IS 4907 (2004): Method of testing timber connector joints [CED 9: Timber and Timber Stores]

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भारतीय मानक

टिम्बर संयोजक जोड़ों के परीक्षण की पद्धति

(पहला पुनरीक्षण)

Indian Standard

METHOD OF TESTING TIMBER CONNECTOR JOINTS

(First Revision)

ICS 19.020; 21.060; 79.040

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 3

Timber and Timber Stores Sectional Committee, CED 9

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Timber and Timber Stores Sectional Committee had been approved by the Civil Engineering Division Council.

One of the significant advances in timber design has resulted from the improvements in joints through the development and incorporation of metal connectors. The timber connectors which may have a variety of forms; such as split rings, toothed rings, clamping plates, shear plates and claw plates depending on their specific design functions have been extensively used in foreign countries. Due to the non-availability of patented connectors in India, these are not very popular among engineers and builders in this country. However, improvized metallic rings cut from mild steel pipes are gradually beginning to be used for load transfer in structures in this country also besides the other types, wherein a split circular band of steel is placed in the groove cut into the contact faces of the timber members to be joined, the assembly of members being held together with a connecting bolt. The main function of these connectors is to efficiently transfer stress from one member to another. Tests on timber connector are required to be done so as to obtain design data for their use in structural applications. This standard provides suitable procedures for evaluating the strength and rigidity of connectors in timber joints. The testing serves both as basis for developing design criteria and or investigating the effect of various factors such as thickness and width of members, end and edge margins, spacing and moisture contents, etc, on the strength and efficiency of the connector itself under three groups of species of wood.

This standard was first published in 1968. In this revision certain additions and amendments have been made in light of experience gained with testing of improvized metallic ring connector joints. The concept of joint factor and the speed of machine is revised. In the preparation of this standard considerable assistance has been rendered by Forest Research Institute, Dehra Dun.

In the formulation of this standard, due weightage has been derived to international co-ordination among the standards and practices prevailing in different countries in addition to relating to the practices in the field in this country.

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

METHOD OF TESTING TIMBER CONNECTOR JOINTS

(First Revision)

1 SCOPE

This standard deals with the methods of testing timber joints made by using timber connectors. The details of fabrication of such joints, tools needed and the designing methods have not been included in this standard and which may form separate code of practice on 'Metallic rings connectors jointed timber construction' to be brought out.

2 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 707 : 1976 'Glossary of terms applicable to timber technology and utilization (*second revision*)' and the following shall apply.

2.1 Timber Connectors — Rings, grids, plates of dowels of metal or wood set in adjoining members, usually in pre-cut grooves, holes of recesses, to fasten the members together in conjunction with bolt.

2.2 End Distance — The distance measured parallel to the grain of the timber from the centre of the connector to the closest end of the member (*see A* in Fig. 1). When the end of the member is not square out that is for sloping end cut, maintain the edge distance as shown in Fig. 1.

2.2.1 *Loaded-End or Compression-End Distance*

The distance measured from the centre of the connector to the end towards which the load induced by the connector acts.

2.2.2 *Unloaded-End Distance*

The end distance opposite to the loaded end.

2.3 Edge Distance

The distance measured perpendicular to the grain from the centre of the connector to the edge of the member (*see B* and *C* in Fig. 2).

2.3.1 *Loaded-End or Compression-Edge Distance*

The distance measured from the centre of the connector to the edge towards which the load induced by the connector acts (*see C* in Fig. 2).

2.3.2 *Unloaded-Edge Distance*

The edge distance opposite to the loaded edge (*see B* in Fig. 2).

