INTERNATIONAL STANDARD

ISO 22156

First edition
2004-05-15

Bamboo — Structural design

Bambou — Conception des structures

Reference number
ISO 22156:2004(E)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 22156 was prepared by Technical Committee ISO/TC 165, *Timber structures*.

Bamboo — Structural design

1 Scope

This International Standard applies to the use of bamboo structures, i.e. structures made of bamboo (round bamboo, split bamboo, glued laminated bamboo) or bamboo-based panels joined together with adhesives or mechanical fasteners.

This International Standard is based on limit-state design, and on the performance of the structure; see also 7.1. It is only concerned with the requirements for mechanical resistance, serviceability and durability of structures.

Other requirements, e.g. concerning thermal or sound insulation, are not considered. Bamboo used as a composite structure may require additional considerations beyond this International Standard. Execution (work on-site, and fabrication of components off-site, and their erection on-site) is covered to the extent that is necessary to indicate the quality of construction materials and products which should be used and the standard of workmanship on-site needed to comply with the assumptions of the design rules.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6891, *Timber structures — Joints made with mechanical fasteners — General principles for the determination of strength and deformation characteristics*

ISO 16670, *Timber structures — Joints made with mechanical fasteners — Quasi-static reversed-cyclic test method*

ISO 22157-1, *Bamboo — Determination of physical and mechanical properties — Part 1: Requirements*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

joint

connection between two or more bamboo structural elements

3.2

node

place in a bamboo culm where branches sprout and where a diaphragm is inside the culm

4 Symbols and abbreviated terms

σ_{all} the allowable stress, in N/mm^2

I_B the second moment of area, in mm^4

5 Basic requirements

5.1 General

A structure shall be designed and constructed in such a way that

— with acceptable probability, it will remain fit for the use for which it is required, having due regard to its intended life and costs, and

— with appropriate degrees of reliability, it will sustain all actions and influences likely to occur during execution and use and have adequate durability in relation to maintenance costs.

NOTE See also informative Annex B.

5.2 Exceptional events

A structure shall also be designed in such a way that it will not be damaged by events like explosions, impact or consequences of human errors, to an extent disproportionate to the original cause.

5.3 Potential damage

The potential damage should be limited or avoided by the appropriate choice of one or more of the following:

— avoiding, eliminating or reducing the hazards which the structure is to sustain;

— selecting a structural form that has low sensitivity to the hazards considered;

— selecting a structural form and design that can survive adequately the accidental removal of an individual element;

— selecting a structural form and design which provides sufficient continuity between individual elements.

5.4 Choice of materials

The above requirements shall be met by the choice of suitable materials, by appropriate design and detailing and by specifying control procedures for production, construction and use as relevant for the particular project.

5.5 Exception

All bamboo constructions shall comply with this International Standard completely; as an exception, constructions complying only with 6.2.2 and/or 6.2.3 are deemed to comply with the requirements of this standard.

The purpose of this exception is that building processes in the informal sector need a long period of teaching and training in order to support self-help building to the full, and also to promote the self-reliance of lower income groups. National Building Codes should specify step-wise processes starting from zero, until the said assumptions can be reached in the future.

6 Design concepts

6.1 Concepts based on calculations

Bamboo construction design concepts shall be based on calculations, verifying that no relevant limit state or no relevant permissible stress is exceeded (see Clause 7), except as noted in 6.2.

6.2 Concepts based otherwise

6.2.1 General

Bamboo construction design concepts are deemed to comply, provided the concepts are based on one of the items in 6.2.2 or 6.2.3.

6.2.2 Experience from previous generations

Experience from previous generations is well preserved in local traditions, and carefully transmitted to people living today. This expertise can be considered as an informal, non-codified “standard”.

Criteria for reliability are:

— the content shall be generally known and accepted;

— it shall be considered as an old and pure tradition, as general wisdom;

— the community shall be characterised by an undisturbed social structure, with a well-recognised social pattern.

Limitations are:

— the content is only applicable in similar situations;

— after migration, the presence of this tradition is no longer self-evident.

6.2.3 Reports on evaluations

These reports are based on evaluations made after disasters like earthquakes and hurricanes. If these reports contain descriptions cf structures which did survive a quantitatively described disaster, similar structures shall be considered as adequate for similar disasters in the future.

