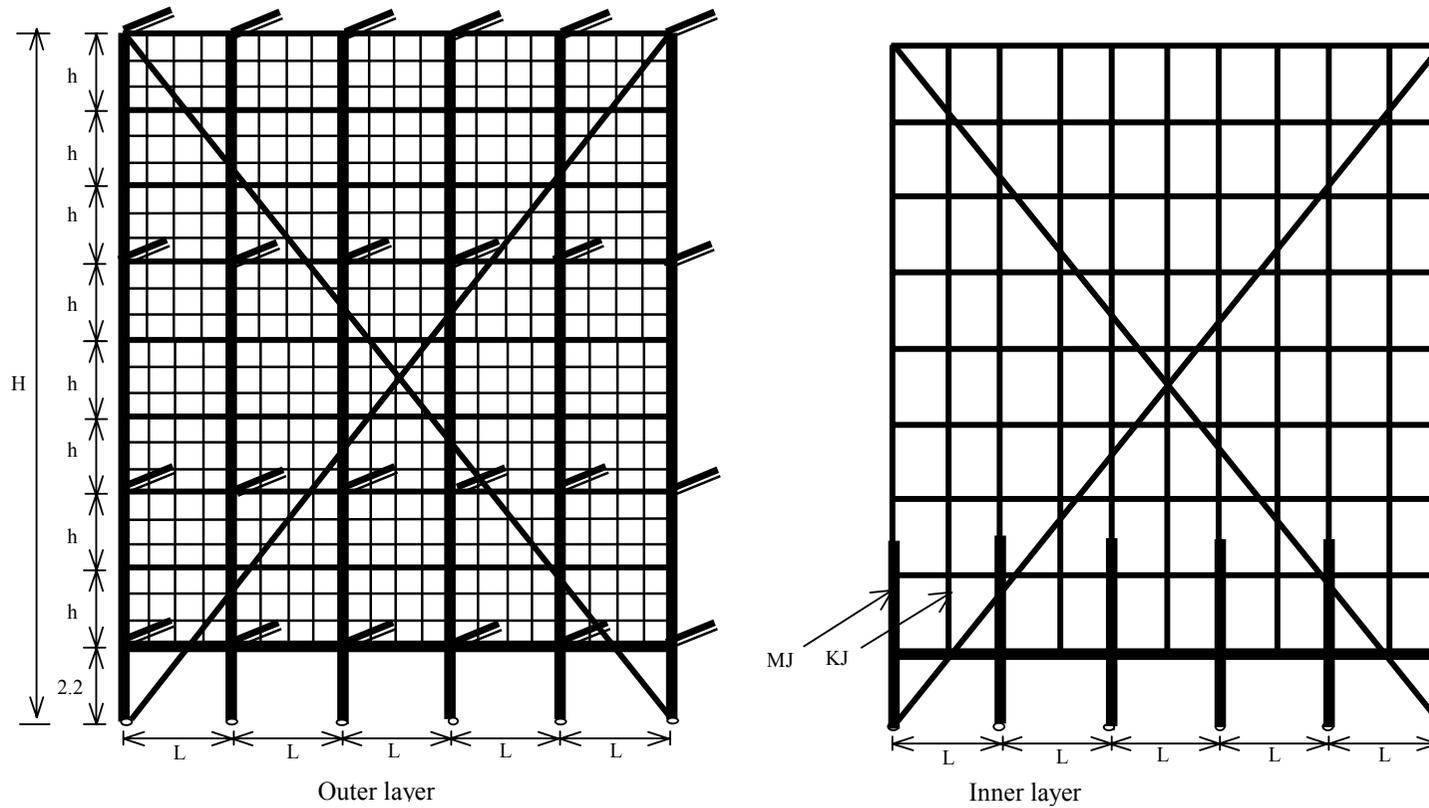


Diagram 4 –Configuration for double-layered bamboo scaffold with a height of 19m (for reference only)

