



TECHNICAL REPORT

**Test methods for light
composite wood-based
beams and columns**

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Foreword

EOTA Technical Reports are developed as supporting reference documents to European Technical Approval Guidelines and can also be applicable to a Common Understanding of Assessment Procedures, an EOTA Comprehension Document or an European Technical Approval, as far as reference is made therein.

EOTA Technical Reports go into detail in some aspects and express the common understanding of existing knowledge and experience of the EOTA bodies at a particular point in time.

Where knowledge and experience is developing, especially through approval work, such reports can be amended and supplemented.

When this happens, the effect of the changes upon the European Technical Approval Guidelines will be laid down in the relevant comprehension documents, unless the European Technical Approval Guideline is revised.

This EOTA Technical Report has been prepared by the EOTA Working Group 03.04/05 – “Light composite wood-based beams and columns” and endorsed by EOTA.

1 Scope

Light composite wood-based beams and columns are used in building construction as structural members.

Beams are primarily subjected to bending, shear and concentrated loads at the supports. Columns are primarily subjected to compressive forces in the axial direction, but also to transversal forces.

2 Principle

To determine strength and stiffness of beams and columns under conditions corresponding to normal use of the products.

For conditions that deviate considerably from that stated in this Technical Report, results should be applied with care.

3 Definitions

Light composite wood-based beams and columns are defined as slender and with low weight. They can be designed as I-beams, box beams or truss beams.

The flanges are made of wood or wood-based materials and, if necessary, reinforced with some other material.

The web consists of wood-based panel or other materials, or, for example, web bars made of different materials.

Flanges and web/web bars are connected with adhesive bonded joints or mechanical joints.

4 Sampling

Shall be carried out as specified in the ETAG 011 – January 2002.

5 Method of test

5.1 Physical properties

5.1.1 Dimensions of beams and columns

The section properties, i.e. flange depth, flange width, depth of section, web thickness, etc, shall be measured with an accuracy of 0.1 mm. Measurements shall be

taken in three sections, one at each end and one at the middle of the beam or column. All measurements shall be made when the specimens are in the moisture condition required for the tests.

5.1.2 Determination of moisture content

The moisture content of the different materials of the beams shall be determined in accordance with EN standard methods applicable to the material in question or other applicable methods.

In ultimate load tests, the test pieces shall be cut as close as possible to the location of fracture.

5.1.3 Determination of density

The density of the different materials of the beams shall be determined in accordance with EN standard methods applicable to the material in question or other applicable methods.

In ultimate load tests, the test pieces shall be cut as close as possible to the location of fracture. If the flanges consist of different members of wood, separated by, for example, fingerjoints, test pieces should be cut out of each member.

5.1.4 Conditioning of test specimens

The test specimens should normally be conditioned to constant mass and moisture content in an atmosphere having a relative humidity of 65% ($\pm 5\%$) and a temperature of 20°C (± 2) according to ISO 554.

When the test specimens are not conditioned a documented adjustment factor should be applied'

NOTE - Constant mass is considered to be attained when the results of two successive weightings, carried out at an interval of 6 h, do not differ by more than 0.1% of the mass of the test specimen.

6.2 Determination of moment capacity, flexural rigidity and shear rigidity of beams

6.2.1 Description of test beams

The beams should have a minimum length of 19 times the nominal depth of the beam.

6.2.2 Test equipment

The test equipment used shall admit testing in accordance with the principles given in Figures 1 and 2.

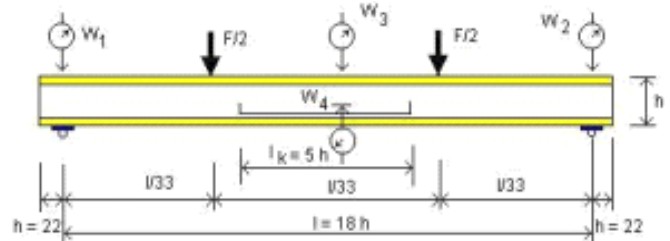


Fig. 1 – Test arrangement and deflection measurements

The principle based on EN 408, is used for testing solid timber and glued laminated timber.

For truss beams it is allowed to adjust the position of the supports and loading points to the nearest node.

The load and the deflections shall be measured with an accuracy according to Table 1.