Criteria for the reliability are:

— the report shall be written by acknowledged engineers, with adequate experience in the field;

— the report shall be accepted by the international technical community and/or proven by referees;

— the report shall provide full details and full information, with which one can build similar structures.

Limitations are:

— the report is only applicable in similar situations.

6.3 Alternative design

It is permissible to use alternative design rules which differ from this International Standard, provided that it is shown that the alternative rules comply with relevant principles and are at least equivalent with regard to the strength, serviceability and durability achieved for the structure with this International Standard.

7 Structural design

7.1 Limit states

NOTE For allowable stress design, see 7.4.

Limit states are states beyond which the structure no longer satisfies the design performance requirements. Limit states are classified into ultimate limit states, and serviceability limit states.

Ultimate limit states are those associated with collapse, or with other forms of structural failure which may endanger the safety of people. States prior to structural collapse which, for simplicity, are considered in place of the collapse itself, are also classified and treated as ultimate limit states. Ultimate limit states, which may require consideration, include

— loss of equilibrium of the structure or any part of it, and

— failure by excessive deformation or excessive forces, causing rupture or loss of stability of the structure or of any part of it, including supports and foundations.

Serviceability limit states correspond to states beyond which specified service criteria are no longer met. Serviceability limit states, which may require consideration, include

— deformations or deflections which affect the appearance or effective use of the structure (including the malfunction of machines or services) or cause damage to finishes or non-structural elements, and

— vibration which causes discomfort to people, damage to the building or its contents, or which limits its functional effectiveness.

7.2 Material properties

7.2.1 Characteristic value

A material property is represented by a 5 percentile property, estimated from test results, obtained as in ISO 22157-1, with 75 % confidence that it represents the population. This is called the characteristic value. It can be obtained with this formula:

$$R_{\mathrm{k}} = R_{0,05}\left(1 - \frac{2{,}7\,\frac{s}{m}}{\sqrt{n}}\right)$$

where

R_{k} is the characteristic value;

$R_{0,05}$ is the 5 percentile from the test data;

m is the mean value from the test data;

s is the standard deviation from the test data;

n is the number of tests (at least 10).

7.2.2 Design stresses

For the derivation of design stresses from the characteristic value, the following rules shall be applied.

Strength and stiffness parameters shall be determined on the basis of tests for the types of action effects to which the material will be subjected in the structure, or on the basis of comparisons with similar bamboo species or bamboo-based materials or on well-established relations between the different properties.

It shall be shown that the dimensional stability and environmental behaviour are satisfactory for the intended purposes.

Special attention shall be given to differences between material originating from different localities.

Since the characteristic values are determined on the assumption of a linear relation between stress and strain until failure, the strength verification of individual members shall also be based on such a linear relation.

The structural behaviour shall generally be assessed by calculating the action effects with a linear material model (elastic behaviour).

Service classes shall be defined according to the temperatures and relative humidity occurring in the regions.

Design stresses shall be determined in a similar way as for timber structures.

7.3 Design requirements

It shall be verified that no relevant limit state is exceeded. All relevant design situations and load cases shall be considered. Possible deviations from the assumed directions or positions of actions shall be considered.

Calculations shall be performed using appropriate design models (supplemented, if necessary, by tests) involving all relevant variables. The models shall be sufficiently precise to predict the structural behaviour, commensurate with the standard of workmanship (of the labour force) likely to be achieved, and with the reliability of the information on which the design is based.

The verification of limit states, and the partial safety factors, shall be in accordance with relevant National Standards.

The loads and actions, to be considered in the calculations, shall be in accordance with relevant National Standards.

7.4 Allowable stresses

Instead of the limit-state design procedure, allowable stress design can be adopted. Allowable stresses can be derived from test results with the following formula:

$$\sigma_{\text{all}} = R_{\text{k}} \times G \times \frac{D}{S}$$

where

σ_{all} is the allowable stress, in N/mm^2;

R_{k} is the characteristic value;

G is the modification for the difference between laboratory quality and practice; default value 0,5;

D is the modification value for duration of load:

- 1,0 for permanent load,
- 1,25 for permanent plus temporary load,
- 1,5 for the above plus wind-load;

S is the factor of safety, default value 2,25.

NOTE With a standard deviation of 15 % and for a permanent load, the allowable stress is about 1/7 of the mean ultimate strength.