Overall height (m)	<= 100	<= 100	100 ~ 500
Basic wind pressure (kPa)	2.86	2.86	3.72
System height, H (m)	15	19	15 and 19
Platform height, h (m)	2.1	2.1	2.1
Post spacing, L (m)	3	3	3
Putlog arrangement	3h	3h	2h
Covered area per putlog (m ²)	18.9	18.9	12.6

Table 1 Layout schedule for double-layered bamboo scaffolds in Diagrams 3 and 4

2.2 Truss-out Bamboo Scaffolds

Diagram 5 shows a typical truss-out bamboo scaffold. It is commonly used for the repair of external drain pipes, spalling concrete, loose external rendering, removing external unauthorized building works, etc. Since it is a light duty scaffold, Kao Jue will generally suffice. The rakers, standards and parallel ledgers must be supported by steel brackets fixed to the structural elements of a building.

The overall height of a truss-out bamboo scaffold should not exceed 6 m.

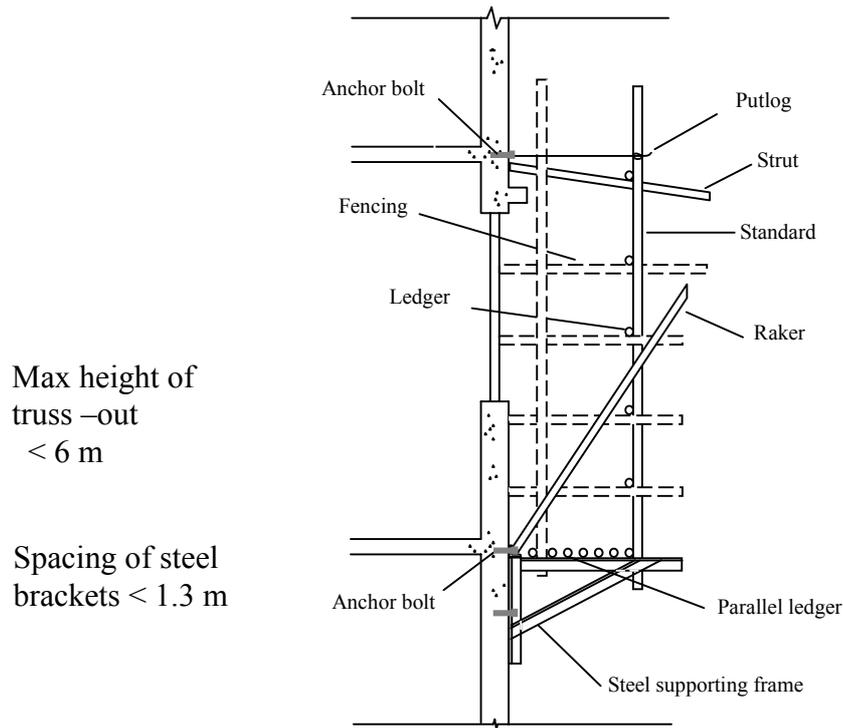


Diagram 5 – Truss-out bamboo scaffold

2.3 Bamboo Scaffolds for Signboards

Diagram 6 shows a typical bamboo scaffold for signboards. It is usually of cantilever construction with a maximum length to height ratio of 4:3. The whole bamboo scaffold is supported by steel wires or hang poles fixed to the structural elements of a building. The scaffold must not obstruct the traffic flow underneath and reference should be made to the “Guide on Erection & Maintenance of Advertising Signs” published by the Buildings Department.

If the bamboo scaffold for signboard projects by more than 5 m, it should be separately designed.