2.4 Connector Axis (*R*)

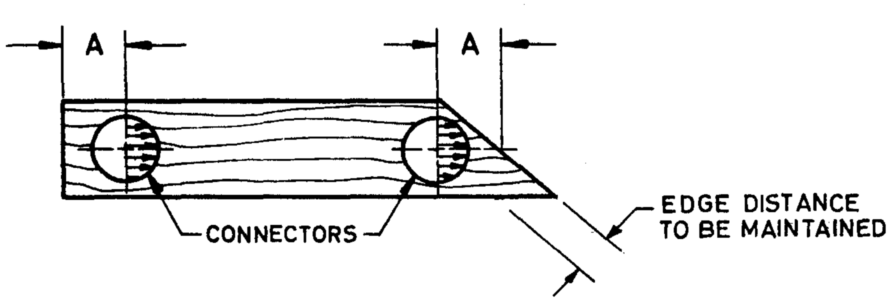
The distance measured between centres of adjacent connectors (*see* Fig. 2) when more than one connector is used in the same contact face of a member in a joint. This is also known as spacing of connector.

2.5 Connector Data

The data covers recommended dimensions of the connectors, minimum timber sizes, bolt and bolt-hole diameters, washer sizes and similar other self-explanatory information which shall be required for use of the particular connector in any design.

2.6 Direction of Load

Unless otherwise specifically stated, direction of load in any joint is the same as the direction of axis or grain of the member on which the load is initially applied.



NOTE — In no case shall the perpendicular distance from centre of connector to sloping end cut of a member be less than the required edge distance.

FIG. 1 END DISTANCE

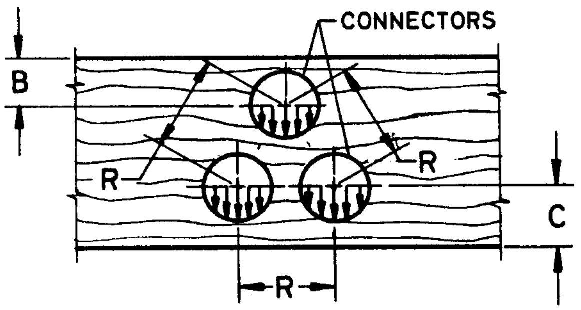


FIG. 2 EDGE DISTANCE AND SPACING

2.7 Direction of Grain

Unless otherwise specifically stated, direction of grain in any joint is the direction of grain of the member to which the load is finally transmitted through the connectors.

2.8 Angle Between Grain and Load (θ)

The acute angle between the direction of load, and the direction of grain in a particular member (*see* Fig. 3).

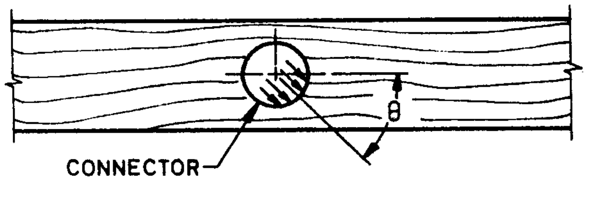


FIG. 3 ANGLE OF LOAD-TO-GRAIN

2.9 Central Member(s)

Member(s) through which the load is initially applied so that the same may be transmitted through the connectors.

2.10 Joint Factor

It is the total load developed by the joint expressed as a percentage of the full load which the main unjointed central member (primary member) may sustain (*see* Annex A).

2.11 Side Member(s)

Member(s) to which the load is finally transmitted through the connectors.

2.12 Specified Slip

The total slip at which the joint shall be assured to carry maximum load.

3 TESTING PROCEDURES

3.1 For purposes of comparison, connectors shall be tested on three groups of species as following:

a) Group A : Species which differ from 'sal' by ± 30 percent in compressive strength.

b) Group B : Species which differ from 'teak' by ± 30 percent in compressive strength.

c) Group C : Species which differ from 'chir' by ± 30 percent in compressive strength.

3.2 All timber members used shall be at a 12 ± 1 percent of moisture content in the dry condition or at well above the fibre-saturation-point in the green condition.

3.3 The connector shall fit singly in precut grooves and shall be so placed as to correspond to the correct position in any designed joint. Where no such pre-designed joint is under consideration, the loaded-edge distance shall be not less than the diameter of the connector and the end distance shall be not less than 1.75 times its diameter on the loaded side. In case the connector is not circular, the limiting dimension shall be the full dimension of the connector in the direction of measurement of the end and edge distance respectively.