Interval	F	w_1, w_2, w_3	w_4
0 - F_{ref}	$0.01 F_{ref}$		
$F_{ref} - F_u$	$0.01 F_u$		
0 - 20 mm		0.1 mm	
> 20 mm		1 %	
0 - 5 mm			0.01 mm
> 5 mm			1 %

F_u = ultimate load
 $F_{ref} = 0.4 F_u$
 w_1, w_2 = deformation at support
 w_3 = global deflection
 w_4 = local deflection

Table 1 - Required accuracy when measuring load and deformations

The test specimen shall be supported by devices that allow an acceptable free support condition. At least one of the supports shall permit the beam end to move freely in the longitudinal direction of the beam.

To avoid local failure at supports and load points, the load transmission devices shall be designed such that stress concentrations are minimised, such as by inserting steel plates between the specimen and the loading heads and supports.

Where specified by the manufacturer, lateral restraints shall be applied on the compression flange to prevent buckling.

Where no specific details are provided by the manufacturer, these restraints should be attached at centre of the span and at every $c = 8b$ (mm) along the entire beam, where b is the width of the compression flange in the main buckling direction. Furthermore, the restraints shall permit the beam to deflect freely without constraint moments or axial forces being introduced in the flange.

An example of arrangement is shown in Figure 2.

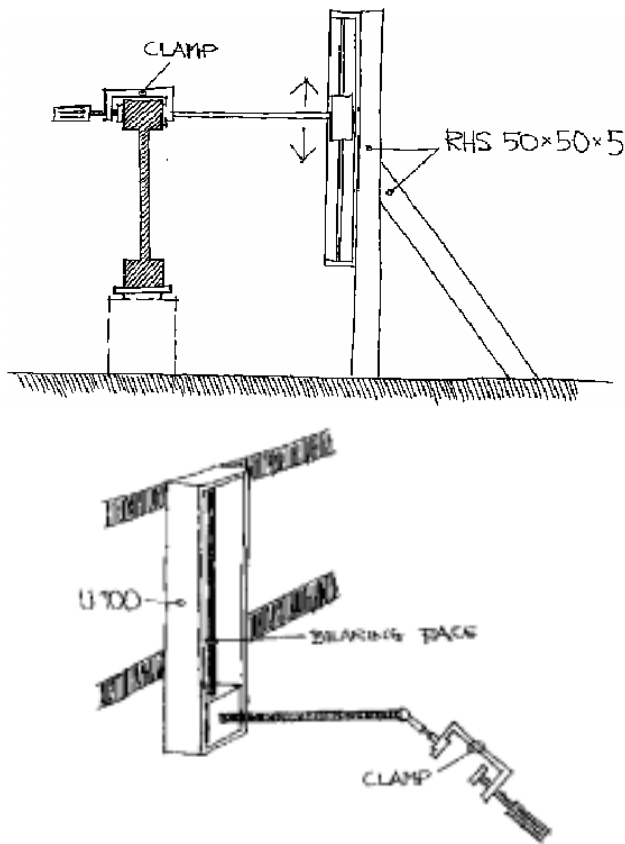


Fig. 2 – Example of arrangement for lateral restraint

6.2.3 Test procedure

The span and the positions of the load points are measured in millimetres.

Load shall be applied either at a continuous rate or in increments. The rate of loading shall be adjusted such that ultimate load occurs within a period of from 5 to 15 minutes. If this is not possible, the time for reaching the ultimate load shall be registered.

The load levels are set in proportion to a load F_{ref} which is defined in Table 1.

The load shall be applied in the following order:

- 1) Loading to $F = F_{ref}$: ca 1 min
- 2) Unloading to $F = 0.1F_u$: ca 1 min
- 3) Loading to $F = F_{ref}$: ca 1 min
- 4) The load $F = F_{ref}$ is kept constant during one hour and, for at least one beam, during 24 hours. Deformations and load shall be registered at equal time intervals.

5) Loading to failure: ca 10 min.

Step 4 will be carried out for at least 5 beams in approval testing only.

Corresponding values of load F and deformation w shall be recorded. When manually reading values, if it is not possible to read simultaneously, the load value should be read before the deformation value.

With regard to the measurement of flexural rigidity, the load/deformation reading should be used over the range of $0,1 F_u$ to $0,4 F_u$ on the second load cycle only.

For each beam the fracture mode shall be noted.