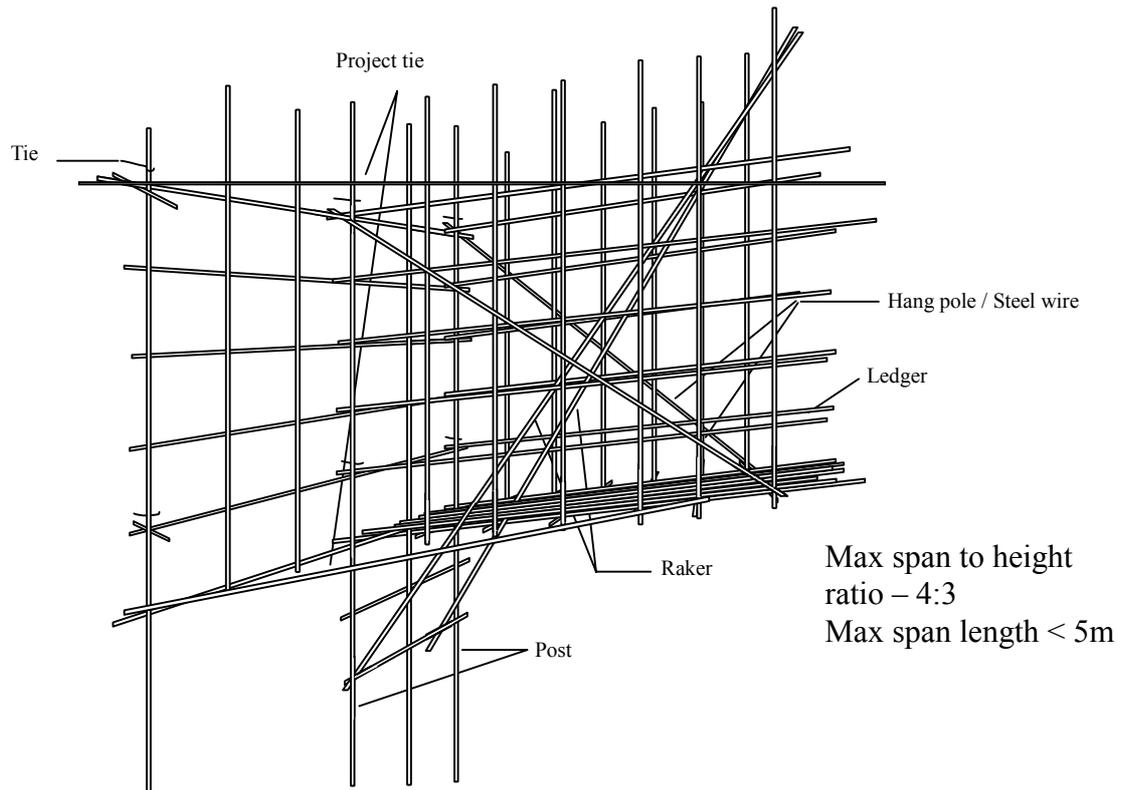


Diagram 6 – Bamboo scaffold for signboard

3. Steel Brackets

Steel brackets are essential to the overall stability of a bamboo scaffold. Diagram 7 shows the details of a steel bracket for the support of posts of a bamboo scaffold for construction site. All steel brackets should be securely mounted onto the structural elements of a building with high quality anchor bolts and comply with the following requirements:

- a. The horizontal spacing between the steel brackets should not be larger than 1.3 m; and
- b. The concrete strength of the structural element to which the steel bracket is fixed should be not less than 25 N/mm².

All anchor bolts should be installed strictly in accordance with the manufacturer's recommendations.