3.4 Unless otherwise required for specific purpose, all tests shall be made on three-member joints with two similar connectors. In the three-member joints each side member shall be of half the thickness of the central member and the central member shall be at least twice the depth (or generally known as width) of the connector, exception for split rings when each side member shall be of 2/3 the thickness of central member. The general dimensions and arrangements are shown in Fig. 4A and Fig. 4B.

3.5 At least five specimens should be tested separately for loadings in the parallel and in the perpendicular directions of grain as shown in Fig. 4A and Fig. 4B. As and when required, a set of five tests may be done at intermediate angles by providing suitable supports for the pieces under test or preferably in appropriate jigs made for the purpose. Test the connector joints as soon after assembly as possible.

3.6 The load shall be applied to the central member in such a manner that the same is parallel to the grain of the member. Application of load through a hemi-spherical loading head is recommended to ensure proper alignment of joint members.

3.6.1 *Rate of Loading*

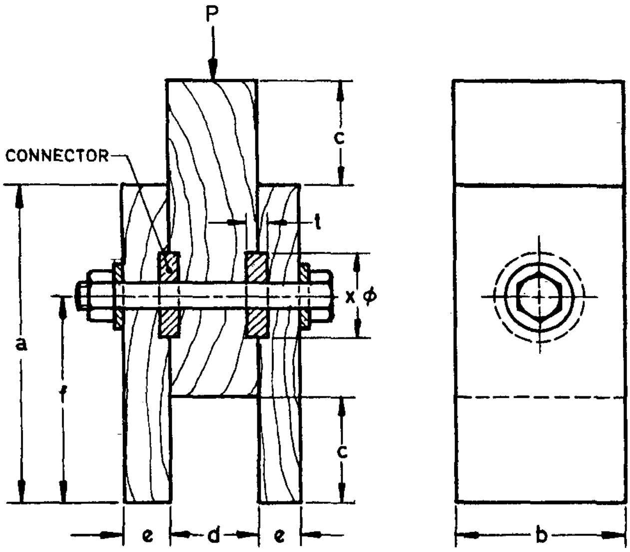
The load shall be applied continuously during the test to cause the movable head of the testing machine to travel at a rate of 0.6 mm/min so as to produce a constant rate of strain. The testing speed of the machine actually adopted shall be recorded on the data sheet.

3.7 The joint shall be initially loaded slowly to about 200 kg and load released to ensure any initial set of connector in the joint. Thereafter the load shall be applied at suitable load intervals in such a way as to produce a constant rate of strain. The slip between the members shall be measured by the movement of the straining head of the machine at suitable load-interval (to permit feasibility of recording the readings) with dial gauge graduated to 0.02 mm until maximum load is reached and/or the deflection continues without increase of load. Any other alternative/suitable device could also be used for measuring slip. A load-slip curve shall be drawn from which the load and slip at proportional limit shall be evaluated. All the data observed and calculated shall be recorded as given in Annex A. A sketch of the connector and a design of the joint shall also be attached to each data sheet indicating the original defects and final failure.

3.7.1 The slip in the joint shall be measured from the beginning of the application of load and at sufficiently frequent load-intervals to permit drawing of an accurate load-slip curve.

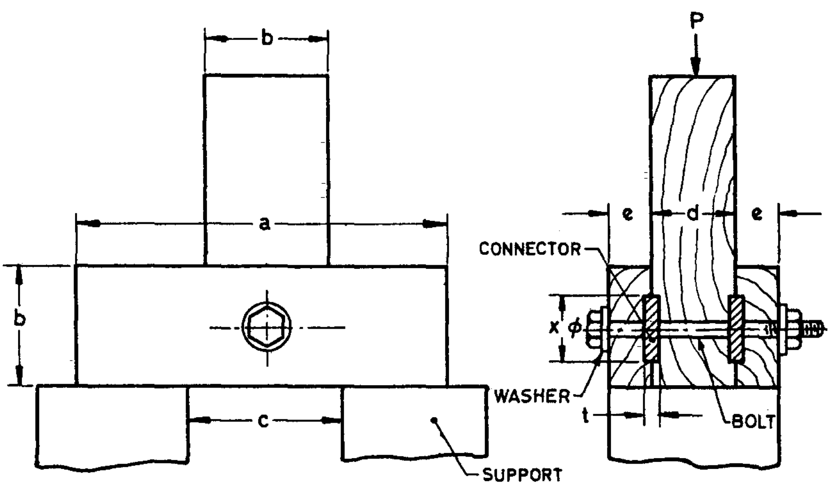
3.8 Additional information about the connectors as described in Annex B shall be obtained whenever necessary and special tests designed for obtaining such information.