6.2.4 Expression of results

The following expressions are only applicable for loading conditions according to Figure 1. i.e. with loads applied in the third points. For other loading conditions, which may have to be used in truss beams, other expressions have to be developed.

The moment capacity M_u is given by the formula:

$$M_u = \frac{F_u l}{6}$$

where:

F_u = total ultimate (the ultimate load is the highest load reached);

l = width of span.

The flexural rigidity $(EI)_{beam}$ is given by the formula:

$$(EI)_{beam} = \frac{\Delta F l_k^2}{48 \Delta w_4}$$

where:

l_k = defined in Figure 1;

$\Delta w_5 = \Delta w_3 - (\Delta w_2 + \Delta w_1)/2$.

6.3 Determination of bearing capacity

6.3.1 General

Tests should be conducted to determine bearing capacity for different bearing lengths.

The bearing length is the length over which the load is distributed at supports and loading points.

The tests should establish:

- the maximum bearing capacity without web reinforcement for a certain bearing length;
- the maximum bearing capacity with specified web reinforcement that will develop ultimate shear capacity;
- any special requirements at intermediate supports of multi-span beams.

6.3.2 Description of test beams

The beams shall have a minimum length of about 4 times the depth of the beam, depending on the type of test (A, B, C or D) as appropriate (see Figure 3).

Beams may be with or without reinforcement.

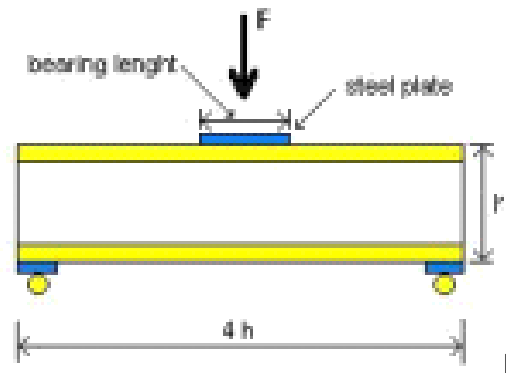
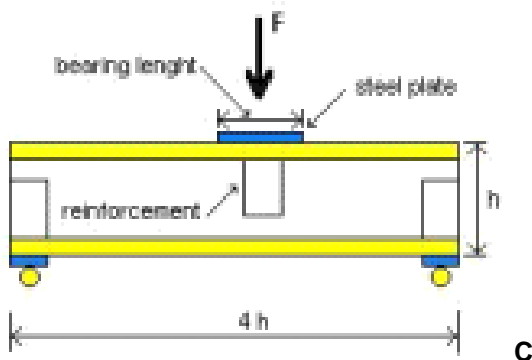
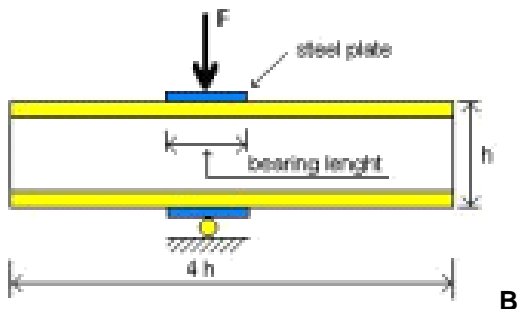
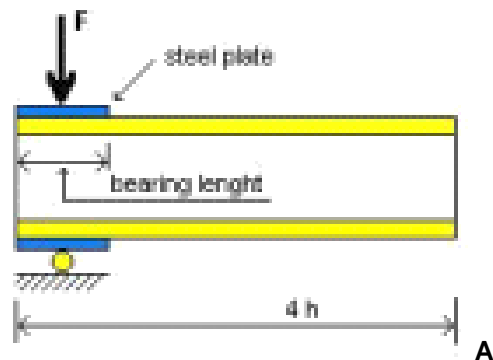


Fig. 3 – Principle for the determination of bearing capacity

6.3.3 Test equipment

The test equipment shall admit a test procedure in accordance with the principles given in Figure 3.

Lateral restraint may be required.

For truss beams, the position of the support and loading points may be adjusted to the nearest node.

The load is applied in the plane of the beam via stiff steel plates with the length for which the bearing capacity is to be determined.

Required accuracy when measuring load is $0.01F_u$.

6.3.4 Test procedure

Load shall be applied either at a continuous rate or in increments.

The rate of loading shall be adjusted such that ultimate load occurs within a period of from 5 to 15 minutes.