7.5 Sound construction practices

The designer shall ensure that sound construction practices are taken into account, according to this subclause.

The use of air-dry bamboo, and of details which ensure that bamboo in buildings shall remain air-dry, and which ensure that bamboo, once it has become wet, shall have the opportunity to dry again before the material can deteriorate due to the moisture content. (For durability and preservation, see Clause 15.)

The permeability of walls, floors and roofs made from bamboo, causing internal pressures, which change the net wind-load acting on the roof, wall and floor.

Special attention shall be given to check whether the workmanship of the labour force, in the factory and on the building site, is according to the assumptions.

Other similar relevant items.

8 Schematisation

This is the process of “translating” the physical reality of a building structure towards a schematised system of symbols to be used during the calculation process. The schematisation is based on the theory of applied mechanics. Typically, bamboo schematisation involves the following assumptions.

The elastic behaviour of bamboo, until failure; as the plastic behaviour is considered to be not significant.

Bamboo culms are analysed as hollow-tube structures with variable thickness.

Bamboo culms are analysed as not perfectly straight members.

Bamboo culms are analysed as tapered.

Nodes do not occur at constant intervals, which is a problem in practice because joints or supports are preferably located near nodes.

Conventional structural-analysis methods are used with definitions of the initial curvature, the diameter and the wall thickness.

Any bamboo joint or support shall be considered to act as a hinge, unless substantiating data are submitted to justify a spring or a fixed joint.

Bernoulli's theorem (flat cross-sections remain flat) is valid for bamboo.

9 Beams (predominantly loaded in bending)

The design of beams shall be based on calculation. Calculation shall be based on the following items, provided the load is symmetrical. For asymmetrical loads, applied stresses at critical points shall be calculated.

The second moment of area I_B shall be determined as follows.

— The outside diameter and the wall thickness shall be measured at both ends, in accordance with ISO 22157-1.

— With these values, the mean diameter and the mean wall thickness for the middle of the beam shall be calculated.

— The second moment of area I_B shall be calculated with these mean values for diameter and wall thickness.

NOTE This method is on the conservative side. Another method is to calculate the I_B at both ends and take the mean value of these two I_Bs; this gives a bigger value. Therefore, this calculation is not applied in this standard.

The maximum bending stress shall be calculated, and compared with the limit state or the allowable stress, using the loads prescribed in the National Building Code.

The deflection shall be calculated, and compared with the allowable deflection according to National Standards. The initial curvature shall be considered in the calculation of the deflection.

The shear stress in the neutral layer at the small end shall be checked, if the length of the beam is less than 25 times the diameter at that end.

Forces acting on a beam, being loads or reaction forces at supports, shall act in nodes or as near to nodes as by any means possible.

For beams where combined axial and bending loads occur, the interaction of applied stresses shall be considered.

10 Columns (predominantly loaded in an axial direction)

For bamboo columns, the best available straight bamboo culms shall be selected.

The design of columns shall be based on one of the following two items.

— Full-scale buckling tests on the same species, size and other relevant variables,

— Calculations, which shall be based on the following paragraphs.

The second moment of area shall be determined in accordance with Clause 9.

The bending stresses due to initial curvature, eccentricities and induced deflection shall be taken into account, in addition to those due to any lateral load.

Buckling calculation shall be according to Euler, with a reduction to 90 % of the second moment of area I_B. This reduction to 90 % takes into account the effect of the taper. The taper is defined as the ratio of difference between minimum and maximum outer diameter to length. The taper shall be less than 1 to 170; otherwise this paragraph is not applicable.

Combined bending and compression in predominantly axially loaded members needs special consideration.

11 Joints

11.1 General

11.1.1 Based on calculations

Joints shall be designed to achieve structural continuity between elements, which includes

— force transmission according to a prescribed manner, and

— deflections which can be predicted and which should be kept within acceptable limits.

Bamboo joint design concepts shall be based on calculations, which shall be based on one of the alternatives in 11.1.3, 11.1.4 or 11.1.5.

11.1.2 Based otherwise

Bamboo joint design concepts are deemed to comply, provided the concepts are based on one of the items in 6.2.2 or 6.2.3.

11.1.3 Complete-joint alternative

In this alternative, the complete joint for a given load and geometry is fully specified for members of a particular size. This includes the description of all fastening-element sizes and locations. Data for this alternative shall be based on full-scale tests.