3.9 Testing of multiple connectors shall be in accordance with the provisions given in Annex C.



$a = 3\,c$, $b \nless 2\,x$, $c \nless 1.75\,x$, $d = 2\,e$, $e \nless t$ and $f = 2\,c$

4A Strength Test Parallel to Grain



$a = 3\,b$, $b \nless 2\,x$, $c = 1.1\,b$, $d = 2\,e$ and $e \nless t$

4B Strength Test Perpendicular to Grain

Fig. 4 Strength Test of Connectors Parallel and Perpendicular to Grains

ANNEX A

(*Clauses* 2.10 *and* 3.7)

DATA SHEET FOR TESTING CONNECTOR JOINTS

Project No.: Room Temperature :

Consignment No.: Average moisture content of the member :

Laboratory No. :

Mark :

Species : Group : Date :

From : Seasoning :

Machine :

Speed of Machine :

Load, kg	**Telescope Reading**	**Load, kg**	**Telescope Reading**

(Space for graph)

Size and type of connectors :

Distinguishing notations :

No. of connectors (n) in each contact face :

No. of contact faces (m) :

Thickness of central member :

Thickness of side members :

Edge distance : Loaded Unloaded

End distances : Compression/Tension

Inclination of central member to side members : 0°/90°/other angles

Percentage of load developed to the full load which the members may take without the joint (joint factor)[1] } Maximum load : / Load at proportional limit : / Load at specified slip :

Average :

Connector factor (average joint factor / $n \times m$)[2]

Defects

Failure

Sketch

[1] For 0° the percentage should be taken at maximum load and load at proportional limit (for 90° and other angles, only the load at proportional limit may be taken).

[2] Connector factors are evaluated only in the case of two connectors three-member joints and not in others and are to be used only for the given edge and end distances.

ANNEX B

(*Clause* 3.8)

ADDITIONAL DATA REGARDING CONNECTORS

B-1 MINIMUM AND MAXIMUM END AND EDGE DISTANCES

For each type of connector and for any given load which is usually the permissible working load, the maximum and the minimum values of loaded edge distances and the end distances for tension and compression may be evaluated separately by experiments.

B-2 EDGE-DISTANCE CHART

The percentage of full load at various edge distances and for various inclinations of load-to-grain represented graphically is known as edge-distance chart. This chart is a useful additional data for the connector. It may be seen from the chart when prepared that the relationship between percentages of full load and edge distances is linear and separate for different angles.

B-3 END-DISTANCE CHART

The percentage of full load at various end distances and for various inclinations of load-to-grain represented graphically is known as end-distance chart. These charts when prepared differ for compression and tension separately, and form useful additional data for the connectors.

B-4 SPACING CHART

For use in the design of multiple connectors, the data on minimum connector spacing for specific percentages of full loads in the 0° and 90° joints in the case of two connectors shall be a useful information from which spacing charts may be prepared.

ANNEX C

(*Clause* 3.9)

NOTES FOR USING CONNECTORS IN VARIOUS STRUCTURES

C-1 ALLOWABLE LOADS

Allowable loads for any joint using connectors shall be calculated by multiplying connector factor, number of connectors in the contact faces and the working loads for the species or group of species under consideration.