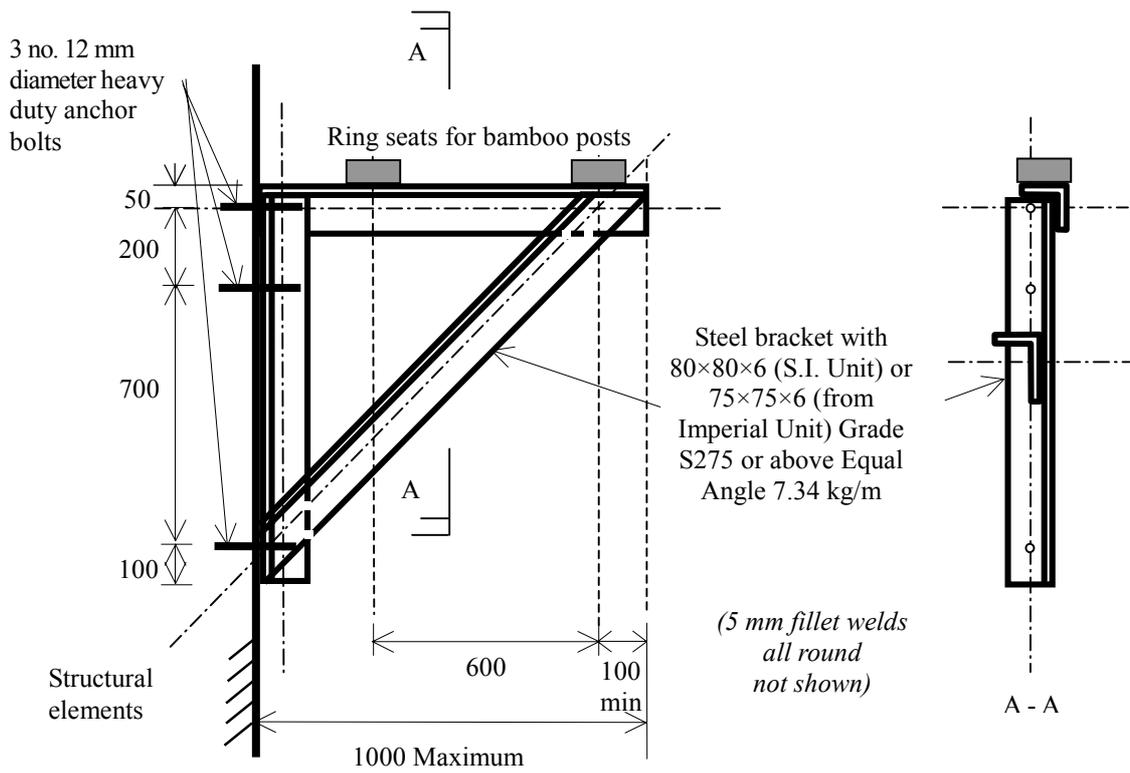


Diagram 7 – Base support for general construction

Diagram 8 shows the details of a steel bracket for the support of standards of a truss-out scaffold.