If this is not possible, the time for reaching the ultimate load shall be registered.

6.3.5 Expression of results

The bearing capacity is defined as:

$$F_b = F_u$$

where:

F_u = the ultimate load.

Failure modes shall be given. For I-beams the failure modes may be divided into:

FB - flange compression failure at the interface between the flange and support material;

WC - web crushing, usually at end reaction with unstiffened ends;

- FS - flange split at end reaction;
- WB - web buckle at end reaction;
- ER - end rotation in a plane perpendicular to the length axis of the beam. Additional lateral restraint probably required.

6.4 Determination of shear capacity

6.4.1 General

The procedure is aimed at determining the shear capacity of beams with or without strength reducing characteristics. For instance the maximum shear capacity of beams containing a hole or a row of holes in the web or having web joints can be determined when these characteristics are located close to the supports.

For adhesive bonded I- or box beams without strength reducing characteristics, such as holes in the web or joints, it may be difficult to obtain shear failure with the procedure described here.

Reinforcement to avoid local failure at loading points may be necessary.

6.4.2 Description of test beams

The beams should have a length of 11 times the depth of the section.

6.4.3 Test equipment

The test equipment shall admit a test procedure in accordance with the principles given in Figure 4. For truss beams it is allowed to adjust the position of the support and loading points to the nearest node.

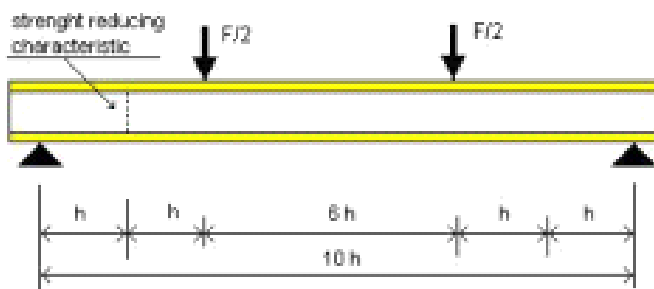


Fig. 4 – Principle for the determination of shear capacity

The loading equipment used shall be capable of measuring the load to an accuracy of $0.01F_u$.

The test specimen shall be supported by devices that allow an acceptable free support condition. At least one of the supports shall permit the beam end to move freely in the longitudinal direction of the beam.

To avoid local failure at supports and load points, the load transmission devices shall be designed such that stress concentrations are minimised, e.g., by inserting steel plates between the specimen and the loading heads and supports.

Where specified by the manufacturer lateral restraints shall be applied on the compression flange to prevent buckling. Where no specific details are provided by the manufacturer these restraints shall be attached at centre of the span and at centres c along the entire beam, where $c = 8b$ and $b =$ the width of the compression flange in the main buckling direction. Furthermore, the restraints shall permit the beam to deflect freely without any constraint moments or axial forces being introduced in the flange. An example of the arrangement is shown in Figure 2.

If necessary the web or web bars under the loading points and at the supports shall be braced to prevent local buckling.

NOTE - To investigate some design parameters (e.g. tension strength of metal web beams) it may be necessary to introduce additional members to the product. It must be demonstrated that such temporary members do not increase the test strength and stiffness of the product. Similarly where alternative means of support are proposed, tests must be carried out for each support condition, e.g. removing a section of the bottom chord to allow the beam to be supported by the top chord can significantly reduce the strength of the beam. Where double webs are to be used to increase the strength of beams the increase must be justified by tests (since the combined strength can be significantly less than double the strength of one web).

6.4.4 Test procedure

Load shall be applied either at a continuous rate or in increments. The rate of loading shall be adjusted such that ultimate load occurs within a period of from 5 to 15 minutes. If this is not possible, the time for reaching the ultimate load shall be registered.

6.4.5 Expression of results

The shear capacity is defined by:

$$F_v = \frac{F_v}{2}$$

6.5 Determination of resistance to compressive axial forces in combination with transverse forces for columns

6.5.1 Description of test columns

The columns should normally have a length of from 2 to 3 metres. The length of the columns to be tested shall be in accordance with the intended use stated by the manufacturer.

The procedure is aimed at determining the axial load capacity of studs with a structural sheeting on both sides e.g. to be used in a timber frame house.

Where specified by the manufacturer other applications may be relevant e.g. only one-sided structural sheeting.