C-2 DEVIATION FROM ALLOWABLE LOADS

Deviation from allowable loads shall be in accordance with the following factors:

a) When allowable load is reduced due to reduced edge distance and end distance or spacing, the reduced allowable load for each shall be determined separately. The lowest allowable load so determined for any one connector shall apply to this connector and all other connectors resisting a common force in a joint.

b) Reductions in load for edge distances, end distances, and spacing are not additive but are co-incident.

c) Loads reduced because of thickness of members do not permit any reduction in edge distances, end distances or spacing without further reduction of load and conversely, loads reduced for edge distances, end distances, or spacing do not permit reduction of the thickness.

C-3 MULTIPLE CONNECTORS

When more than one connector is used in the same contact face, their number, location, and spacing shall be in accordance with the following factors:

a) All connectors are so placed that as far as possible they are symmetrical on the face of contact subject to the condition that all the required minimum edge distances, end distances, and end spacing are satisfied. The arrangement is determined by the minimum spacing permitted and maximum spacing available.

b) The ratio of connectors used to connectors required shall be not more than 2.

c) All connectors and bolts shall be of the same size and shape through out the design and each component used shall be of the same material.

d) The connectors shall be so placed that the angle of resultant load-to-grain shall be more than 45° so as to get the best performance of the connectors and that all loads or components thereof shall act in the same direction on all faces.

e) The maximum allowable load shall be the summation or the allowable loads for each connector used, provided, there are not more than three connectors on each contact face. For each additional connector accepted percentage (which is usually one-third of the allowable load of the same) shall be taken for calculation of the total load.

f) The maximum connector spacing (R) at any angle of loading (θ) is given by:

$$R = \frac{AB}{\sqrt{A^2 \sin^2 \theta + B^2 \cos^2 (\theta)}}$$

where

A = minimum connector spacing for the 0° loading, and

B = minimum connector spacing for the 90° loading.

g) The location of the connectors is determined by the intercept of the diameter of the ellipse whose axis in the direction of grain is equal to A and in the perpendicular direction is equal to B.

NOTE — In the case of two connectors in the same face placed in accordance with the above formula, the direction of load coincides with the direction of connector axis but in the case of more than two, the connector axes make different angles with the direction of grain as shown in Fig. 5.

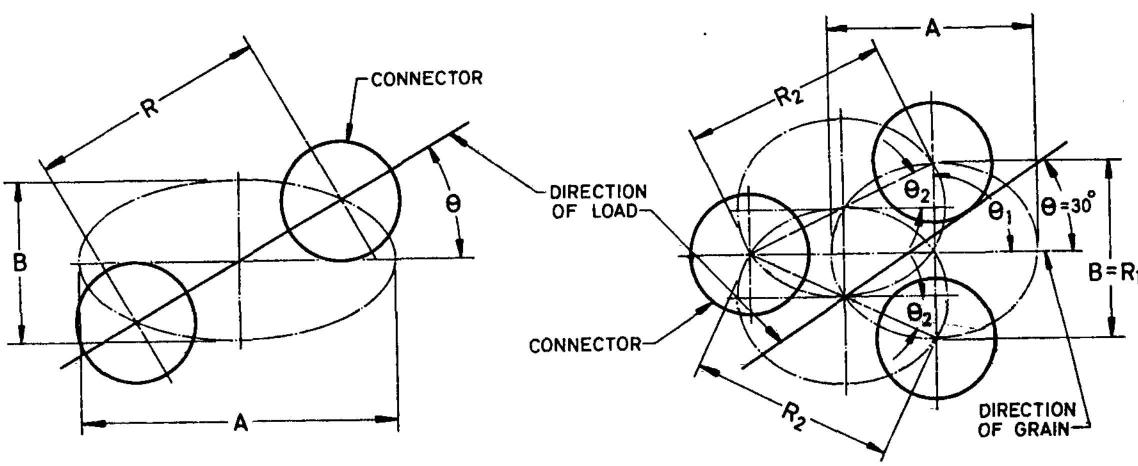


FIG. 5 LOCATION OF CONNECTORS

Bureau of Indian Standards

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

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Amendments Issued Since Publication

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