11.1.4 Component-capacities alternative

This allows a joint to be designed for a given load using the capacity of each of the components of the joint. The capacity of each component shall relate to a specific geometry and load direction. Data about this capacity shall be based on full-scale tests.

NOTE Capacities are the numerical strength of a component, e.g. a compression member will have a capacity in kN; nailed joints in timber structures are often designed this way: nails have given allowable loads, so that by combining an appropriate number of nails in a certain geometry, an efficient joint can be relatively easily designed.

11.1.5 Design-principles alternative

Here the basic mechanics of joints and their materials shall be specified in a way that will enable designers to design safe and efficient joints of varying geometries and load directions.

NOTE Principles give the requirements that must be in place for the capacities to be valid. These are frequently non-numerical details, e.g. end connections for a compression member to give the appropriate effective length for the capacity to be valid. Other common examples include the spacing and connections between elements in a built-up column member, or the required rigidity for buckling restraints.

11.2 Tests

Tests on full-scale joints or on components shall be carried out in accordance with ISO 6891 or ISO 16670, as applicable.

11.3 Test results

When using load-deformation diagrams, obtained from tests on joints, the following paragraphs shall be taken into account.

The capacity of a multiple-fastener joint will frequently be less than the sum of the individual fastener capacities.

If, in a joint. more than one type of fastener is being used, account shall be taken of the effect of different fastener properties.

The capacity of a joint will be reduced if it is subject to reversal of load.

11.4 Good design practices

Good design practices in disaster-prone areas shall include consideration of the following.

Care shall be taken regarding the joints between structural components since damage in bamboo structures, caused by typhoons and earthquakes, has been found to be initiated by structural failure of the joints.

The structure shall be designed so that the structural members and joints have adequate strength for the linear lateral force response caused by severe earthquake motions. The damping of joints is taken into account accordingly, with available experimental evidence.

Ductility of joints shall not be expected, unless shown otherwise by direct testing.

Solid walls, or bracing in walls, shall be considered for resisting in-plane shear.

12 Assemblies (trusses)

12.1 General

Unless a more general model is used, trusses shall be represented for the purpose of analysis by beam elements, set out along system lines, and connected together.

The system lines for all members shall lie within the member profile, and for external members shall coincide with the member centre-line.

Fictitious beam elements may be used to model eccentric connections or supports. The orientation of fictitious beam elements should coincide as closely as possible with the direction of the force in the member.

In the analysis, the geometric non-linear behaviour of a member in compression (buckling instability) may be disregarded if it is taken into account in the strength verification of the individual member.

12.2 Global analysis

Trusses shall be analysed from well-known principles of mechanics in the determination of the deformations of the members and joints. The influence of support eccentricities and the stiffness of the supporting structure are taken into account in the determination of the member forces and moments.

If the system lines for internal members do not coincide with the centre-lines, the influence of the eccentricity shall be taken into account in the strength verification of these members.

The analysis shall be carried out using the appropriate values of member stiffness, (taking into account moisture content, duration of loading, grading class, differences between node and internode, and taper), and joint slip (based on tests). Fictitious beam elements should be assumed to be as stiff as the adjacent elements.

In view of the fact that a stress-strain diagram for bamboo is linear until very near failure, only linear analysis shall be carried out.

Joints may be generally assumed to be rotationally pinned.

Slip at the joints has to be taken into account for the strength verification, unless the influence on the distribution of internal forces and moments can be assumed to be negligible.

Joints may be assumed to be rotationally stiff, if their deformation would have no significant effect upon the distribution of member forces and moments.

12.3 Simplified analysis

As an alternative to a global analysis, a simplified analysis is permitted for fully triangulated trusses that comply with the following conditions.

— The external profile is one single triangle or one rectangle.

— Some part of the bearing width lies vertically below the support node.

— The truss height exceeds 0,15 times the span in the case of a triangular truss, or 0,10 times the span in case of a rectangular (parallel) truss.

The axial forces in the members should be determined assuming that every joint is pin-jointed.

Bending moments in a member, which is continuous over a joint, shall be determined as if the member is a continuous beam over that joint. The effects of deflection at the joints and partial fixity at the joints shall be taken into account.

12.4 Strength verification of members

For members in compression, the effective length for in-plane strength verification should generally be taken as the distance between two adjacent points of contraflexure.