In this case the test arrangement shall be modified correspondingly.

6.5.2 Test equipment

The test equipment shall allow a test procedure with axial loading and transverse loading in the third points in accordance with the principles given in Figure 5.

For truss columns, the position of the transverse loading points may be adjusted to the nearest node.

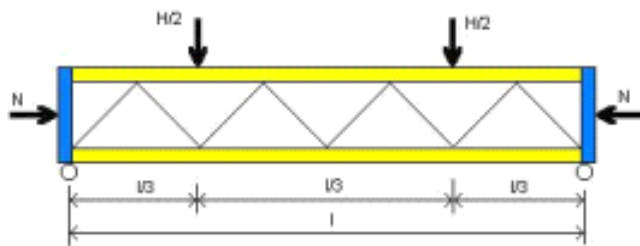


Fig. 5 - Principles for testing columns.

The loading equipment used shall be capable of measuring the load to an accuracy of $0,01F_u$.

Lateral restraints shall be applied to prevent buckling out of the plane of the column. The restraints shall permit the columns to deflect freely without any constraint moments or axial forces being introduced in the flange.

NOTE - "The application of a load perpendicular to the longitudinal direction of the column may be omitted ($H = 0$) if a simultaneous loading in longitudinal direction of the column and perpendicular to it is taken into account by calculation." Furthermore, the tests should also take account of buckling failure.

6.5.3 Test procedure

A serviceability limit state N_1 and H_1 for axial and transverse loads respectively is chosen, either from a particular performance requirement the column shall meet, or from an assumed maximum capacity.

For pre-loading a column, an axial load of approximately $0.5N_1$ combined with a transverse load of approximately $0.5H_1$ is first applied.

The pre-load is maintained for a short time, e.g. 2 - 3 minutes, and then removed.

The column is then loaded with an axial load of N_1 .

The axial load is maintained at N_1 as a horizontal load H_1 is applied.

The loading speed shall be such that the combined loadings N_1 and H_1 are reached in a period of between 5 min and 10 min.

The horizontal load is then increased to H_2 , the unfactored load specified by the manufacturer.

Where no specific details are provided by the manufacturer H_2 may, for example, be taken as sH_1 , i.e. the load at the serviceability limit state is multiplied by a factor "s", given by the appropriate loading and construction rules in codes or standards.

Remark

When the partial coefficient method is used, the factor is:

$$s = \frac{\gamma_M \cdot \gamma_F}{k_{mod}}$$

where:

γ_F = partial safety factor for the actions;

γ_M = is the partial safety factor for materials;

k_{mod} = is the duration of load factor.

Finally, the vertical load is increased until failure occurs, while at the same time the horizontal load is kept constant at H_2 .

The loading speed shall be the same as that for loading to the serviceability limit state.

The failure load is defined as the maximum vertical load recorded before the column collapses.

7 Test report

The Test Report shall include the following information, if relevant:

- a. name and address of the testing laboratory;
- b. identification number of the Test Report;
- c. name and address of the organisation or the person who ordered the test;
- d. purpose of the test;
- e. method of sampling and other circumstances (date and person responsible for the sampling);
- f. name and address of manufacturer or supplier of the tested object;
- g. name or other identification marks of the tested object;
- h. description of the tested object, e.g.:
 - nominal size;
 - description of the quality and origin of the materials included;
 - any other information which may have influenced the test results, for example manufacturing conditions;
- i. date of supply of the tested object;
- j. date of the test;
- k. test method;
- l. conditioning of the test specimens, environmental data during the test (temperature, pressure, etc);
- m. identification of the test equipment and instruments used;
- n. any deviations from the test method;
- o. test results (in SI units). The following information for each test beam shall normally be given:
 - moisture content at the time of test;
 - density of the materials included;
 - actual dimensions;
 - rigidity and strength values;
 - mode of fracture;
 - load/deformation records;
 - any other information which may influence the use of the test results, for example the conditions of sampling wood for test beams or lateral restraint while testing;

- p. inaccuracy or uncertainty of the test results. If a statistical treatment of the test results is carried out, the method used and the results obtained shall be given.
- q. date and signature.

Annex A
Bibliography

- EN 408 – Timber structures. – Structural timber and glued laminated timber. – Determination of some physical and mechanical properties.
- ISO 554 – Standard atmospheres for conditioning and/or testing. – Specifications.