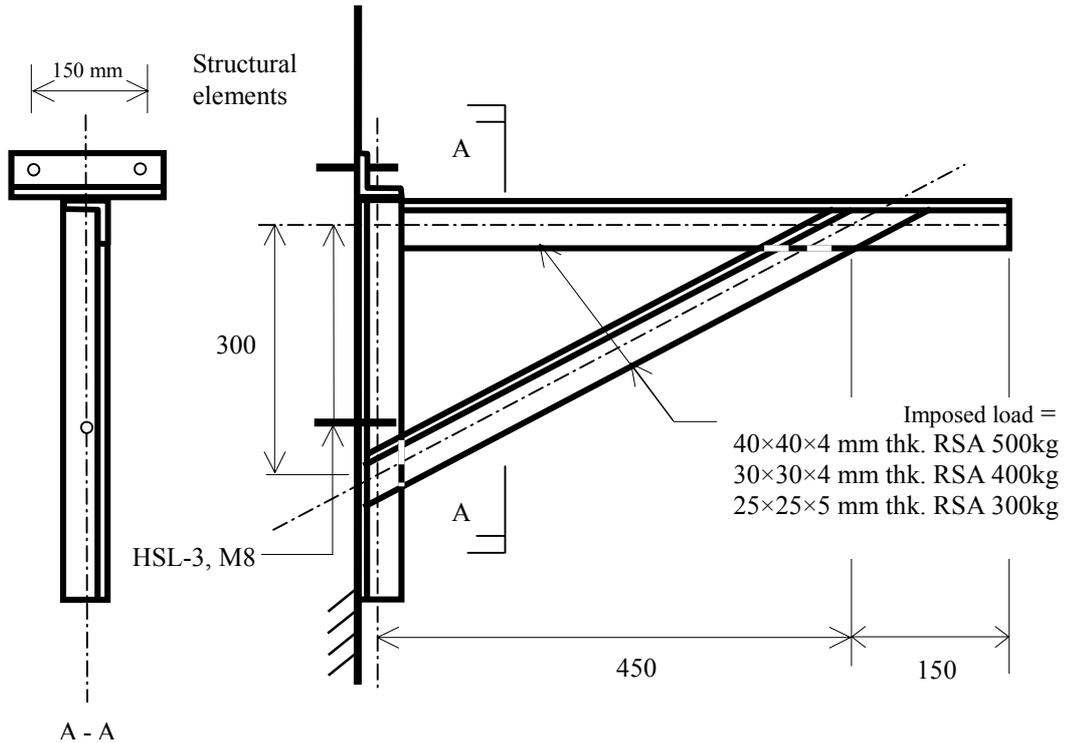


Diagram 8 – Base support for truss-out scaffold

There may be occasions that a post of a bamboo scaffold does not rest on the steel bracket, the design engineer should ensure that the loading from the misaligned post can be effectively transferred to the steel bracket.

4. Erection

- 4.1 Bamboo scaffolds shall be erected by trained workmen under the immediate supervision of a competent person.
- 4.2 Work should be started from the bottom level to the top level and from the interior part to the exterior part. The height of the bamboo scaffolds erected at any side should not be greater than the topmost part of the building or structure by one storey. The cantilever portion at top should be properly tied and secured against wind.
- 4.3 All vertical members of scaffolds should be plumbed.

- 4.4 The scaffolds should be effectively braced and tied back to ensure overall stability. The bracings should extend from the base to the top of the scaffolds.
- 4.5 Where the scaffolds are erected adjacent to a road or pathway, overlay or screen nets must be provided to envelop the scaffolds for the protection of persons or vehicles against falling objects.
- 4.6 The building on which the truss-out scaffolds are to be erected should be examined to ensure that the structural elements can support the loadings of the scaffolds. Strictest control should be exercised on the loads applied to the truss-out scaffolds.
- 4.7 All knottings between bamboo members should be tight and secure. Knottings for posts/standards and ledgers, ledgers and transoms, bracings/rakers, etc. should be tied by nylon strips. For post/standard, ledger and transom to be tied together, any two of them should be tied up first and then the remaining one should be tied up on top of them.
- 4.8 For connection between two bamboo members, the following length of overlap should be followed:
 - a. 1.5 m to 2 m for posts/standards,
 - b. at least 2 m for ledgers and bracings/rakers

Besides, the distance between two knottings on the overlapping portion of the bamboo members should not be greater than 300 mm, and the tail of one bamboo member should be connected to the head of the other. Diagram 9 illustrates the proper connection of bamboo members for bracings/rakers, ledgers, posts/standards used in a bamboo scaffold.