For fully triangulated trusses, the effective length for single-span members without especially rigid end connections, and continuous members without lateral load or support shall be taken as the span length.

When a simplified analysis has been carried out, the following effective lengths may be assumed.

a) For continuous members with a lateral load but without significant end moments:

   — in an outer span: 0,8 times the span length;

   — in an inner span: 0,6 times the span length;

   — at a joint: 0,6 times the largest adjacent span length.

b) For continuous members with a lateral load and with significant end moments:

   — at the beam end with moment: 0 (i.e. no column effect);

   — in the penultimate span: 1,0 times the span length;

   — remaining spans and joints: as described above.

For the strength verification of members in compression and connections, the calculated axial forces should be increased by 10 %.

A check shall also be made that the lateral (out-of-plane) stability of the members is adequate.

13 Panels

13.1 General

Until International Standards for bamboo panels are available, the following is applicable.

13.2 Plybamboo

Plybamboo sheets are composed of woven bamboo mats glued together, or of layers of split bamboo strips, laid across each other and glued together. They shall be produced so that they maintain their integrity and strength in the assigned service class throughout the expected life of the structure. Testing for the determination of structural properties shall be carried out in accordance with the applicable national standard for testing of plywood.

13.3 Particleboard and fibreboard

Bamboo particleboard and fibreboard shall be produced so that they maintain their integrity and strength in the assigned service class during the expected lifetime of the structure. Testing for the determination of structural properties shall be carried out in accordance with the applicable national standard for testing of particleboard or fibreboard.

13.4 Adhesives

Adhesives shall maintain their integrity.

14 Reinforcement in concrete and soil

14.1 In concrete

Bamboo used as reinforcement in concrete, mortar, plaster, etc., shall be applied only if appropriate tests have shown that bamboo will meet the following requirements. It will function as reinforcement during the expected service lifetime of the structure, with special attention to the swelling and shrinkage of the bamboo, the bond, and the influence of the humidity and the alkaline environment on the bamboo. The deformation shall meet the requirements for the structure.

14.2 In soil

Bamboo used as reinforcement in soil shall be applied only if appropriate tests have shown that bamboo will meet the following requirements. It will function as reinforcement during the expected service lifetime of the structure, with special attention to the lifetime of the bamboo in the organic environment.

15 Durability and preservation

To ensure an adequately durable structure, the following interrelated factors shall be considered:

— the expected service lifetime of the bamboo;

— the use of the structure;

— the required performance criteria;

— the expected environmental conditions;

— the composition, properties and performance of the materials;

— the shape of members and the structural detailing;

— the quality of workmanship and level of control;

— the particular protective measures;

— the likely maintenance during the intended lifetime.

The environmental conditions shall be taken into account at the design stage to assess their significance in relation to durability and to enable adequate provisions to be made for protection of the materials.

Bamboo and bamboo-based materials shall be given a preservative treatment, unless they have adequate natural durability for their intended use. In the case of export, this treatment shall be sufficient for both the environment of origin and the environment of destination.

Normally only dry or seasoned bamboo shall be used. Otherwise, special attention shall be given to dimensional changes occurring during the drying process in a joint. These changes will create internal stresses in the joint, possibly causing distortion and eventual failure.

Metal fasteners and other structural connections should, where necessary, either be inherently corrosion-resistant, or be protected against corrosion.

Special attention shall be given to environmental aspects, and to health aspects, both for the labour force and the users of the structure, during any preservation process.

Special attention shall be given to prevent failure of joints, caused by deterioration of the bamboo, due to moisture accumulation, lack of ventilation around joints, and attack by borers and termites.

16 Fire protection

Fire-resistance rating shall be determined in accordance with the applicable national standards.

17 Grading

Bamboo shall be graded in accordance with approved rules ensuring that the properties of the bamboo are satisfactory for use, and especially that the strength and stiffness properties are reliable.

The grading rules shall be based on a visual assessment of the bamboo, on the non-destructive measurement of one or more properties, or on a combination of the two methods.

Special attention shall be given to properties like the age, the taper of a culm, the straightness, the internodal length, and the distribution of nodes.