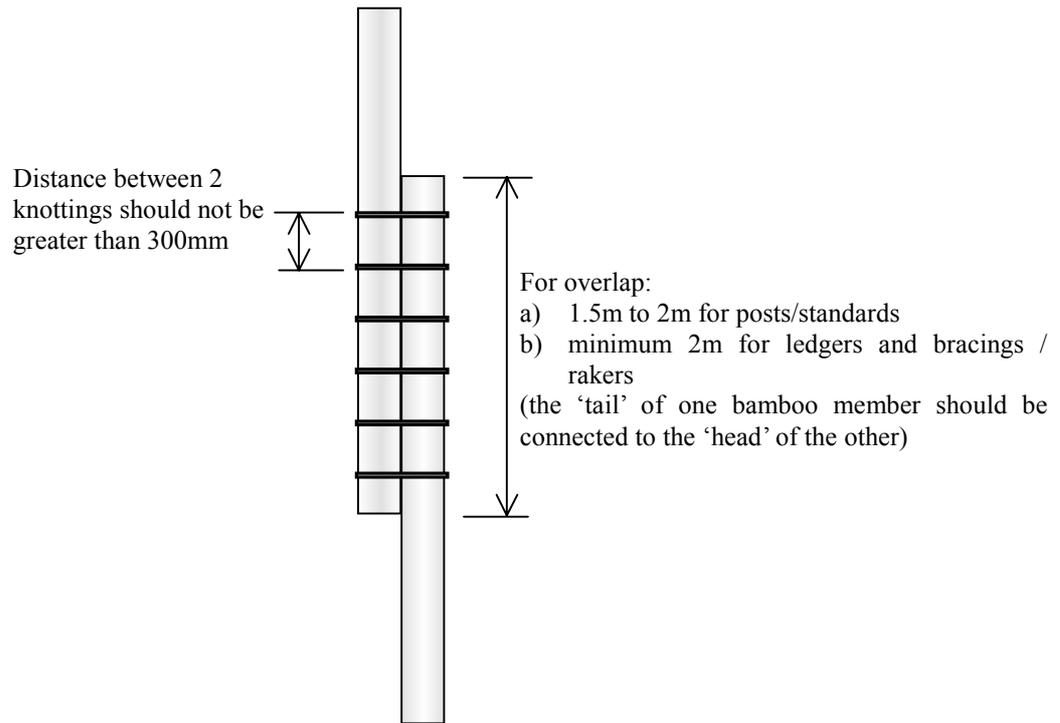


Diagram 9 – Proper connection of bamboo members for bracing / rakers, ledgers, standards / posts

- 4.9 All ledgers, bracings, rakers, ties, struts and transoms should not be used for hanging equipment, tool and materials.
- 4.10 The truss-out bamboo scaffolds should be supported by the structural elements of a building and are prohibited to rest on decorative features nor non-structural elements of the building.

5. Maintenance and Inspection

- 5.1 Bamboo is a natural material and it expands and contracts as the moisture content changes. Proper workmanship, close supervision and frequent inspection are required to ensure the structural integrity of the bamboo scaffolds.
- 5.2 The bamboo scaffolding works should be supervised by a competent person who should inspect the bamboo scaffold as follows:-
 - a. upon completion of the first erection of the bamboo scaffold;

- b. at intervals of not more than 14 days after the first inspection;
- c. after a tropical cyclone, heavy rain or storm;
- d. after any substantial addition or alteration of the bamboo scaffold; and
- e. before commencement of dismantling the bamboo scaffold.

5.3 More frequent inspection must be provided when:-

- a. a tropical cyclone warning signal is announced;
- b. a strong monsoon signal is announced; or
- c. there is severe gusts, especially during April and May

5.4 Plastic sheeting, especially for bamboo scaffolds for demolition works, must be removed when a tropical cyclone warning signal or a strong monsoon signal is announced.

5.5 The competent person should check the strength and stability of the scaffold and ascertain there are no defects and deterioration. Defects found during the inspection should be rectified immediately.

5.6 The competent person should record his inspection and findings in the inspection record form.

5.7 The competent person should possess the following qualification, experience and competence:

- a. has satisfactorily completed a formal training in bamboo scaffolding works such as the 3-year Bamboo Scaffolder Apprenticeship Scheme operated by the Vocational Training Council or the 1-year full-time training course in Bamboo Scaffolding of the Construction Industry Training Authority (CITA), or has satisfactorily passed the Trade Test on Bamboo Scaffolding of the CITA; and
- b. possesses an experience of 10 years or more in bamboo scaffolding works (inclusive of experience under the formal period); and

- c. should be able to read and understand the scaffolding plan, design drawings, specifications and method statement of the scaffolding works, and be capable of identifying existing and potential hazards in the works area and the surrounding.
- 5.8 The bamboo scaffold should be erected, altered and dismantled by trained workmen under the supervision of a competent person. The construction and workmanship of the bamboo scaffold should be in accordance with these guidelines.
- 5.9 The trained workmen should have satisfactorily completed a formal training in bamboo scaffolding works equivalent to any of those required for a competent person and possess at least 3 years experience in bamboo scaffolding works (inclusive of experience under the formal training period).
- 5.10 For bamboo scaffolds in construction site where a site supervision plan is required to be lodged, the Technically Competent Person (TCP) T1 in the Registered Contractor's Stream is required to inspect the integrity of the bamboo scaffolds regularly. The other TCPs in the various streams should also make inspections to the bamboo scaffold as appropriate. The TCPs should ensure no man-made damage of the bamboo scaffolds by other trades of works.

6. Dismantling

- 6.1 Bamboo scaffolds must be immediately removed once the construction/repair works are completed.
- 6.2 Dismantling work must be carried out by trained workmen under the immediate supervision of a competent person.
- 6.3 The strength and stability must be ensured prior to dismantling works.
- 6.4 No components endangering the stability of the bamboo scaffolds should be removed. Unless necessary precautions have been taken, all the ties and bracings should be securely held in position.

- 6.5 Before dismantling the critical members, such as ledgers, ties, struts, rakers, transoms or bracings, the stability of the bamboo scaffolds must be assured by fixing a similar piece of bamboo member at a lower level before removing that critical member.
- 6.6 No materials or debris shall be stacked on the scaffold.
- 6.7 Scaffolds should not be dismantled in vertical section from one end towards the other.
- 6.8 The affected area must be fenced off at the ground level and a warning sign should be displayed in a conspicuous place.
- 6.9 Removed bamboo members must not be thrown, tipped or shot down from a height.
- 6.10 Dismantling should start from upper level to lower level, from exterior to interior and from non load-bearing parts to load-bearing parts.
- 6.11 Scaffolders should note the Factories and Industrial Undertakings Ordinance, Chapter 59 for labour safety.

7. Administrative Arrangement

Before erection of a bamboo scaffold, the building owners, property management companies, Incorporated Owners or the bamboo scaffolding contractor should inform the Buildings Department using the notification form at Appendix A. The name of the bamboo scaffolding contractor, the name of the competent person, the address of the site, the type of building works involved, the BD's file reference number (if available), the name of the authorized person (if available) and the date of commencement and completion of the scaffolding works should be provided.

C Brief Design Guidelines for Bamboo Scaffolds

1. Performance-based Design Approach

Where the recommendations for typical scaffolding systems in these guidelines are not followed, the bamboo scaffolds should be justified by full scale tests or designed by a performance-based design approach. A performance-based design approach can be based on a second-order stability analysis. The load factor used should be 1.5 for dead and live loads and 1.4 for wind load. The wind load can be deduced from a wind speed of a 2-years return period or the design life of the bamboo scaffolds whichever is the greater with appropriate use of wind coefficients for shape and location from the Code of Practice on Wind Effects in Hong Kong 2004.

2. Design Engineer

For performance-based design approach, a design engineer should be appointed to design the bamboo scaffolds. He should be a corporate member of the Hong Kong Institution of Engineers in the civil or structural discipline.

3. Drawings and Specifications

The scope should at least cover the main frame of the bamboo scaffolds, the base support and the putlog.

4. Engineering Justifications

The framing of structural members and details of construction of the bamboo scaffold should be justified in accordance with recognised engineering principles to meet the loads to which the bamboo scaffold may be subjected. The loads should include dead load, imposed load, wind load and operating load. Other practical considerations such as sway of the bamboo scaffold and initial geometrical imperfection and dynamic effects should be properly accounted for.

Original – Buildings Department
 Duplicate – Owners/IO/Property management company/AP
 Triplicate – Scaffolding contractor

Buildings Department
BAMBOO SCAFFOLDS
Notification Form

To : Site Monitoring Section
 Buildings Department
 Room 2901, 29/F
 113 Argyle Street
 Mongkok
 Kowloon

(Fax No.: 3162 0993)

Name of scaffolding contractor	
Address:	
Telephone number:	
Address of site:	
Purpose:	Demolition/Construction site/Repair/Drainage/Removal of UBW*
Commencement date of scaffolding works:	
Completion date:	
Name of competent person:	
Mobile phone number:	
BD file reference no. (if applicable):	
Name of Authorized Person/Registered Structural Engineer/Registered Geotechnical Engineer (if applicable)	

*Name of Owners/Incorporated Owners(IO)/
 Property management company/
 Authorized Person(AP)/ Scaffolding contractor :

*Post held in Firm : _____

Telephone number : _____

Date : _____

Signature : _____

*Delete whichever is inapplicable