18 Quality control

18.1 Introduction

A quality assurance manual, subject to the approval of the qualified agency shall be written and maintained for each product and each production facility. A qualified agency is defined as an agency that has access to the manufacturing facilities, and has trained technical personnel to verify that the grading, measuring, species, construction, bonding, workmanship and other characteristics of the products, as determined by inspection, sampling and testing, comply with all the applicable requirements specified in the quality assurance manual. The qualified agency also must have no financial interest in, nor is owned, operated or controlled by, any single company manufacturing the product being inspected or tested.

18.2 Quality assurance manual

The quality assurance manual shall include subject matter necessary for the quality assurance program, including the following.

Material specifications, including incoming material, inspection and acceptance requirements.

Quality assurance inspection testing and acceptance procedures.

Sampling and inspection frequencies.

Procedures to be followed upon failure to meet specifications or upon out-of-control conditions.

Finished product marking, handling, protection and shipping requirements as they relate to the performance quality of the product.

18.3 Quality assurance records

All pertinent quality assurance records shall be maintained on a current basis and shall be available for review by the qualified agency personnel. As a minimum, such records shall include:

— all inspection records and reports of test equipment calibration, including identification of personnel carrying out the tests;

— all test data, including retests and data associated with the rejected production and details of any corrective actions in the disposition of any rejected production resulting from tests or inspections.

18.4 Testing programme

The quality control manual shall contain a minimum-testing program to maintain the quality of the product.

Data from the quality assurance tests shall be evaluated prior to shipping material represented by the sample. Analytic procedures shall determine if the material properties are under statistical control. The control level selected shall be consistent with current design values and the intended use of the material.

When the analysis of the data indicates that the material properties are below the control level, the associated portion of production shall be subject to re-examination.

Annex A
(informative)

Background and history

This International Standard has been prepared and submitted by INBAR, the International Network for Bamboo and Rattan, which is an international agency with its head office in Beijing. The aim is to bring bamboo towards the level of an internationally recognised and accepted building and engineering material. INBAR aims to do so in favour of the well-being of lower income groups in developing countries, and in favour of a better environment in bamboo-growing countries.

Discussion about the need for an International Standard started already in 1988, during the International Bamboo Workshop in Cochin, India. Due to lack of funds, the real work started as late as in 1997, when INBAR was launched as an International Agency, and when the Dutch Government provided the needed funding.

In 1998, draft texts were written and distributed to a group of specialists inside INBAR who acted as volunteers and spent their time and expertise to propose improvements. Members of this group met for the first time in a meeting on 30-31 October 1998 in San José, Costa Rica. Participants were N.S. Adkoli, K. Ghavami, R. Gnanaharan, H.N.S. Jagadeesh, J.J.A. Janssen, K.S. Pruthi, I.V. Ramanuja Rao, D. Sands, J.O. Siopongco, K. Stochlia, and D. Tingley.

During 1999, the results from this meeting were incorporated in the draft texts. In September 1999, these were discussed in a meeting with ISO/TC 165 in Harbin, China. In October 1999, a meeting took place with representatives of the National Standard Institutes of Bangladesh, China, Colombia, Ecuador, Ethiopia, India, Indonesia, Nepal, Philippines, Tanzania, Thailand and Vietnam. This meeting was held at FPRDI in Los Baños, Philippines. The outcome of this meeting was a considerable improvement of the texts, and a general agreement to submit the draft texts to ISO for the formal procedure.

Besides INBAR, CIB (especially committee W 18 B) has also been involved in the preparation. Discussions during meetings of W 18 B (e.g. Singapore 1987 and Kuala Lumpur 1992) have greatly contributed.

Because this is the first International Standard on bamboo, it does not cancel or replace other documents in whole or in part, besides the draft documents prepared and distributed for internal discussion by INBAR during 1998 and 1999. For similar reasons, significant technical changes from previous editions only apply to these previous draft documents.

Annex B
(informative)

Assumptions

In this International Standard, the following assumptions apply.

— Structures are designed by appropriately qualified and experienced personnel. Verification of the qualifications of the professional to design a bamboo structure is the responsibility of the jurisdiction in which the project is to be constructed.

— Adequate supervision and quality control are provided in factories, in plants and on-site.

— Construction is carried out by personnel having the appropriate skill and experience.

— The construction materials and products are used as specified in this International Standard or in the relevant material or product specifications.

— The structure will be adequately maintained.

— The structure will be used in accordance with the design brief.

ICS 91.080.20

Price based on 15 pages